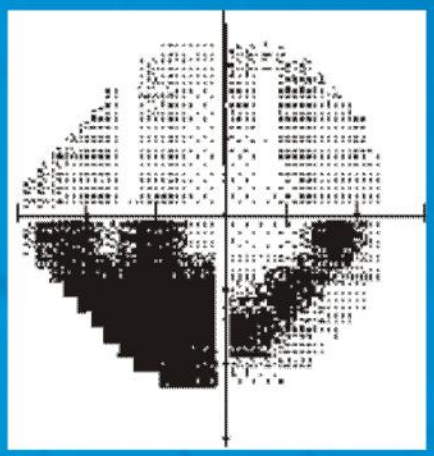
Detection of Glaucoma Field Defects with Humphrey Field Analyzer/SWAP/FDT-Matrix

A Visual Field Evaluation with Automated Devices

GR REDDY



Foreword
Dr R Ramakrishnan

JAYPEE

Second Edition

A Visual Field Evaluation with Automated Devices

BOOK REVIEW— ILLUSTRATED AUTOMATED STATIC PERIMETRY (FIRST EDITION)

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Detection of glaucoma field defects with Humphrey Field Analyzer: Illustrated Automated Static Perimetry. G R Reddy, New Delhi, Jaypee Brothers, Medical Publishers (P) Ltd., New Delhi- 2003. 1st ed. 163 pages, illustrated.

Reviewed by Dr Baskaran M, Sankara Nethralaya, Chennai.

The heavily-illustrated, well-written guide to the interpretation of Humphrey Automated Perimetry comes at an apt time when the usage of this instrument among the ophthalmologists in India is increasing. The author's laborious collection of field charts from his practice almost covers all the basic and practical aspects of his puzzling statistical tool. The olderly manner of dealing with visual fields interpretation is handled in this textbook also but in a simplified manner from single field analysis, artefacts to change analysis with box plot interpretation. The author has correctly not dwell into too much statistics and has left the strategies to the last chapter so that the reader is kept at ease till the end of the book. The book should serve as a ready reckoner in the clinic, though it may be limited by not having Octopus fields interpretation. But, since Humphrey's is the common perimeter used, the book serves its purpose very well. The easily priced edition is a welcome addition to the desks of postgraduates and general ophthalmologists.

A Visual Field Evaluation with Automated Devices

Detection of glaucoma field defects with Humphrey Field Analyzer / SWAP/ FDT-Matrix

2nd Edition

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Foreword
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A Visual Field Evaluation with Automated Devices

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to

Dr T Satyanarayana Reddy *MS*
Narayana Reddy Eye Hospital
Anaparthi, EG Distt (AP), India

the inspiring force behind my entry into the field of Ophthalmology

Foreword to the Second Edition

Glaucoma is one of the important causes for irreversible blindness all over the world. Various studies conducted in India have clearly indicated that there are about 2.6 to 4 percent of our Indian population are suffering from glaucoma. Most of our glaucoma patients sought medical aid only at the terminal stages of the disease because of its asymptomatic nature. Emerging modern biotechnological discoveries and technological innovations are most helpful in screening, early diagnosis and treatment of this problem. However, we still rely upon careful clinical examination, with additional investigations like tonometry, gonioscopy, ophthalmoscopy and visual field examination. Visual field evaluation has undergone tremendous development for the past two decades. Even though there are so many types of automated visual field analyzers, Humphrey visual field is thought to be the gold standard in glaucoma practice and management. Many textbooks are available on this subject. Most of them are very complicated and little more difficult for the general ophthalmologist to understand. There is no Indian textbook on visual fields in glaucoma.

Dr GR Reddy by knowing this problem has taken enormous effort to write this book on *A Visual Field Evaluation with Automated Devices and Detection of Glaucoma Field Defects with Humphrey Field Analyzer/ SWAP/ FDT-Matrix*. It is very difficult for an ophthalmologist, practicing alone in a semirural area to bring such a textbook, unless he has some commitment. In that way Dr GR Reddy has dedicated himself to understand the art of perimetry thoroughly and fulfill the long felt need of a simple textbook on automated perimetry for general ophthalmologists. He has done a wonderful job. All the chapters from fundamentals of perimetry to interpretation, visual field loss in glaucoma, follow-up, etc. are well-covered with necessary visual field printouts, all from his own clinical experience. Moreover it is written in a very simple way which can be understood by all. I am sure that this textbook will be an useful guide for those who want to understand the automated visual field and practice glaucoma. I definitely feel this book will be a boon for general ophthalmologists and postgraduate students.

Dr R Ramakrishnan
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Chief Medical Officer
Aravind Eye Hospital
Tirunelveli, (TN) India

Preface to the Second Edition

Two years have elapsed since the publication of 1st edition of *Illustrated Automated Static Perimetry*. The contents of this book have been updated, expanded and rearranged for better understanding of the visual field printouts. All the illustrations have been carefully scrutinized and revised as necessary. Four chapters—The custom tests, The follow-up tests (Glaucoma progressive analysis), Short wavelength automated perimetry (SWAP) and Frequency doubling technology (Humphrey FDT - Matrix) have been included. However, the main aim to facilitate easy use by all practitioners and PG students in the interpretation of visual fields, remains the same.

Understanding of single field analysis printout is the primary intent of this edition. Each zone of single field analysis printout is discussed in depth. The follow-up field tests are also presented in a better fashion than that of the 1st edition. The sequence of the chapters have been rearranged in a more appropriate manner.

For the last two years, I have been addressing many appreciative gatherings of friends and colleagues of Ophthalmology Department at various centers; which also includes " The instructive course " at 63rd AIOS conference at Bhubaneshwar. I convey my sincere regards to Dr S Natarajan, Director, Adityajyot Eye Hospital, Mumbai and Scientific Committee Chairman, AIOS for giving me an opportunity to conduct this session. The more we read, the more we try to assimilate information, the more we realize how far we are from the understanding of the topic. The interactions during these scientific sessions, made my concepts more clear and the need for revised first edition was thought necessary and mandatory, as the usage of Humphrey visual fields in our day-to-day practice has been in a perpetually accelerating flux.

I am grateful to Dr R Ramakrishnan, Chief of Glaucoma Service and Chief Medical Officer, Aravind Eye Hospital, Tirunelveli for his foreword to the 2nd edition. My sincere thanks to Robert L Stamper, Professor of Clinical Ophthalmology, Director, Glaucoma Service, University of California, San Francisco for giving his valuable suggestions and comments about this book. According to his suggestion the title of the book *Illustrated Automated Static Perimetry* is changed to *A Visual Field Evaluation with Automated Devices*, since in this edition I included frequency doubled technology which is not really static perimetry.

I am thankful to Prof. Dr Andre Mermound, Head of Glaucoma Unit, Hospital Ophthalmique Jules Gonin, University of Lausanne, Switzerland and Dr Devindra Sood, Senior Consultant Glaucoma Imaging Center, New Delhi for their comments on this book. I am thankful to Carl Zeiss India Private Limited for providing me the information regarding glaucoma progression analysis and FDT-Matrix.

GR Reddy

Preface to the First Edition

The primary intention of this book is to present automated perimetry in a simple and illustrated manner devoid of all technical details and theoretical abstractions which abound in standard perimetry textbooks. It is designed to serve as a handbook for practicing ophthalmologist by providing information to supplement what is available in currently prescribed textbooks. Its contents have been so organized to facilitate easy use by all practicing ophthalmologists and postgraduate students and to serve as a guide in the interpretation of visual field printouts of automated perimetry.

Emphasis is laid on the fundamentals of automated perimetry; especially the units used to express light intensity and retinal threshold value, selection of the test and interpretation of single field analysis printouts. Change analysis printouts of selected cases gleaned from my personal experience, have been included for a broader perspective.

This book owes its existence to an update lecture I delivered at Kakinada to a appreciative gathering of colleagues and friends. I convey my special thanks to Dr R Sriram, Nayana Eye Care Center, Kakinada, for inviting me to the above conference on behalf of Kakinada Ophthalmic Association. I am deeply indebted to a large number of talented and thoughtful colleague ophthalmologists who helped me in many ways during the preparation of this book. To each of these my dearest friends, I wish to express my most sincere gratitude.

I am grateful to Dr Amod Gupta, Professor and Head of the Department of Ophthalmology, PGI, Chandigarh, for giving his foreword. My sincere thanks to my father Sri G Subbi Reddy, Retd. Principal, Bobbili College, mother Smt. Jayalakshmi, wife Lakshmi and children Dr Jaya Madhury and Dr Sandeep Reddy for their support in completing this book.

I hope the readers of this book will find it useful in their day-to-day practice. I am conscious that my first endeavor may have shortcomings and hope discerning readers will help me to improve it in the future.

I am thankful to Dr K Vengala Rao, Former Professor and Head of the Department of Ophthalmology, Guntur Medical College (AP), Dr G Chandra Sekhar, Director, VST Center for Glaucoma Care, LV Prasad Eye Institute, Hyderabad and Dr K Viswanath, Professor and Head of the Department of Ophthalmology, Osmania Medical College, Hyderabad for their comments in this book.

GR Reddy

Contents

1 Introduction to Automated Static Perimetry

Automated perimetry is the current gold standard to diagnose glaucoma and its management. The main aim of this book is to make the ophthalmologist to understand the basic fundamentals of automated static perimetry, to select the most appropriate test to the clinical condition he is dealing with, to understand the visual field printouts and to interpret the printouts without much difficulty so that he should be able

1. To identify a field defect.
2. To decide whether the field defect is due to glaucoma.
3. To make a reasonable decision whether the defect is progressive one or not.

Reasons for Computerized Perimetry

1. Reproducible testing conditions.
2. Data-storage capability: Results can be compared overtime and analyzed using expert system software.
3. More sensitive testing: Many researchers claim static perimetry to be superior to kinetic perimetry to identify defects.
4. Easy operation and menu driven software make automated perimetry easy to learn and to use.

History

1970 - The original octopus perimeter was first introduced. Because of its room size and high expensive nature it became unpopular.
1982 - Humphrey field analyzer was first displayed at American Academy of Ophthalmology.
1983 - August- Michael Patella showed its first clinical trail.
1984 - February- started production and became very popular because of its small size and affordable price.

The Automated Static Perimetry will be Discussed Under the Following Headings

1. Fundamentals of automated perimetry.
2. Selection of the test.

3. Understanding of single field analysis printout.
4. Interpretation of the single field analysis printout.
5. Visual field loss in glaucoma.
6. Follow up fields.
7. Custom tests.
8. Screening tests.
9. Short wavelength automated perimetry (SWAP).
10. Frequency doubling technology perimetry (FDT).
11. Important clues in operating Humphrey field analyser.

Website : www.humphrey.com

2 Fundamentals of Automated Perimetry

Definition of Visual Field

The visual field is defined as that part of the environment that is visible to the steadily fixing eye. The extension of visual field is as follows.

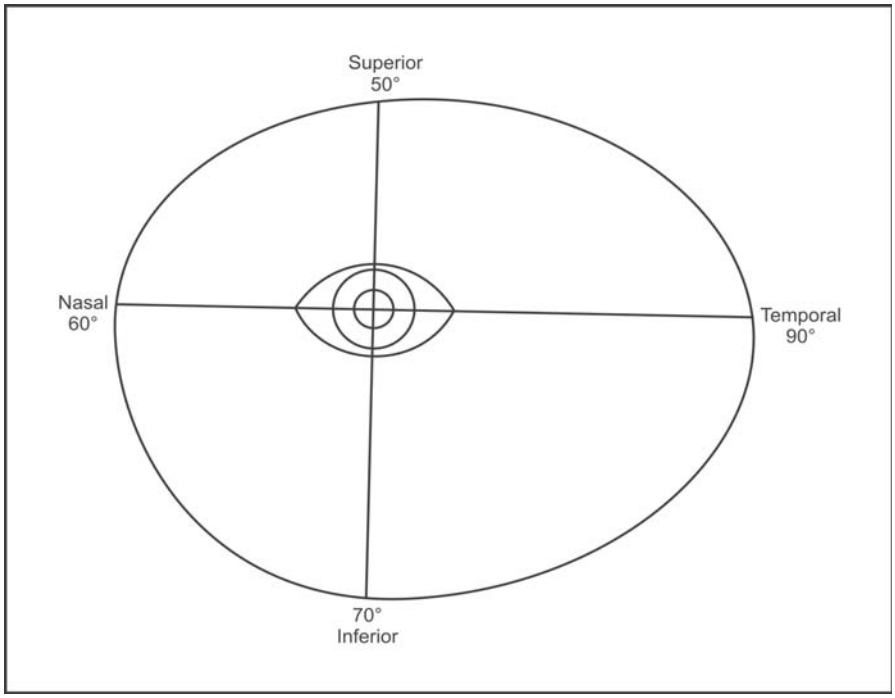


FIGURE 2.1 : The functional boundaries of the normal visual field approximate a spiral: 50° above, 60° nasally, 70° below and 90° temporally

MEASUREMENT OF VISUAL FIELDS

The visual field is three dimensional and is measured in two ways—kinetic perimetry and static perimetry.

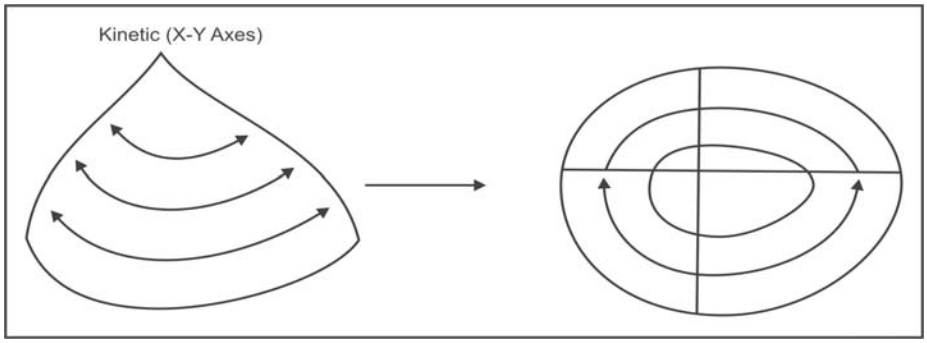


FIGURE 2.2 : When the island hill-of-vision is kinetically explored along the X-Y axes (i.e. a plane parallel to the surface of the sea), the locations of points with the same threshold are identified; these are isopters

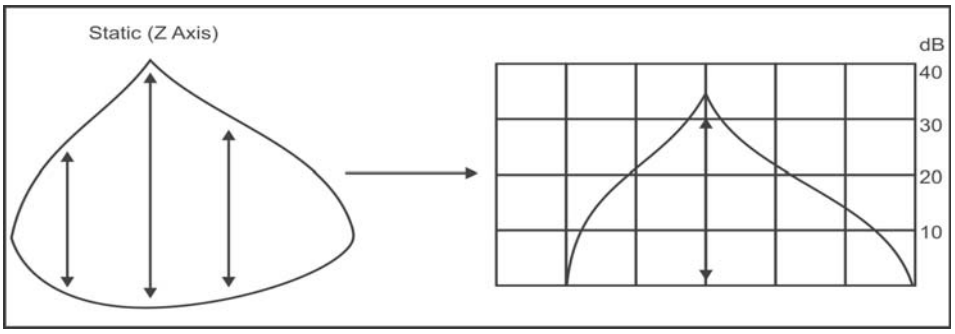


FIGURE 2.3: When the island hill-of-vision is statically explored along the Z axis(i.e. in a plane perpendicular to the surface of the sea), the varying points of sensitivity are identified; these are the thresholds displayed as a meridional cut

KINETIC PERIMETRY

Measuring along X-Y axes, out lining the border of the visual field in which the object is moved from non-seeing area to seeing area.

Disadvantages

Kinetic tests are suprathreshold and are not always reproduced. Early or subtle changes can be overlooked.

STATIC PERIMETRY

The main aim of static perimetry is to find out the threshold of retina at various fixed points. Static perimetry is a technique while the patient looks into a white hemispherical bowl at a small fixation point at the center, at fixed stationary locations the visual field stimuli are briefly presented usually for about 200 milliseconds duration and the patient presses a response button when the stimulus is detected. Usually the factors affecting the stimulus visibility are stimulus size, background illumination and brightness of the stimulus. **Typically in static perimetry the size of the stimulus and the background illumination remain constant, the light intensity is varied according to a staircase (bracketing) procedure to define the minimum intensity necessary for the detection of stimulus.**

Size of the stimulus: Goldmann size III is the standard stimulus size for all perimeters. But the size of the stimulus can be changed depending on the clinical conditions. The size III can be changed to size V when we do fields for macular disorders. But please note during the entire test period, the size of the stimulus whether it is size III or size V will remain constant along with the background illumination while the light intensity of sitmulus varies.

Background illumination: The background illumination is not the same for all perimeters. The background illumination for different field analyzers are shown below.

Octopus 101	Octopus 1-2-3	Humphrey 700	Dicon
4 asb (1.27 cd/m^2)	31.4 asb (10 cd/m^2)	31.5 asb (~10 cd/m^2)	31.5 asb (~ 10 cd/m^2)

The stimulus intensity is varied by the use of attenuation filters. The attenuation of light is expressed in logarithmic units and is more commonly in tenths of log units what is called decibel (dB). 1 decibel =1/10 log unit of attenuation of maximum available stimulus. (10,000 asb units for the current Humphery perimeters). The maximum and minimum intensities of light projected by each perimeter varies. The maximum intensity of light projected by Humphrey field analyzer is 10,000 asb units and 4,000 asb units for Octopus 1-2-3. The minimum intensity of light projected by Humphrey field analyzer is 1 asb unit and 0.4 asb unit is for Octopus 1-2-3 model. The change in the stimulus intensity will be discussed in detail when the units used to express light intensity and retinal sensitivity will be dealt later in this chapter.

Automated static perimetry uses a standardized test procedure which ensures that testing is performed in a unified manner from one time to another and one location to another. Because a standard test procedure is used, databases of normal values for individuals of all ages have been established for automated static perimetry. This allows the examiner to compare an individual test results to age adjusted normal population characteristics to identify whether various locations are within normal sensitivity limits or whether they are outside normal limits by a specific amount.

DEFINITION OF THRESHOLD

The visual threshold is often thought of as minimum brightness which the patient can see at a given location in the same field. But it is not so.

So it is very important to have a clear concept on threshold sensitivity, suprathreshold sensitivity and infrathreshold sensitivity. The threshold is the physiological capacity to detect a stimulus at a given location under specific conditions.

If a particular intensity of light is shown 100 times and if it is appreciated 50 times and that particular intensity of light is termed as threshold (threshold for a given point is defined that stimulus intensity which has a 50 % probability of being seen). If the stimulus intensity is seen 90% of times it is termed as suprathreshold and if it is seen 15% of times, it is termed as infrathreshold. This is clearly shown in the frequency of seeing curve (Fig. 2.4).

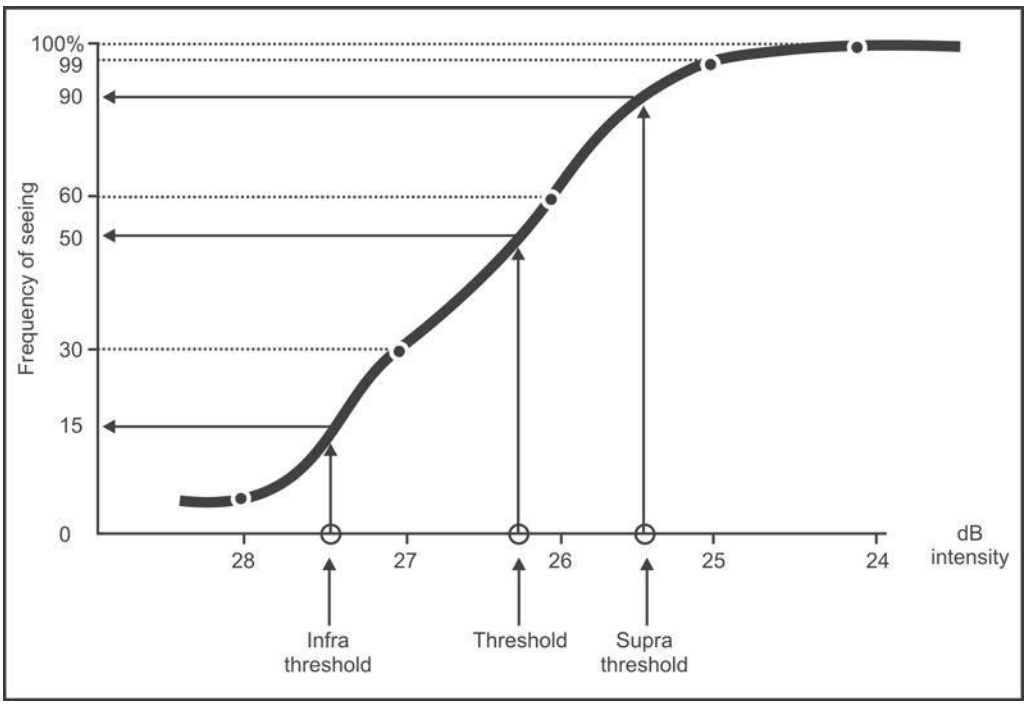


FIGURE 2.4 : Frequency of seeing curve

In this Figure 2.4, frequency of seeing curve the X axes represents the intensity of light in dB values and the Y axes represents the percentage of frequency of seeing. If the light intensity of around 27 dB is projected 100 times it is appreciated by 15% times (so infrathreshold value is around 27 dB). If the light intensity of around 26 dB is projected 100 times it is appreciated by 50% times (so threshold value is around 26 dB). If the light intensity of around 25 dB is projected 100 times it is appreciated by 95% times (suprathreshold value is around 25 dB).

So the most important point to be noted in this Figure 2.4 is as the dB value is decreasing, the light intensity is increasing. This point will be discussed in detail later in this chapter.

Units used to express light intensity and retinal sensitivity

It is very important to have a clear concept on units of light intensity and retinal sensitivity expressed in asb units or in decibel values.

The light intensity is usually expressed either in apostilbs (asb units) or in decibel units and retinal sensitivity in dB units.

The Humphrey perimeter projects the maximum intensity of light of 10,000 asb units. The brightness of the stimulus is attenuated by the use of filters. If there is no attenuation of light intensity it is labeled as 0 decibel. So by convention the perimeter's the maximum intensity of stimulus is assigned a value of 0 decibel (which means there is no attenuation of light). So in Humphrey field analyzer '0' dB value = 10,000 asb units. So it is very important to note that 0 decibel light intensity means the brightest light that is projected by the perimeter.

Conversion of asb units to decibel units

The attenuation of light is expressed in logarithmic units and is more commonly in tenths of log units what is called decibel (db). 1 decibel =1/10 log unit of attenuation of maximum available stimulus. (10,000 asb units for the current Humphery perimeters.)

The 10 decibel stimulus is one log unit less intense than the maximum stimulus of 10,000 asb units that is 1/10 of 10,000 asb units which is equal to 1,000 asb units.

The 20 decibel stimulus is 2 log units less intense than the maximum stimulus of 10,000 asb units that is 1/100 of 10,000 asb units which is equal to 100 asb units.

The 30 decibel stimulus is 3 log unit less intense than the maximum stimulus of 10,000 asb units that is 1/1000 of 10,000 asb units which is equal to 10 asb units.

The 40 decibel stimulus is 4 log units less intense than the maximum stimulus of 10,000 asb units that is 1/10,000 of 10,000 asb units which is equal to 1 asb unit.

In Humphrey system the 40 decibel stimulus is equal to 1 asb unit (the least projected stimulus intensity) and '0' decibel stimulus is equal to 10,000 asb units (the maximum intensity of light projected by Humphrey field analyzer).

Apostilbs are absolute units of light intensity. (100 asb intensity on one instrument is same as 100 asb intensity on another instrument.) **In contrast, the decibels are relative units.** That means the decibel value depends on the maximum intensity projected by each perimeter. As the brightest light projected by each perimeter varies the dB value also varies. So decibel units are not absolute units but they are relative units to express light intensity . For example on Goldmann perimeter, the maximum light intensity is 1000 asb and 10 dB attenuation results in 100 asb light intensity. On Humphrey perimeter, the maximum intensity of light is 10,000 asb and 10 dB attenuation results in 1,000 asb light intensity. Thus the 10 dB stimulus on Goldmann perimeter which is equal to 100 asb units is not the same intensity as a 10 dB stimulus on Humphrey field analyzer, which is equal to 1,000 asb units. But 10 dB does

represent the same percentage reduction from maximum intensity in both the instruments. The conversion from asb units to decibels is logarithmic, not a simple multiplication factor.

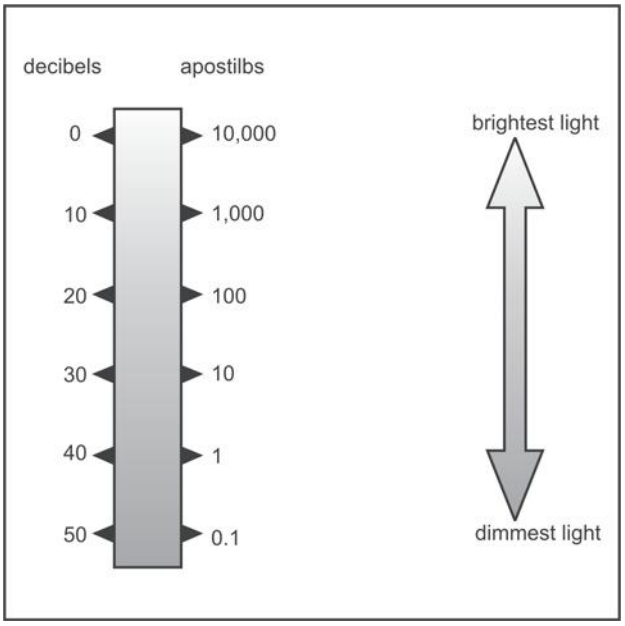


FIGURE 2.5 : The decibel-apostilbs (asb) scale of Humphrey field analyzer

Please note that as the decibel value increases (that means the attenuation of light increases) the brightness of the light decreases. So higher the decibel value, lower the light intensity in asb units and higher the retinal sensitivity.

As shown in the Figure 2.5, 0.1 to 1,0000 asb unit scale is represented by 0 to 50 dB scale Humphrey field analyzer.

As discussed above and as shown in the Figure 2.5 the decibel units and its corresponding asb units are related to each other in Humphrey field analyzer as follows.

0 decibel stimulus = 10,000 asb units of light intensity (The maximum intensity of light projected by Humphrey field analyzer.)

10 decibel stimulus = 1,000 asb units of light intensity

20 decibel stimulus = 100 asb units of light intensity

30 decibel stimulus = 10 asb units of light intensity

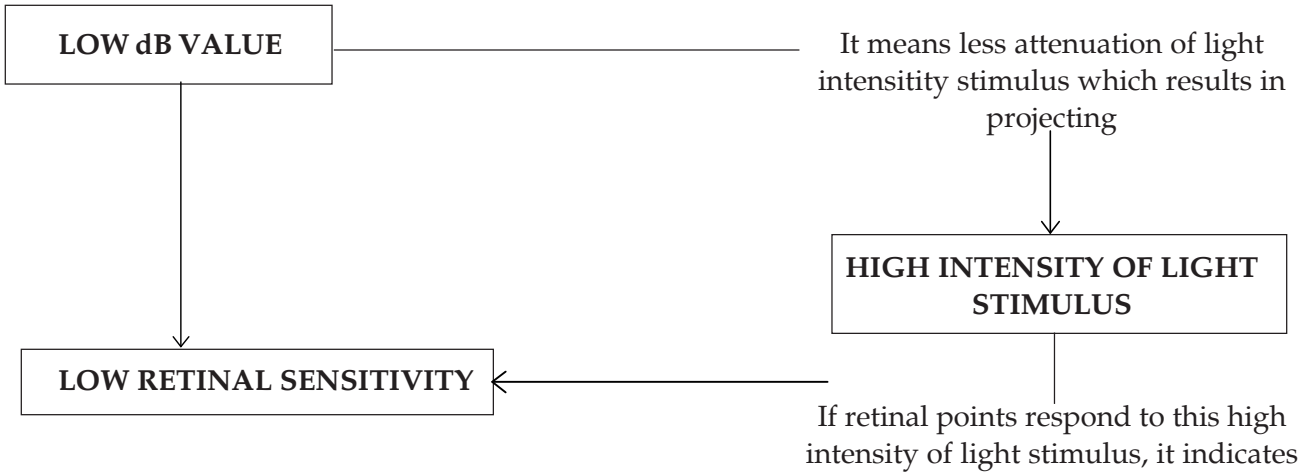
40 decibel stimulus = 1 asb unit of light intensity

50 decibel stimulus = 0.1 asb units of light intensity

So it is very important to note that a small shift in the decibel scale represents a major change in the intensity of light in terms of asb units.

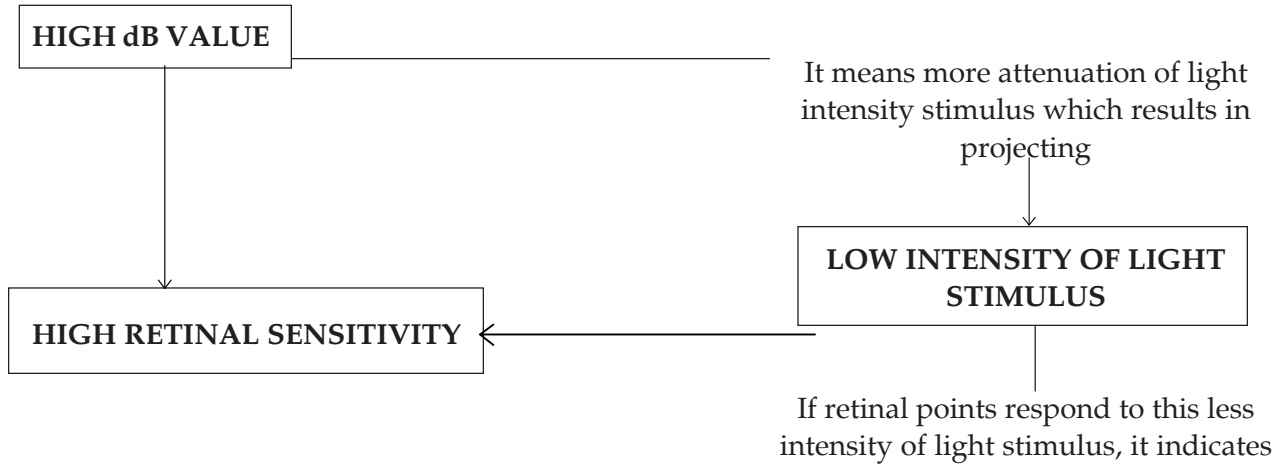
The most important point to be noted is that the dB units represent to express the light intensity and retinal threshold value.

For example:



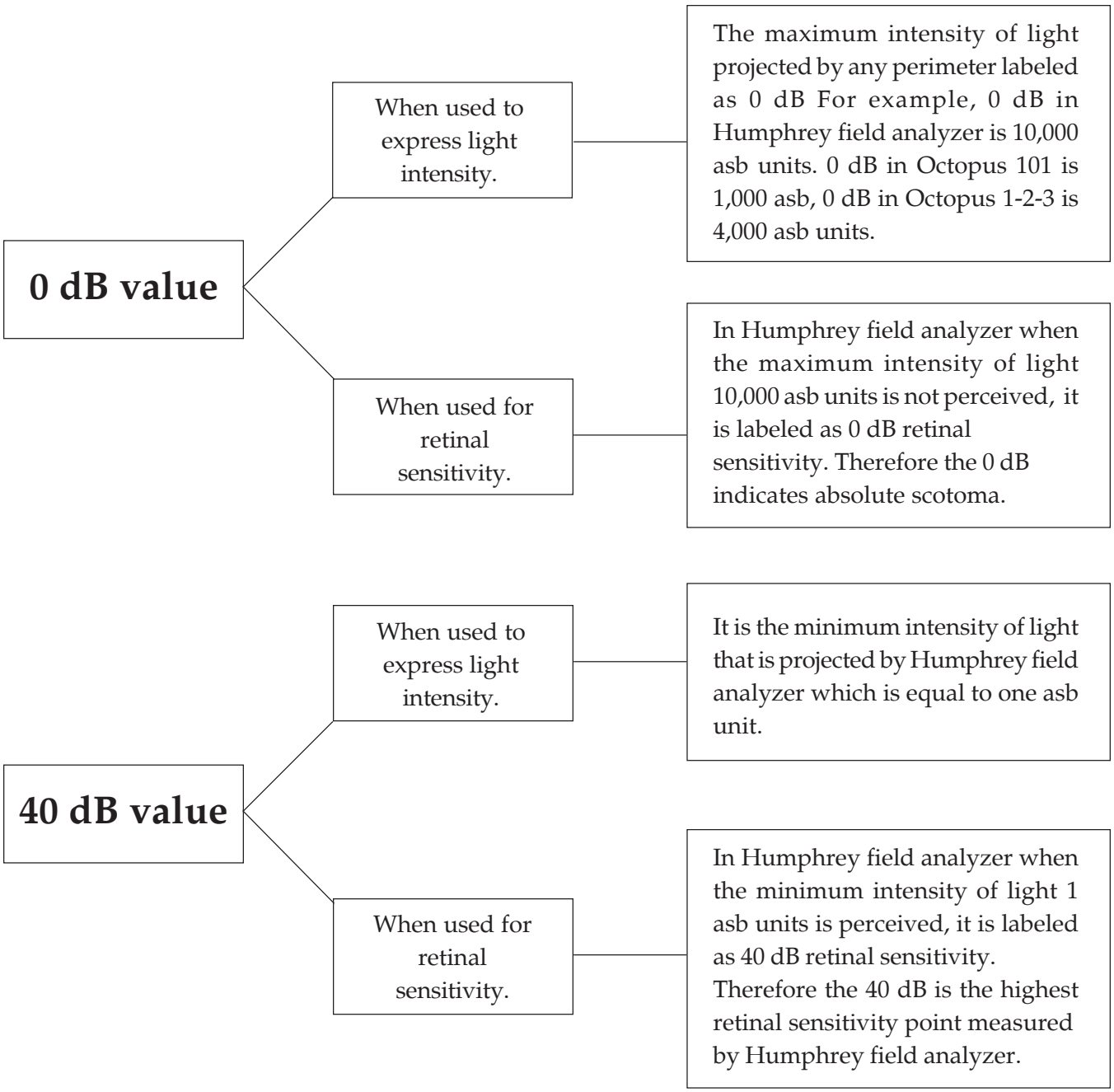
Low dB value indicates higher the light intensity and lower the retinal sensitivity

For example:



High dB value indicates lower the light intensity and higher the retinal sensitivity

The most important point to be noted is that the dB units represent to express the light intensity and retinal threshold value.



The entire visual field testing is to find out the retinal sensitivity of the selected points. The measured retinal sensitivity is now compared with the mean normal retinal sensitivity of those points of the same age group of the patient and the difference will be calculated. Thus measured retinal sensitivity will be expressed in the form of normal values. If the measured retinal sensitivity is higher than normal, no sign will be given to the deviation value and if the measured sensitivity is less than normal, minus sign will be given to the deviation value. **Now we must know the relation between the decreased measured retinal sensitivity which is expressed in terms of deviation from normal values and the severity of loss of retinal sensitivity.**

The fall of retinal threshold from 40 dB, the resultant new threshold value and the stimulus intensity needed to get the response to the new retinal threshold value are shown in Table 2.1.

TABLE 2.1 : Fall of retinal threshold from 40 dB

Fall of retinal threshold from 40 dB	*Retinal threshold intensity*	*Stimulus*
– 0 dB	**40 dB**	**1 asb**
– 1 dB	39 dB	1.3 asb
– 2 dB	38 dB	1.6 asb
– 3 dB	**37 dB**	**2 asb**
– 4 dB	36 dB	2.5 asb
– 5 dB	35 dB	3.2 asb

If you carefully follow the table, when the retinal threshold decreases from 40 dB to 37 dB (-3 dB) you will notice the facts as follows.

The 40 dB threshold point of retina requires a light intensity of one asb unit to get the response and the 37 dB threshold point of retina requires a light intensity of 2 asb unit to get the response. From this you understand that the fall of retinal sensitivity at a particular point by 3 dB value, that retinal point requires the double the intensity of light to get threshold response.

3 dB decrease in measured threshold value always means that the eye has lost approximately half of the retinal sensitivity.

Fall of retinal sensitivity by 5 dB (that is from 40 dB to 35 dB) the 35 dB point of retina requires 3.2 asb units of light intensity to get the response. That means that particular point requires 3 times original threshold stimulus to get the threshold response.

TABLE 2.2 : Fall of retinal threshold from 40 dB

Fall of retinal threshold from 40 dB	*Retinal threshold*	*Stimulus intensity*
- 0 dB	40 dB	1 asb
-1 dB	39 dB	1.3 asb
-2 dB	38 dB	1.6 asb
-3 dB	37 dB	2 asb
-4 dB	36 dB	2.5 asb
-5 dB	35 dB	3.2 asb
-10 dB	30 dB	10 asb
-20 dB	20 dB	100 asb
-30 dB	10 dB	1000 asb
-40 dB	0 dB	10000 asb

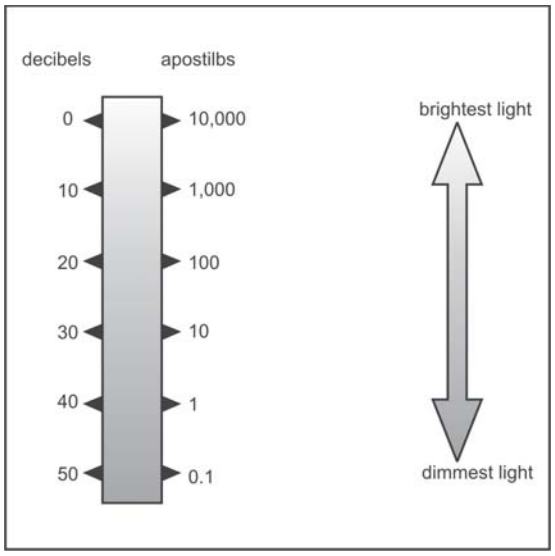


FIGURE 2.6 : The decibel-apostilbs (asb) scale of Humphrey field analyzer

Fall of retinal sensitivity by 10 dB (that is from 40 dB to 30 dB) the 30 dB point of retina requires 10 asb units of light intensity to get the response. That means that particular point requires 10 times original threshold stimulus to get the threshold response.

Fall of retinal sensitivity by 20 dB (that is from 40 dB to 20 dB) the 20 dB point of retina requires 100 asb units of light intensity to get the response. That means that particular point requires 100 times original threshold stimulus to get the threshold response.

Fall of retinal sensitivity by 30 dB (that is from 40 dB to 10 dB) the 10 dB point of retina requires 1,000 asb units of light intensity to get the response. That means that particular point requires 1,000 times original threshold stimulus to get the threshold response.

Fall of retinal sensitivity by 40 dB (that is from 40 dB to 0 dB) the 0 dB point of retina requires 10,000 asb units of light intensity to get the response. That means that particular point requires 10,000 times original threshold stimulus to get the threshold response.

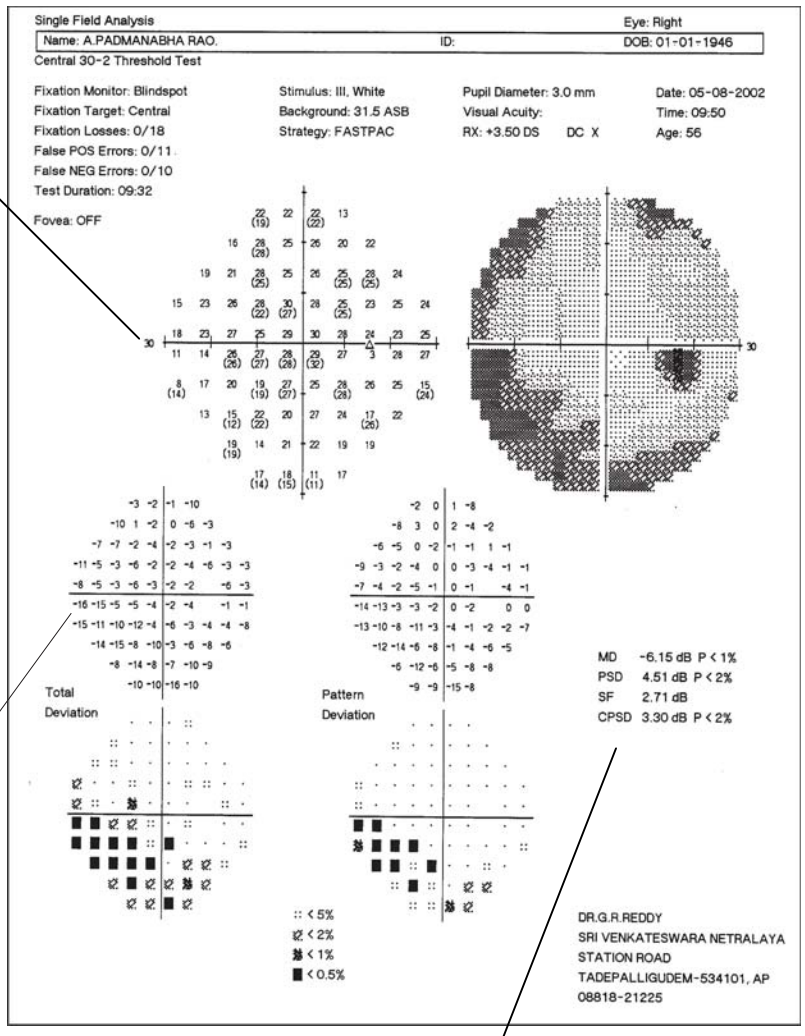
From the above discussion, we understand the following facts in Humphrey field analyzer.

If the retinal sensitivity falls by 10 dB - the retina loses its sensitivity by 10 times.
If the retinal sensitivity falls by 20 dB - the retina loses its sensitivity by 100 times.
If the retinal sensitivity falls by 30 dB - the retina loses its sensitivity by 1,000 times.
If the retinal sensitivity falls by 40 dB - the retina loses its sensitivity by 10,000 times.

In single field analysis printout retinal threshold values and its related derivatives are expressed in dB units as shown below.

Raw data of the patient

The retinal sensitivity is expressed in dB units instead of asb units. If the retinal threshold values are to be expressed in asb units we require more space. Take for example, a point is having threshold value of 10 dB units and if 10 dB is expressed in asb units, it will be 1,000 asb units. So, in order to avoid big numbers, retinal threshold value is expressed in dB units instead of asb units.

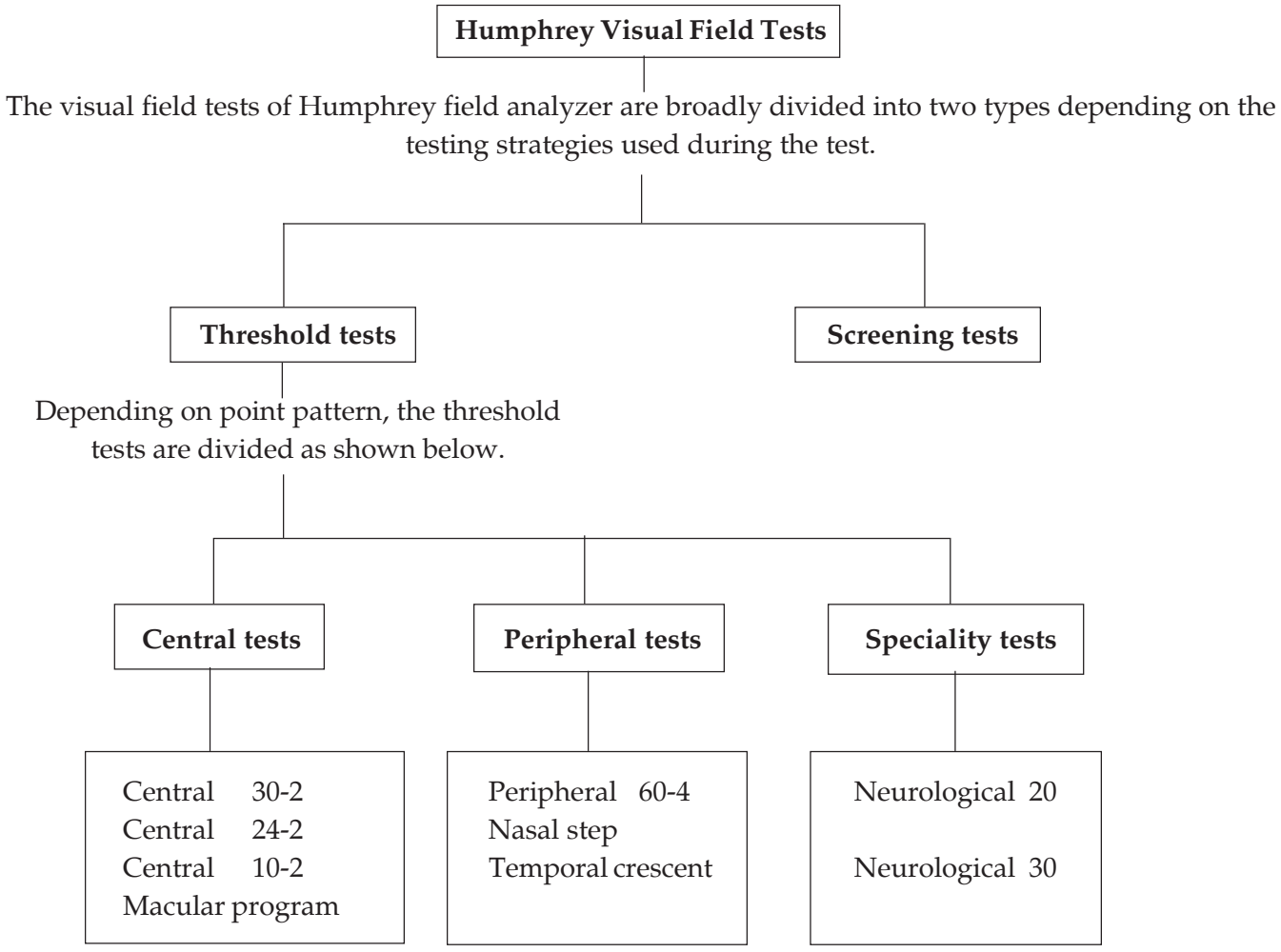


Total deviation numerical plot
The deviations from normal are also expressed in dB units with (–ve) or no sign in front of each number.

Global indices
Mean deviation index, pattern standard deviation (PSD), short-term fluctuation (SF) and corrected pattern standard deviation (CPSD) are expressed in dB units.

**In order to understand visual field printouts,
one should have a very good concept on dB units.
dB units are used to measure both retinal sensitivity and light intensity.**

CLASSIFICATION OF HUMPHREY VISUAL FIELD TESTS



Threshold tests are used to detect glaucoma field defects. Basically, the automated static visual field testing consists of two components:

1. Where we test (point pattern)
2. How we test (testing strategy)

For example, the selected test is central 30-2 Full Threshold. In this test the first component (point pattern) is central 30-2 and the second component (testing strategy) is Full Threshold strategy. Now we will discuss the point patterns and the testing strategies in detail.

THRESHOLD TEST - POINT PATTERNS

The point pattern where the threshold has to be determined is usually designed according to the disease pattern. For example, in case of glaucoma we know the field defects are usually seen in central fields in an arcuate pattern and the loss of retinal sensitivity mainly on either side of horizontal meridian and more on the nasal side. So the point patterns are designed accordingly. For example, in neurological conditions we select the point patterns where the points will be concentrated on either side of the vertical axes. In order to select proper point pattern to clinical condition under investigation we must know the fundamentals of point patterns in detail.

The Humphrey field analyzer offers many point patterns in the threshold tests. Out of those we usually select one of the following point patterns to detect glaucoma field defects according to the stage of glaucoma.

1. 30-2 Central threshold test pattern
2. 24-2 Central threshold test pattern
3. 10-2 Central threshold test pattern
4. Macular programing test pattern
5. Nasal step

Whenever we talk about point patterns the following points should be noted:

1. Extension of visual field testing.
2. Number of test points.
3. Point density (the distance between two points in degrees).
4. The degree of bare area around the fixation spot.
5. The relation of the points to the horizontal and vertical axes.

30-2 CENTRAL THRESHOLD TEST PATTERN

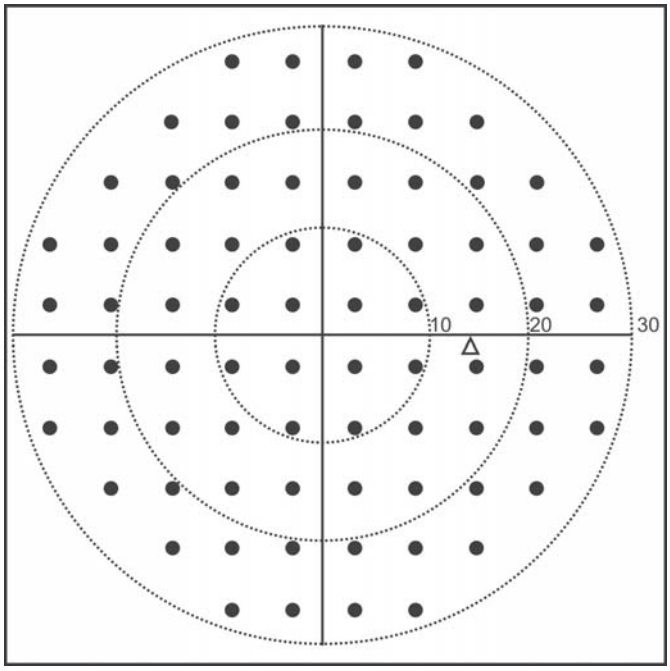
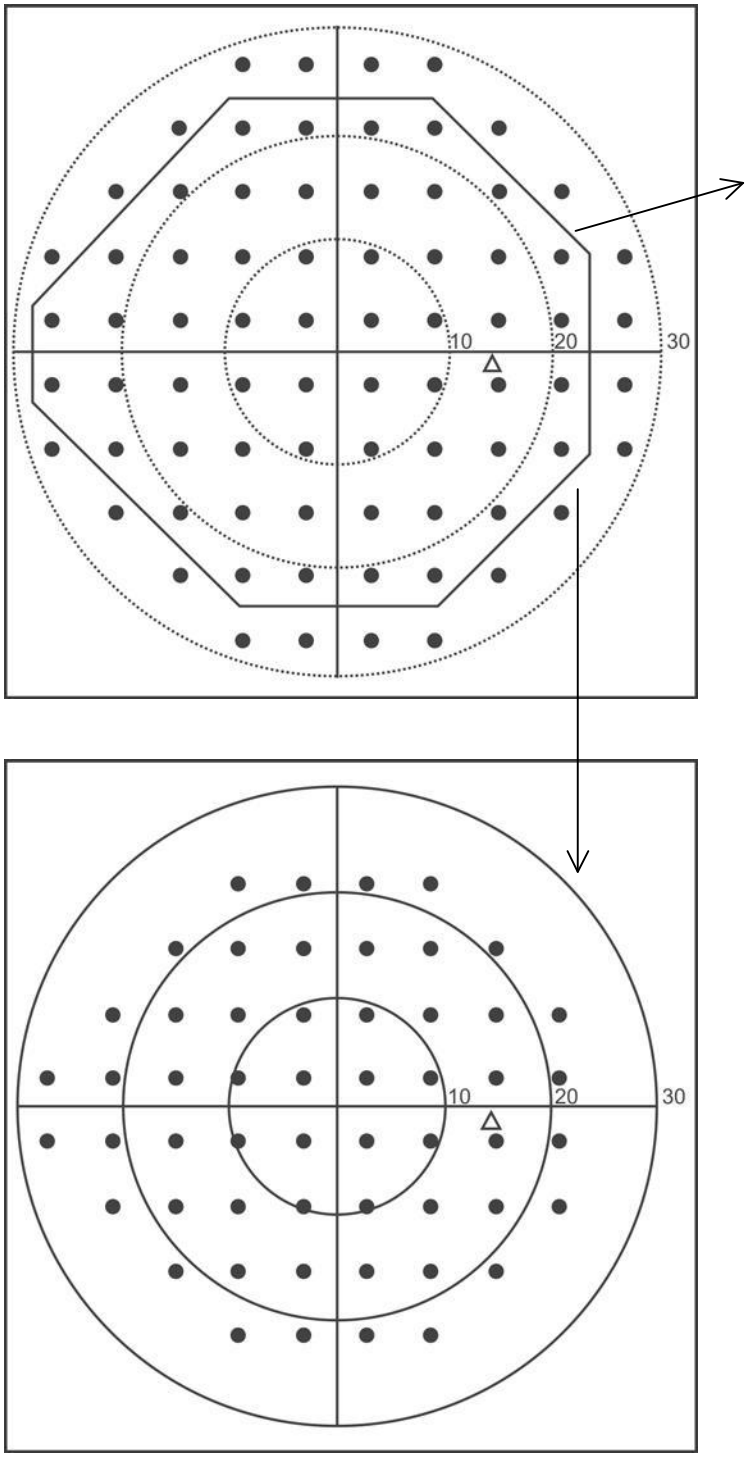


FIGURE 2.7

Number of test points - 76.
The distance between each two points is 6º (the point density is 6º).
The test points straddle the horizontal and vertical axes. Because the test points delibrately straddling both the horizontal and the vertical axes, the four innermost points are 3º from the fixation spot. So only 3º bare area is left surrounding the fixation spot.

The points are spread in 3º area from fixation point.

30-2 CENTRAL THRESHOLD TEST PATTERN



Please note that all the 54 points within the octogan are exactly similiar to 24-2 test pattern. So, 24-2 test pattern is nothing but the 54 points of 30-2, which are present within 24º area from fixation point. Because of this reason, the results from 30-2 and 24-2 may be presented with same printout.
Number of test points - 54.

The distance between each two points is 6° (the point density is 6°).
The test points straddle the horizontal and vertical axes. Because the test points deliberately straddling both the horizontal and the vertical axes, the four innermost points are 3° from the fixation spot. So only 3° bare area is left surrounding the fixation spot.

The points are spread in 24° area from fixation point.

FIGURE 2.8

24-2 CENTRAL THRESHOLD TEST PATTERN

10-2 CENTRAL THRESHOLD TEST PATTERN

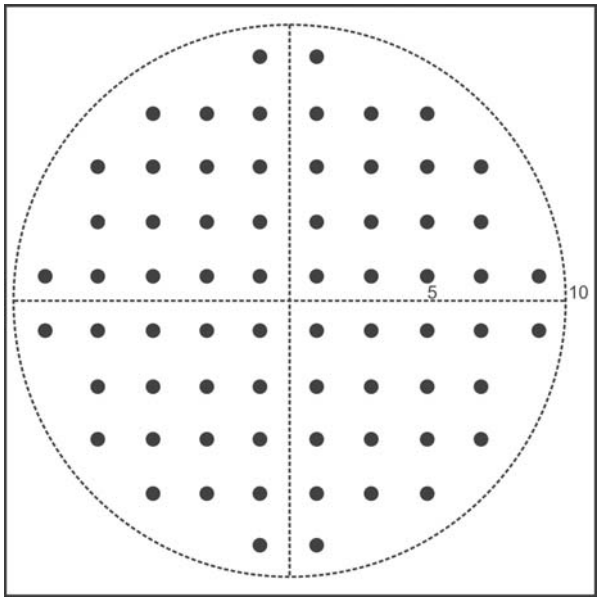


FIGURE 2.9:

Number of test points - 68.
The distance between each two points is 2° (the point density is 2°).
The test points straddle the horizontal and vertical axes. Because the test points deliberately straddling both the horizontal and the vertical axes, the four innermost points are 1° from the fixation spot. So only 1° bare area is left surrounding the fixation spot.

Please note that 10-2 contains more number of test points than 24-2 because of greater resolution, i.e. point density is 2°.

The points are spread in 10° area from fixation point.

24-2 Central Threshold Test Pattern

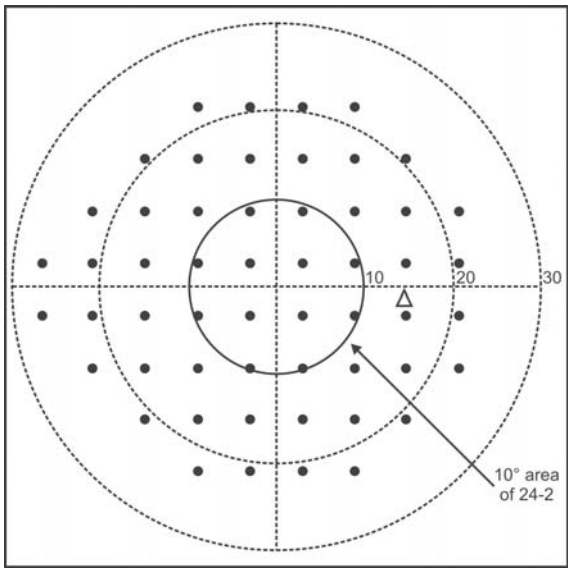


FIGURE 2.10

10-2 Central Threshold Test Pattern

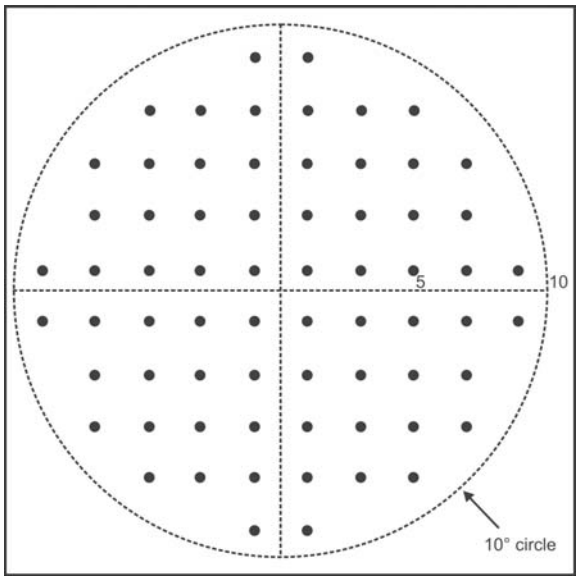
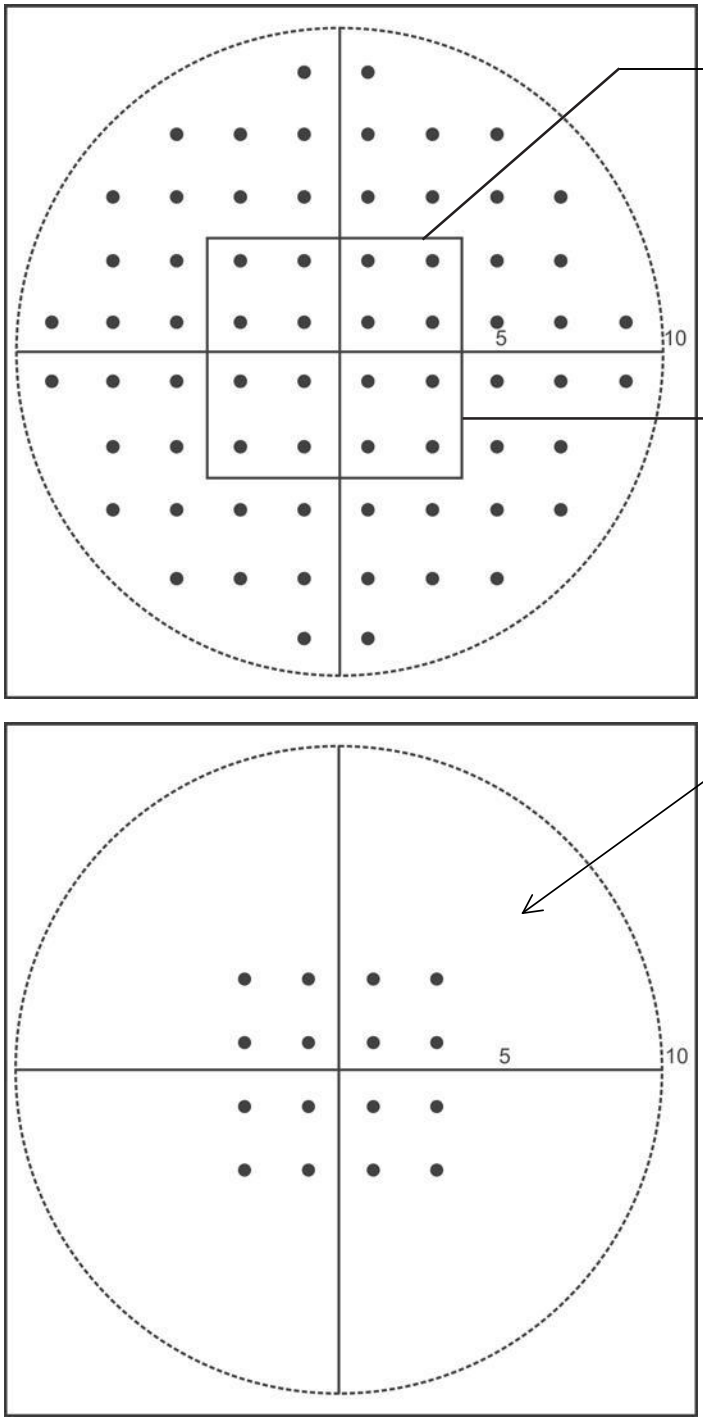


FIGURE 2.11

Please note that the 30-2 and 24-2 contain only 12 points within the 10° area whereas 10-2 contains 68 points in the same extent area. So, there is a vast difference in number of points between 10-2 test patterns and 30-2 or 24-2 test pattern. So, if we want to know the retinal sensitivity within 10° area, the test of choice is 10-2 test pattern. The reason for highest number of points in 10-2 is because of distance between each point is 2°. Whereas the distance between each point in 24-2 and 30-2 is 6°.

CENTRAL 10-2 THRESHOLD TEST PATTERN



Please note that all the 16 points are exactly similiar to macular program test. So, macular program test is nothing but the 16 central points of 10-2 which are present within 5° area from fixation point. Because of this reason, in advanced cases of glaucoma, we advice macular program tests with stimulus size III or V.

Number of test points - 16.
The distance between each two points is 2° (the point density is 2°).
The test points straddle the horizontal and vertical axes. Because the test points deliberately straddling both the horizontal and the vertical axes, the two innermost points are 1° from the fixation spot. So only 1° bare area is left surrounding the fixation spot.

The points are spread in 3° area from fixation point.

FIGURE 2.12

MACULAR PROGRAMING TEST PATTERN

NASAL STEP THRESHOLD TEST PATTERN

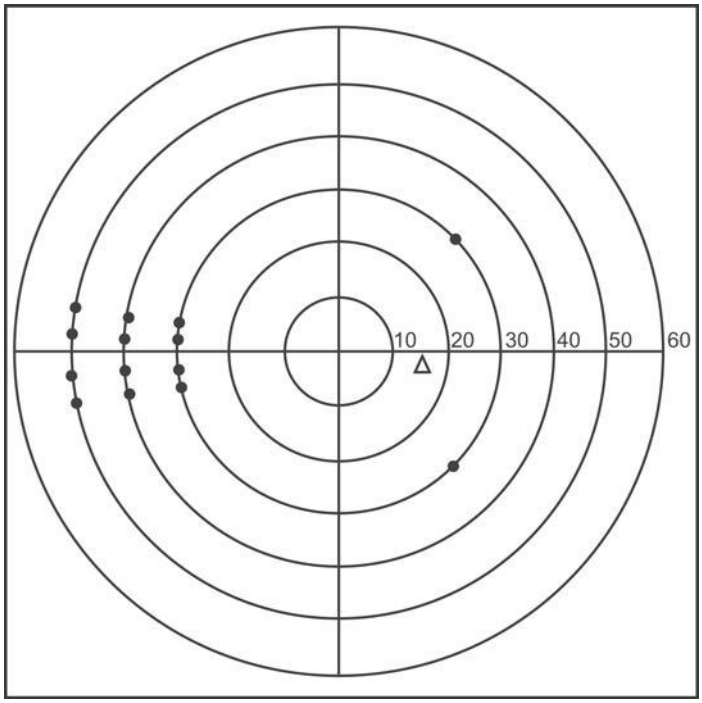


FIGURE 2.13‘

It is the peripheral test pattern that explores from 30° to 50°. The nasal step test points provide 2 points above and below the horizontal axes at 30°, 40°, 50° as well as 2 accentric central points as shown in the figure.
Number of points - 14.

Table 2.3: Summary of the threshold field test patterns

Test pattern	*Point density (degrees)*	*No of test points*	*Notes*
10-2	2 degrees	68	Test points straddle the horizontal and vertical meridians. The region tested about the same Amsler grid.
24-2	6 degrees	54	Test points straddle the horizontal and vertical meridians.
30-2	6 degrees	76	Test points straddle horizontal and vertical meridians.
Macular program	2 degrees	16	
Nasal step	—	14	50 degree extension of the field.
24-1	6 degrees	56	Test points fall on horizontal and vertical meridians.
30-1	6 degrees	71	Test points fall on horizontal and vertical meridians.

WHY WE SELECT 30-2 / 24-2 / 10-2 CENTRAL FIELD TEST PATTERNS IN PREFERENCE TO 30-1 /24-1/ 10-1 CENTRAL FIELD TEST PATTERNS BECAUSE OF THE FOLLOWING REASONS

30-1 Central Field

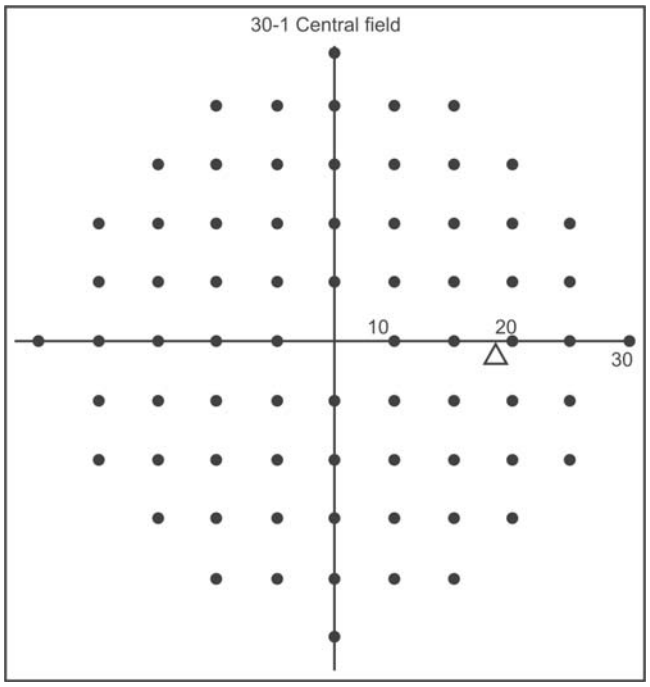


FIGURE 2.14

30-2 Central Field

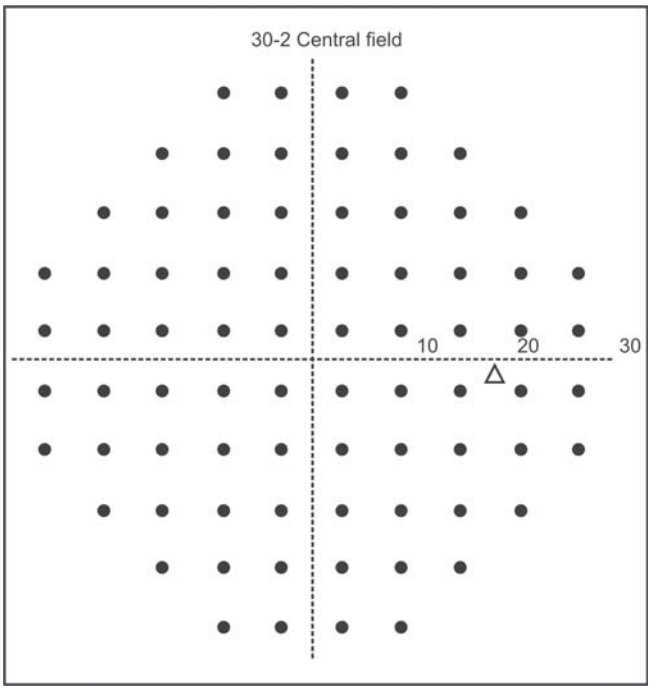


FIGURE 2.15

As an example, we take 30-2 and 30-1 central tests and discuss the differences between these two tests. The central 30-2 consists of a 76-point grid, each point 6 degree apart, deliberately straddling both the horizontal and vertical axes so that the four inner most test points are 3 degree from fixation spot. This contrasts with the central 30-1, whose 71 point rectilinear grid actually falls on the horizontal and vertical axes. This spacing however leaves 6 degree bare area of test points surrounding the fixation spot. Because of its greater number of points and their greater proximity to fixation, the central 30-2 is commonly preferred as the primary testing pattern. By design, though the two grids are interlocking and complementary. Hence their results can be merged by the computer to provide the testing density of 4.2 degrees.

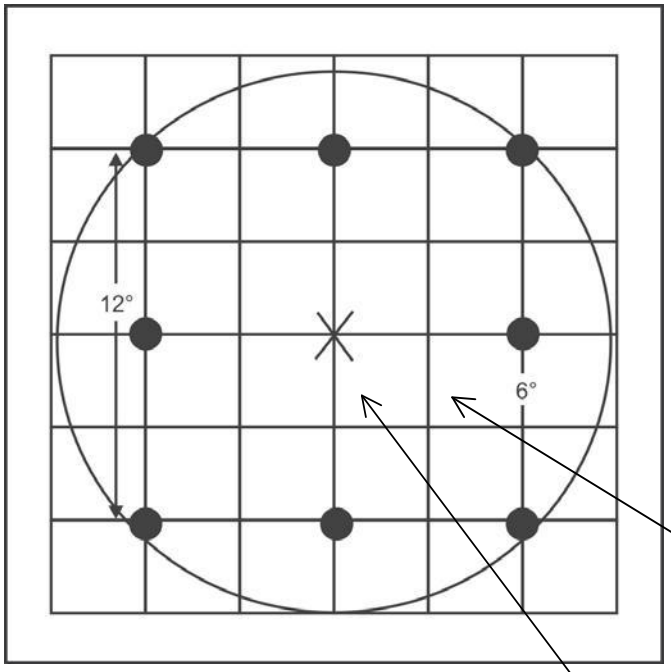


FIGURE 2.16

Bare area of 6° radius around fixation spot in 30-1 central field

Number of test points - 71.
The distance between each two points is 6° (the point density is 6°).
The test points begin on horizontal and vertical axes. Because the test points fall under horizontal and vertical axes it leaves 6° bare area of test points, surrounding the fixation spot. So the central 6° field in 30-1 is not tested.

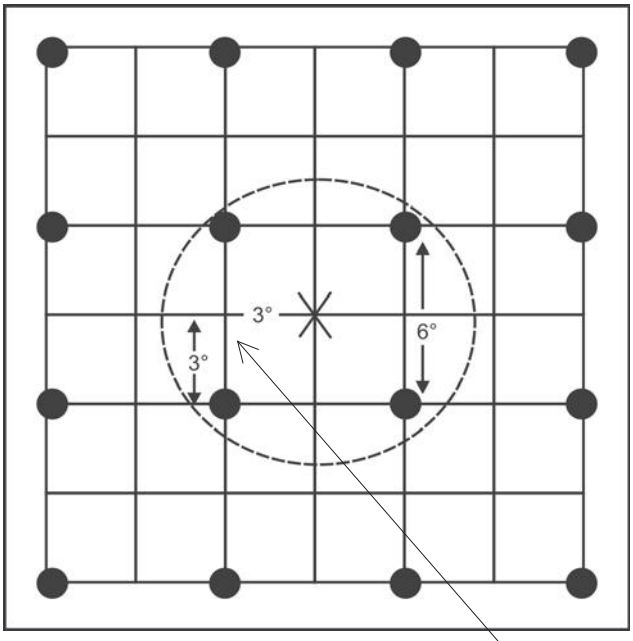
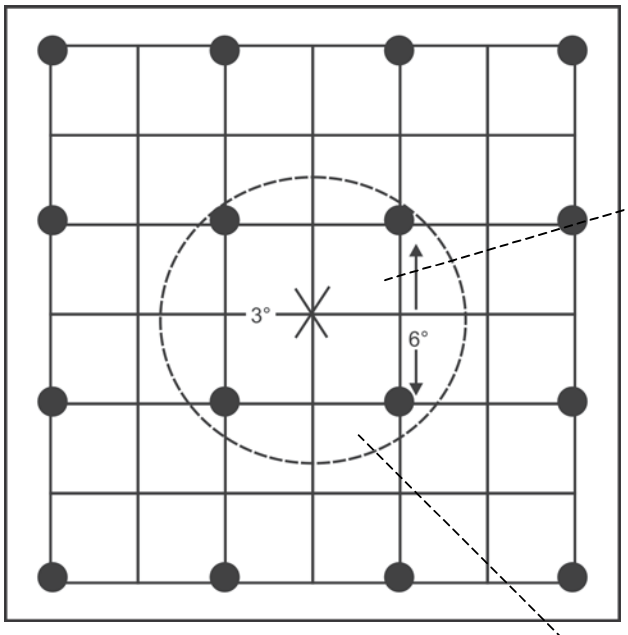


FIGURE 2.17

Bare area of 3° radius around fixation spot in 30-2 central field

Number of test points - 76.
The distance between each two points is 6° (the point density is 6°).
The test points straddle the horizontal and vertical axes. Because the test points deliberately straddling both the horizontal and the vertical axes, the two innermost points are 3° from the fixation spot. So only 3° bare area is left surrounding the fixation spot. Because of it's greater number of test points and their greater proximity to fixation, the central 30-2 field is commonly preferred as the primary testing pattern.

In 30-2, 24-2, the test points are 3° away on either side of the horizontal axes. Whereas in 30-1, 24-1, they are 6° away on either side of the horizontal axes. So, in glaucoma hemifield test analysis, the 30-2, 24-2, test patterns are more appropriate point patterns because glaucoma hemifield test (GHT, see page 55) is a comparative test between the points on either side of the horizontal axes.



Bare area of 3° radius around fixation spot in 30-2 and 24-2 central field

Area of 3° radius around fixation spot is free of test points in 30-2 and 24-2 central fields and hence the 3° area will not be tested.

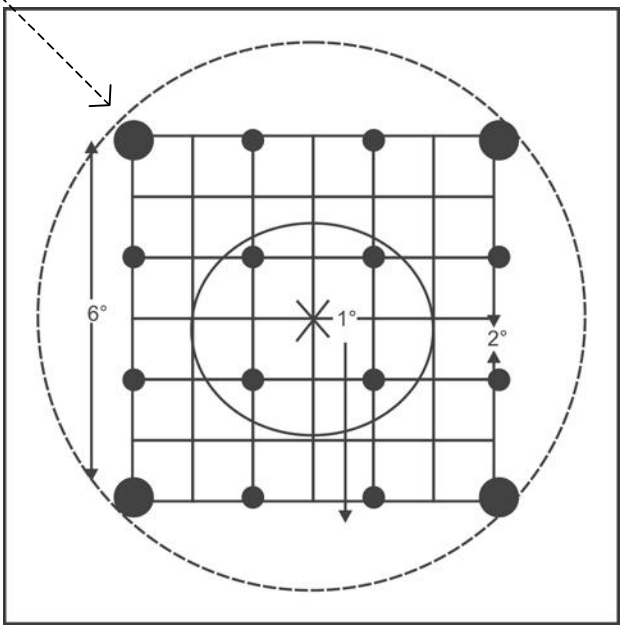
FIGURE 2.18

10-2 Central Field

The number of test points is 68.

The distance between each test point is 2°. The test points straddle the horizontal and vertical axes. The most important point is to be noted in the 10-2 field is, 2° resolution. Because the test points straddle the horizontal and vertical axes, the innermost points are only one degree from the fixation spot. So, only one degree of bare area is left surrounding the fixation spot. From this we understand, most of the central space surrounding the fixation spot is tested in 10-2 field. Hence it became the test of choice in all advanced cases of glaucoma to know about the macular status.

3° bare area of
30-2 and 24-2 central fields
containing 16 points in
10-2 central field



Only 1° bare area is not tested surrounding the fixation spot in 10-2 central field.

FIGURE 2.19

THRESHOLD TESTING STRATEGIES

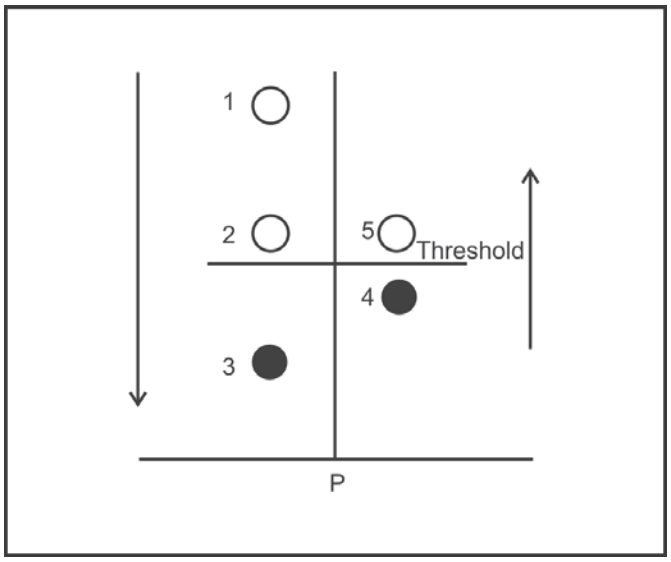
The test "strategy" refers to the method of presenting stimuli to the patient to attain the desired information. There are two types of strategies: screening or suprathreshold testing strategies and threshold testing strategies. In a suprathreshold screening test, each stimulus is intense enough to be seen by nearly all normal patients. This strategy provide only general, qualitative information about the visual field and consumes less time. **While threshold strategies consume more time, they provide detailed, quantitative information to find out the threshold at each selected point of retina. There are different threshold strategies available to the Humphrey field analyzer.**

The testing threshold strategies are of 2 types:

1. Old standard threshold strategies
2. Newer threshold strategies

1. Full Threshold strategy (1983)
1. FAST PAC (1991)
2. SITA Standard (1997)
3. SITA Fast (1997)

(SITA means Swedish Interactive Threshold Algorithm)



Threshold determination at a visual field point P, open circle indicates patient response to stimulus. Filled circle indicates no response to stimulus. Down arrow indicates stimuli decreasing in 4 dB steps. Up arrow indicates stimuli increasing in 2 dB steps. Numbers indicate order of stimulus presentation.

FIGURE 2.20

Staircase method (Bracketing method) of detecting threshold.

This method is used in full threshold strategy.

DETERMINATION OF THRESHOLD

During determination of threshold at each point in the test grid, stimulus intensities will vary in such a way that some stimuli will be suprathreshold (brighter than necessary to elicit a response most of the time) and some will be infrathreshold (too dim to elicit a response most of the time). Threshold is thus bracketed by the stimuli as the examination proceeds. This method of bracketing is also known as staircase method for determining threshold.

Illustration of staircase method (bracketing) for determining threshold (Figure 2.20)

First stimulus: The first stimulus presented at the point P is seen and hence it is labeled as open circle 1.

Second stimulus: Because the first stimulus was seen a intensity of light was dimmed by 4 dB In this example, the second stimulus was also seen and labeled as open circle 2.

Third stimulus: As the second stimulus was also seen, the third stimulus was dimmed further by 4 dB. The third stimulus is too dim to elicit a response and hence indicated by closed circle 3. **This is the first crossing from seeing zone to nonseeing zone.**

Fourth stimulus: Now the machine makes the stimulus brighter but in 2 dB steps. The fourth stimulus was also too dim to elicit a response and hence indicated by closed circle 4.

Fifth stimulus: The fifth stimulus is further brightened by 2 dB and this time, the patient pushes the button and hence labeled as open circle 5. **This is the second crossing of the threshold from nonseeing zone to seeing zone.** Since the step size was 2 dB, threshold is the value that lies between the intensity values of the last 2 stimuli. Obviously if the first stimulus presented to the point was not seen, the machine will make the stimuli brighter in 4 dB steps until the threshold is crossed and then dimmer in 2 dB steps until the second crossing. **This standard method is adopted in determining threshold in the full threshold strategy.** Thus the theoretical best threshold resolution is 2 dB.

The newer threshold strategies reduce the test time of the threshold tests by more than 40% by measuring threshold with an alternative strategy to the standard staircase method. In the newer strategies change the stimulus in 3 dB steps and crosses the threshold only once. The threshold assigned to each tested point lies between the two stimulus intensities where the threshold is crossed. The theoretical best threshold resolution is 3 dB rather than the theoretical 2 dB resolution of the full threshold (algorithm). The threshold values determined by the newer fast methods were found to be similar to those found on the standard testing strategies (Full Threshold strategy and FAST PAC).

It is very important to note that the Full Threshold strategy is a confusing terminology because there are no half threshold strategies. Because the standard staircase method is adopted in detecting the threshold in Full Threshold strategy it should have been named as standard threshold strategy rather than as full threshold strategy.

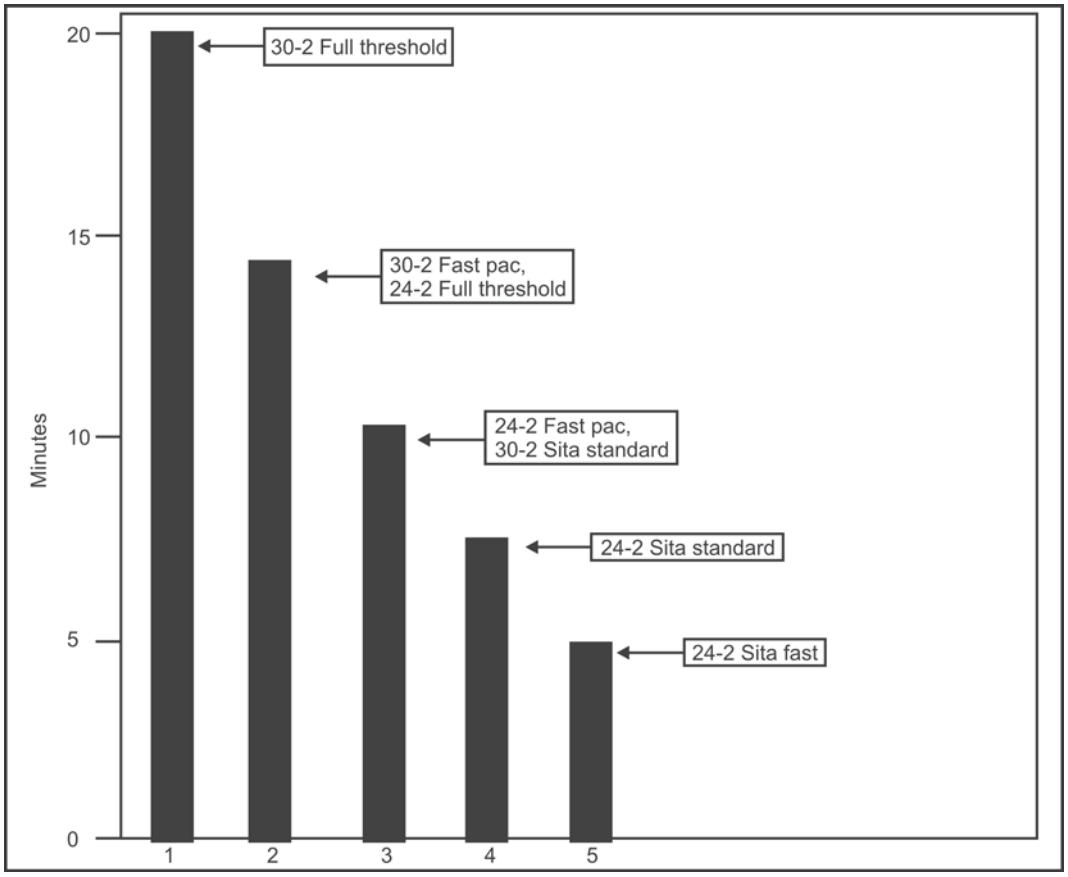


FIGURE 2.21

Typical test time ranges (minutes) comparative test times for four main threshold test algorithms. **Percentages are relative to typical test time for full threshold 30-2 testing.**

From the above figure, you understand the test time for each selection of the test is as follows:

1. 30-2 FULL THRESHOLD - 20 MINUTES

2. 30-2 FAST PAC, 24-2 FULL THRESHOLD } - 14 MINUTES

3. 24-2 FAST PAC, 30-2 SITA STANDARD } - 10 MINUTES

4. 24-2 SITA STANDARD - 7 MINUTES

5. 24-2 SITA FAST - 5 MINUTES

Please see pages 63- 69 for further details on the threshold testing strategies.

IMPORTANT THRESHOLD TESTS TO DETECT GLAUCOMA FIELD DEFECTS

Now, we know the available point patterns and the testing strategies. Whenever we ask for a visual field test we have to specify the point pattern and the testing strategy.

The usual available central threshold test point patterns are as follows:

30-2 central field, 24-2 central field, 10-2 central field, macular program and nasal step.

Available threshold testing strategies:

Full threshold, FAST PAC, SITA Standard, SITA Fast.

Each of the above test point pattern can be tested with any of the above threshold strategy. For example, the 30-2 central field with Full Threshold strategy, 30-2 central field- SITA standard, 30-2 central field - SITA Fast and central field 30-2 FAST PAC. Like that the 24-2 central fields and 10-2 central fields test can be done with all these strategies. Please note that both SITA Standard SITA Fast testing strategies are not available for macular program and nasal step field test point patterns.

We can tabulate the above information as follows:

Table 2.4		Testing Strategies			
		Full threshold	**FAST PAC**	**SITA standard**	**SITA fast**
POINT PATTERNS	**30-2 Central field**	30-2 Full Threshold	30-2 FAST PAC	30-2 SITA-Standard	30-2 SITA Fast
	24-2 Central field	24-2 Full Threshold	24-2 FAST PAC	24-2 SITA-Standard	24-2 SITA Fast
	10-2 Central field	10-2 Full Threshold	10-2 FAST PAC	10-2 SITA-Standard	10-2 SITA Fast
	Macular program	Macular program Full Threshold	Macular program FAST PAC	*Both-SITA Standard SITA Fast testing strategies are not available for Macular program and Nasal Step Field Test Patterns.*	
	Nasal step	Nasal step Full Threshold	Nasal step FAST PAC		

SELECTION OF POINT PATTERNS

The selection of point patterns to find out visual field defects in glaucoma mainly depends on the cup/disc ratio of optic nerve head. Usually we ask for visual field testing in cases of glaucoma in four different situations.

The first situation (suspicious cases of glaucoma): In this condition we want to know whether there is a field defect or not. So in this situation we have to go for central 30-2 point pattern where we have more number of points to be tested and extended over an area of 30°. (76 points, resolution 6° and central bare area 3°.)

The second situation (established case of glaucoma): In this condition our aim is not to diagnose glaucoma but to know how much field is lost. So we go for 24-2 point pattern. (54 points, resolution 6° and central bare area 3°.)

The third situation (advanced cases of glaucoma): In this situation our aim is to know how much central field is retained around the fixation spot. For this we have to go for 10-2 point pattern. (68 points, point resolution 2° and central bare area 1°.) When the patient has advanced glaucomatous optic atrophy the first thing we should do is to test the central 10° field. The central 10-2 consists of 68 test points with 2° resolution. If the field defect is so advanced that most points have sensitivity less than 10 to 15 decibels, it is then preferable to use macular program. Macular program can be done with standard size III target or, if the sensitivity is low, do the test with the size V target. We find the macular program is useful to determine whether the macula is split or not. This has a baring on the patients prognosis - a test showing a split macula with the size III target should be repeated using the size V stimulus -the absence of a split macula on the size V macular program indicates a better visual prognoses .The macular program is generally used only when there is 5 degree central field remaining. It may help to bring out any localized scotoma which might have been missed in 30-2 or 24-2 field test because of their 6 degree resolution. Suppose in advanced cases of glaucoma if you ask for 30-2 or 24-2 central fields point patterns, we do not know how much field around fixation point is retained, as there are no testing points. within the 3 degree around the fixation spot. For example, in suspicious case of glaucoma if you ask for 10-2 central field, it will come as a normal visual field report as the central 10-2 field will be normal in early cases of glaucoma. Similarly if you ask for 30-2 or 24-2 central field test in advanced cases of glaucoma the printouts will not give any information regarding macular split as these test patterns will not contain any test points with in 3° around fixation point.

The fourth situation (followup cases of glaucoma): In followup cases of glaucoma the selection of the test depends upon the previous test pattern and the selection of the testing strategy is always same as previous test strategies.

SELECTION OF TESTING STRATEGY

The selection of testing strategy does not depend on the cup/disc ratio of glaucomatous optic atrophy unlike the selection of the point pattern. Usually SITA Standard or Full Threshold testing strategy ususally will be selected and if the patient is old and not able to concentrate for a longer time SITA Fast or FAST PAC can be selected.

Selection of the point patterns in patients of glaucoma according to the stage of glaucoma

30-2 central is the first test to be selected.

If no pathology is seen and peripheral 30° is free of scotoma, the following test can be selected during followup tests

↓

24-2 central field

For situations like advanced glaucoma selection of the test would be

↓

10 -2 central field

If the field is so advanced and most of the points sensitivity is less than 10-15 dB, and if macular split is present, the selection of the test would be

↓

10-2 Central field with size V stimulus or macular program with size V stimulus

↙ ↘

If there is no split of the macula the prognosis after surgery is good.

SPLIT macula is a potential risk factor following filtering sugery.

We can represent the selection of the test to detect glaucoma field defects in a tabular form as follows:

GLAUCOMA SUSPECT	:	30-2 Full Threshold test
	:	30-2 SITA Standard
ESTABLISHED GLAUCOMA AND FOLLOW UP	:	24-2 Full Threshold
	:	24 -2 SITA Standard
	:	24-2 FAST PAC
ADVANCED GLAUCOMA	:	10-2 Full Threshold
	:	10-2 SITA Standard
	:	Macular program test - Full Threshold (All the above tests can be conducted with stimulus size V.)
ELDERLY PATIENTS AND THOSE WHO CANNOT WITHSTAND LONG DURATION TESTS	:	24-2 SITA Fast

PROFORMA OF ORDER FORM FOR VISUAL FIELD TESTING

Whenever we subject the patient for visual field testing we have to feed the field analyzer the details of the patient data and the test data properly. For this purpose a proforma order form for visual field testing is designed. This proforma must be properly filled before sending the patient for visual field testing.

Patient Data:

Name of the patient: Age:

Refractive error correction: V A: Rt
(for near vision) Lt

Test Data:

Selection of the test: Test point pattern:
Test strategy: Pupil size:

Fixation target: Central

Size of the stimulus: Size III

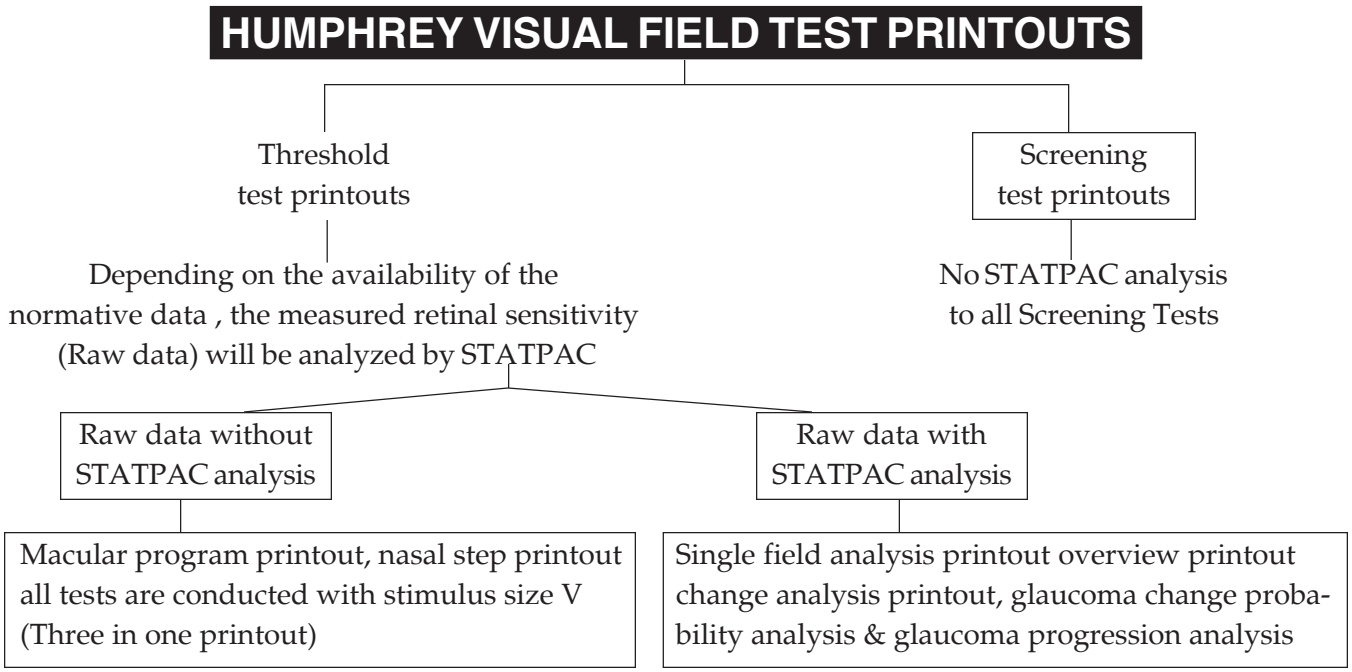
Indication for field testing:

Regarding fixation target, if nothing is mentioned it is understood that, it is the cental fixation. In situtations like macular degenerations, the fixation target will be changed to small diamond or large diamond. Regarding the size of the stimulus, if nothing is mentioned it is understood that the stimulus size is size III. In situtations like advanced glaucoma, to know macular status, size V stimulus can be used. To reduce high fixation losses sometimes to we have to change the central fixation target to either small diamond or big diamond. The change of the size of the stimulus from size III to size V will also help to reduce the high fixation losses to make the test more reliability.

The above patient data and the test data will be fed to the field analyzer by the technician. The test will be conducted after educating the patient about the way of performing the test. Then the printout of Humphrey field analyser will be available for interpretation.

Always the data in the proforma must be properly fed to the field analyzer. The test data and the patient data that is present in the visual field printouts must be exactly similar to the data given in the proforma.

3 Classification of Visual Field Printouts



The normative data is available to the tests that are conducted with the following parameters. So the STATPAC (The Humphrey field analyzer's statistical package) will analyse tests that fall within the parameters listed below.

Test pattern	:	Central 30-2, 24-2, 10-2
Test strategy	:	SITA standard, SITA fast, Full threshold, FASTPAC
Stimulus size	:	III
Fixation target	:	Central, small diamond, big diamond
Foveal threshold	:	On or off.
Fluctuation	:	On or off

First, we will discuss in detail the single field analysis printout with STATPAC analysis. Later we will talk about printouts without STATPAC analysis and follow-up tests.

UNDERSTANDING OF SINGLE FIELD ANALYSIS PRINTOUT

We deal with interpretation of Humphrey field analyzer's printouts, since it is the instrument we use in our clinical practice. The Humphrey field analyzer's statistical package (STATPAC) can be used to produce an in depth statistical analysis of visual field test results.

The field analyzer determines the retinal sensitivity (threshold) at all predetermined points and plots them as raw data. From the raw data we have to find out the change in the retinal sensitivity at each point. The dissimilar retinal sensitivity values of the raw data do not indicate the visual field loss as the retinal sensitivity values at all points are not same even in the normal field. The retinal sensitivity value at the fovea is high and as we move towards the periphery, the values decrease. So the raw data will have different retinal sensitivity values even in normal field. Hence, we cannot identify early field defects by seeing the raw data, which contains dissimilar values. To know whether the measured retinal sensitivity is normal or not, the normal retinal sensitivity values at each point should be known for each age group. But, without knowing the normal values, it is not possible to conclude whether the raw data is normal or not. So to overcome this problem, the computer stores the mean normal threshold values at each point for all age groups. To establish the mean normal threshold values for different age groups, large number of normal population were tested keeping in mind the following parameters, which are properly monitored (age of the patient, size of the pupil, refractive error correction, selection of the point pattern, selection of testing strategy, size of the stimulus, fixation center, reliability indices, etc.).

The raw data of the patient is now compared with mean normal threshold values of the same age group and calculates the difference between the measured retinal sensitivity and the mean normal retinal sensitivity at all points and plots as total deviation numerical plot (TDNP). So, the TDNP is nothing but raw data expressed in terms of normal values. Establishing the total deviation numerical plot is the most important function of automated field analyzers. It is very easy to detect the loss of retinal sensitivity from the TDNP. If there is no field loss, TDNP must have the deviation values in the range of 0 to -2db. If there is a localized field defects, we can identify it by locating high deviation values at those particular areas. If there is a uniform field loss, all the deviation values will be almost symmetrical and the difference between the maximum and minimum deviation values will be minimal. In irregular field defect, the deviation values in TDNP will show dissimilar deviation values and the difference between the maximum and minimum deviation values will be very high.

Basically, the loss of retinal sensitivity can be in the form of a localized defect / uniform generalized defect / localized defects masked by generalized field defect (irregular generalized field defect). The field charts are designed in such a way, to express the field defects in terms of the above field loss pattern. Indicators were developed to express localized field defects and overall severity of field loss. These indicators help to pick up the defects at an early stage and also to pick up even the mild progression in the disease process and probability plots were developed to show the field defects in scotomatous form.

For example, in single field analysis printouts, pattern standard deviation (PSD) was developed to express the irregular loss of retinal sensitivity (localized field defects). The mean deviation index (MD index) was developed to express overall severity of field loss. The STATPAC expresses the severity of MD

index and PSD value in terms of statistical significance (P value). Now, the STATPAC calculates the P value of each decibel deviation in the total deviation numerical plot. A symbol is given to each P value. Thus each deviation value in the total deviation numerical plot is converted to symbolic form according to its P value and plotted as total deviation probability plot. Thus, the total deviation probability plot is the scotomatous form of raw data or total deviation numerical plot. The next step is the conversion of TDNP to pattern deviation plots to highlight the local field defects masked by generalized depression. STATPAC corrects the total deviation plot for diffuse loss, raising or lowering the overall height of the island of vision towards the mean for the reference population, and displays the results as the pattern deviation numerical plot. The STATPAC calculates the P value of each corrected decibel deviation in the pattern deviation numerical plot. And thus each deviation value in the pattern deviation numerical plot is converted to symbolic form according to its P value and plotted as pattern deviation probability plot. PDPP was developed to highlight the localized field defects in scotomatous form masked by generalized field defect. From the probability plots, we can know the pattern of field defect, whether it is an arcuate / biarcuate / nasal step / bitemporal hemianopia / homononymous hemianopia, etc.

The localized field defects can be identified either by a high PSD value or by the probability plots (both TDPP and PDPP show symmetrical field defects). The uniform generalized field defect can be identified either by high mean deviation index and minimum PSD value or by the probability plots (TDPP shows generalized field defect with a normal PDPP). The irregular generalized field defect can be identified either by high mean deviation index and high PSD value or by the probability plots (TDPP shows generalized field defect and PDPP shows a localized defect).

The STATPAC developed a new software—Glaucoma hemifield test (GHT), to pick up glaucoma at a very early stage by picking up the difference in the retinal sensitivity values between the prefixed corresponding points on either side of the horizontal meridian. So, GHT is directed primarily at the diagnosis of glaucomatous visual field loss and not other diseases.

From the above information, one can know whether the field loss is generalized / localized / both. So, please remember that the field charts tell you that the field defect is either localized or generalized. If it is generalized it tells whether it is uniform generalized field defect or irregular generalized field defect. Now it is upto us to decide if the field defect is corresponding to our clinical condition or not. Usually in pure cases of glaucoma, we see only a localized field defect. If glaucoma is associated with cataract, there will be an irregular generalized field defect. When we suspect glaucoma in cases of cataract, the suspicion of glaucoma can be eliminated if the fields show only a generalized field defect in total deviation probability plot without any localized field defect in pattern deviation probability plot (as an irregular generalized field defect is mandatory in such cases).

For better understanding and to interpret the visual field systematically the single field analysis printout is divided into 10 zones. Braodly these ten zones can be classified into two groups:

1. Zones - Independent of normative data and STATPAC analysis
2. Zones - Dependent on normative data and STATPAC analysis.

Zones - Independent of normative data and STATPAC analysis

Zone 1: Patient data / test data

Zone 2: Reliability indices / foveal threshold

Zone 3: Raw data

Zone 4: Gray scale

Zones- Dependent on normative data and STATPAC analysis

Zone 5: Total deviation numerical plot,

Zone 6: Total deviation probability plot

Zone 7: Pattern deviation numerical plot,

Zone 8: Pattern deviation probability plot

Zone 9: Global indices—Mean Deviation Index in dB value and with its P value. Pattern Standard Deviation (PSD) in dB value and with its P value, Corrected Pattern Standard Deviation (CPSD) in dB value and with its P value. Short-term Fluctuation (SF) in dB value.

Zone 10: Glaucoma hemifield test :

a. Out side normal limits
b. Border line
c. Abnormally low sensitivity,
d. Abnormally high sensitivity,
e. Within normal limits.

From the above classification, it is understood that if normative data is not available, the zones dependent on normative data—STATPAC analysis will not be seen in the visual printout charts.

SINGLE FIELD ANALYSIS PRINTOUTS WITH STATPAC ANALYSIS

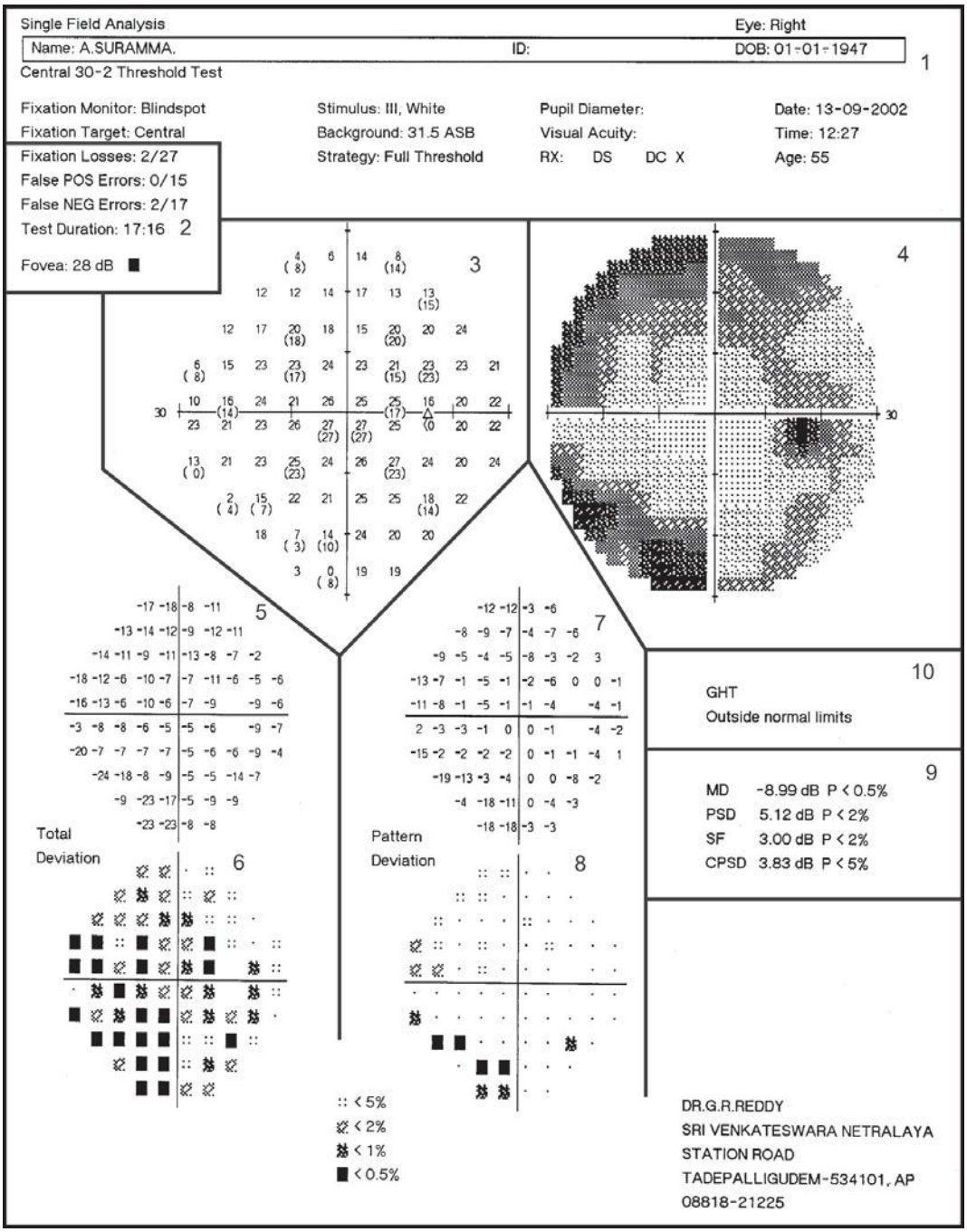
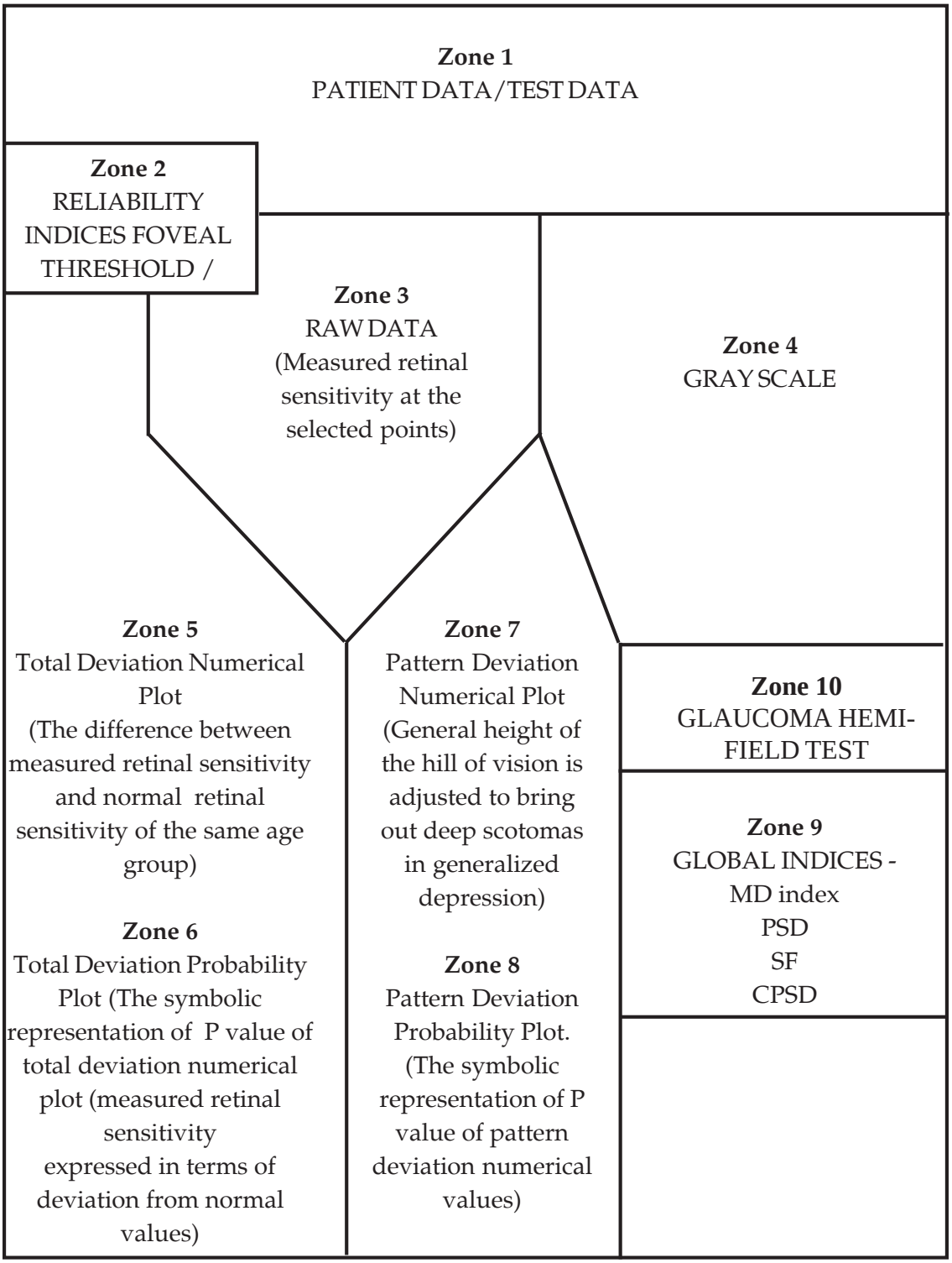


FIGURE 3.1

To understand single field analysis printout systematically we recommend the single field analysis printout to be divided into 10 Zones as shown below.



ZONE 1- PATIENT'S DATA AND TEST DATA

Patients data:

Name of the patient :
Date of birth and age :
Pupil diameter :
Visual acuity :
Refractive error correction for N.V.

The test data includes:

fixation monitor - Blind spot
fixation target - Central
Colour of the stimulus - White
back ground illumination - 31.5 asb
stimulus size - Goldmann size III
Threshold test pattern
Testing strategy

In the test data, fixation monitor (Blind spot), color of the stimulus: white, background illumination 31.5 asb are constant parameters. The fixation target (Central), stimulus size III, threshold test pattern and testing strategy vary according to the clinical conditions subjected to visual field examinations.

Fixation target :

The fixation targets are of four types:

1. **Central—**Yellow light in the center of the bowl
2. **Small diamond —**It is located below the central target and should be used if the patient cannot see the central fixation light (e.g : macular degeneration). The patient should look in the center of the diamond formed by the four lights.
3. **Large diamond—**It is located below the central target and is used for patient with central scotoma who cannot see either central fixation light or small diamond.

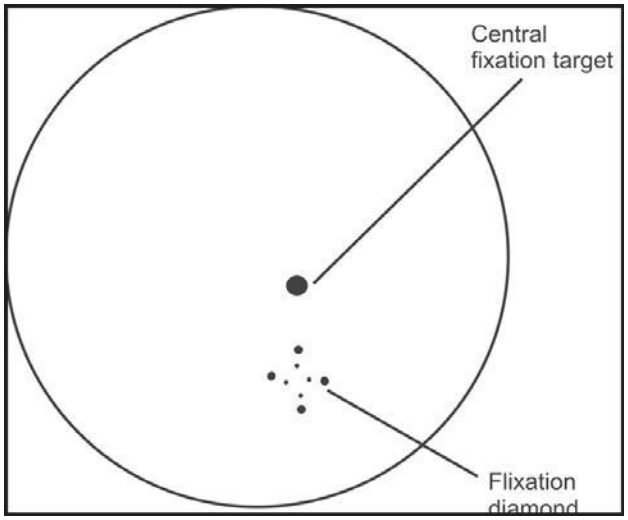


FIGURE 3.2

4. **Bottom LED—**Some tests have points in the superior visual field that require a lower fixation light than the central target. The target used is the bottom LED of the large diamond. When testing with the superior 64 or superior 36 screening speciality tests, the bottom LED is the default fixation target. It is automatically illuminated at the beginning of a test.

Size of the stimulus: The standard size of the stimulus is size III for all routine tests. But in situations like advanced glaucoma, the test will be conducted with size V to know the status of macular split.

Age of the Patient

Since the interpretation of raw data by STATPAC is age dependent, it it is the very important to enter the age of patient accurately. Otherwise the patient's raw data will be compared to mean normal threshold values of a wrong age group and thus derived decibel deviations from normal will form total deviation numerical plot. Thus, we will get inaccurate total deviation numerical plot. So, all the deviations values of total deviation numerical plot will be inaccurate and the essence of the test is inaccurate. For example, if the age of the 70 years old patient was entered as 30 years old and the raw data of the 70 years old patient will be compared to 30 years old age group's mean normal values and thus we get the wrong test analysis. Normally, 70 years old patient's raw data should be compared to the same age group's mean normal threshold values to get the correct analysis. Suppose by mistake if the age of the patient is wrongly entered but all the other parameters are normal and the reliability indices are excellent what is your reaction? Do you ignore the test completely?

The answer is no, because the raw data that is obtained is correct. Only the raw data and the gray scale will be taken into consideration because these two results depend on patient's response to the stimuli. Because the correct raw data is compared to the mean normal values of different age groups (because the date of birth of the patient is wrongly entered) the decibel deviation at each point plotted in total deviation numerical plot is inaccurate. Because the total deviation probability plot, pattern deviation plots, global indices and glaucoma hemi field test are all derivatives of inaccurate total deviation numerical plot, we don't take them into consideration.

Effect of the Size of the Pupil

Normally the size of the pupil should be between 3-4 mm. (The stored mean normal values of the normal population are obtained with the pupil size 3-4mm). Constricted pupil is thought to give rise to diffuse visual field depression or edge scotomas. Pupil less than 2 mm is more likely to exert a significant effect on the overall level of the visual field particularly if media opacity is present in the visual axis. So it is recommended that the pupil less than 2 mm size should be dilated before we conduct the test. To note the size of the pupil is very important particularly in the follow up tests. Before interpreting the follow up field test we should always see that the size of the pupil of the present test and previous test. On the average the size of the pupil must be within the normal limits (3 to 4 mm), otherwise there is a chance for misinterpretation.

Refractive Error

The patient's near vision refractive error must be properly corrected. Otherwise the visual field will show generalized depression. Besides not only correcting the refractive error for near vision, but also we should see that the glasses are properly placed in the trail frame of the automated perimeter and the correcting lens should be very close to the testing eye. Otherwise it can produce artefacts. If visual acuity explains the measured foveal threshold of the patient and *vice versa*, it indicates that the refractive error correction for near vision is proper.

ZONE 2- FOVEAL THRESHOLD AND RELIABILITY INDICES

Foveal Threshold and Visual Acuity

It may be useful to measure foveal threshold at the very beginning of the test. If the patient is not properly focused on the interior of the bowl, the foveal sensitivity will be reduced along with the remainder of the field. **If the patient has good visual acuity and significant reduction in the foveal threshold then the technician should become alert to know that the optical correction is not correct.**

Reliability Indices

The reliability indices include the fixation losses, false positive errors, false negative errors and Short-term fluctuations. Even if the test has very low reliability criteria this does not necessarily imply that the field will provide no useful information. It is just that such fields are not included in the data bases hence such fields should be interpreted with more caution.

Fixation Losses

During the test itself 5 % of the stimuli will be presented on to the blind spot. The patient's response to this stimulus presentation is due to shift of fixation.

Importance of locating blind spot before interpreting the visual field analysis.
100% fixation losses in Figure 3.3 resulting from proper localization of the blind spot followed by performance of the test while fixating on the lower fixation target instead of the center.

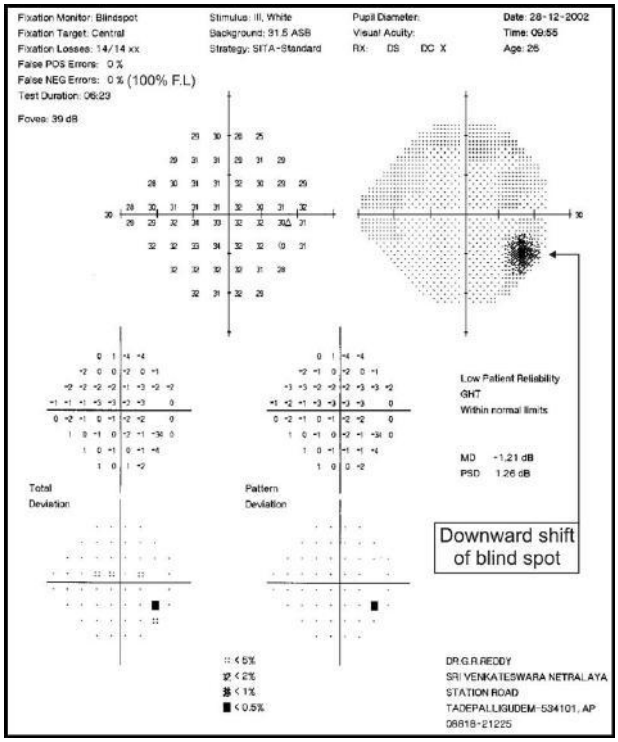


FIGURE 3.3

The fixation losses > 20% are considered to be unreliable:

An unusual cause for high fixation losses is shown in the Figure 3.3. The blind spot was correctly localized, indicated by the small triangle just below the horizontal meridian 15 degrees temporal to fixation (fixation is at the intersection of the vertical and horizontal axes: each hash mark on the axes is 10 degrees) however, the patient performed the test while fixing on the lower fixation target in the bowl. This served to move his actual blind spot down; this point measured 4 dB and then 0 dB and appears as a black spot below the horizontal on the gray scale. Since the machine thought the blind spot was in the area indicated by the triangle, and the eye was rotated down, each fixation loss catch trail was in actuality projected on to seeing retina and elicited a response, resulting in the 100% fixation loss rate recorded. Care must be taken in all aspects of test performance to avoid such problems.

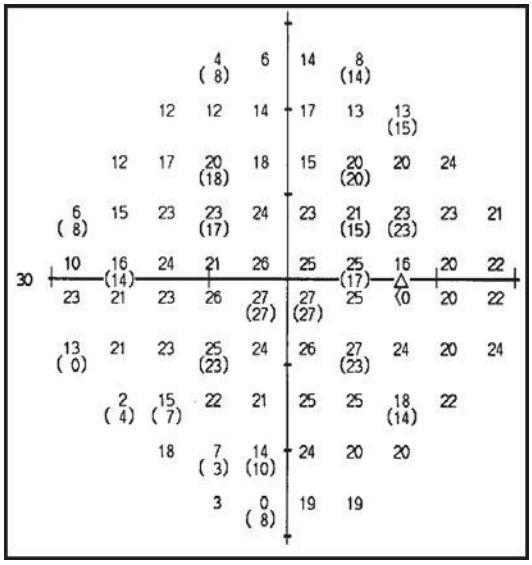
False Positive Response

If the patient pushes the response button to the non projected stimulus it will be recorded as false positive response. **Most patients will have some false positive responses during the test and up to 20% rate is considered to be acceptable**. If the false positive rate exceeds 33%, the printout will indicate so by printing "XX"next to the rate ("XX" next to any of the indices is considered to be unacceptable by the machine and indicative of unreliable). With high rate of false positive responses the gray tone printouts show multiple white scotomas corresponding to areas of abnormally high sensitivity.

False Negative Response

Failure to respond to the brightest stimulus in an area previously determined to have some sensitivity is a false negative response. High false negatives may indicate lack of attentiveness, fatigue or hypnosis. In general greater than 20% rate of false negative response is considered to be abnormal though the machine defaults to 33%. **Fields should not be considered unreliable solely upon a false negative response rate, particularly if there is a great deal of pathology. In patients with advanced glaucomatous optic nerve damage we may get more than 50% false response which can be attributed in small shifts in fixation.**

ZONE 3- RAW DATA



Measured retinal sensitivity (raw data)

FIGURE 3.4

The raw data is the exact retinal sensitivity in dB units of the selected points calculated by field analyzer. Only the numerical values of the retinal sensitivity is displayed in the raw data and the dB units are omitted. In the raw data '0' indicates absolute scotoma (no response to the maximum intensity of light intensity-10,000 asb in Humphrey field analyzer.) The numerical 40 indicates response to 1 asb unit. The numerical 40 is the highest retinal sensitivity that can be recorded by the Humphrey field analyzer because 1 asb unit of light intensity is the dimmest light that can be projected by Humphrey field analyzer. In the same patient the raw data calculated by different strategies is not exactly similar. That is why, for follow-up tests we also select the same strategy what was used for the previous test. Then only the result of the latest test will be compared with the previous tests. By seeing the measured retinal senstivity value at each point we can not tell whether the measure retinal sensitivity is normal or decreased since we do not know the normal sensitivity value at that point. As the computer stores the mean normal value of each point, the raw data will be compared with the mean normal value and calculates the difference between measured retinal sensitivity and the mean normal retinal sensitivity at all points and plot them as total deviation numerivcal plot. So, that, it is easy for anyone to identify the change in retinal sensitivity from total deviation numerical plot. Now, the Humphrey field analyzer with the help of the STATPAC (The Humphrey field analyzer's statistical package) analyzes the total deviation numerical plot.

ZONE 4- GRAY SCALE

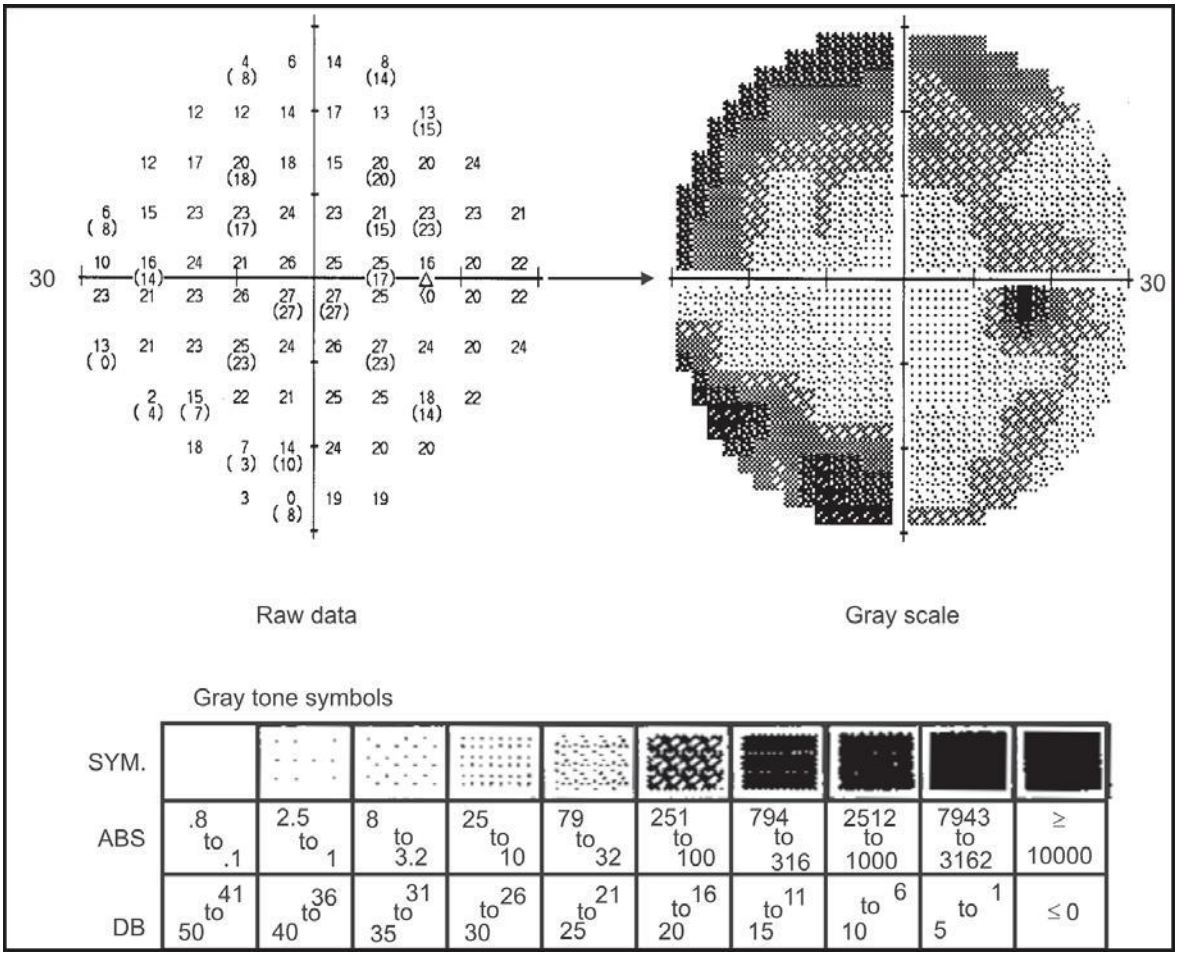


FIGURE 3.5

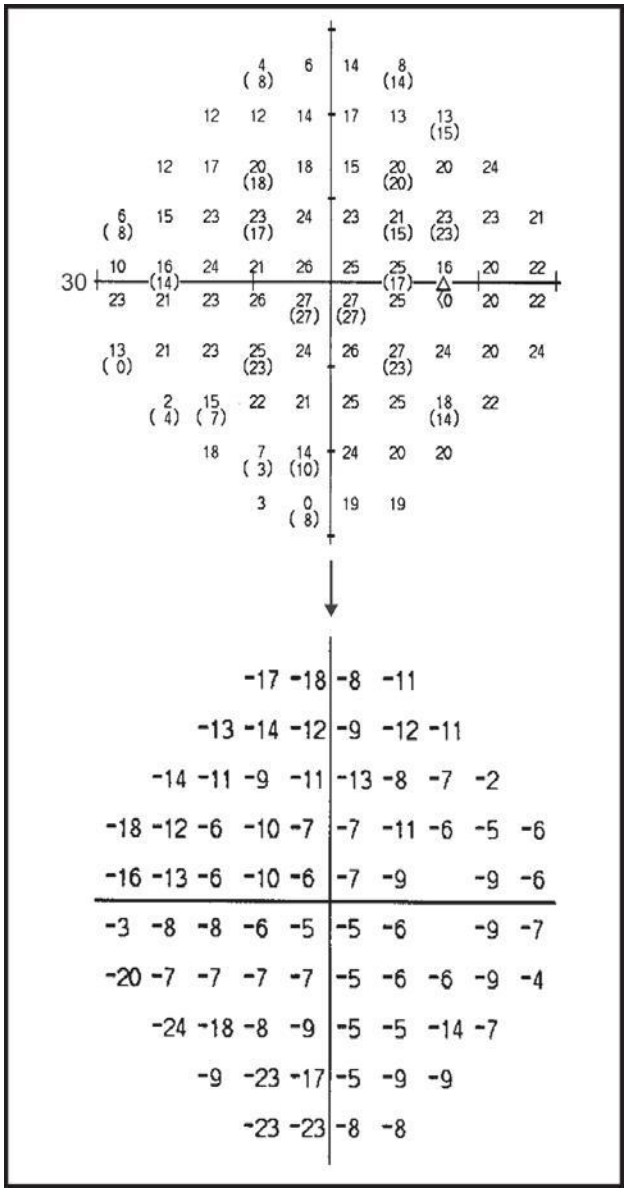
The retinal sensitivity values from 0 to 50 dB are divided into 10 groups. Each step of the pattern corresponds to a change of 5 dB intensity, except the first column represented by 41 to 50 dB and 0 to 10 dB is represented by 10th column. Now, the numerical values of the raw data in (dB) units are presented graphically according to a gray scale format in which, areas of high sensitivity are denoted by lighter shades and areas of low sensitivity are denoted by darker shades. **The conversion of the raw data to gray scale does not involve any statistical calculations or normative analysis**. We dont make any diagnosis on the basis of gray scale. It only gives beauty to the printout format. In high false positives, areas of white zones will be appreciated. When there are high false negatives the gray scale gives a clover leaf appearance. The gray scale is also useful to explain the seriousness of the condition to the patient.

ZONE 5- TOTAL DEVIATION NUMERICAL PLOT

Total deviation plot contains total deviation numerical plot and total deviation propability plot.

Total Deviation Numerical Plot (TDNP)

The measured retinal sensitivity (raw data) is now compared with the mean normal retinal sensitivity of those points of the same age group of the patient and calculates the difference between them at each point and plots them as total deviation numerical plot. So, the total deviation numerical plot is nothing but raw data expressed in normal values.



Total deviation numerical plot

FIGURE 3.6

If the measured retinal sensitivity is equal to mean normal values of the same age group, 0 will be displayed in the total deviation numerical plot. If the measured retinal sensitivity is better than mean normal values of the same age group, no sign is given to the deviation value that is displayed in the total deviation numerical plot. If the measured retinal sensitivity is less than mean normal values of the same age group, (-)ve sign is given to the deviation value that is displayed in the total deviation numerical plot. In other words 0 in the total deviation numerical plot tells the measured retinal sensitivity is equal to mean normal values of the same age group. The numerical value without sign (possitive) in total deviation numerical plot indicates the measured retinal sensitivity is better than mean normal values of the same age group. The numerical value with (-)ve sign in the total deviation numerical plot indicates the measured retinal sensitivity is worse than the mean normal values of the same age group. The loss or change of retinal sensitivity will be better appreciated by the deviation values of the TDNP. If there is no field loss, TDNP must have the deviation values in the range of 0 to -2db. If there is a localized field defects, we can identify them by locating high deviation values at those particular areas. If there is a uniform generalized field loss, all the deviation values will be almost symmetrical and the difference between the maximum and minimum deviation values will be minimal. In irregular generalized field defect, the deviation values in TDNP will show dissimilar deviation values and the difference between the maximum and minimum deviation values will be very high.

The total deviation numerical plot becomes the platform for the calculations of global indices (Mean deviation index and pattern standard deviation), and the box plot formation in the change analysis printout. The total deviation numerical plot will be converted into pattern deviation numerical plot to highlight localized field defects masked by generalized field defect. The conversion of total deviation numerical plot to pattern deviation numerical plot will be discussed in detail in Zone 7.

CONVERSION OF NUMERICAL DATA TO PROBABILITY DATA (P VALUE)

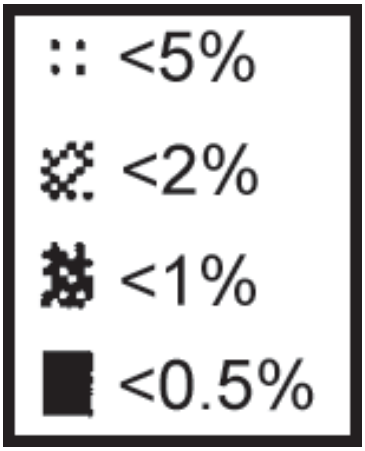


FIGURE 3.7

P < 5% indicates the retinal sensitivity of that point is seen in < 5% of normal population. The P value < 5% is represented by -

P < 2% indicates the retinal sensitivity of that point is seen in < 2% of normal population. The P value < 2% is represented by -

P < 1% indicates the retinal sensitivity of that point is seen in < 1% of normal population. The P value < 1% is represented by -

P < 0.5% indicates the retinal sensitivity of that point is seen in less 0.5% of normal population. The P value < 0.5% is represented by -

Before we talk about total deviation probability plot, we should have a very good concept on P value. The probability statements are based on the distribution seen in the normal population. Saying that less than 0.5% of the normal population deviates from the normal by a certain amount, means just that and no more. It does not mean that there is only a 0.5% (P < 0.5%) chance that the result is normal. Please note that the darker the symbol the greater the probability of abnormality as indicated by P value. From this we understand that higher the P value lesser the chances the field being abnormal. If the measured retinal sensitivity which is expressed in terms of deviation from normal values is seen in less than 0.5% normal population the measure retinal sensitivity or the corresponding deviation value in total deviation numerical plot is expressed as P < 0.5% and represented by dark square. Thus each numerical value in the total deviation numerical plot depending on its P value is assigned the corresponding symbol of P value. If the measured retinal sensitivity has the P value 0.5% what exactly it means is that the measured retinal sensitivity of the point is seen in one in two hundred normal population of the patients age group. But it never tells that the measured retinal sensitivity is abnormal or diseased. It only tells that the retinal sensitivity at that point is seen in one in two hundred normal population of the patients age group. Because it is seen in one in two hundred normal population and clinically we are suspecting abnormality at that location we presume that point is abnormal or diseased.

The global indices which include mean deviation index and pattern standard deviation values are also expressed interms of their P values. For these P values no symbol is given.

ZONE 6- TOTAL DEVIATION PROBABILITY PLOT

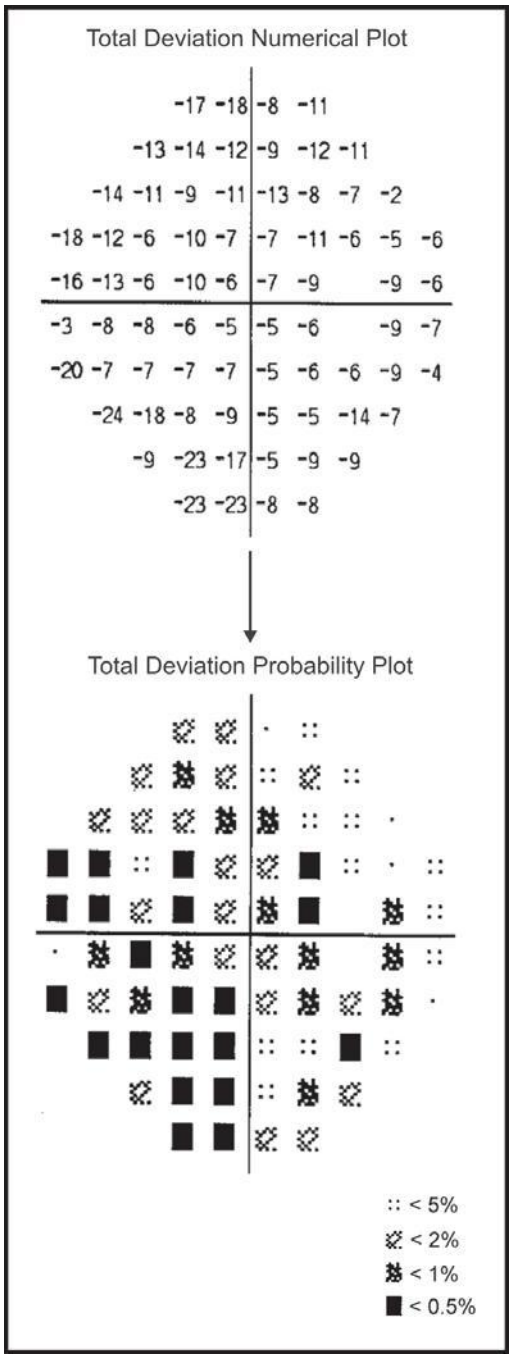


FIGURE 3.8

STATPAC calculates the P value of each decibel deviation in the total deviation numerical plot. A symbol is given to each P value as shown in the fig.3.7. Thus each deviation value in the total deviation numerical plot is converted to symbolic form according to its P value and plotted as total deviation probability plot. If you carefully observe the total deviation numerical plot, the deviation value more than –8 dB has the P < 0.5% which is represented by black square in the total deviation probability plot. So the black square is representing a wide range of deviation values from –8 to –24 dB in this total deviation numerical plot. By seeing the black squares in the total deviation probability plot we cannot tell the depth defect of that point whether its value is –8 dB or –12dB or –24dB, etc. This is the most important draw back of the total deviation probability plot. In order to over come this drawback the pattern deviation plots are created from total deviation plots by the STATPAC of the Humphrey field analyzer.

The main aim of the field chart is to show the field loss in scotomatous form. Each deviation value of the total deviation numerical plot is given a symbol on the basis of its P value as shown in the Figure 3.7. Thus the numerical values are converted into symbolic form of the P value of the deviation values of total deviation numerical plot.

ZONE 7 - PATTERN DEVIATION NUMERICAL PLOT

Pattern Deviation Plot:

Pattern deviation plot contains pattern deviation numerical plot and pattern deviation probability plot.

The main function of pattern deviation plot is to expose localized defects that may be masked by either a generalized depression or an elevation of the hill of vision.

Conversion of total deviation numerical plot to pattern deviation numerical plot

The conversion total deviation numerical plot to pattern deviation numerical plot can be represented by three steps.

Step 1 : Selection of 7th best retinal sensitivity point of TDNP

The most important key point for the conversion of total deviation numerical plot to pattern devia tion numerical plot is the selection of 7th best retinal sensitivity point in the total deviation numerical plot. (TDNP) Before selecting 7th best retinal sensitivity point in TDNP the following points are to be noted.

1. The three points nearer to the blind spot are ignored.
2. In 30-2 point pattern only points of 24-2 point pattern (the subset of 30-2 point pattern) is considered after ignoring the 3 points nearer to the blind spot. (Total number of points - 51)
3. In 24-2 point pattern only the 3 points nearer to the blind spot are ignored. (Total number of points - 51)
4. In 10-2 point pattern all points are considered Since there is no blind spot in 10° field (Total number of points - 68)

Now, the computer selects the 7th best retinal sensitivity points in the total deviation numerical plot after ignoring the above mentioned points

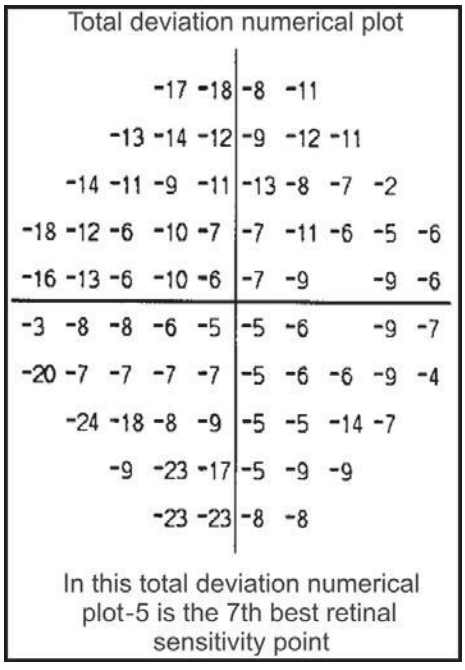


FIGURE 3.9

For convenience sake, to select the 7th best retinal sensitivity point the numerical values of total deviation numerical plot are divided into three groups.

First group : The points whose retinal sensitivity is better than normal sensitivity values are represented by numbers with out sign in total deviation numerical plot. **In this total deviation numerical plot there is no point whose retinal sensitivity is better than normal retinal sensitivity value.**

Second group : The points whose retinal sensitivity is equal to normal sensitivity values are represented by 0 in total deviation numerical plot. **In this total deviation numerical plot there is no point whose retinal sensitivity is equal to normal retinal sensitivity value.**

Third group : The points whose retinal sensitivity is less than normal sensitivity points are represented by numbers with (–) ve sign in total deviation numerical plot.

Step 2 : 7th best retinal sensitivity of TDNP is converted to 0

The calculated 7th best retinal sensitivity point in this total numerical plot is -5. Add + 5 to convert the 7th best deviation value to 0. (By adding + 5 we are making the sensitivity of the 7th best retinal sensitivity point to normal threshold value of the same age group, the general height of hill of vision is increased by 5 dB and 7th best retinal sensitivity becomes a point in the normal contour of hill of vision.

Step 3 : Addition of the threshold value that converts the 7th best retinal sensitivity of TDNP to 0 to all points in TDNP

Add + 5 (The numerical value that makes the 7th best retinal sensitivity value to 0) to all the decibel deviation values of total deviation numerical plot including the ignored points while selecting the 7th best deviation value point. Thus the total deviation numerical plot is converted to pattern deviation numerical plot. By adding + 5 to all the points the general height of hill of vision is increased by 5 dB. **By adding + 5 to all the points the general height of hill of vision is increased but the contour of hill of vision is not changed.**

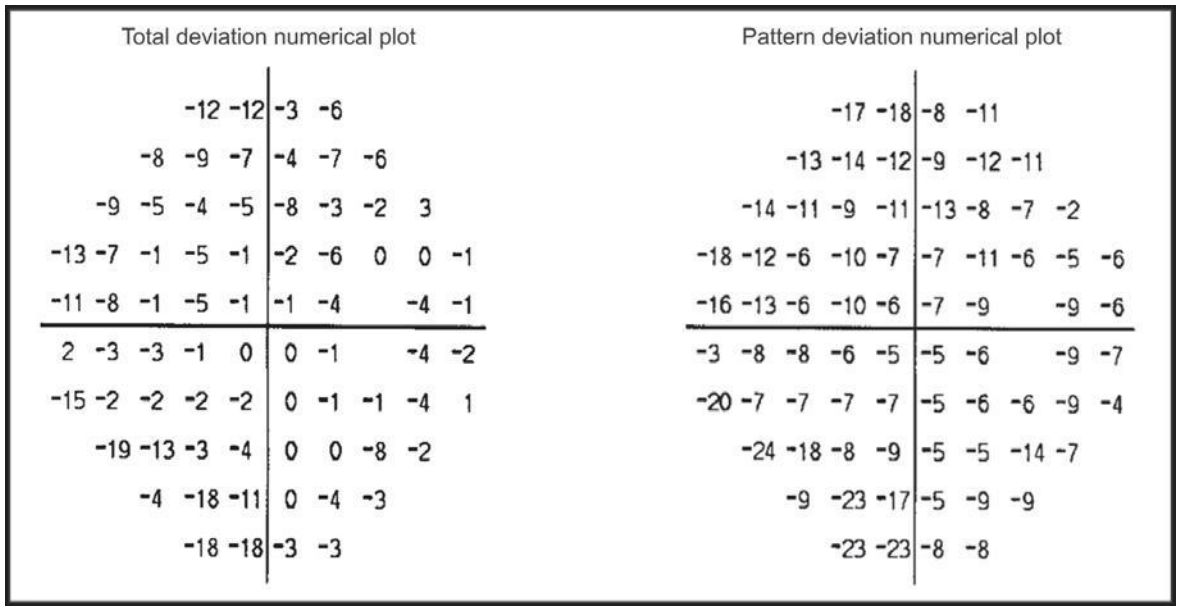


FIGURE 3.10

Adjustment of general height of vision: The outer set of points of 30-2 are eliminated as shown in the figure and the 7th best point of the remaining 51 points is adjusted to 0 deviation.

The pattern deviation numerical plot is not true representation of the measured retinal sensitivity unlike the total deviation numerical plot. The pattern deviation numerical plot is a modified form of TDNP to bringout deep scotomas. In pattern deviation plot, the measured retinal sensitivity of each point is elevated by the dB units that converts 7th best retinal sensitivity point of TDNP to normal. Thus by elevating the retinal sensitivity at each point, the P value of each point is changed. Some point's P value becomes non significant. But some points still have significant P value and some points retain their P value < 0.5%. So the total deviation numerical plot is converted to pattern deviation plot to highlight those points, which have significant P value even after elevating the retinal sensitivity by dB value which converts the 7th best retinal sensitivity point of total deviation numerical plot to normal. The pattern deviation numerical plot is also the basis for glaucoma hemi field test analysis.

ZONE 8 - PATTERN DEVIATION PROBABILITY PLOT

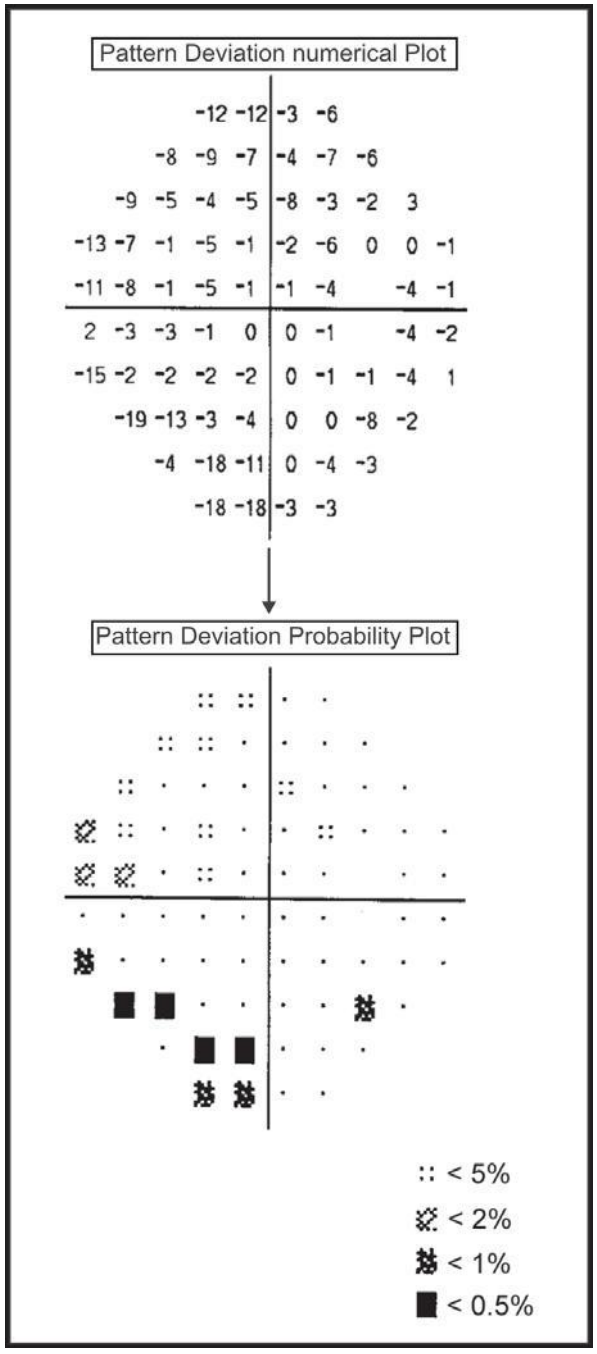


FIGURE 3.11

The pattern deviation probability plot is the symbolic representation of P value of each numerical threshold deviation values of pattern deviation numerical plot or the symbolic representation of P value of each measured retinal sensitivity corrected for generalized loss. Thus the numerical values of the pattern deviation are converted into symbolic form of P value.

The total deviation plot is converted to pattern deviation plot to bring out deep scotomas in a generalized depression.

The total deviation numerical plot is changed to pattern deviation numerical plot in such away that the mild to moderate degree of decibel deviations are eliminated and only greater degree of decibel deviations are highlighted in pattern deviation numerical plot. In a generalised depression to get a scotoma in pattern deviation probability plot, the generalized depression should be of irregular nature. In uniform generalised depression, we do not see any scotoma in the pattern deviation probability plot. In irregular generalised depression the mild and moderate field defects are elimilated and the deep defects are highlighted in the pattern deviation probability plot. This is the basic concept behind the 2 probability plots in the single field analysis. **The main aim of the pattern deviation probability plot is to differentiate uniform generalized depression from the irregular generalized depression. The pattern deviation probability plot is almost normal in uniform generalized depression and in irregular generalized depression the pattern deviation probability plot shows localized field defects and the location of deep scotomas (Pattern) masked by generalized depression.**

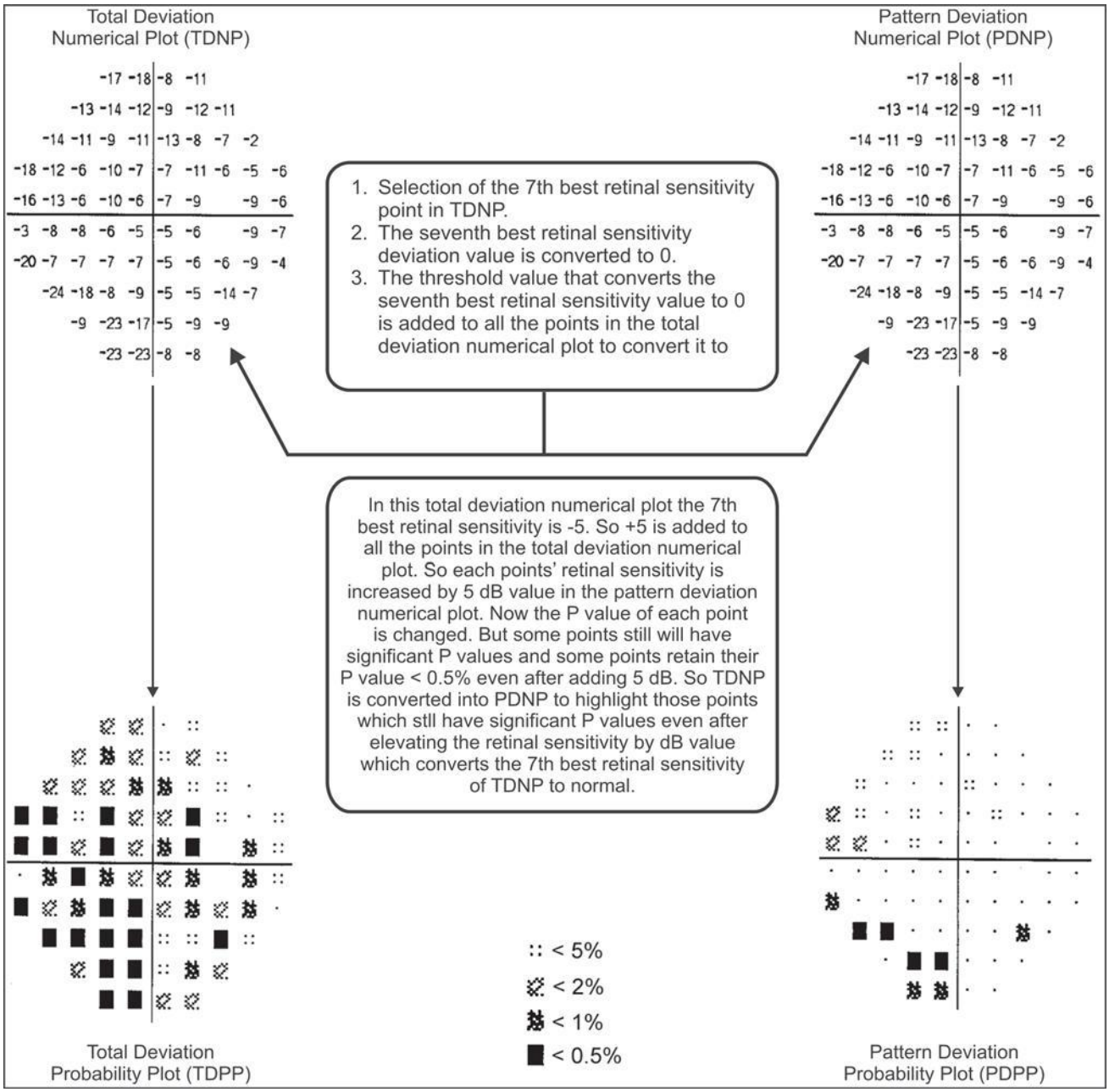

Total Deviation
Numerical Plot (TDNP)
Pattern Deviation
Numerical Plot (PDNP)
1. Selection of the 7th best retinal sensitivity point in TDNP.
2. The seventh best retinal sensitivity deviation value is converted to 0.
3. The threshold value that converts the seventh best retinal sensitivity value to 0 is added to all the points in the total deviation numerical plot to convert it to
In this total deviation numerical plot the 7th best retinal sensitivity is -5. So +5 is added to all the points in the total deviation numerical plot. So each points' retinal sensitivity is increased by 5 dB value in the pattern deviation numerical plot. Now the P value of each point is changed. But some points still will have significant P values and some points retain their P value < 0.5% even after adding 5 dB. So TDNP is converted into PDNP to highlight those points which stll have significant P values even after elevating the retinal sensitivity by dB value which converts the 7th best retinal sensitivity of TDNP to normal.
:: < 5%
< 2%
< 1%
< 0.5%
Total Deviation
Probability Plot (TDPP)
Pattern Deviation
Probability Plot (PDPP)

FIGURE 3.12

ZONE 9 - GLOBAL INDICES

There are three basic concepts that help to understand the usefulness of visual field indices or global indices:

1. Visual field loss tends to occur in a diffuse pattern, a localized pattern or a combination of the two;
2. It is clinically useful to determine which of the two components (diffuse or localized loss) is changing more rapidly; and
3. If the information regarding the amount of diffuse vs. localized loss and the relative rate of change of each can be quantified and then reduced to a simple number, the clinician can assess valuable information about each of these parameters at a glance.

The basic global field indices

1. Mean deviations (MD)
2. Short term fluctuation (SF)
3. Pattern standard deviation (PSD)
4. Corrected pattern standard deviation (CPSD)

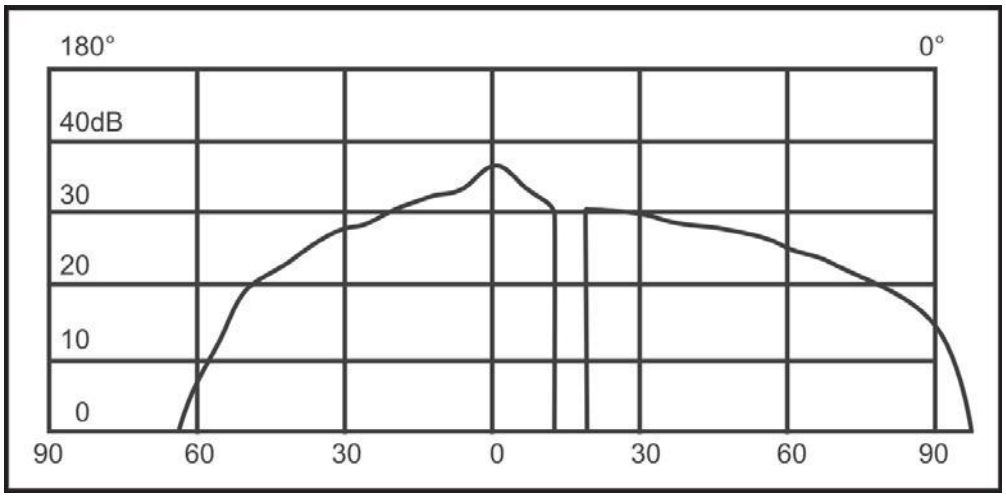


FIGURE 3.13

To understand global indices we should have clear concept on hill of vision. In the normal visual field the fovea is the highest retinal sensitivity point. So the peak of the hill of vision is represented by the fovea and retinal sensitivity decreases as it moves away from the center (fovea) to the periphery. This drop of sensitivity from centre to periphery gives characterstic shape and contour to the hill of vision. The slope of normal hill of vision is quite smooth. The normal shape and height of hill of vision are shown in the figure. When we talk about hill of vision the most important points to be focussed are the height of hill of vision and the smooth contour of the hill of vision. The change in the retinal sensitivity will affect either the height of hill of vision or the smooth contour of the hill of vision or both. To express the height of hill of vision and the contour of hill of vision the global indices are developed. The mean deviation index expresses the change in the height of hill of vision and the PSD expresses the change in smoothness of the contour of the hill of vision.

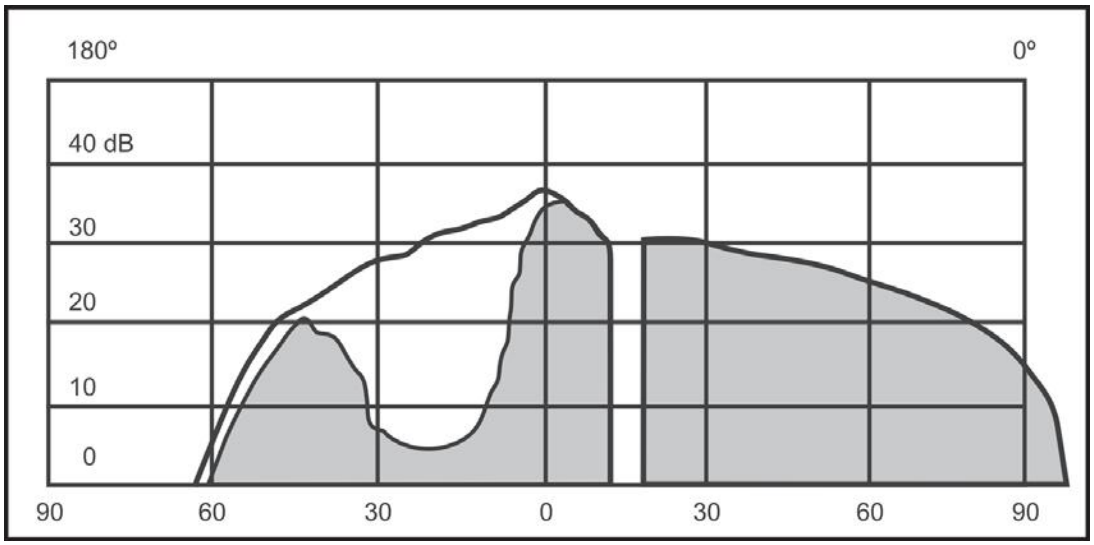


FIGURE 3.14

A localized loss of retinal sensitivity will not affect the height of hill of vision but the smooth contour of hill of vision becomes irregular. The contour of hill of vision. is an index of localized defect indicated by high PSD value.

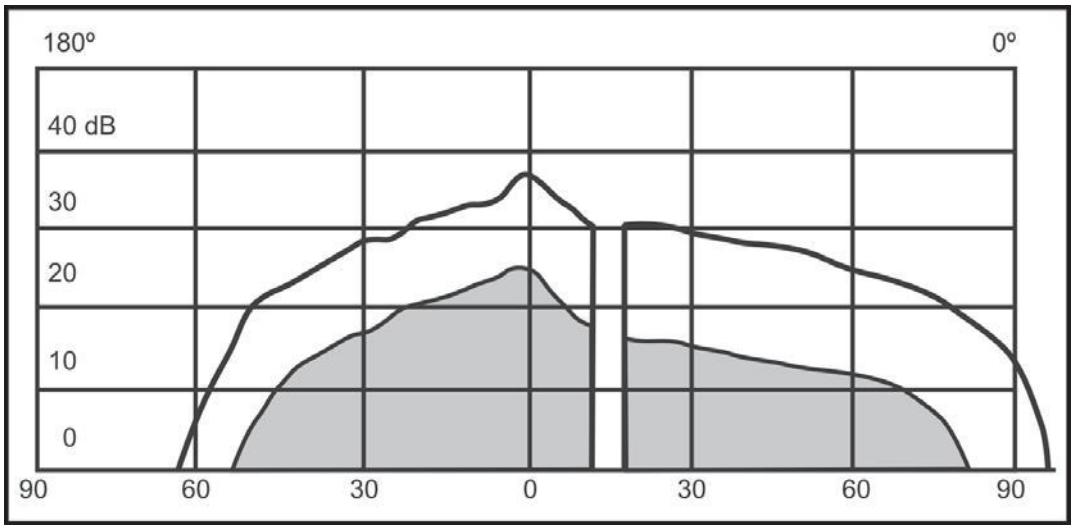


FIGURE 3.15

The uniform generalized depression will not affect the smooth contour of hill of vision (0 PSD value) but decreases the height of hill of vision (high MD index).

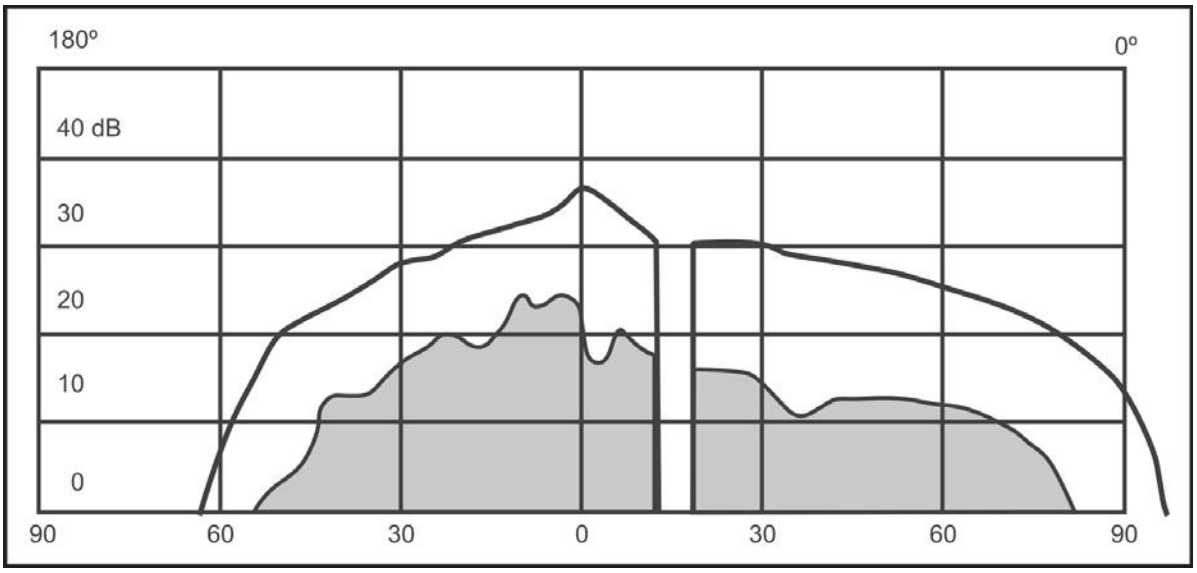


FIGURE 3.16

The generalized depression is associated with irregular loss of retinal sensitivity will have irregular contour of hill of vision (high PSD value) and decrease in height of hill of vision (high MD index).

MEAN DEVIATION

		-17	-18	-8	-11				
	-13	-14	-12	-9	-12	-11			
-14	-11	-9	-11	-13	-8	-7	-2		
-18	-12	-6	-10	-7	-7	-11	-6	-5	-6
-16	-13	-6	-10	-6	-7	-9		-9	-6
-3	-8	-8	-6	-5	-5	-6		-9	-7
-20	-7	-7	-7	-7	-5	-6	-6	-9	-4
	-24	-18	-8	-9	-5	-5	-14	-7	
		-9	-23	-17	-5	-9	-9		
			-23	-23	-8	-8			

Total deviation numerical plot (TDNP)

FIGURE 3.17

The mean deviation index signifies average overall severity of field loss. In principle, it is the average of all the numbers shown in the total deviation plot except the two points nearer to the blind spot. The deviation from normal at each point is weighed according to the variance of the normal values at that location, Thus points with low variance-that is, closer to fixation-affect the MD value more than eccentric points, which have a higher variance. The mean deviation is expressed in dB units with P value. The positive value indicates that the patient's overall sensitivity is better than normal observer where as negative value indicates that the patient's overall sensitivity is worse than the average normal individual.

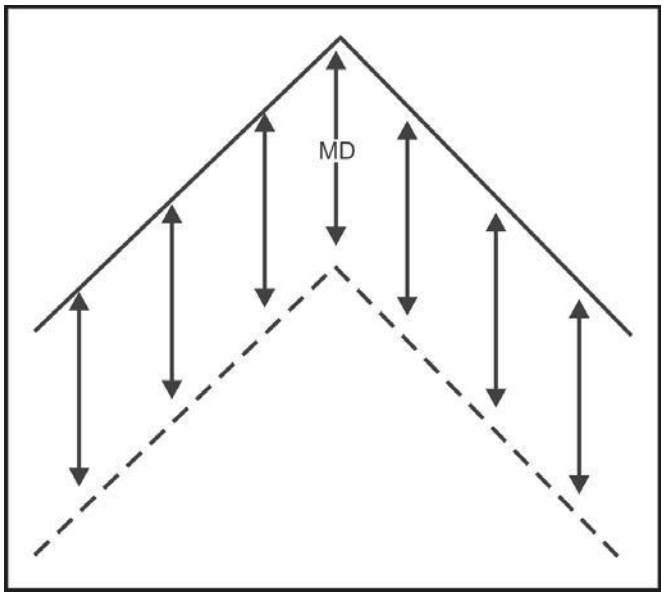


FIGURE 3.18

The sensitivity profile ('hill of vision") of the normal visual field is depicted by the solid diagonal lines. and a general depression of visual field sensitivity is depicted by the dashed line. The mean deviation (MD) is the amount of visual field depression relative to normal, as indicated by the length of the arrows. usually, the sensitivity depression is not exactly the same at all locations, in which case the MD is the average amount of loss.

If the MD is lower than that found in 10% of the normal subjects in the perimeter's database, a significant level is printed ($p > 10\%$, $p < 5\%$, $p < 2\%$, $p < 1\%$, or $p < 0.5\%$), making it unnecessary to memorize the corresponding limits of normality. No probability statement is given for supernormal findings.

Role of MD index in the dignosis of early glaucoma : Rarely mean deviation falls outside the normal range by virtue of glaucoma without first producing one of the diagnostic signs of a localized defect. If we suspect glaucoma on the basis of assymmetry of intra ocular pressure or of disc cupping, the difference of mean deviation index between both the eyes, should be taken as a serious clue in conforming the diagnosis of glaucoma. (1) 2 dB difference of mean deviation index between the two eyes. (2) An average 1.5 dB difference must be maintained between the two eyes on two consecutive tests. (3) An average difference of 1 dB must be maintained between the two eyes on four consecutive tests.

Role of MD index in the follow-up tests : In change analysis follow-up tests, the change in mean deviation index per year will be calculated. Normally mean deviation index will be changed by 0.08 dB to 0.1 dB per year. If the mean deviation index changes more than 0.1 dB per year, it gives a message that the mean deviation is significant at P value 5% and it also gives the magnitude of the change of mean deviation index. In glaucoma change probability analysis, a change in mean deviation index of the patient will be compared to the change in deviation index among of stable glaucoma patients. The amount of change in decibels is printed under the message MD change. If the MD change is significant at the 10%, 5% or 2.5% level that P value is printed along with a solid triangle to indicate degradation or an open triangle to indicate improvement. If the amount of change is not judged to be significant, the words non-significant follow the decibel value.

PATTERN STANDARD DEVIATION

PSD is developed to express the irregular loss of retinal sensitivity. The irregular loss of retinal sensitivity can be in the form of localized field loss or generalized field loss. The PSD can be better understood when it is correlated with the concept of hill of vision. The hill of vision has two components: 1) Height of hill of vision (represented by mean deviation index), 2) The contour of hill of vision (represented by PSD value). The irregular contour of hill of vision will be represented by high PSD value. When the PSD value is 0 or not significant the contour of hill of vision will be smooth.

Specifically the PSD is the standared deviation around the mean that constitutes the MD index and indicates the degree to which the numbers in the total deviation numerical plot are not similar to each other.

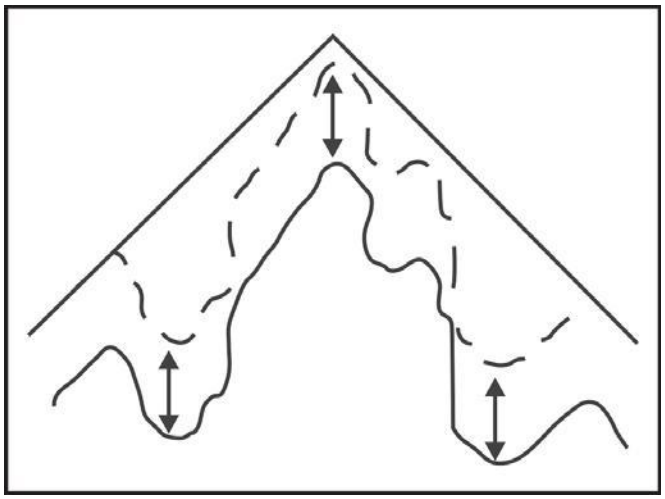


FIGURE 3.19

The slope of the normal visual field is quite smooth, as depicted by the upper solid diagonal lines in Figure 3.19. If the visual field profile of a patient is also smooth like this, the PSD will be close to zero. The lower solid line that is irregular, depicts the visual field of a patient with localized visual field loss. The dashed line represents the adjustment of the visual field profile to account for the average or generalized deviation of the visual field from normal. Here even after adjusting the height of the visual field to account for the average deviation from normal, there are irregular departures from the normal slope. It is either zero (no departure from the average normal slope of hill of vision) or a positive number. The higher the number the greater the depature from the normal slope of hill of vision.

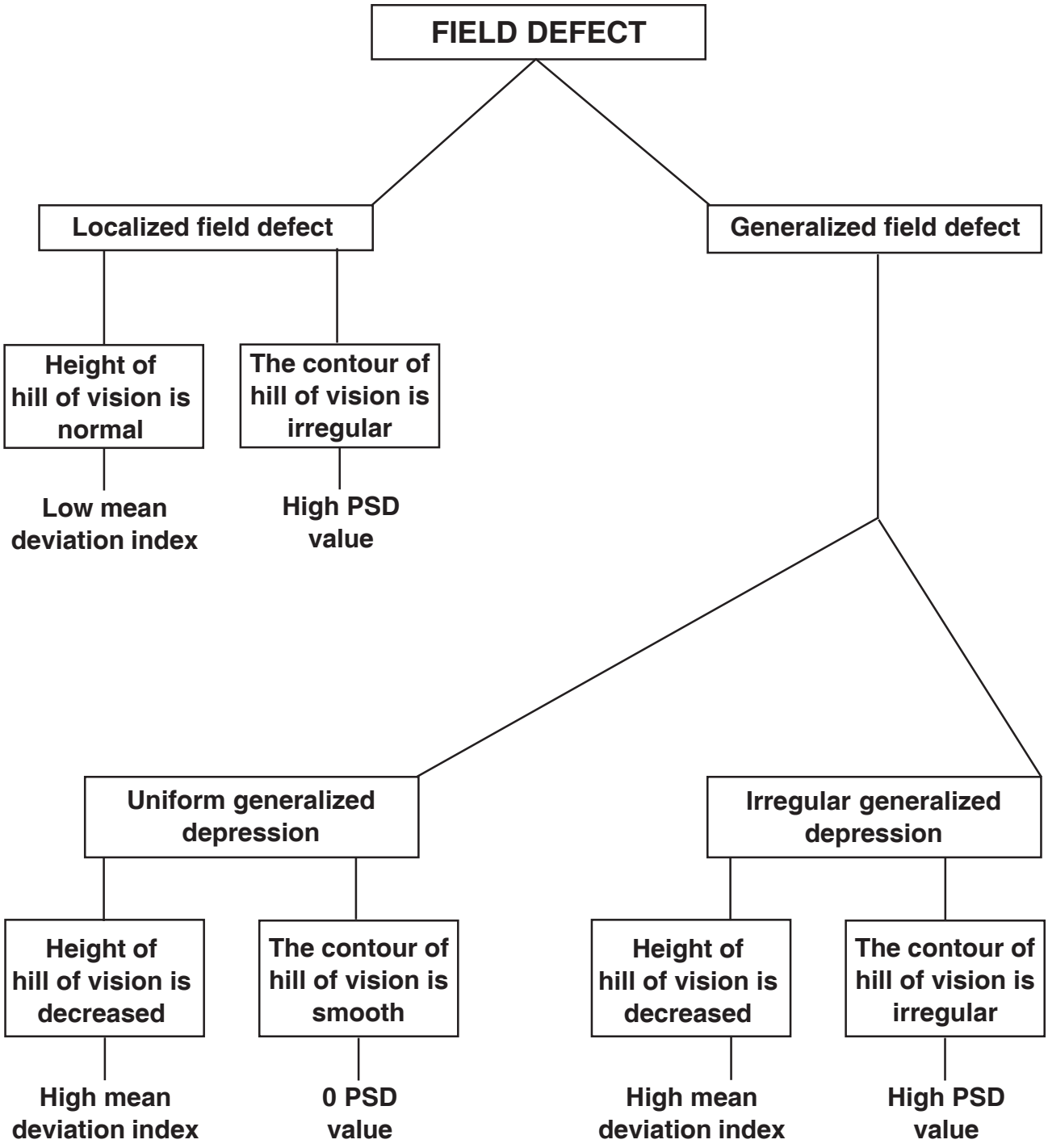
CORRELATION BETWEEN PSD VALUE AND CONTOUR OF HILL OF VISION

As you know the PSD is developed to express the irregular loss of retinal sensitivity - higher the irregularity in the loss of retinal sensitivity the higher the PSD value. When there is a localized field defect, the contour of field of vision is irregular without affecting the height of hill of vision (high PSD value) When there irregular generalized field defect, the height of hill of vision is decreased and the contour of hill of vision is irregular (high mean deviation index and high PSD value) When there is uniform generalized depression (the loss of retinal sensitivity at each point is identical), there is no dissimilarity in the loss of retinal sensitivity and hence the contour of hill of vision is smooth and the height of hill of vision is decreased (0 PSD and high mean deviation index).

CORRELATION BETWEEN PSD VALUE AND PATTTERN DEVIATION PROBABILITY PLOT

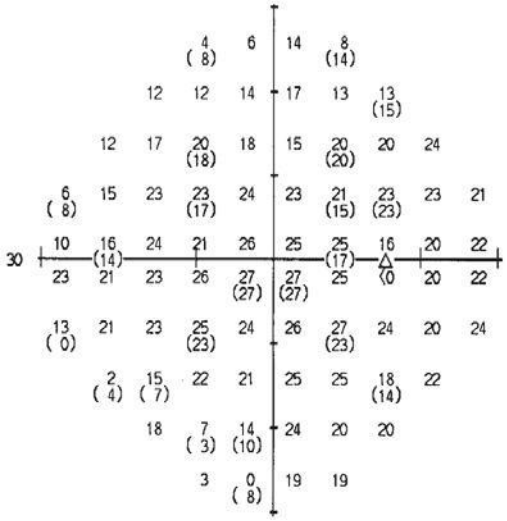
The PSD values can be correlated with pattern deviation probability plot. Whenever the PSD value is high (the sign of irregular loss of retinal sensitivity) the pattern deviation probability plot will be abnormal. When the PSD value is zero (that is either field is normal or there is uniform generalized loss of retinal sensitivity), we see normal pattern deviation probability plot.

PSD is the index of irregular loss of retinal sensitivity which is better appriciated by the different deviation values in total deviation numerical plot and abnormal pattern deviation probability plot.

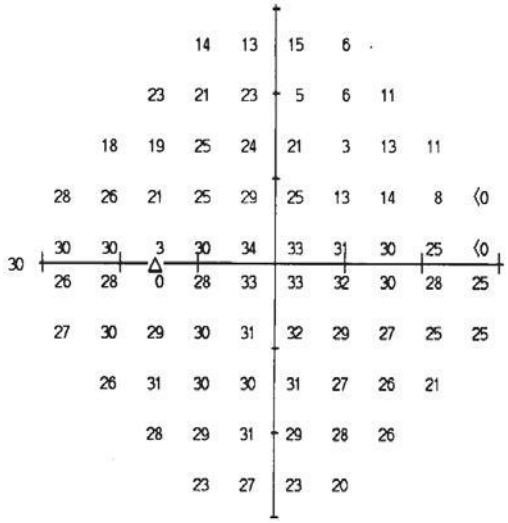

FIELD DEFECT
Localized field defect
Generalized field defect
Height of hill of vision is normal
The contour of hill of vision is irregular
Low mean deviation index
High PSD value
Uniform generalized depression
Irregular generalized depression
Height of hill of vision is decreased
The contour of hill of vision is smooth
Height of hill of vision is decreased
The contour of hill of vision is irregular
High mean deviation index
0 PSD value
High mean deviation index
High PSD value

SHORT-TERM FLUCTUATION

It is an index of intra test variation. At ten preselected points the retinal sensitivity will be calculated twice. The result of the first series of the threshold values at the these points are compared with the second series of threshold values at these points and the difference between them is calculated and expressed as root mean square (RMS) of standard estimated at these locations that underwent duplicate testing for normal patients. The short-term fluctuation value is almost always less than 3 dB and is usually between 1 to 2.5 dB. The short term fluctuation is the indicator of reliability and it could be an indicator of pathology. If the ten predetermined points are pathological, the variability could be greater and in that case the short term fluctuation would reflect pathology. If all these fixed tested points are normal in the visual field, a high short term fluctuation would indicate low reliability. So high SF sometimes indicates pathology and sometimes index of unreliable. It is also used to correct PSD to produce CPSD.



Only full threshold strategy and FASTPAC calculate SF and hence CPSD will be calculated.



SITA strategies do not calculate short-term fluctuations and hence CSPD cannot be calculated.

FIGURE 3.20

With the SITA strategies, no global estimate of test-retest variation (i.e., SF) is made. Compared with the older strategies, patient reliability is better determined from the improved false positive and false negative reliability parameters, and abnormality of the field is better determined by the threshold estimates, the probability deviation plots, and the GHT.

CORRECTED PATTERN STANDARD DEVIATION (CPSD)

Is CPSD calculated as an adjustment to the PSD? The intra testing variability (SF) is removed from PSD for produce CPSD. Much of the theoretically superiority of CPSD over PSD is lost in practice. In balance CPSD is not always a better representation of a localized field loss than the uncorrected PSD. The CPSD is not calculated if SF is not estimated during the test.

ZONE 10- GLAUCOMA HEMI FIELD TEST (GHT)

Glaucoma hemi field test evaluates five zones in the uper field and compares these zones to their mirror image zones in the lower field. The zones are constructed in the approximate patterns of retinal nerve fibers, and thus GHT is directed primarily at the diagnosis of glaucomatous visual field loss at a very early stage and not other diseases.

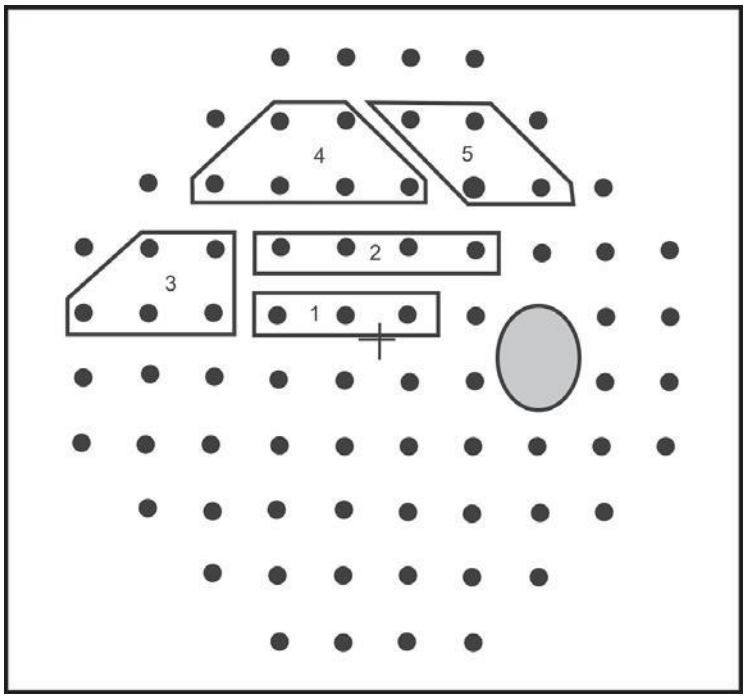


FIGURE 3.21

A score assigned to each zone based on the deviation values of these points in the **pattern deviation numerical plot.** A comparison of each uper zone is made with the corresponding lower zone and the difference in scores between the upper and lower zones is calculated. The difference is compared with significant limits taken from a data base of normal subjects.

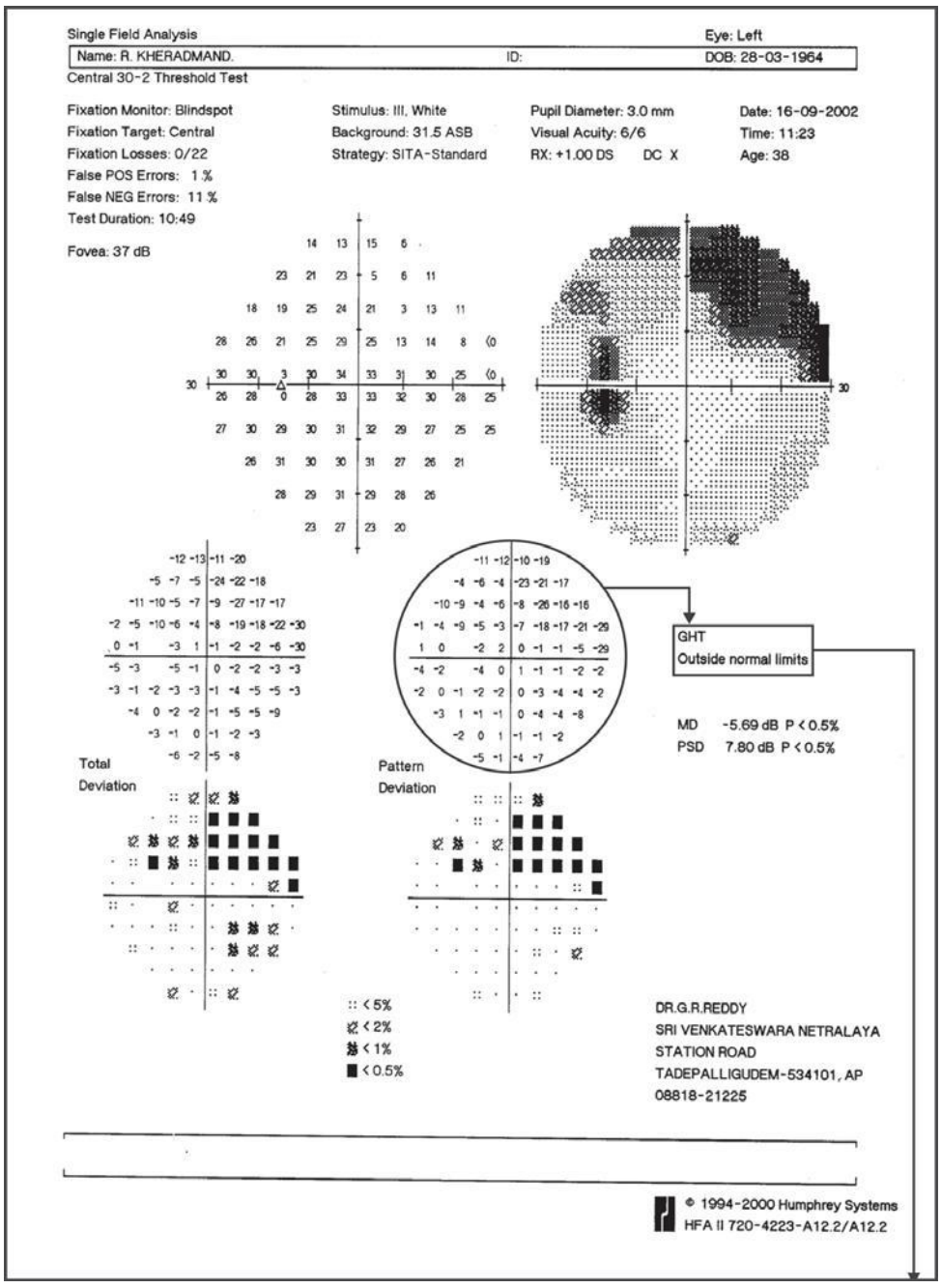
Five possible messages may appear as the summary result of the GHT. The only two that can appear simultaneously are "borderline" and general reduction in sensitivity".

The five messages are:

1. **Outside normal limits.** This message means that one of two conditions has been met: (1) when the score in the upper zones are compared with those of the lower zones, at least one sector pair's score difference must exceed that found in 99% of the normal population; or (2) the individual zone scores in both members of any zone pair exceed that found in 99.5% of normal individuals.
2. **Borderline.** In comparing the upper zones with lower zones, at least one zone pair difference exceeds that found in 97% of normal individuals.
3. **General reduction of sensitivity.** This message appears only if neither of the conditions for the "outside normal limits" message is met, but the General Heigth calculation shows the best part of the field to be depressed to a degree that occurs in fewer than 0.5% of normal population.
4. **Abnormally high sensitivity.** The general height calculation shows the overall sensitivity in the best part of the field to be higher than that found in 99.5% of the normal population. This message supersedes and suppresses all others. In the face of abnormally high sensitivity, the comparison of upper zones with lower zones is not made.
5. **Within normal limits**. This message appears if none of the preceding four conditions is met.

The glaucoma hemi field test is not designed to detect a temporal wedge defect. Fortunately, such defects are rare.

SINGLE FIELD ANALYSIS PRINTOUT WITH GHT OUTSIDE NORMAL LIMITS

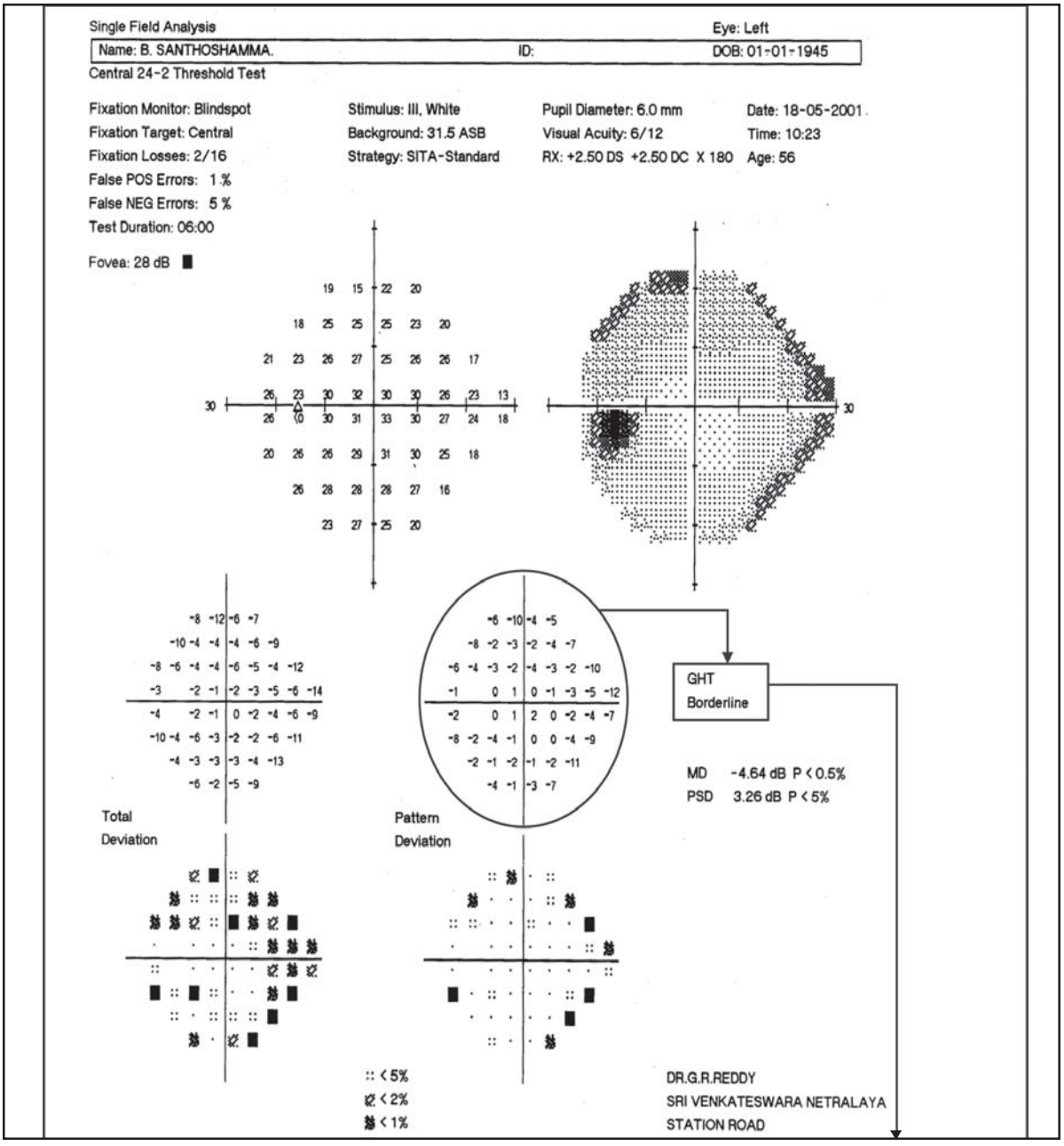


a. G.H.T. out side normal limits :

If the values between any sector in the upper and lower zone differ to an extent found in the one percent of the normal population OR if one pair of sectors is depressed to the extent that would be expected in the 0.5 % of the population.

FIGURE 3.22

SINGLE FIELD ANALYSIS PRINTOUT WITH GHT BORDER LINE

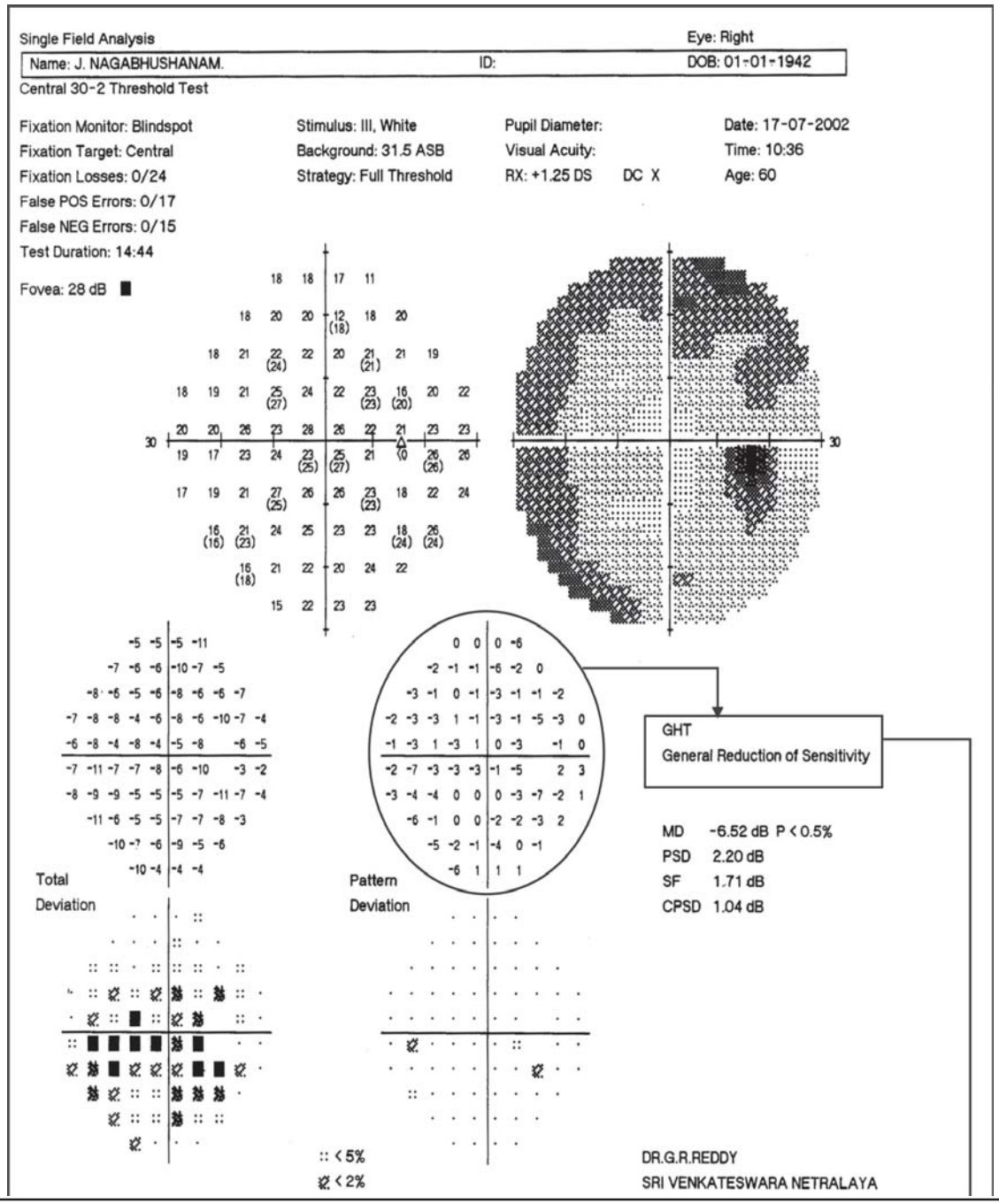


b. G.H.T. border line :

The difference between any one of the upper and lower zones is what might be expected in less than 3% of the normal population (In comparing the upper zones with lower zones, at least 1 zone pair difference exceeds that found in 97% normal population

FIGURE 3.23

SINGLE FIELD ANALYSIS PRINTOUT WITH GHT GENERAL REDUCTION OF SENSITIVITY

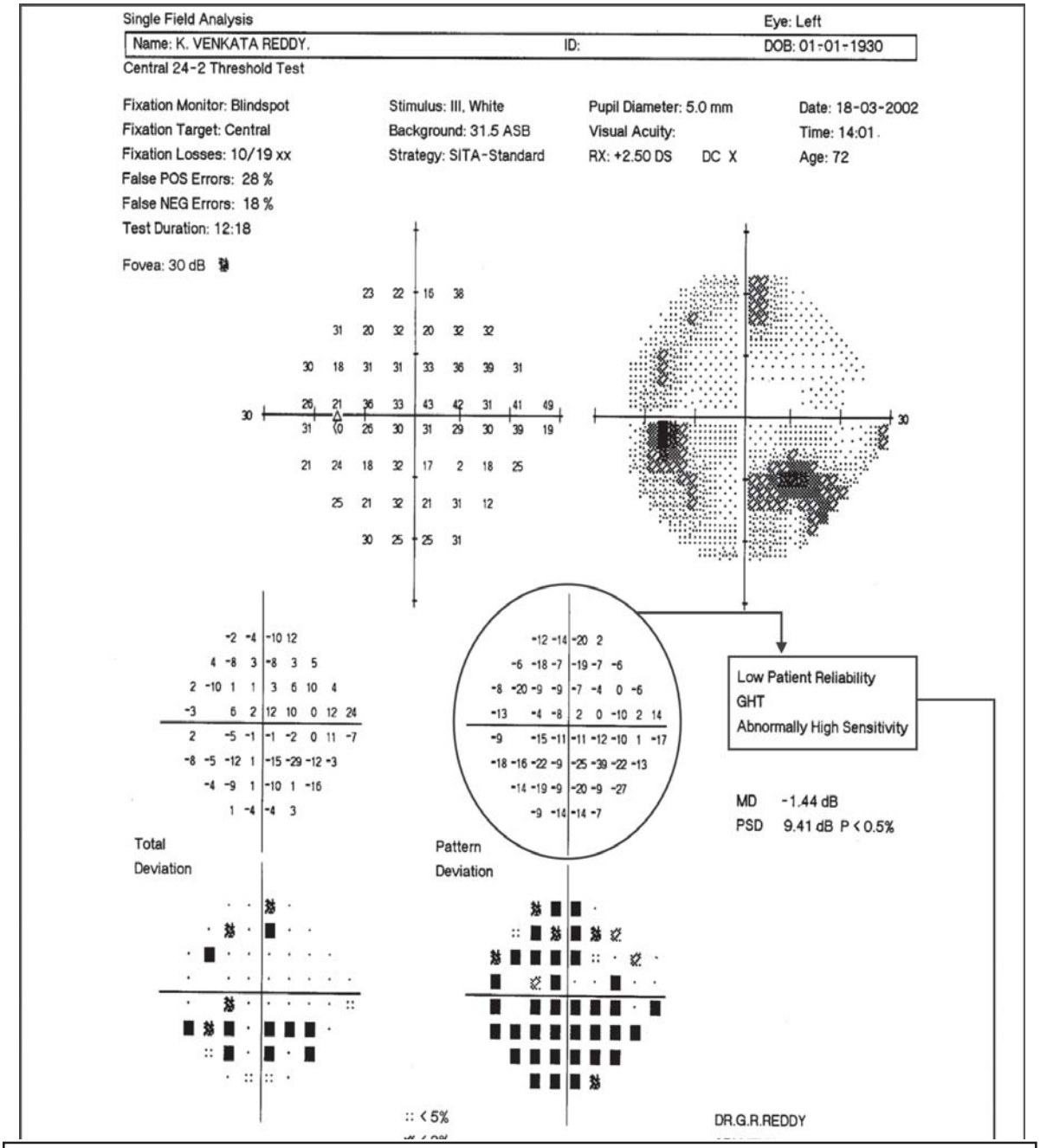


c. G.H.T. abnormally low sensitive :

If the best part of the visual field is seen less than 5% of the normal population. The glaucoma hemi field test is not designed to detect a temporal wedge defect fortunately such defects are rare (See Page No. 116)

FIGURE 3.24

SINGLE FIELD ANALYSIS PRINTOUT WITH GHT ABNORMALLY HIGH SENSITIVITY

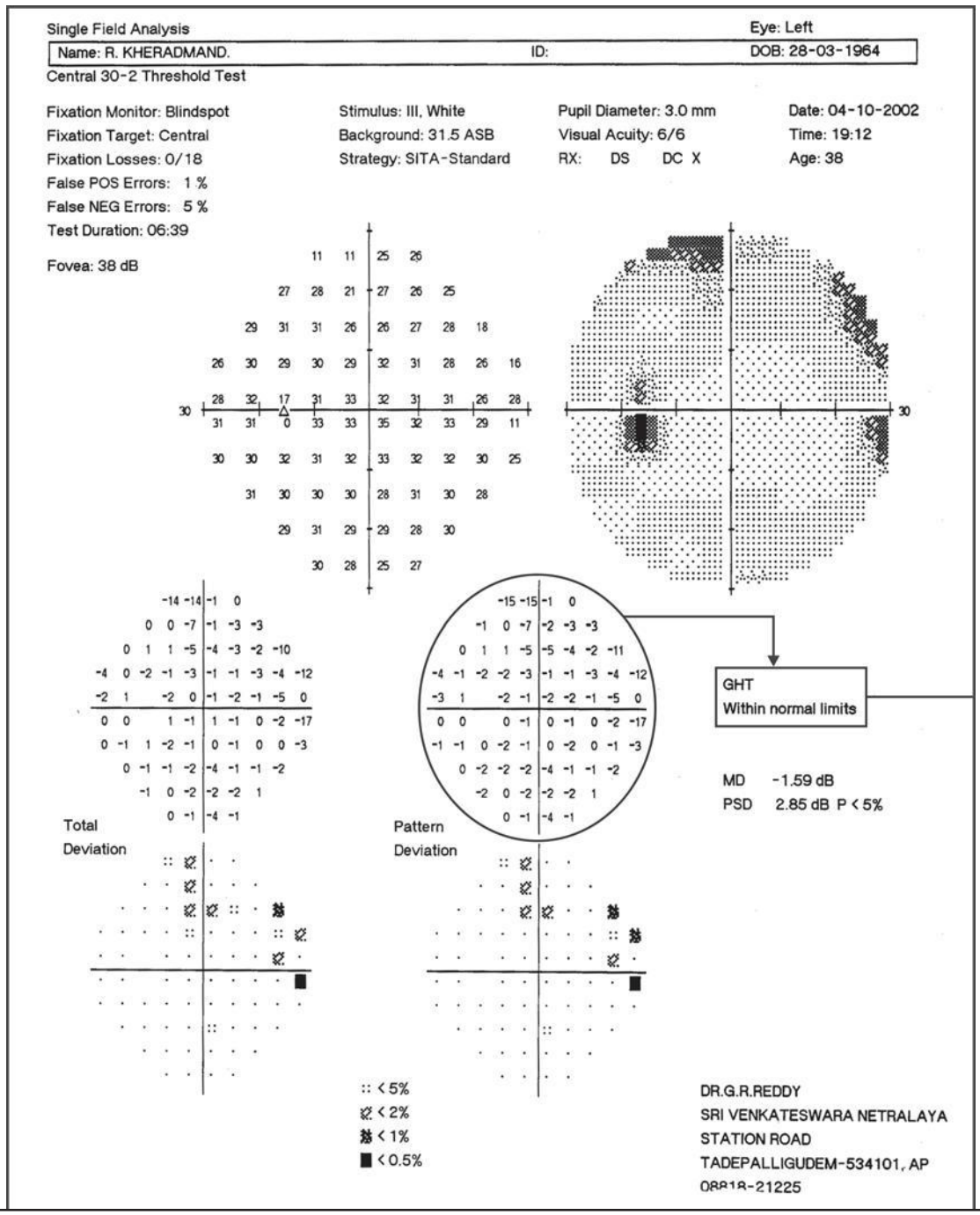


d. G.H.T. abnormally high sensitive :

The general height calculation shows the overall sensitivity in the best part of the field to be higher than that found in 99.5% of the normal population. This messge supersedes and suppresses all others. In the face of abnormally high sensitivity the comparison of upper zones and with the lower zones is not made.

FIGURE 3.25

SINGLE FIELD ANALYSIS PRINTOUT WITH GHT WITHIN NORMAL LIMITS



e. Within normal limits :
This message appears if none of the preceding four conditions is met.

FIGURE 3.26

SUMMARY OF THE SINGLE FIELD ANALYSIS PRINTOUT

1. **Measurement of exact retinal sensitivity of the patient (Raw data)**

2. **Expression of Raw data in terms of decibel deviations from expected normal retinal sensitivity - Total deviation numerical plot (TDNP)**

3. **STATPAC analysis of TDNP to bringout the following analytical data.**
   a. Establishing total deviation probability plot (TDPP)
   b. Establishing pattern deviation numerical plot
   c. Establishing pattern deviation probability plot
   d. Establishing global indices with P value
   e. G.H.T. Analysis.

ESTABLISHING TOTAL DEVIATION PROBABILITY PLOT (TDPP) FROM RAW DATA

RAW DATA

↓

Compared with the stored mean normal threshold values of the same age groups and calculates the difference between the measured retinal sensitivity of each point and the mean normal threshold value of that point of the same age group of the patient and plots as

↓

TOTAL DEVIATION NUMERICAL PLOT (TDNP)

↓

The STAT PAC analyzes how often the threshold deviations of the patient is seen in normal population and plots as

↓

TOTAL DEVIATION PROBABILITY PLOT

A symbol is assigned to each deviation value indicating the probability of finding such deviation value in the normal population. The darker the symbol the greater the probability of abnormality as indicated by P value.

ESTABLISHING PATTERN DEVIATION PROBABILITY PLOT FROM TDNP

TOTAL DEVIATION NUMERICAL PLOT

↓

STAT PAC eliminates or diminishes the general depression of the measured field and thus the focal loss remains clearly visible or enhanced and plots as

↓

PATTERN DEVIATION NUMERICAL PLOT

↓

These threshold deviation values will be analyzed and its probability of the abnormality in normal population will be plotted as

↓

PATTERN DEVIATION PROBABILITY PLOT

A symbol (in the probability plots) is assigned to each deviation value indicating the probability of finding such deviation value in the normal population. The darker the symbol the greater the probability of abnormality as indicated by P value.

ESTABLISHING GLOBAL INDICES FROM TDNP

TOTAL DEVIATION NUMERICAL PLOT

↓

GLOBAL INDICES

1. Mean deviation index in dB value and with its P value.
2. Pattern standard deviation (PSD) in dB value and with its P value,
3. Corrected pattern standard deviation (CPSD) in dB value and with its P value.
4. Short term fluctuation (SF) in dB value.

GLAUCOMA HEMIFIELD TEST (G.H.T) FROM PATTERN DEVIATION NUMERICAL PLOT

↓

a. GHT out side normal limits
b. GHT border line
c. GHT abnormally low sensitive
d. Abnormally high sensitivity
e. Within normal limits.

FEATURES OF FULL THRESHOLD TESTING STRATEGY AND FASTPAC TESTING STRATEGY

Full Threshold strategy is the old standard threshold strategy in which staircase method (Bracketing method) is used to detect the threshold. The details of the testing method is discussed in Pages 23, 24

FASTPAC threshold strategy: FASTPAC decreases Full Threshold test time by about 40%. It follows a similiar staircase stepping technique as in Full Threshold, but uses 3 dB increments instead of 4dB and crosses the threshold only once. (Already discussed in chapter 2.)

All the threshold tests as shown below can be tested with Full Threshold strategy and FASTPAC Strategy.

1. 30-2 Central threshold test pattern
2. 24-2 Central threshold test pattern
3. 10-2 Central threshold test pattern
4. Macular program test pattern
5. Nasal step
6. All tests conducted with stimulus size V
7. 60-4 Peripheral field.

The single field analysis printout with Full Threshold strategy and FASTPAC strategy, we have common following features:

1. Reliability indices expressed in fractions and ratios as shown below.

Reliability indices.
Fixation losses (0/24)
False positive response rate (1/17)
False negative response rate (0/24)

2. Calculates short term fluctuations. (SF)
3. Calculates corrected pattern standard deviations. (CPSD)

Glaucoma hemifield test (GHT) is present with Full Threshold printout.
GHT analysis is absent in FASTPAC threshold printout.

Please note that these testing strategies are threshold testing strategies and hence they are used in threshold tests. Testing strategies used in screening tests are different. They are supra threshold testing strategies and they are discussed in chapter 8.

SINGLE FIELD ANALYSIS PRINTOUT WITH FULL THRESHOLD STRATEGY

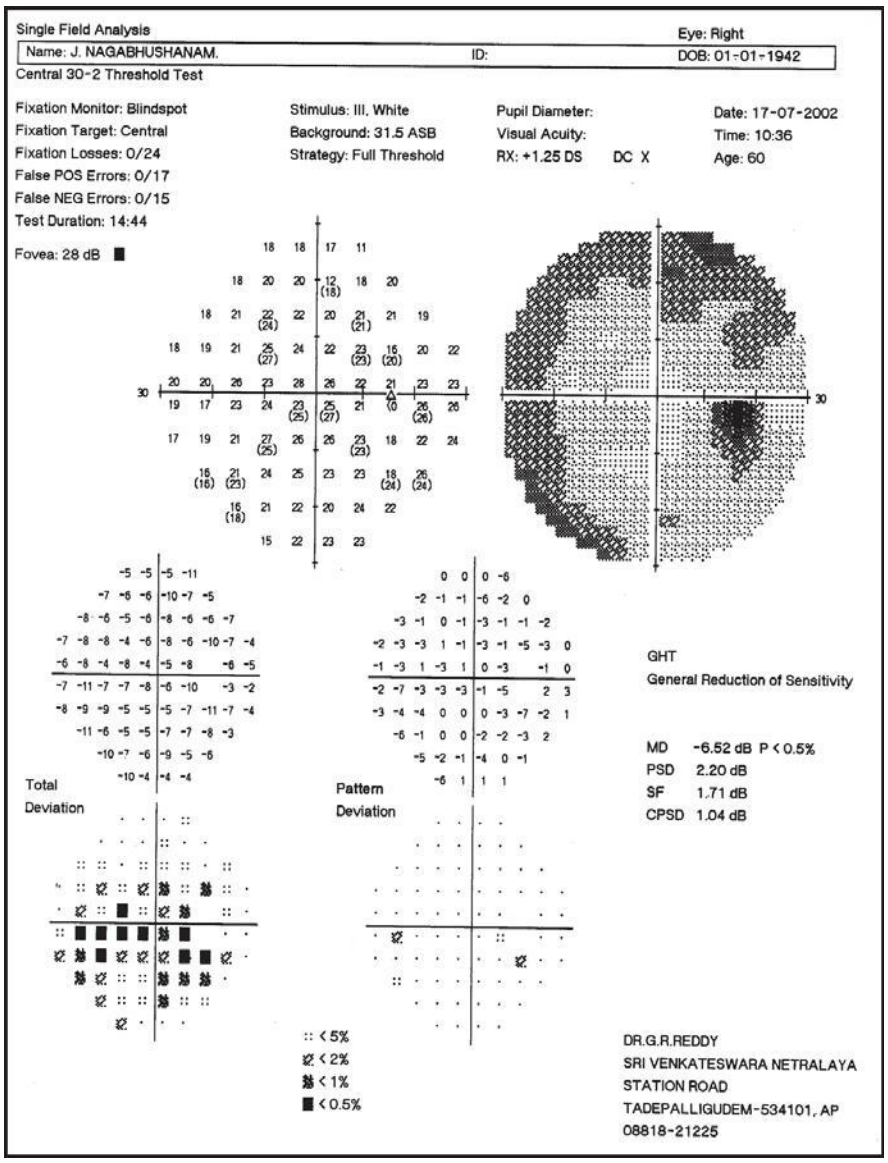


FIGURE 3.27

1. Reliability indices expressed in fractions.
2. Calculates shortterm fluctuation. (SF)
3. Calculates corrected pattern standard deviation. (CPSD)
4. G.H.T. analysis present.
5. All the threshold test patterns can be tested with Full Threshold strategy.

Reliability indices.
Fixation losses
False positive response rate
False negative response rate

SINGLE FIELD ANALYSIS PRINTOUT WITH FASTPAC STRATEGY

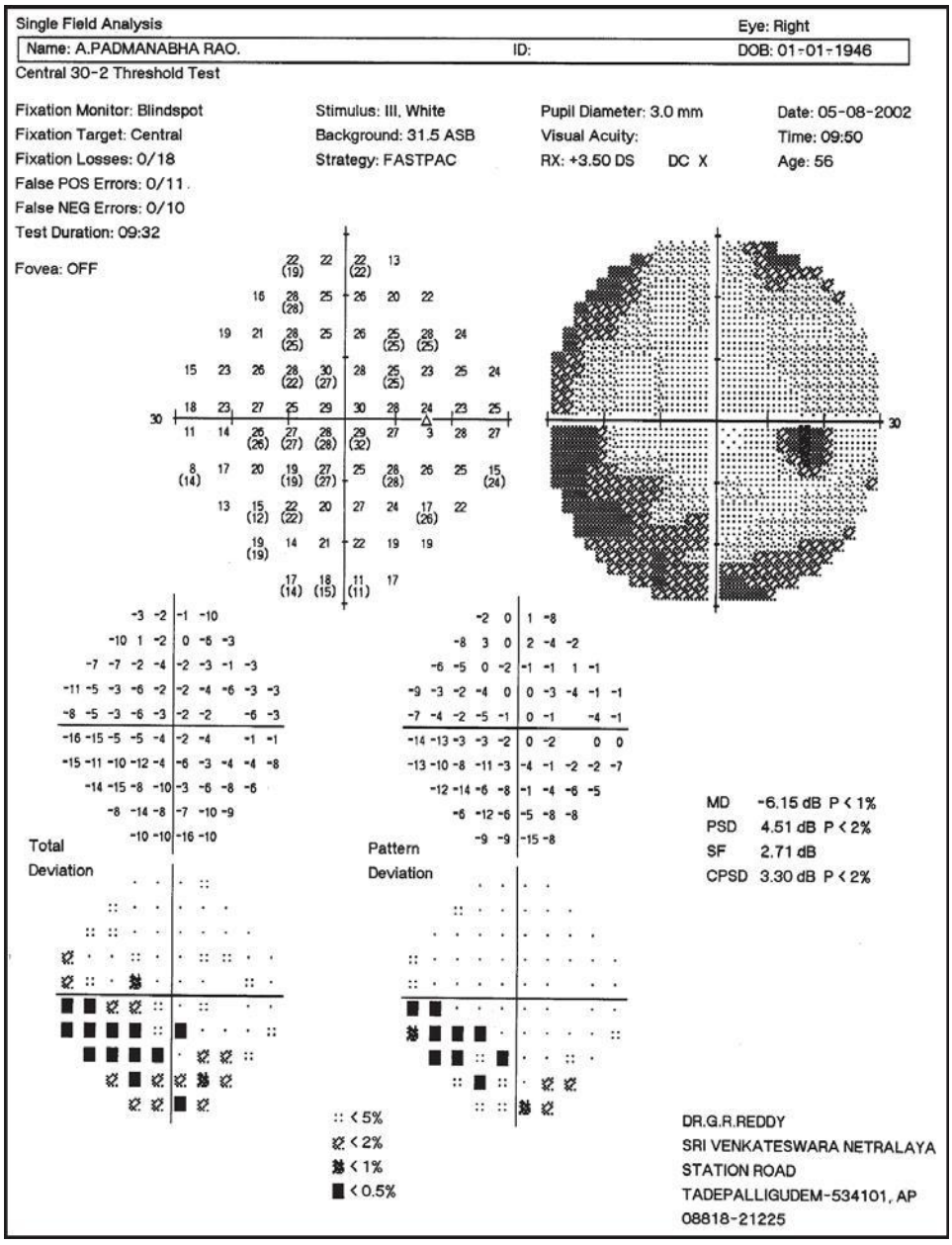


FIGURE 3.28

1. Reliability indices expressed in fractions.
2. Calculates short-term fluctuation. (SF)
3. Calculates corrected pattern standard deviation. (CPSD)
4. G.H.T. analysis absent.
5. All the threshold test patterns can be tested with FASTPAC strategy.

FEATURES OF SITA STANDARD AND SITA FAST TESTING STRATEGIES

The Humphrey system has developed two separate strategies with two separate goals.

1. **SITA-Standard:** The goal was to design a perimetric thresholding method which collects twice as much information per unit time as Humphrey Full Threshold standard algorithm. SITA Standard cuts the test time in half without compromising test reproducibility relative to the current international standard.
2. **SITA-Fast:** The goal was to design a thresholding method which collects twice as much information per unit time as FASTPAC. SITA-Fast cuts the test time in half relative to FASTPAC, without compromising test reproducibility.

Both SITA-Standard and SITA-Fast are designed to run with these threshold tests:

Central 10-2
Central 24-2
Central 30-2
Peripheral 60-4

All SITA tests must use a White, Size III stimulus. Any time a SITA strategy is used, these two parameters will be automatically set by your HFA II.

Please note that macular program test pattern, nasal step and any test conducted with stimulus size V cannot be tested by SITA.

The single field ananlysis printout with SITAStandard strategy and SITAFast strategy, we have common following features:

1. Reliability indices expressed in percentages except in case of fixation losses which is expressed in fractions.

Reliability indices.
Fixation losses (1/20)
False positive response rate (1%)
False negative response rate (0%)

2. Does not calculate short-term fluctuations. (SF)
3. Does not calculate corrected pattern standard deviations. (CPSD)

Glaucoma hemifield test (GHT) is present with both SITA strategies.

Please note that these testing strategies are threshold testing strategies and hence they are used in threshold tests. Testing strategies used in screening tests are different. They are supra threshold testing strategies and they are discussed in Chapter 8.

SINGLE FIELD ANALYSIS PRINTOUT WITH SITA STANDARD STRATEGY

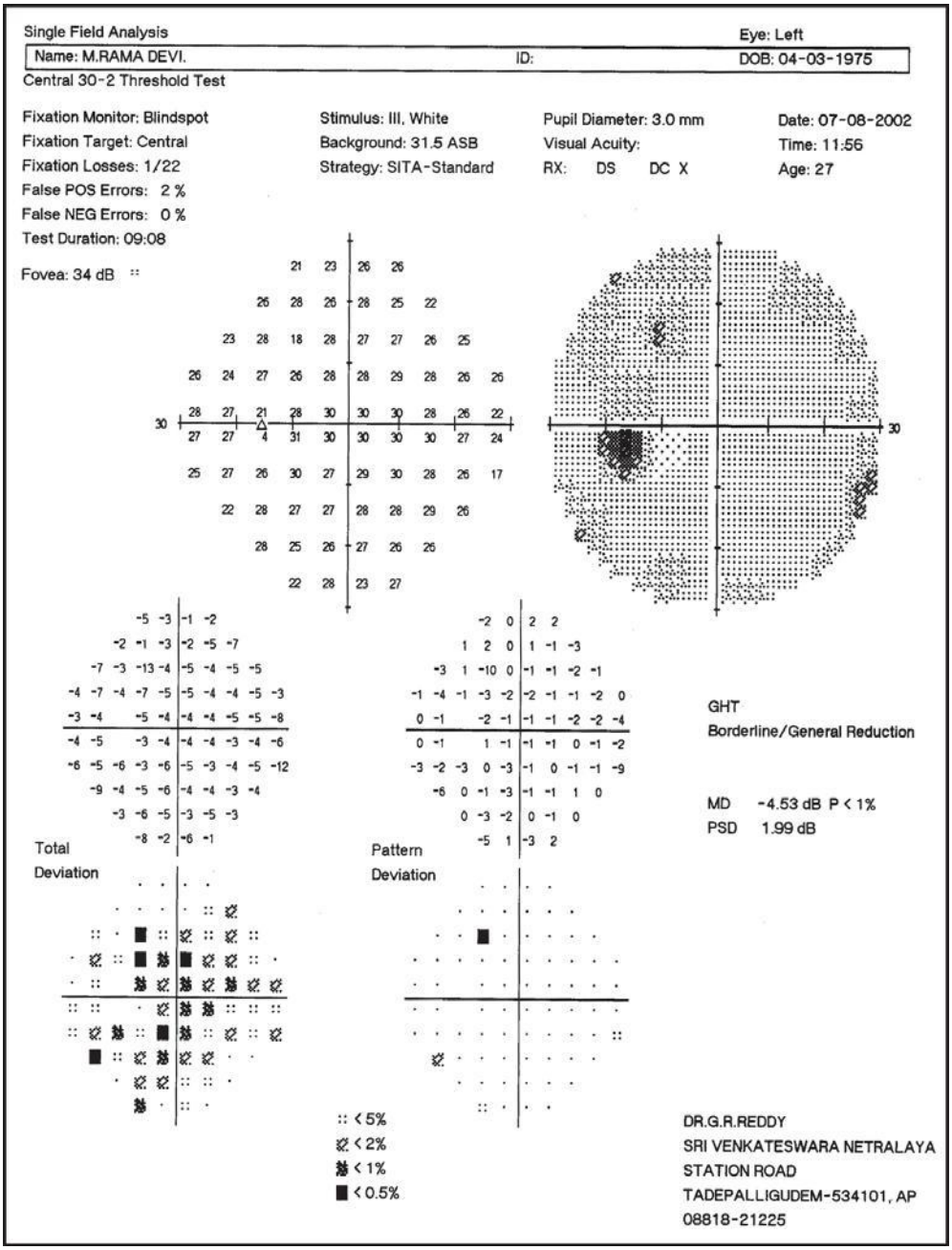


FIGURE 3.29

1. Reliability indices expressed in percentage.
2. Does not calculate short-term fluctuation. (SF)
3. Does not calculate corrected pattern standard deviation. (CPSD)
4. G.H.T. analysis present.

SINGLE FIELD ANALYSIS PRINTOUT WITH SITA FAST STRATEGY

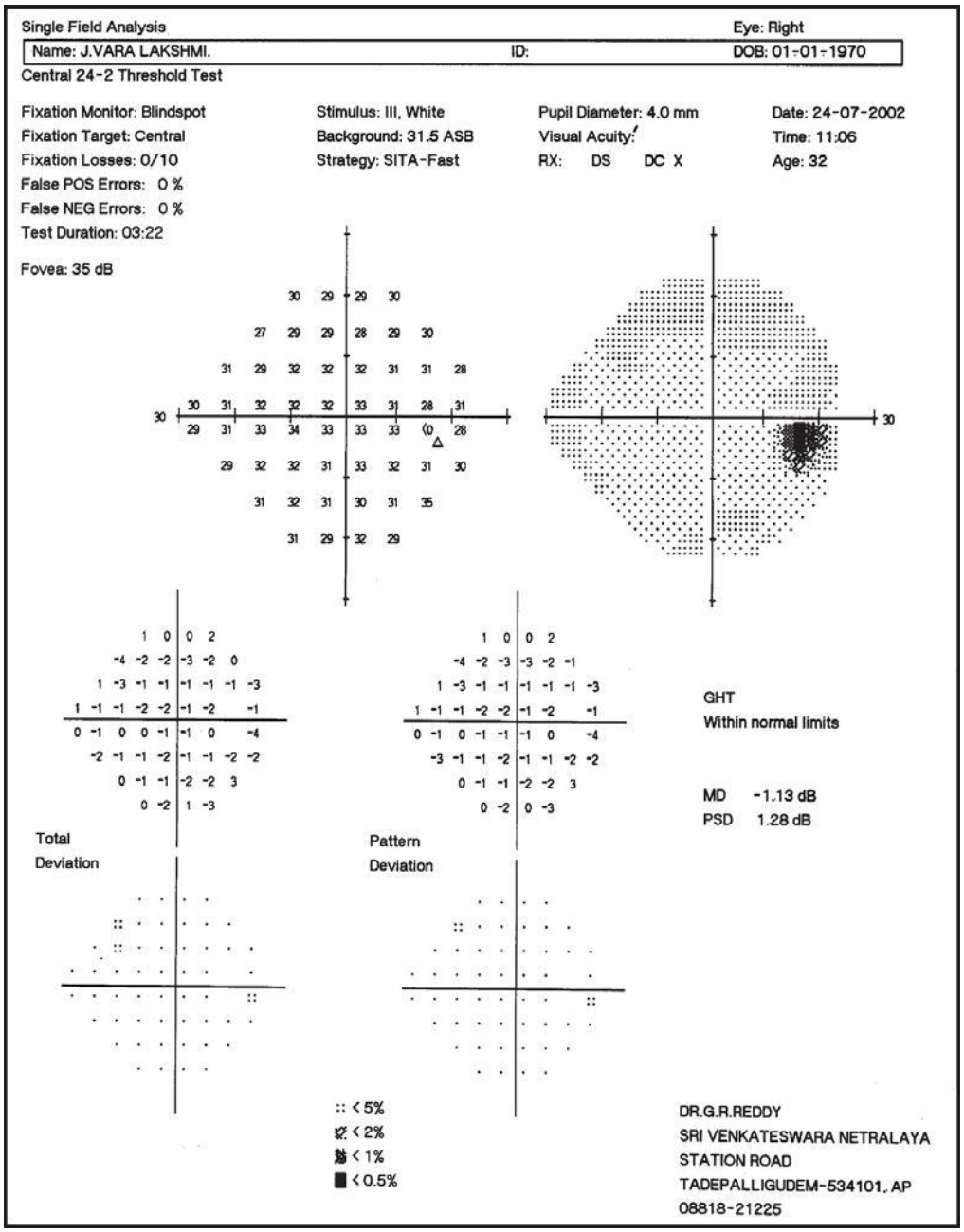


FIGURE 3.30

1. Reliability indices expressed in percentage.
2. Do es not calculate short-term fluctuation. (SF)
3. Does not calculate corrected pattern standard deviation. (CPSD)
4. G.H.T. analysis present.

The features of single field analysis and change analysis printouts with four major threshold strategies are presented in the following table

Threshold Strategy	Reliability indices	Short term fluctuation (SF)	CPSD	GHT	Change analysis printout	Test time
Full Threshold	F.P errors F.N errors Fixation losses are indicated in fractions Ex:- 3/26	Calculates SF	Calculates CPSD	GHT analysis present	Normal box plot printed on the left side of the dB scale	The most standard way of determining threshold sensitivity
FASTPAC	F.P errors F.N errors Fixation losses are indicated in fractions Ex:- 3/26	Calculates SF	Calculates CPSD	GHT analysis absent	Normal box plot printed on the left side of the dB scale	40% of Full threshold strategy time
SITA Standard	F.P errors F.N errors are indicated in Percentage Ex:- 2%, 3% (Fixation losses are indicated in fractions. ex: 3/26)	Does not calculate SF	Does not calculate CPSD	GHT analysis present	Normal box plot not printed on the left side of the dB scale	50% of Full threshold strategy time
SITA Fast	F.P errors F.N errors are indicated in Percentages Ex:- 2%, 3% (Fixation losses are indicated in fractions. ex: 3/26)	Does not calculate SF	Does not calculate CPSD	GHT analysis present	Normal box plot not printed on the left side of the dB scale	50% of FASTPAC strategy time

**(A clinical correlation is of paramount importance.
One should never interpret a visual field in isolation)**

HUMPHREY VISUAL FIELD TEST PRINTOUTS WITHOUT STATPAC ANALYSIS

When there is no normative data available, for comparing the measured retinal sensitivity the STATPAC cannot analyse the measured retinal sensitivity. The normative data is not available for the following tests.

1. Any test that is done with test pattern macular test, nasal test, peripheral test
2. Any test that is done with stimulus size V
3. Any test that is done with custom tests

So the format of above test parameters will not contain total deviation plots, pattern deviation plots, global indices and G.H.T analysis.

If we select the threshold test parameters that do not meet the criteria for STATPAC analysis their results will be printed in different formats as shown below.

1. Three-in-one printout
2. Two-in-one printout—Nasal step threshold test
3. Three-in-one printout—Macula threshold test
4. Peripheral tests

The STATPAC (The Humphrey Field Analyser's statistical package) will analyse tests that fall within the parameters listed below.

Test pattern	:	Central 30-2, 24-2, 10-2
Test strategy	:	SITA standard, SITA fast, Full threshold, FASTPAC
Stimulus size	:	III
Fixation target	:	Central, small diamond, big diamond
Foveal threshold	:	On or off.
Fluctuation	:	On or off

The most important point to be remembered is that there are no normal values available to STATPAC for the tests conducted with size V stimulus, for custom tests and any test done with point patterns - nasal tests, macular tests, or peripheral tests. So the field analyzer determines the central reference value which helps to calculate the expected threshold value. The central reference value is a hypothetical threshold sensitivity at the centre of the field ignoring the foveal peak. It may be a value projected on the basis of normal slope of hill of vision and emperically determine threshold at four or five locations or assigned value (by age or as a minimal value). It is used to determine the expected threshold values to calculate defect depth.

HUMPHREY VISUAL FIELD TEST PRINTOUTS WITHOUT STATPAC ANALYSIS

So far, we have discussed Humphrey visual field test printouts with STATPAC analysis. Now we will be discussing the Humphrey visual field printouts without STATPAC analysis. They are as follows: 1) visual field testing with stimulus Size V, 2) Macular program printout and 3) Nasal step printout

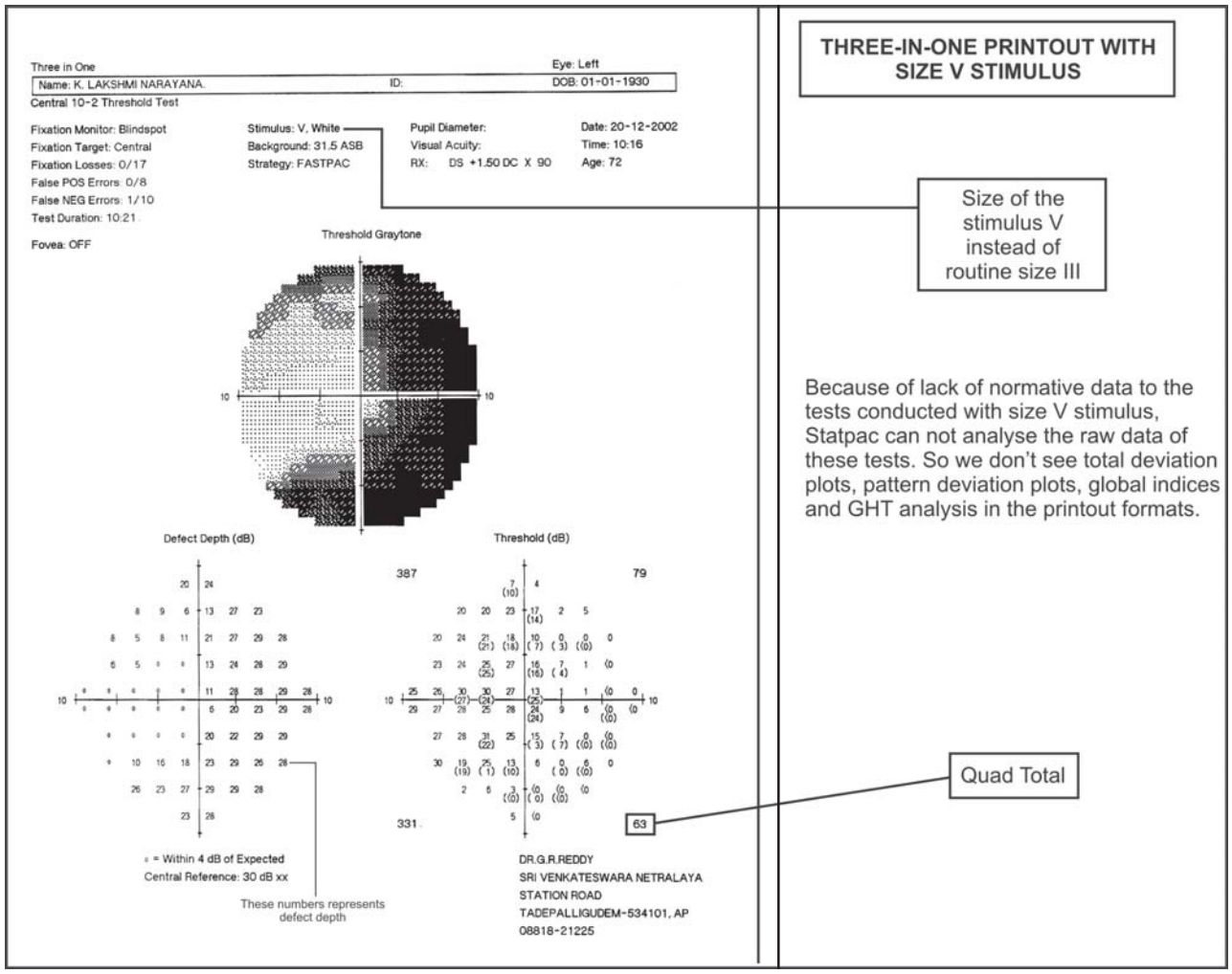


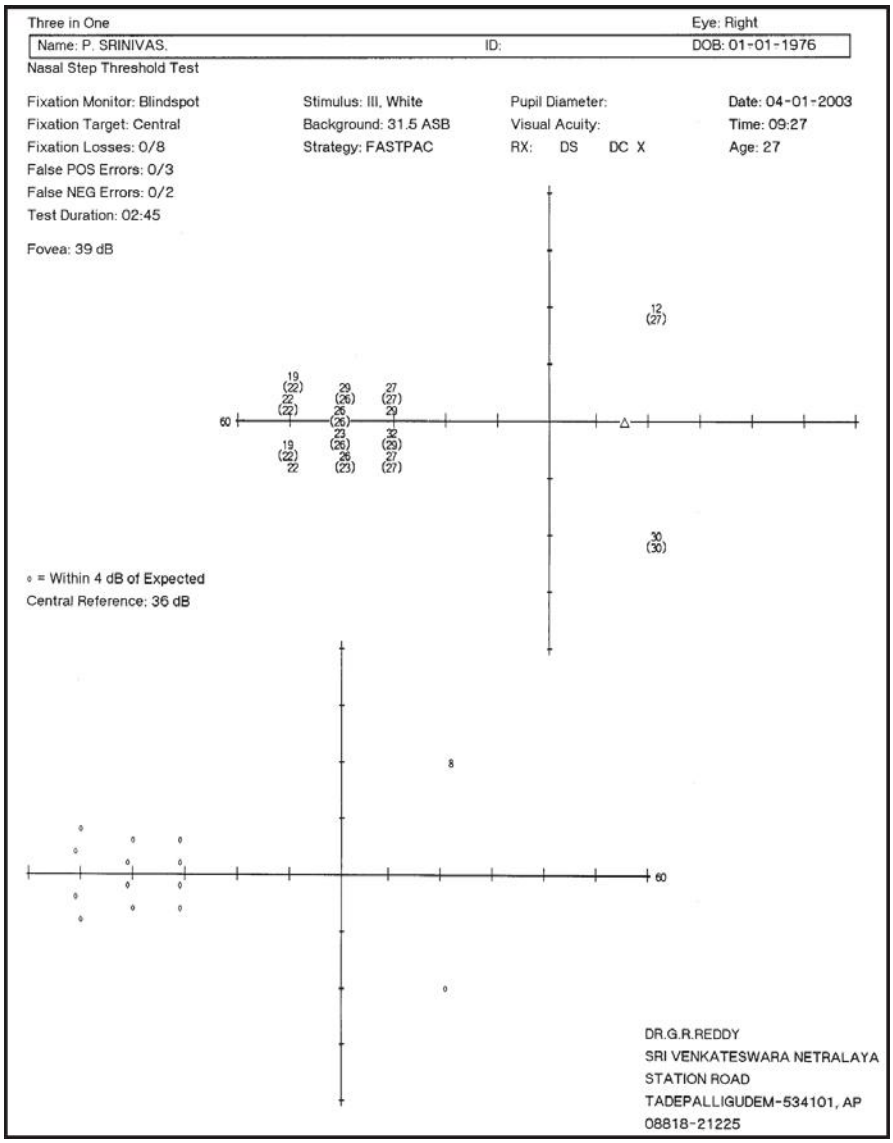
FIGURE 3.31

In three-in-one printout, we will have

1. Gray scale
2. Raw data
3. Defect depth plot (The defect depth is the difference between the expected threshold value and measured threshold value).

The numbers which appear outside each quadrant of the numeric grid are called "Quad Totals" and represent a summation of the threshold values determined in each Quadrant. These numbers which even in normals will not be the same in each quadrant, can be useful in comparing several tests on the same patient over time. These numbers are helpful in absence of statistical assistance.

TWO -IN- ONE PRINTOUT NASAL STEP THRESHOLD TEST



SITA strategies are not available to the Nasal step point pattern threshold test. So, they have to be tested with full threshold or FASTPAC strategies.

Because of lack of normative data to the tests conducted with nasal step point pattern STATPAC can not analyse the raw data of these tests. So, we do not see total deviation plots, pattern deviation plots, global indices and GHT analysis in the printout formats.

FIGURE 3.32

In two-in-one printout, we will have

1. Raw data
2. Defect depth Plot (The defect depth is the difference between the expected threshold value and measured threshold value).

THREE -IN- ONE PRINTOUT MACULA THRESHOLD TEST

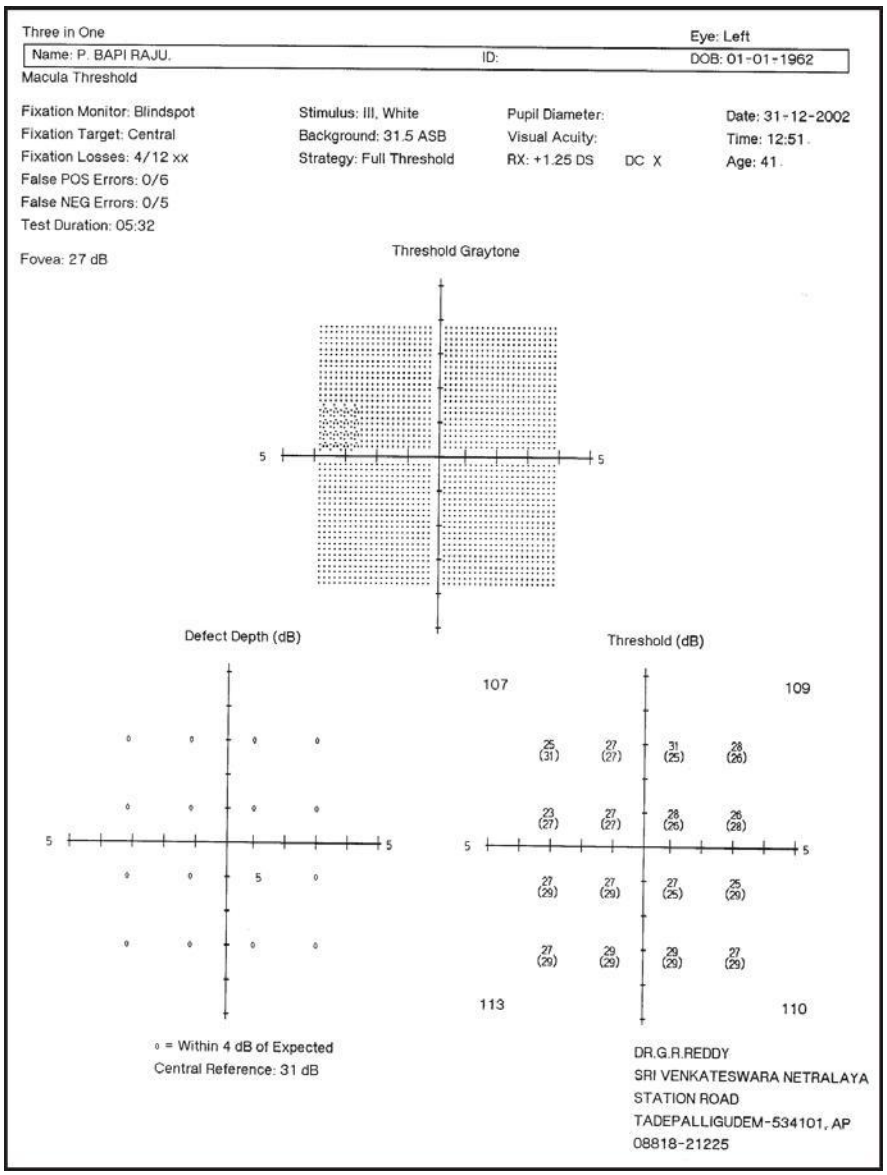


FIGURE 3.33

SITA strategies are not available to the macula threshold test. So, they have to be tested with full threshold or FASTPAC strategies.

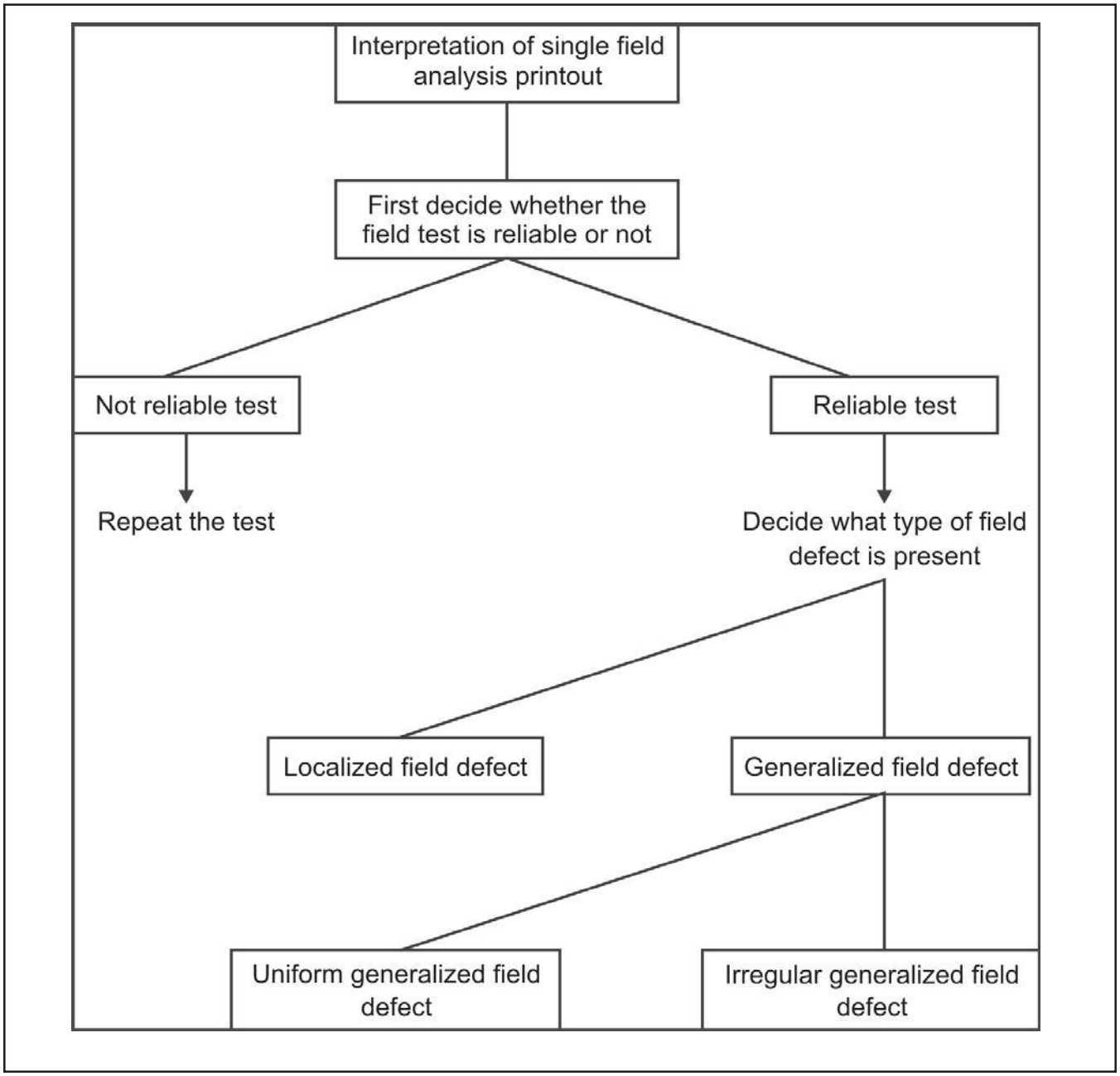
Because of lack of normative data to the tests conducted with macular program point pattern STATPAC can not analyse the raw data of these tests. So we don't see total deviation plots, pattern deviation plots, global indices and GHT analysis in the printout formats. STATPAC analysis is not required to the macular threshold test because we conduct this test in advanced cases of glaucoma. That is why normative data is not stored for macular threshold tests.

In three-in-one printout, we will have

1. Gray scale
2. Raw data
3. Defect depth plot (The defect depth is the difference between the expected threshold value and measured threshold value.

The numbers which appear outside each quadrant of the numeric grid are called "Quad Totals" and represent a summation of the threshold values determined in each Quadrant. These numbers which even in normals will not be the same in each quadrant, can be useful in comparing several tests on the same patient over time. These numbers are helpful in absence of statistical assistance.

4 Interpretation of Single Field Analysis Printout



Step 1: Verify whether the patient data and the test data are properly fed to the field analyzer by the technician. This information fed to the field analyzer should be like that exactly given in the order form for visual field testing.

Step 2: Decide whether the test is reliability or not and the selection of test is proper or not.

WHEN WE SAY THE TEST IS NOT RELIABILITY	
Technician's faults	**Patient's lack of performance skill**
1. Age of the patient not properly entered	1. High fixation losses > 20%
2. Refractive error not properly corrected for NV	2. High false (+)ve errors > 33%
3. Pupil size < 3 mm	3. High false (-)ve Errors > 33%
4. Not properly positioning the patient's head.	4. Short-term fluctuations > 2.5dB

Step 3: The measured foveal sensitivity correlates with visual acuity, it indicates the refractive error correction for near vision is correct.

Step 4: Importance of location of blind spot. Confirm the normal position of the blind spot. (See Page no. 38)

Step 5: Analysis of total deviation probability plot and pattern deviation probability plot and their correlation with mean deviation index, pattern standard deviation and GHT analysis.

During the analysis of total deviation and pattern deviation probability plots usually we encounter the following situations.

1. Localized defect in the total deviation probability plot and almost similiar defect in the pattern deviation probability plot. We see this type of defects in pure cases of early glaucomatous optic nerve damage and retinal pathology.

2. Generalized defect in the total deviation probability plot and localized defect in the pattern deviation probability plot. We see this type of defects in irregular generalized field defects produced by cases of cataract associated with glaucoma.

3. Generalized defect in the total deviation probability plot and no defect in the pattern deviation probability plot. we see this type of defects in media opacities—cataract, small pupil, refractive errors, advanced glaucoma and optic neuritis.

Localized defect in the total deviation probability plot and almost similiar defect in the pattern deviation probability plot as shown in the following examples.

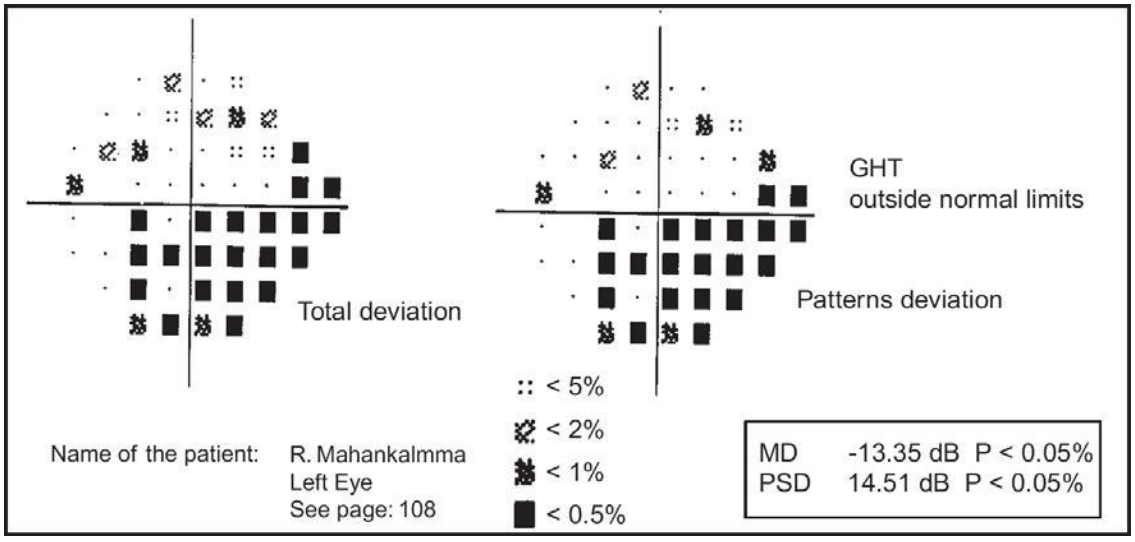


FIGURE 4.1

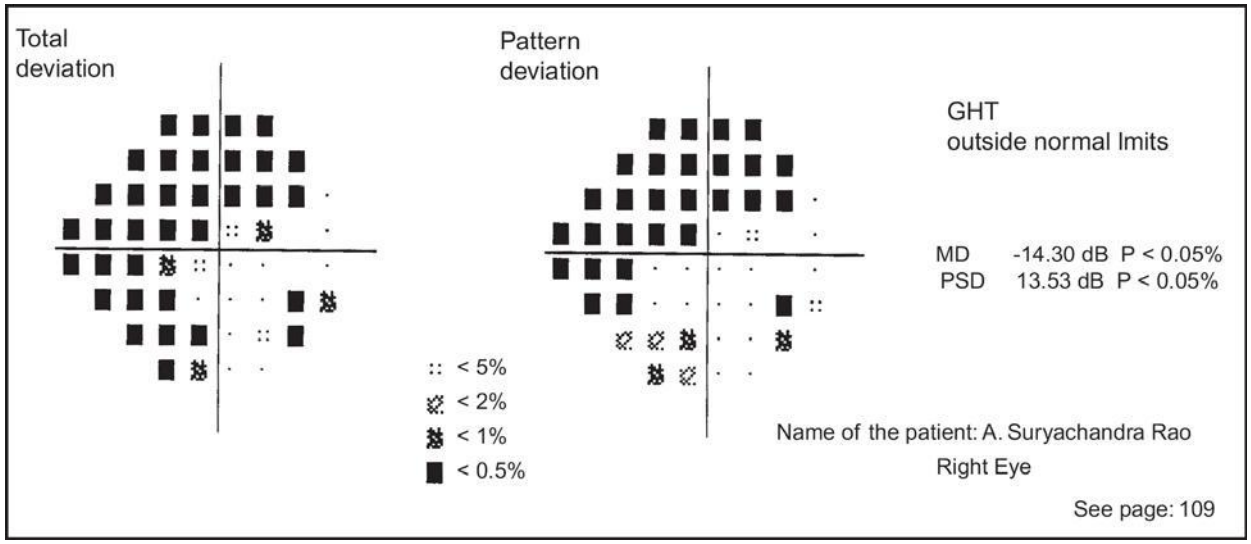


FIGURE 4.2

In localized field defects the total deviation probability plot and the pattern deviation probability plot look alike. The localized field defects are usually caused by glaucoma, local retinal pathology are optic nerve damage due to various etiologies.

Generalized defect in the total deviation probability plot and localized defect in the pattern deviation probability plot as shown in the following examples.

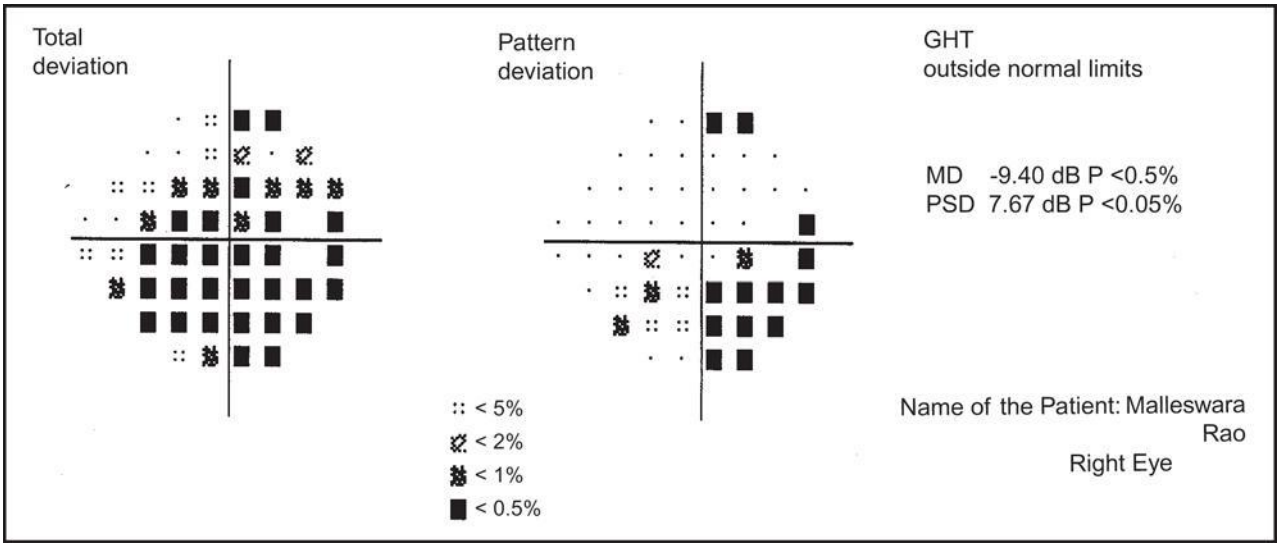


FIGURE 4.3

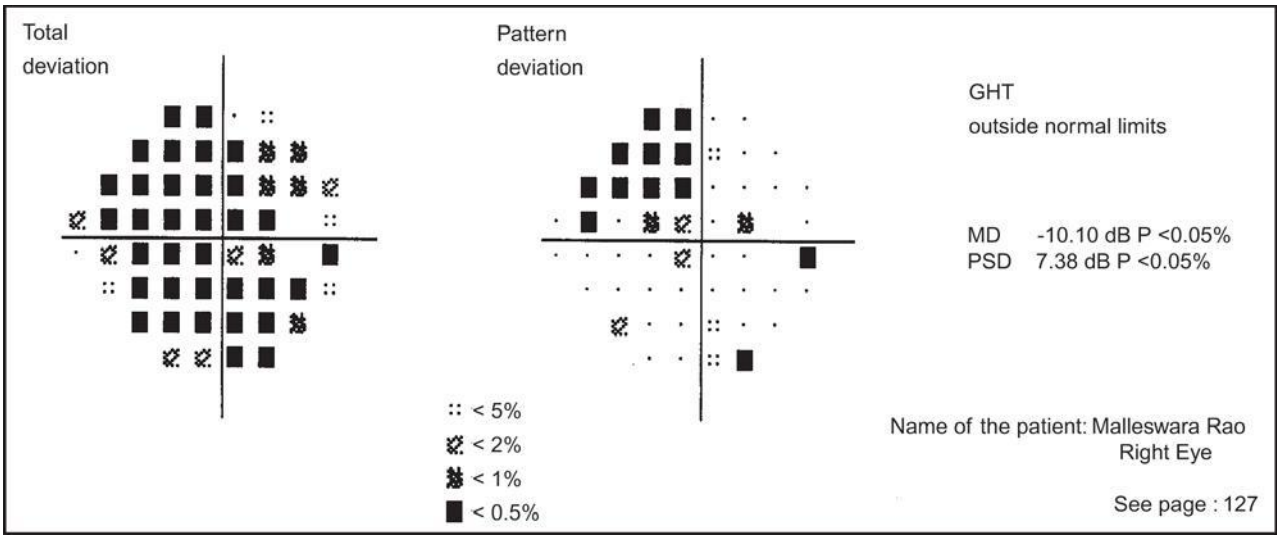


FIGURE 4.4

When the TDPP is showing generalized depression and pattern deviation probability plot is showing a localized defect, it indicates that the loss of retinal sensitivity is irregular in nature. The mild to moderate defects are eliminated and the deep defects are highlighted in the pattern deviation probability plot. In the situation we will have high MD value and high PSD value. GHT: Outside normal limits. This type of defects are usually seen in combined cases of cataract and glaucoma.

Generalized depression in the total deviation probability plot and no defect in the pattern deviation probability plot as shown in the following examples.

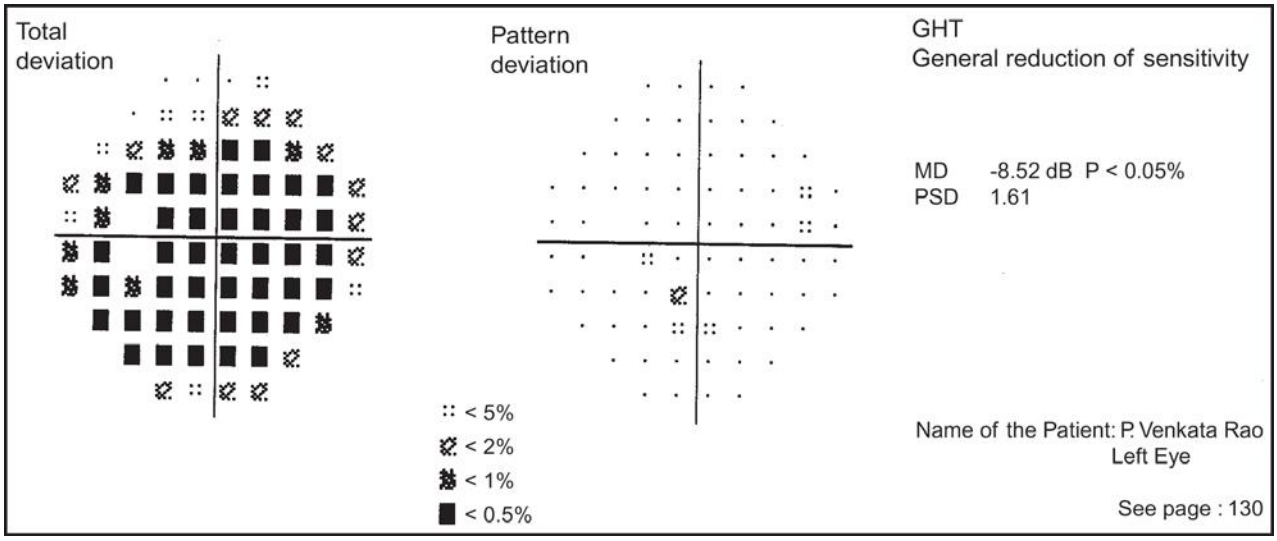


FIGURE 4.5

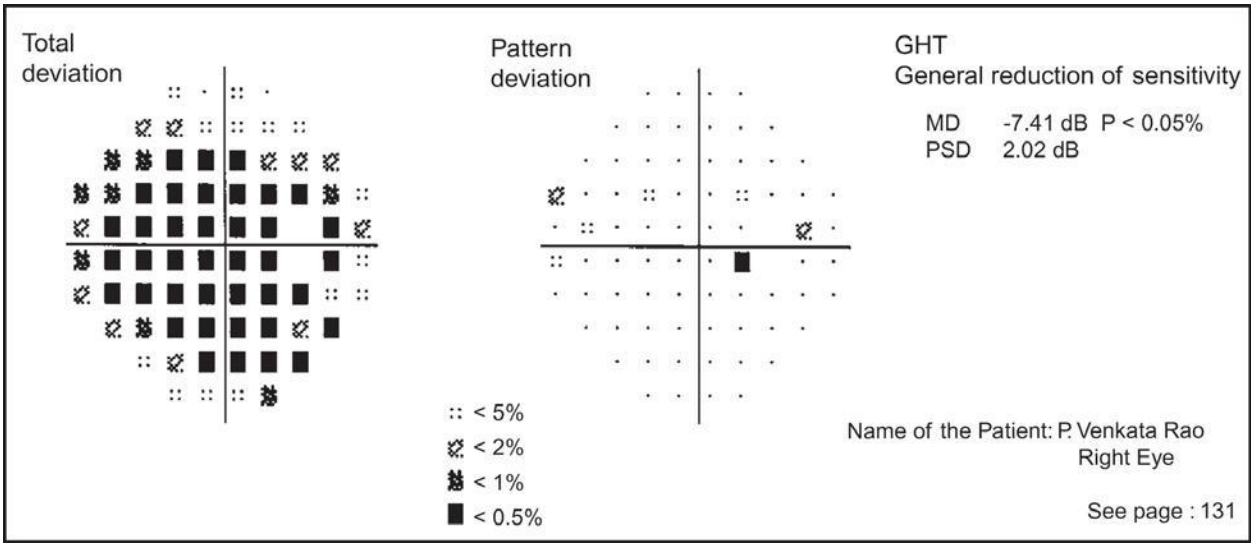


FIGURE 4.6

When the TDPP is showing generalized depression and pattern deviation probability plot is showing no defect, it indicates that the loss of retinal sensitivity is of uniform nature. Whenever there is uniform loss of retinal sensitivity we don't get any scotoma in the pattern deviation probability plot. In these situations, we will get high MD value and low or zero PSD values. Usually we see this type of picture in pure cases of cataract, advanced cases of glaucoma.

LOCALIZED FIELD DEFECT - *(BOTH THE PROBABILITY PLOTS LOOK SIMILAR - WHY?)*

When there is a localized field defect the total deviation probability plot and the pattern deviation probability plot almost look alike. From this we understand that there is no change in the numerical values of total deviation numerical plot when it is converted to pattern deviation numerical plot by the addition of the threshold value that converts the seventh best retinal sensitivity point of TDNP to 0 deviation. This is only possible when the threshold value that converts the total deviation numerical plot to pattern deviation numerical plot should be either 0 or very small numerical value. So by adding this minimal value to all the points in TDNP. There will not be much change in their deviation values and hence their P values of PDNP.

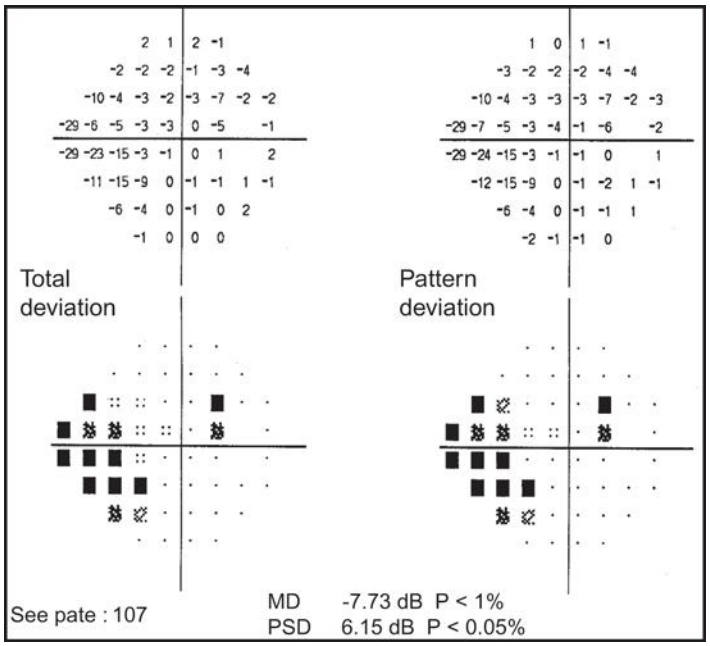


FIGURE 4.7

1. In this case the retinal sensitivity values of TDNP are varying from 2 to -29 dB.
2. The 7th best retinal sensitivity point in TDNP - (+1).
3. The threshold value that converts the seventh best retinal sensitivity value to 0 deviation is added to all the points in the total deviation numerical plot to convert it to pattern deviation numerical plot is (-1).
4. To convert total deviation numerical plot to pattern deviation numerical plot, -1 dB is added to all the deviation values of the total deviation numerical plot. So the measured retinal sensitivity at each point is changed by -1 dB only, in the pattern deviation numerical plot. Because there is no significant change in the deviation values of pattern deviation numerical plot from the deviation values of total deviation numerical plot, their probability plots look similar.

When there is a localized field defect the some part of retina is normal. So the seventh best retinal sensitivity value in the total deviation numerical plot is either 0 or minimal deviation from normal. So to make the seventh best retinal sensitivity in TDNP to 0 or normal, the threshold value needed is almost negligible. When this minimal threshold value is added to all the values in the total deviation numerical plot almost similar numerical values appear in the pattern deviation numerical plot. This is the reason why the numerical values of both total deviation and pattern deviation are similar and so the probability plots also look similar.

Actually the pattern deviation plots are created to highlight the localized scotomas masked by generalized depression. When a localized scotoma is already seen in total deviation probability plot there is no need to see the pattern deviation probability plot. Even if you see, it will be similar to total deviation probability plot. Why they look alike is already discussed.

Only when there is generalized depression in total deviation probability plot, we see the pattern deviation probability plot to know whether there are any localized field defects masked by generalized depression. When there is a localized scotoma in the total deviation probability plot, there is no need to see the pattern deviation probability plot.

UNIFORM GENERALIZED DEPRESSION (GENERALIZED DEFECT IN THE TOTAL DEVIATION PROBABILITY PLOT AND ALMOST NORMAL PATTERN DEVIATION PROBABILITY PLOT - WHY?)

In the uniform generalized depression we see a generalized depression in the total deviation probability plot and normal pattern deviation probability plot. When there is uniform generalized depression all the points' retinal sensitivity will be decreased almost equally, and there will not be any dissimilarity among the deviation values of total deviation numerical plot.

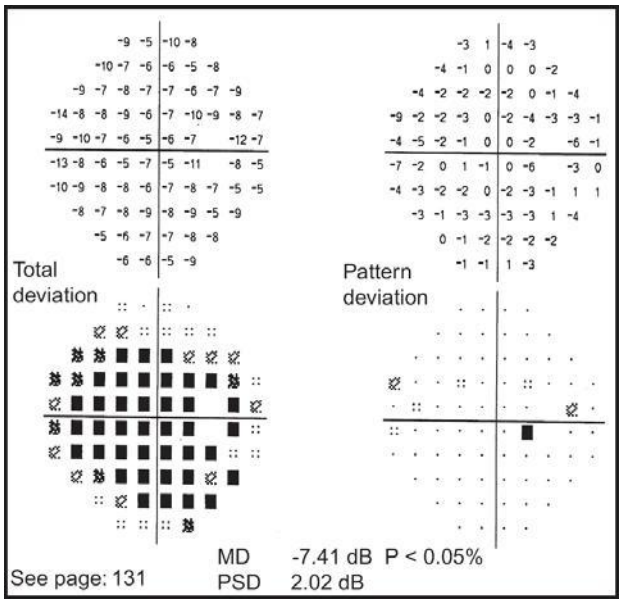


FIGURE 4.8

1. In this case the deviation values of TDNP is varying from -5 to -12 dB.
2. The 7th best retinal sensitivity point in TDNP -6.
3. The threshold value that converts the seventh best retinal sensitivity value to 0 deviation is added to all the points of total deviation numerical plot to convert it to pattern deviation numerical plot is (+6).
4. To convert total deviation numerical plot to pattern deviation plot, + 6 dB is added to all the deviation values in the above case. So the measured retinal sensitivity at each point is elevated by 6 dB in the pattern deviation numerical plot. So the P value of each deviation value of pattern deviation numerical plot is changed and became non-significant. As all points P value in the pattern deviation numerical plot became non-significant and hence, we don't see any scotoma in the pattern deviation probability plot.

When there is no scotoma in the pattern deviation probability plot, it indicates the numerical values of the pattern deviation numerical plot are within normal limits. It means when the total deviation numerical plot is converted to pattern deviation numerical plot by adding the threshold value that made the seventh best retinal sensitivity value to 0 in TDNP, to all the points, the deviation values in PDNP became normal. The next question is why the numerical values of total deviation numerical plot became normal in pattern deviation numerical plot in a case of uniform generalized depression.

In the above case of generalized depression almost all the points are uniformly depressed. The seventh best retinal deviation value is almost similar to all the remaining deviation values. So the deviation value that made the seventh best retinal deviation value to 0, when it is added to all the remaining numerical values, they become either 0 or a value within normal limits. When there is uniform generalized depression the seventh best retinal deviation value of TDNP, and the mean deviation index value are equal. Because there is no dissimilarity among all the points' retinal sensitivity values, the PSD will be 0 and the pattern deviation probability plot will not have any scotomas.

When there is generalized depression the pattern deviation plots are created to highlight the localized defects that are masked by generalized depression. When the generalized depression is of uniform nature indicated by 0 PSD and the mean deviation index value is equal to numerical deviation values of all points of TDNP, we do not see any scotoma in the pattern deviation probability plot.

IRREGULAR GENERALIZED DEPRESSION *(GENERALIZED DEPRESSION IN THE TOTAL DEVIATION PROBABILITY PLOT AND A LOCALIZED FIELD DEFECT IN THE PATTERN DEVIATION PROBABILITY PLOT - WHY?)*

In the irregular generalized depression we see a generalized depression in the total deviation probability plot and a localized field defect in the pattern deviation probability plot. Whenever there is an irregular generalized depression all the points' retinal sensitivity will be decreased irregularly and there will be a wide range of dissimilarity among the deviation values of total deviation numerical plot.

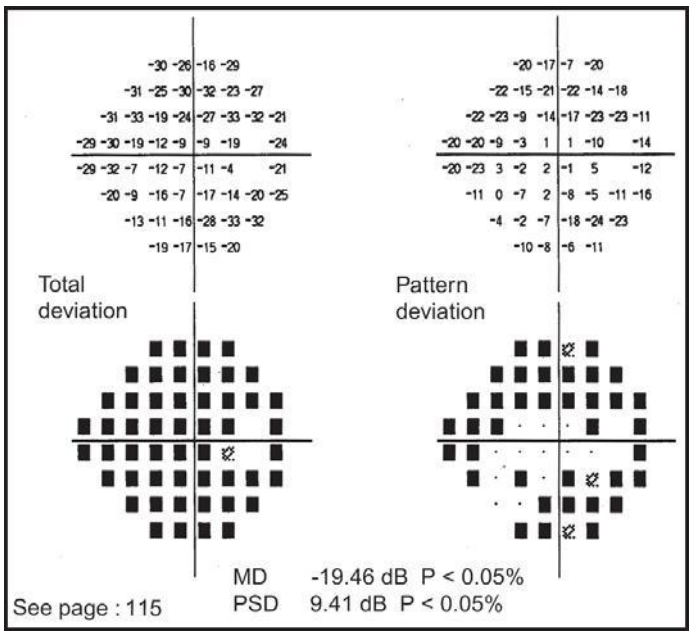
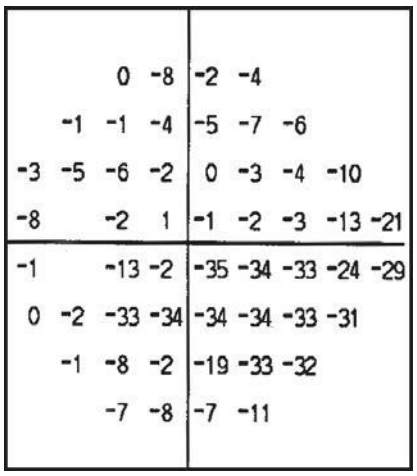


FIGURE 4.9

1. In this case the deviation values of TDNP is varying from -4 to -33 dB.
2. The 7th best retinal sensitivity point in TDNP (-9).
3. The threshold value that converts the seventh best retinal sensitivity value to 0 deviation is added to all the points of total deviation numerical plot to convert it to pattern deviation numerical plot is (+9).
4. +9 is added to all deviation values of TDNP to convert tdnpto pdnp. by adding +9, there will be significant change in the deviation values of pdnp from those of tdnp.
5. Because some point's P value became non-significant by elevating each point's retinal sensitivity value by +9 dB, they are not represented by any symbol in PDPP. So you see only a localized scotoma in the PDPP.

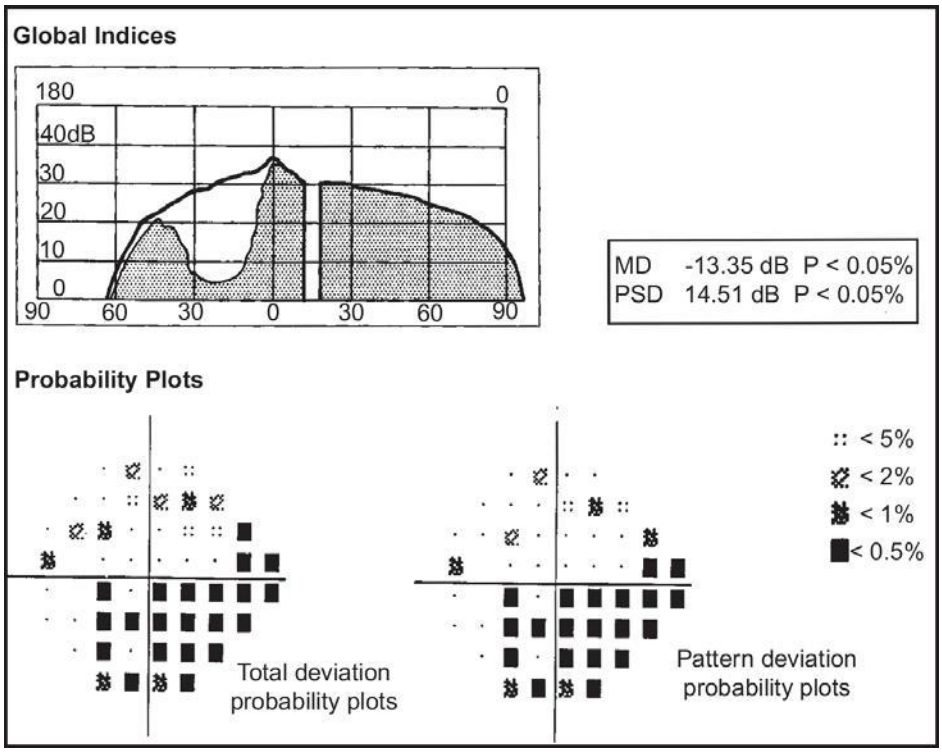
In the above situation the total deviation numerical values and the pattern deviation numerical values are not similar. That is why both the probability plots are not similar. The seventh best retinal sensitivity is -9dB. So to make the seventh best retinal sensitivity point to normal we have to add +9. So +9 is added to all the points in the total deviation numerical plot to convert it to pattern deviation numerical plot. So the measured retinal sensitivity at each point is elevated by 9 dB in the pattern deviation numerical plot. So the P value of each deviation value of pattern deviation numerical plot is changed. Some points' P value became non-significant and hence these points will not be represented by any symbol in the pattern deviation probability plot. Some points' P value is changed but still they are at significant level, so they are represented by a symbol according to the changed P value. But still some points retain their P value, 0.5% even after the addition of +9 dB. These points are represented by black squares in the pattern deviation probability plot. So in irregular generalized depression, by adding +9 dB to all points, some points' P value becomes non-significant and some point-retain their P value at significant level and so we see localized depression pattern in pattern deviation plot because some points' P value becomes non-significant.

THE FEATURES OF LOCALIZED FIELD DEFECT



Total deviation
numerical plot

In localized field defects only some areas of retina loses its sensitivity and some areas of retina will have normal sensitivity values. In this total deviation numerical plot mainly the lower nasal retina is affected and the remaining retina is normal. In this TDNP the deviation values are varying from 0 to -35. So the PSD will be very high, which is the index of dissimilarity among the deviation values of TDNP. As it is a localized defect the height of hill of vision is normal and the mean deviation index value will depend on the extent and the depth of the field defect.

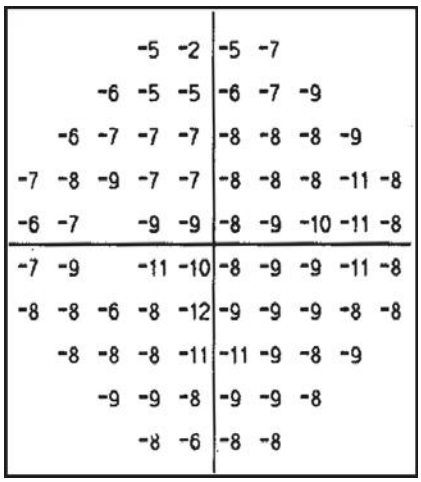


The localized field defect will have high PSD value represented by irregular contour of hill of vision. In localized field defect the height of hill of vision the normal and the change in mean deviation index will depend on the extent and depth of the field loss.

In localized field defect

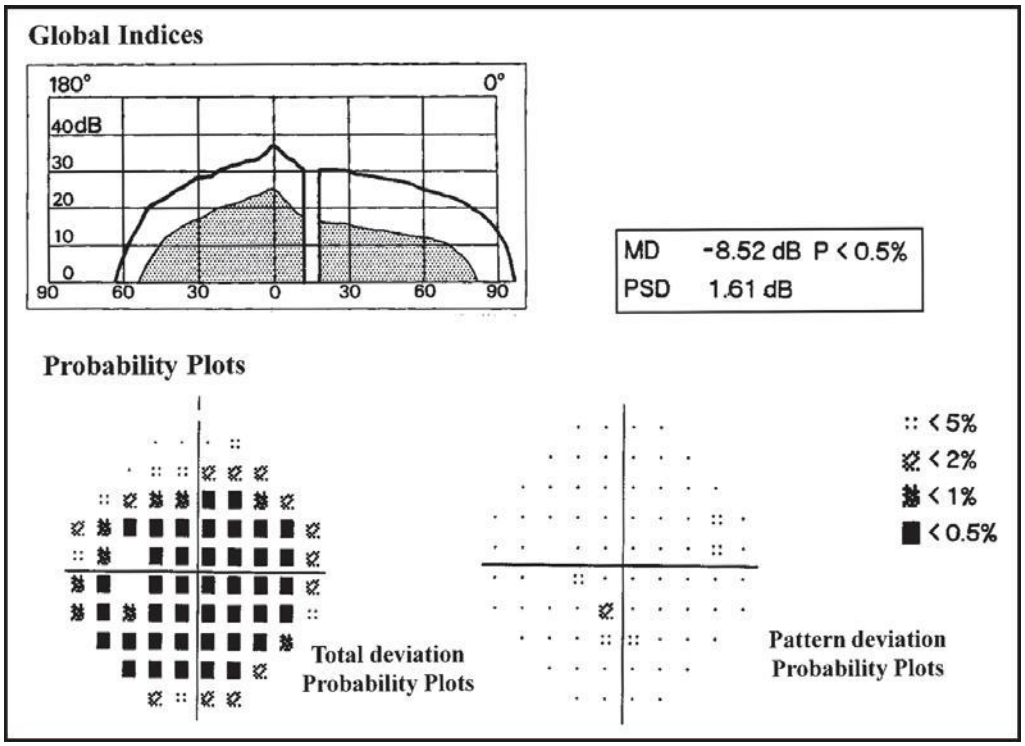
1. The total deviation probability plot and pattern deviation probability plot look identical.
2. High PSD value 3. Mean deviation index depends on the size on the depth of localized defect.

THE FEATURES OF UNIFORM GENERALIZED FIELD DEFECT



Total deviation numerical plot

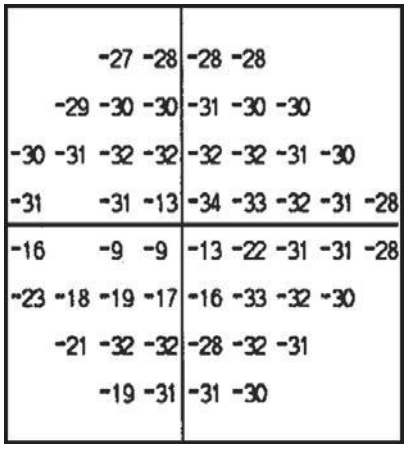
In uniform generalized depression the entire retina loses its retinal sensitivity almost equally. Hence, the TDNP will have almost similar deviation values varying from -7 to -9 dB. This tells that there is no dissimilarity among the deviation values of TDNP, which is indicated by low PSD. Because all the points are almost equally affected the most of the deviation values of TDNP will be equal to the mean deviation index. Uniform generalized depression is usually seen in cataract, small pupil, uncorrected refractive errors, and any media opacities.



The uniform generalized depression will have high MD index represented by decrease in height of hill of vision, and low PSD value represented by smooth contour of hill of vision.

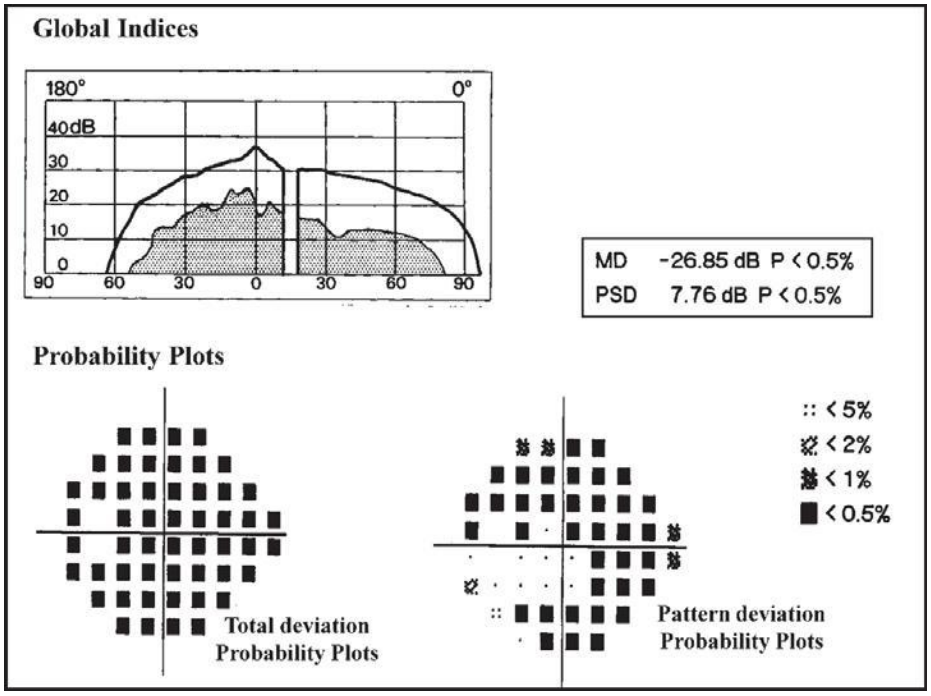
In uniform generalized field defect
1. Generalized depression in the total deviation probability plot and almost normal pattern deviation probability plot.
2. 0 or low PSD value 3. High mean deviation index.

THE FEATURES OF IRREGULAR GENERALIZED FIELD DEFECT



Total deviation
numerical plot

In irregular generalized depression all the points lose their retinal sensitivity and the loss of retinal sensitivity at each point will be of different defect depths. In this TDNP all the points lost their retinal sensitivity and the deviation values of TDNP are varying from -9 to -33 dB, Such a gross dissimilarity is seen among the deviation values of TDNP which was indicated by high PSD value and the irregular contour of hill of vision. Because all the points are affected the mean deviation index will be high and the height of hill of vision will be decreased.



The irregular generalized depression will be associated with irregular loss of retinal sensitivity and hence the mean deviation index and PSD values will be high and represented by decrease in height of hill of vision and irregular contour of hill of vision respectivly.

In irregular generalized field defect—
1. Generalized depression in the total deviation probability plot and localized field defect in the pattern deviation probability plot.
2. High PSD value 3. High mean deviation index.

SUMMARY OF INTERPRETATION OF SINGLE FIELD ANALYSIS PRINTOUT AND FOLLOW-UP TESTS

Interpretation of Single Field Analysis Printout:

1. Verify whether the patient's data and the test data are properly fed to the field analyzer by the technician. The information fed to the field analyzer should be similar to that given in the order form for the visual field test.
2. Decide whether the test is reliability or not (Reliability Indices: fixation losses, false positive errors and false negative errors should be within normal limits).
3. Note the size of the pupil (The size of the pupil should be 3-4 mm).
4. Correlate the foveal sensitivity and visual acuity. If they correlate to each other the refractive error correction for near vision is accurate.
5. Location of the blind spot: Confirm the normal location of the blind spot. See page 38.
6. Identification of the type of field defect by global indices and probability plots.

Localized field defect -

1. The total deviation probability plot and pattern deviation probability plot look identical.
2. High PSD value
3. Mean deviation index depends on the size on the depth of localized defect.

Uniform generalized field defect -

1. Generalized depression in the total deviation probability plot and almost normal pattern deviation probability plot.
2. 0 or low PSD value
3. High mean deviation index.

Irregular generalized field defect -

1. Generalized depression in the total deviation probability plot and localized field defect in pattern deviation probability plot.
2. High PSD value
3. High mean deviation index.
7. GHT analysis report

Interpretation of overview printout - No additional information more than that is present in single field analysis printout.)

Interpretation of change analysis printout:

i. Box plot
ii. Global indices
iii. Regression analysis of mean deviation analysis.

Interpretation of glaucoma change probability analysis and glaucoma progression analysis printout:

i. Baseline
ii. Glaucoma change probability printout—change from baseline plot, change probability plot, linear regression analysis of mean deviation.
iii. Glaucoma progression analysis—Establishing the decibel deviation plot, establishing the progression analysis plot.

THE EFFECT OF SIZE OF THE PUPIL ON THE VISUAL FIELD

Normally the size of the pupil should be between 3-4 mm (The stored mean normal retinal sensitivity of the normal population are obtained with the pupil size 3-4 mm). Constricted pupil is thought to give rise to diffuse visual field depression or edge scotomas. Pupil less than 2 mm is more likely to exert a significant effect on the overall level of the visual field particularly if media opacity is present in the visual axis. So it is recommended that the pupil less than 2 mm size should be dilated before we conduct the test. To note the size of the pupil is very important particularly in the follow-up tests. Before interpreting the follow-up field test we should always see that the size of the pupil of the present test and previous test. On the average the size of the pupil must be within the normal limits (3 to 4 mm), otherwise there is a chance for misinterpretation.

It is very important to know how exactly the size of the pupil influences its effect on the visual field examination. As you know the visibility of the stimulus depends on the contrast between the stimulus intensity and the background illumination. The light intensity of the stimulus and the background illumination change in proportion by the size of the pupil. So the contrast is unaffected. The visibility also depends on the total amount of light reaching retina. This is affected by the size of the pupil, the optical properties of the central part of the lens and the optical correction for near vision.

In general, testing of the visual field will be done with the normal size of the pupil and pupil should not be dilated unless there is a definite indication. All the Humphrey normal data is collected from the subjects with undilated pupil. So, finally the clinician must decide whether to dilate the pupil before subjecting the patient to perimetry. A subcapsular cataract that seriously impedes vision in the undilated state is an example of an exception. So, the clinician should take necessary precaution when to dilate the pupil.

SINGLE FIELD ANALYSIS PRINTOUT WITH 2 MM PUPIL SIZE

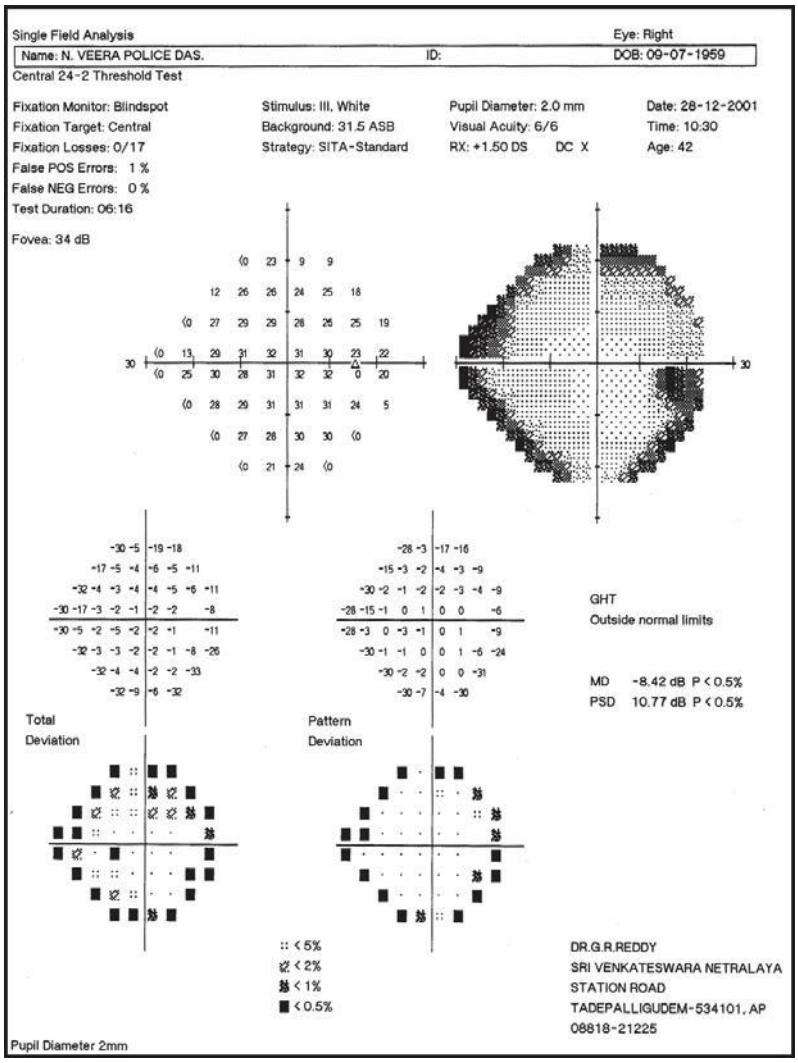


FIGURE 4.10

Name of the patient	:	Veera Police Daas	Age : 42
Visual acuity	:	6/6	Indication for field : ocular hypertension
Pupil size	:	2 mm. (Figure 4.10)	
Refractive error correction for N.V	:	+1.50 DSph	

Selection of the test: 24-2 threshold test - threshold strategy SITA Standard (Figure 4.10)

Figure 4.10 single field analysis printout was performed when the patient was on eyedrops Pilocarpine 2% with 2 mm pupil size. In this field printout both the total deviation probability plot and pattern deviation probability plot are showing many deep edge scotomas in 24-2 central field—giving an impression the glaucoma field defect started in the patient.

SINGLE FIELD ANALYSIS PRINTOUT WITH 3 MM PUPIL SIZE OF THE SAME PATIENT

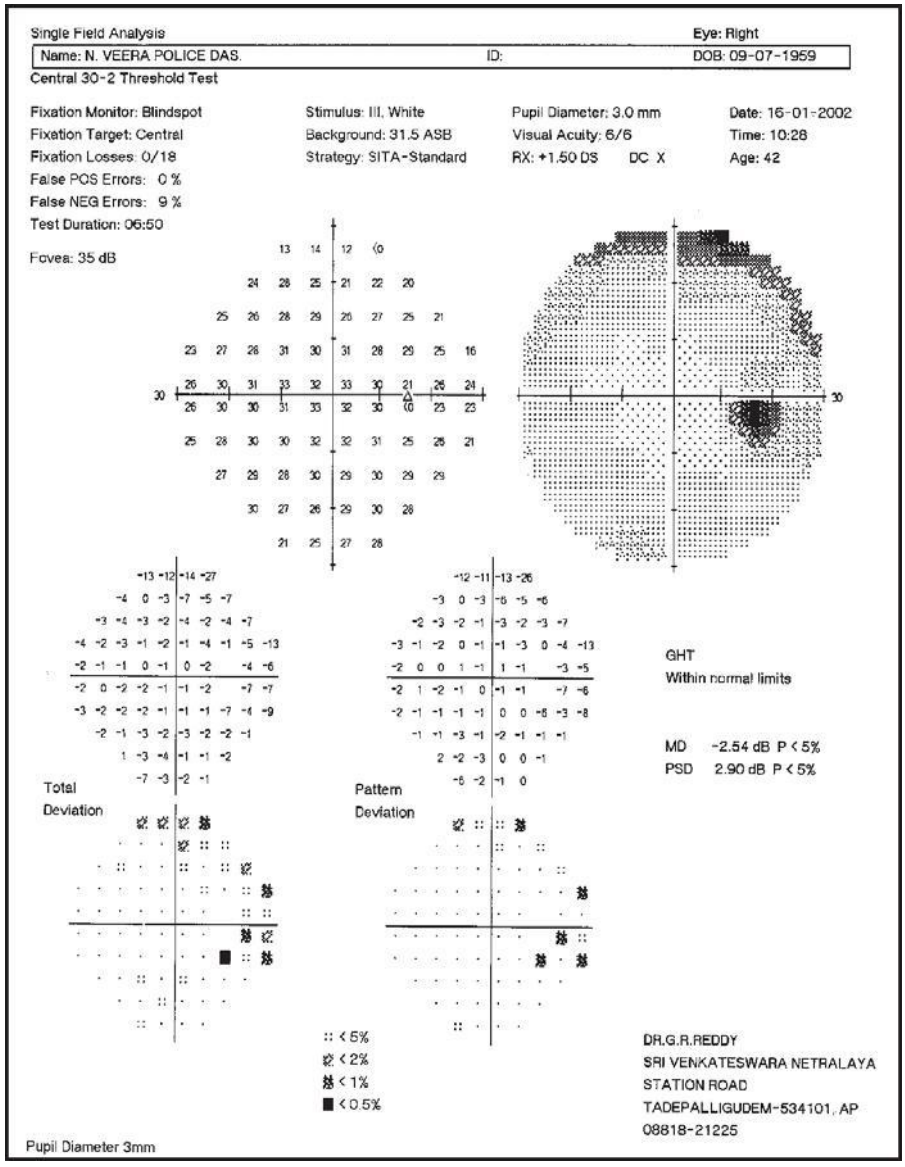


FIGURE 4.11

When the field was repeated with selection of a test 30-2 SITA Standard (Figure 4.11) after stopping Pilocarpine drops all the deep edge scotomas in both total and pattern deviation probability plots have disappeared.

From this, the most important point we should remember is even in 24-2 central field the edge scotomas should not be considered as defective when the pupil size is less than 2 mm.

Even in 30-2 central field, with 3 mm pupil size, we did not get edge scotomas which were seen in 24-2 when the pupil size is 2 mm.

IMPORTANCE OF PROPER REFRACTIVE ERROR CORRECTION ON VISUAL FIELD

The patient's near vision refractive error must be properly corrected. Otherwise the visual field will show generalized depression. Besides not only correcting the refractive error for near vision, but also we should see that the glasses are properly placed in the trail frame of the automated perimeter. Otherwise it can produce artefacts.

If visual acuity explains the measured foveal threshold of the patient and vise versa, it indicates that the refractive error correction for NV is proper.

Sometime we will not be able to give near vision correction while doing the test. In these circumstances we need not get worried because the uncorrected refractive error will not have any effect on the pattern deviation plots. Usually the uncorreted refractive errors will produce generalized depression in total deviation probability plot and will not produce any field defect in pattern deviation probability plot. So if you see the defects in the pattern deviation probability plots we have to consider these defects. If the pattern deviation plot is normal we can ignore the generalized depression of total deviation probability plot caused by uncorrected refractive errors.

SINGLE FIELD ANALYSIS PRINTOUT WITHOUT REFRACTIVE ERROR CORRECTION

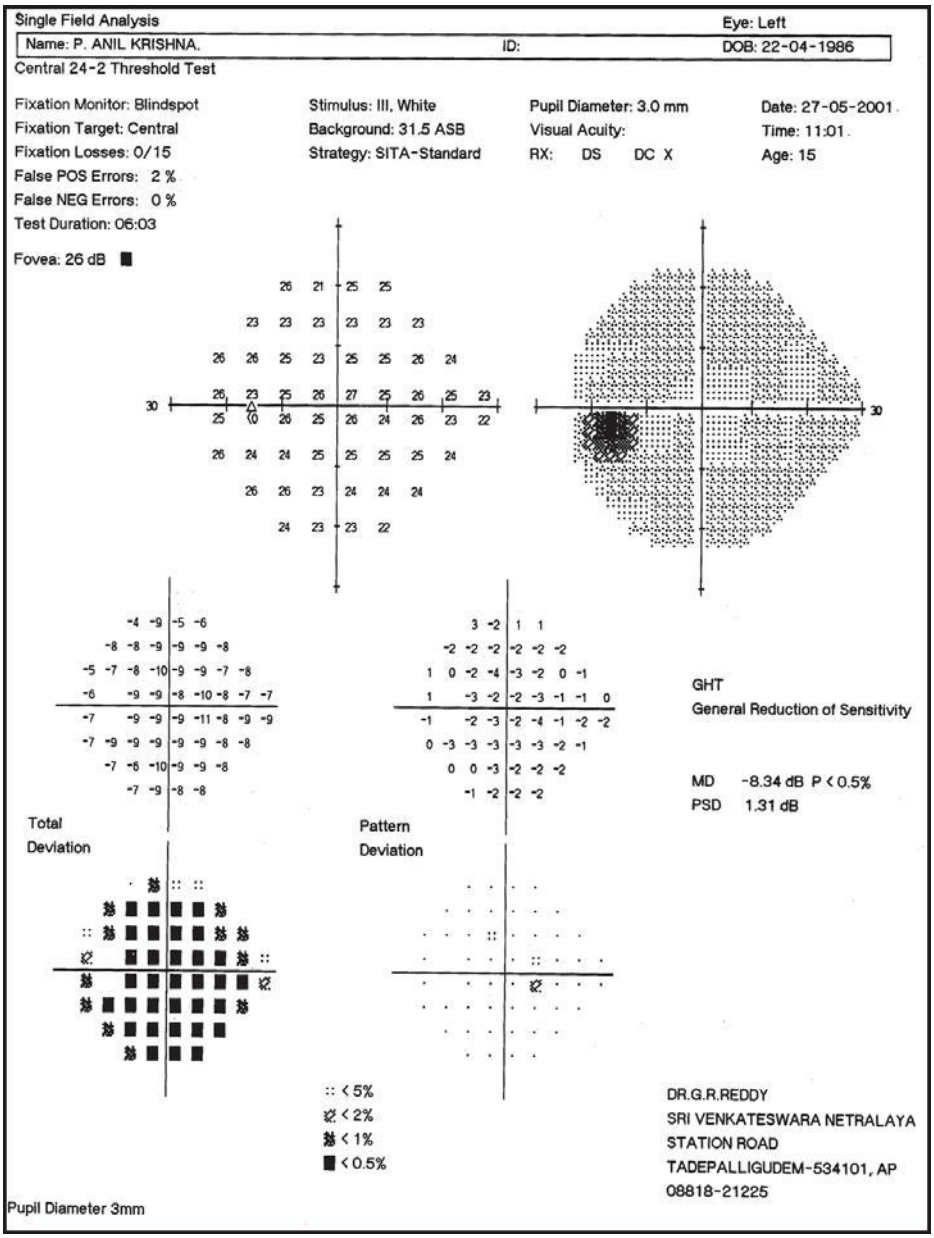


FIGURE 4.12

The visual field analysis printout performed (Figure 4.12) without refractive error correction for a known patient of -7.00DSph

In Figure 4.12 single field analysis printout the total deviation probability plot is showing generalized depression with P value less than 0.5% for most of the tested points when the test was performed without refractive error correction.

SINGLE FIELD ANALYSIS PRINTOUT WITH REFRACTIVE ERROR CORRECTION

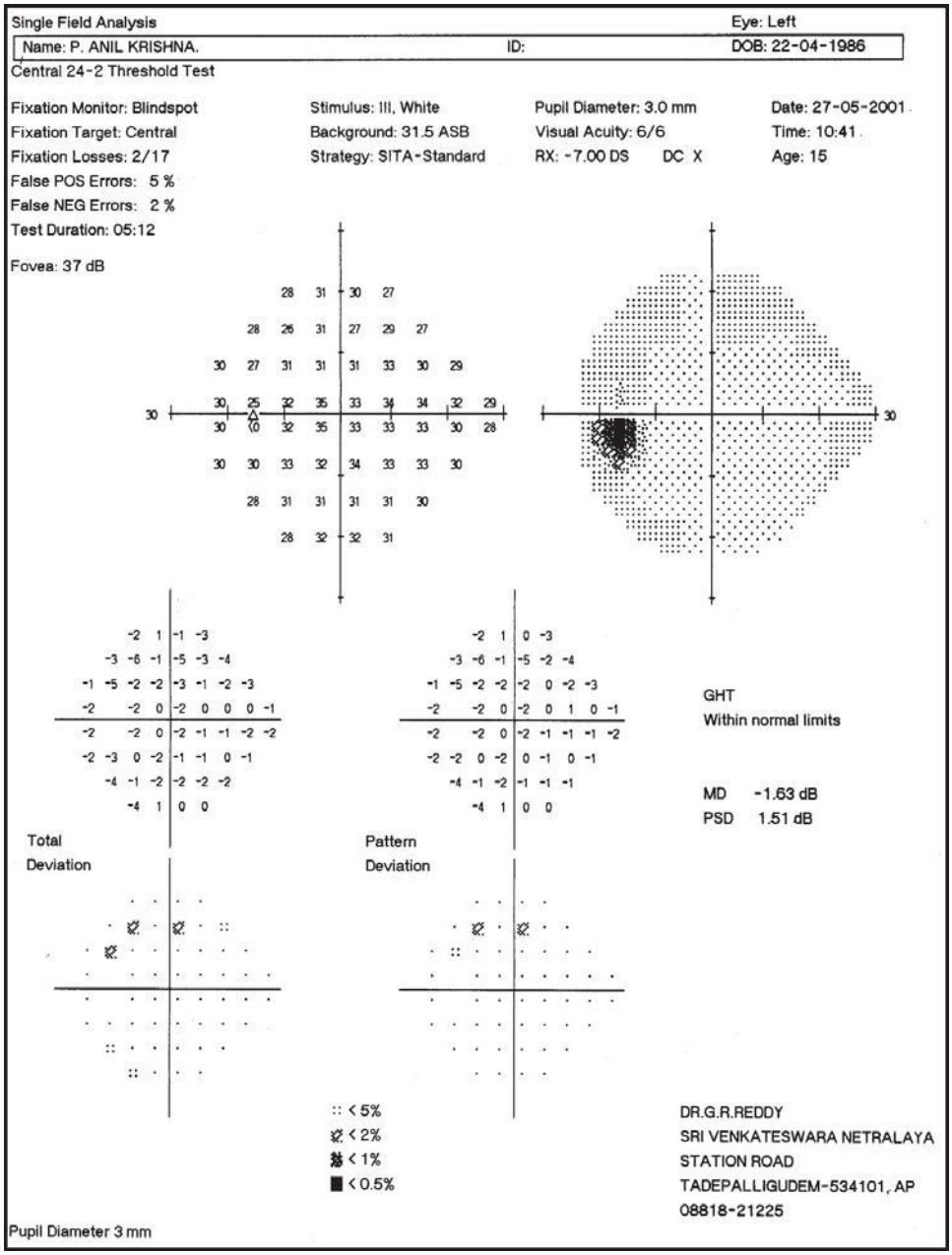


FIGURE 4.13

In Figure 4.13 single field analysis printout the total deviation probability plot of the same patient is not showing any scotomas when the test was performed with refractive error correction -7.00DSph.

From this example we came to know that a proper refractive error correction for near should always be given while performing the field test.

FAILURE TO DETECT BLIND SPOT

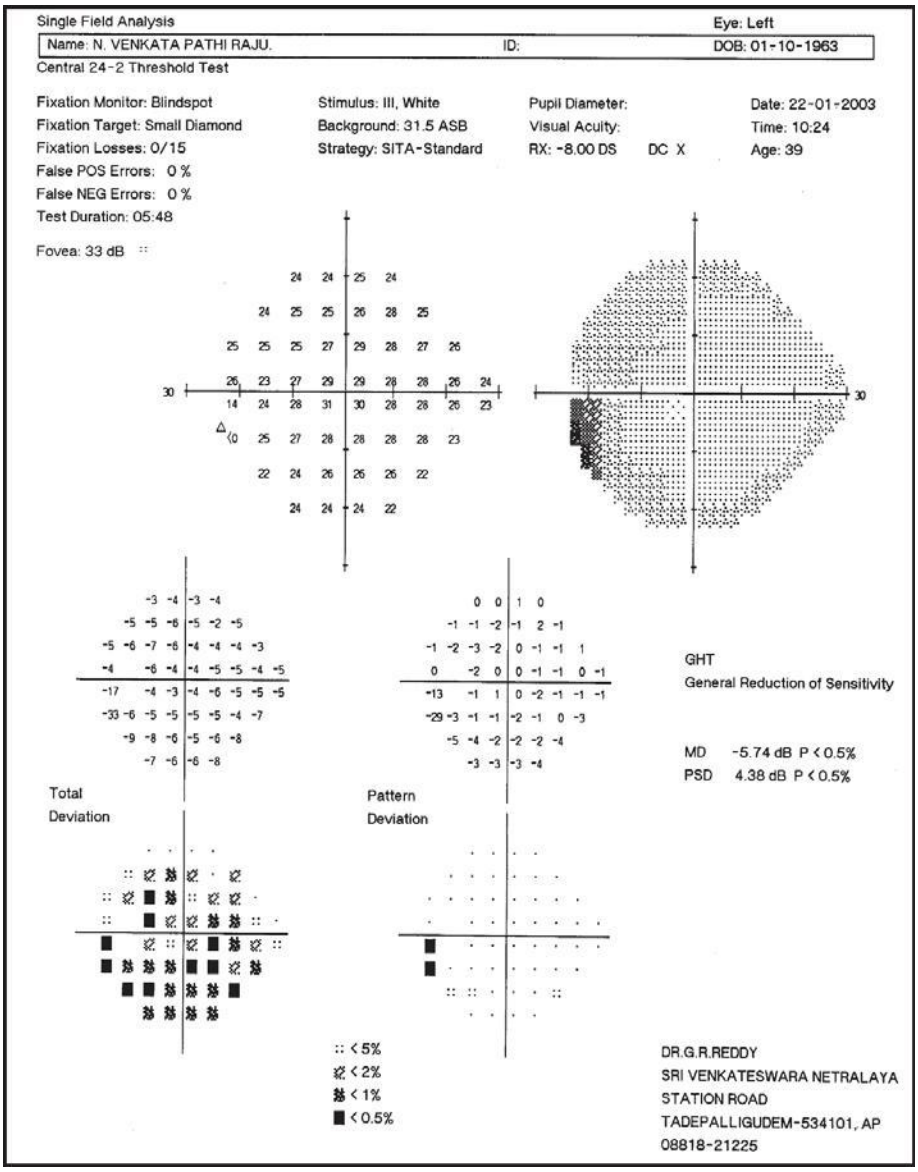


FIGURE 4.14

No blind spot: The most striking feature of this 24-2 single field analysis printout is the absence of blind spot either on the gray scale or on the raw data.

Comment: This field strikingly demonstrates how an absolute scotoma, the size of a blind spot - approximately 6° across and 8° vertically - can remain undetected by a standard threshold program. The blind spot literally fell between the test points and it managed to hover undetected within the 6° spacing of the test points. Interestingly the number of fixation losses were acceptable. This means the projection into the blind spot is successful and thresholding did not occur at that precise location. In fact, missing the blind spot indicates excellent fixation since there is no shifting of the scotoma into the adjacent test sites.

FIXATION LOSSES

The Humphrey field analyzer has the capability of monitoring fixation behavior of the patient and determining if the fixation losses have occurred. The technique used is the Heijl-Krakau method. At the beginning of the test, the instrument assumes the anatomically average location for the blind spot. If the patient responds to either of the first two blind spot checks, the machine will locate the blind spot by serially presenting the suprathreshold stimuli around the presumed blind spot until the boundaries are located. A small triangle will appear on the video display and the printout indicating the location of the blind spot. During the test itself about 5% of the stimuli is presented into the center of the mapped blind spot. A patient's response to the stimulus presentation is presumed to have resulted from a shift of fixation. The number of fixation losses and trails is kept as a running tally on the video display during the test. The fixation losses of 20% are considered as reliability. In circumstances when we get high fixation losses even though a patient is well instructed then it is better to change the test parameters as follows - to reduce fixation losses.

i. Changing the central fixation target to small diamond or big diamond.

ii. Changing the stimulus size III to stimulus size V.

When field tests are done in suspected cases of glaucoma, one should see that there are no fixation losses as even one fixation loss may affect the field in such away to meet the Anderson's criteria to detect early glaucoma field defects. So, in suspected cases of glaucoma the fixation loses, false positive and false negative errors should be absolutely 0%. In established cases of glaucoma the fixation losses, false positive errors and false negative errors can be upto 20%.

SINGLE FIELD ANALYSIS PRINTOUT WITH HIGH FIXATION LOSSES 7/15 XX

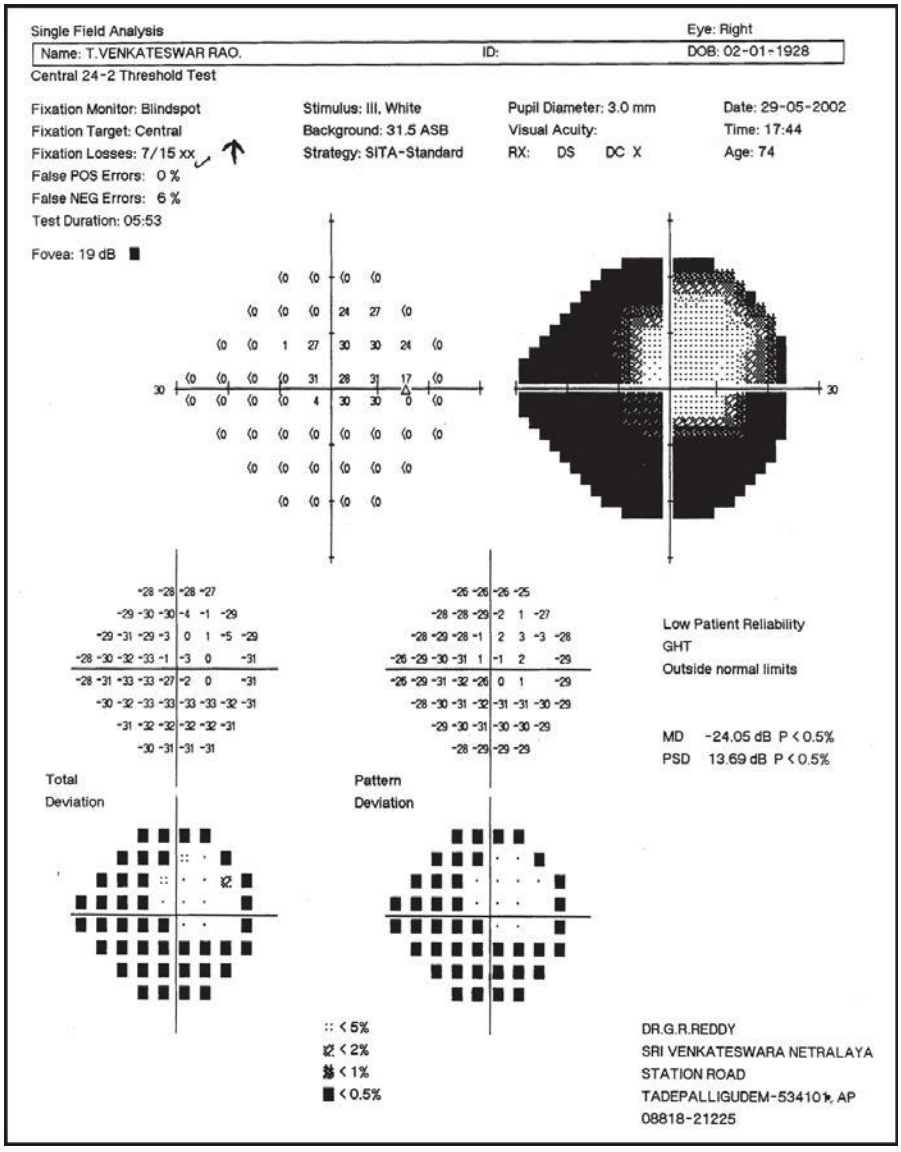


FIGURE 4.15

Name of the patient : T.Venkateswar Rao Age: 74
Visual acuity : Not recorded
Refractive error correction for N.V: Not recorded Pupil size: 3.0 mm

Indication for Field: Cup Disc Disparity between the Two Eyes

Selection of the test: 24-2 threshold test, strategy SITA Standard
Step 1: Reliability indices: high fixation losses 7/15xx (Figure 4.15)
Interpretation: Advised to repeat the test because of high fixation losses >20%

SINGLE FIELD ANALYSIS PRINTOUT WITH FIXATION LOSSES 2/16

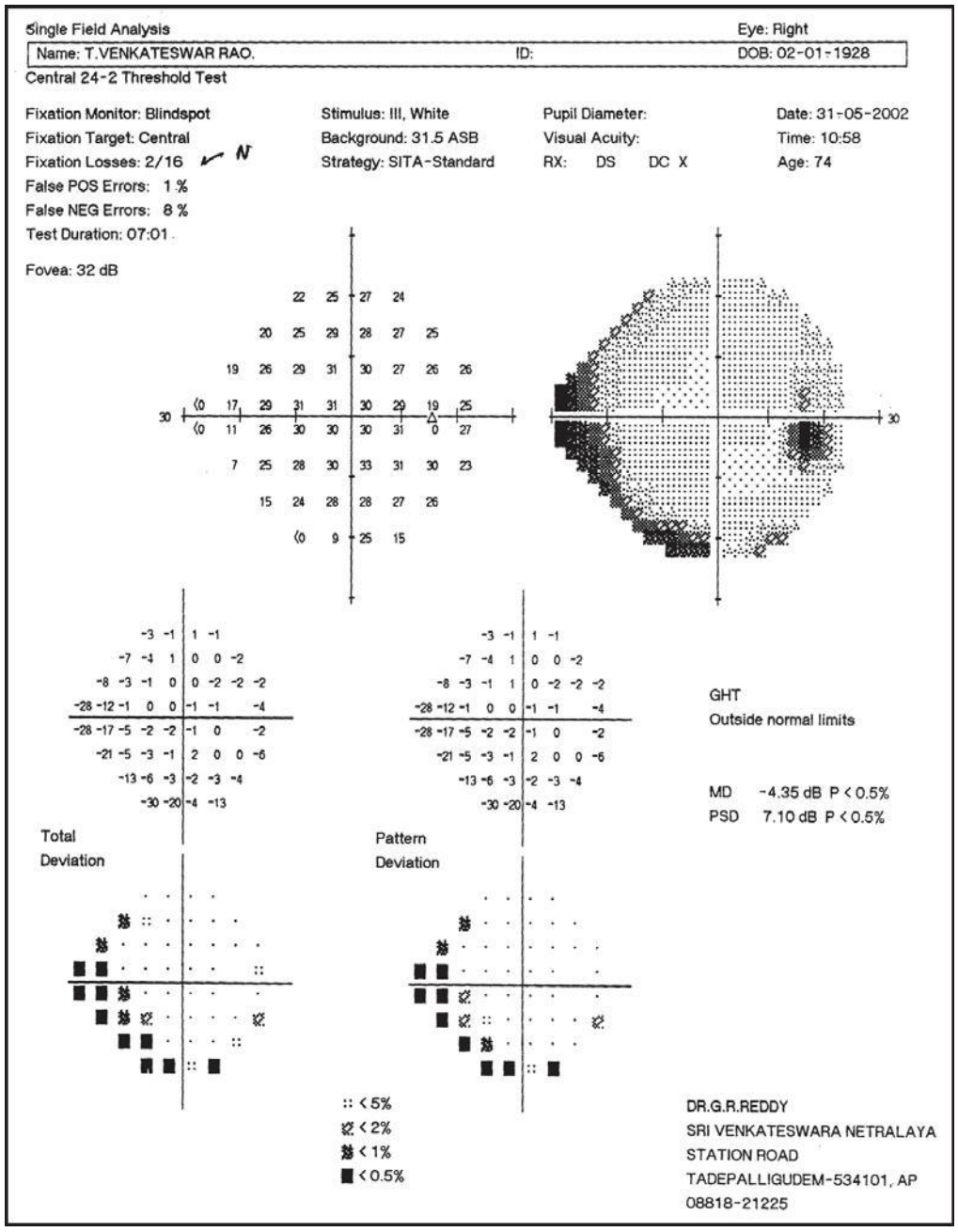
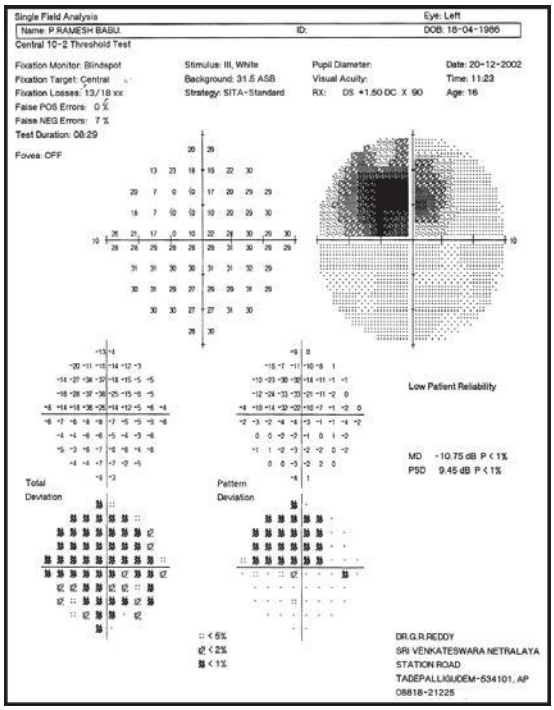


FIGURE 4.16

The test was repeated and the rate of fixation losses came down from 7/15xx to 2/16 (within normal range) Figure 4.16 Note the difference of the 2 visual field analysis printouts. So by mistake if we fail to notice the high fixation losses in the first printout (Figure 4.15), we should have labelled the field defect as advanced glaucoma field defect.

IMPORTANCE OF SELECTION OF PROPER FIXATION TARGET TO REDUCE HIGH FIXATION LOSSES



Name of the patient : P. Ramesh Babu
Left Eye

Diagnosis : Macular degeneration

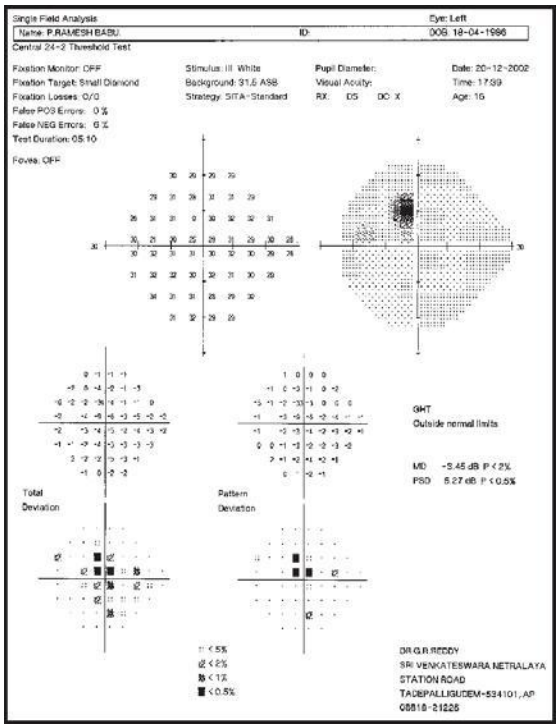
Fixation Target : Central

Selection of the test : 10-2 SITA Standard

Reliability : Poor reliability because of high fixation losses 13/18 xx

Because of central scotoma, the patient is not able to fix the central target.

Because of high fixation losses patient is advised to repeat the test with fixation target small diamond.



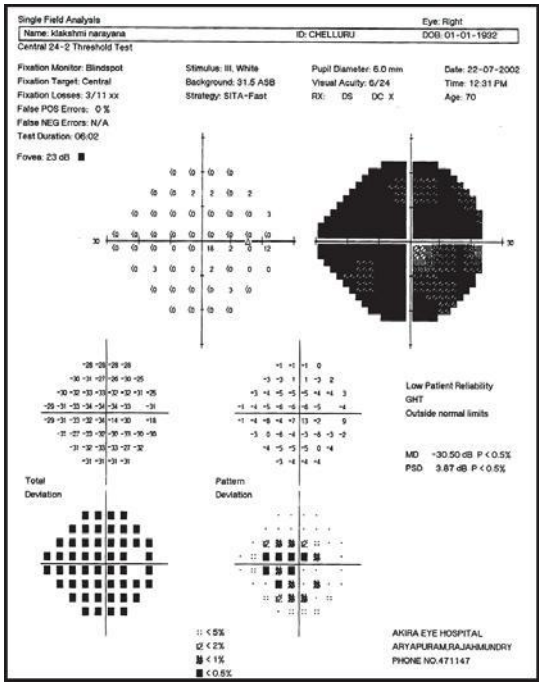
Selection of the test: 24-2 SITA Standard

Fixation target: Small diamond

Reliability: Good
Fixation losses: 0/0
False POS errors: 0/0
False NEG errors: 6%

The total deviation probability plot, and pattern deviation probability plot are showing central scotoma. Please note that high fixation losses 13/18 xx with central fixation target came down to 0/0 with small diamond as fixation target. So, in macular degenerations the fixation target should be either small diamond or big diamond instead of central fixation target.

IMPORTANCE OF SELECTION OF PROPER SIZE OF THE STIMULUS IN ADVANCED CASES OF GLAUCOMA TO REDUCE HIGH FIXATION LOSSES

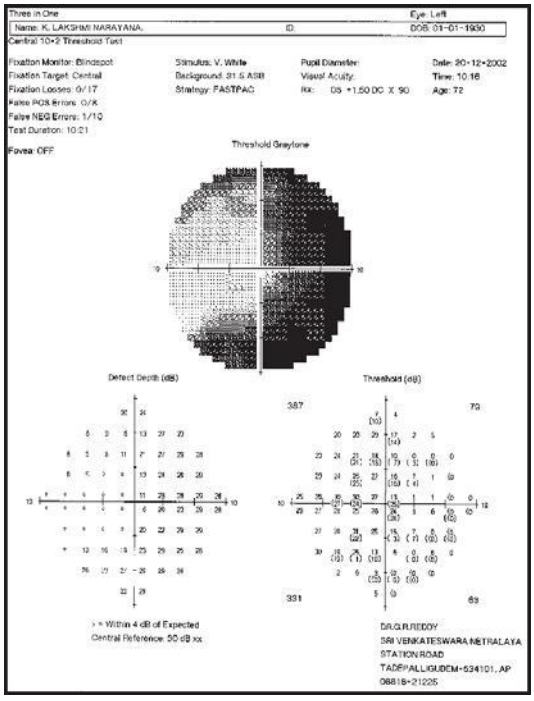


Name of the patient : K. Lakshmi Narayana
Right Eye

Selection of the test : 24-2 SITA Fast

Reliability : Poor reliability because of high fixation losses 3/11 xx

Because of high fixation losses in this case of advanced glaucoma, the size of the stimulus III is changed to stimulus size V and repeated the test.



Selection of the test: 10-2 SITA Standard
Size of the stimulus: Size V

Because of lack of normative data to the tests conducted with size V stimulus, STATPAC cannot analyze the raw data of these tests. So we don't see total deviation plots, pattern deviation plots, global indices and GHT analysis in the printout formats. So you will get Three-in-One printout instead of single analysis printout.

Reliability: Good False POS errors: 0/8
Fixation losses: 0/17 False NEG errors: 1/10

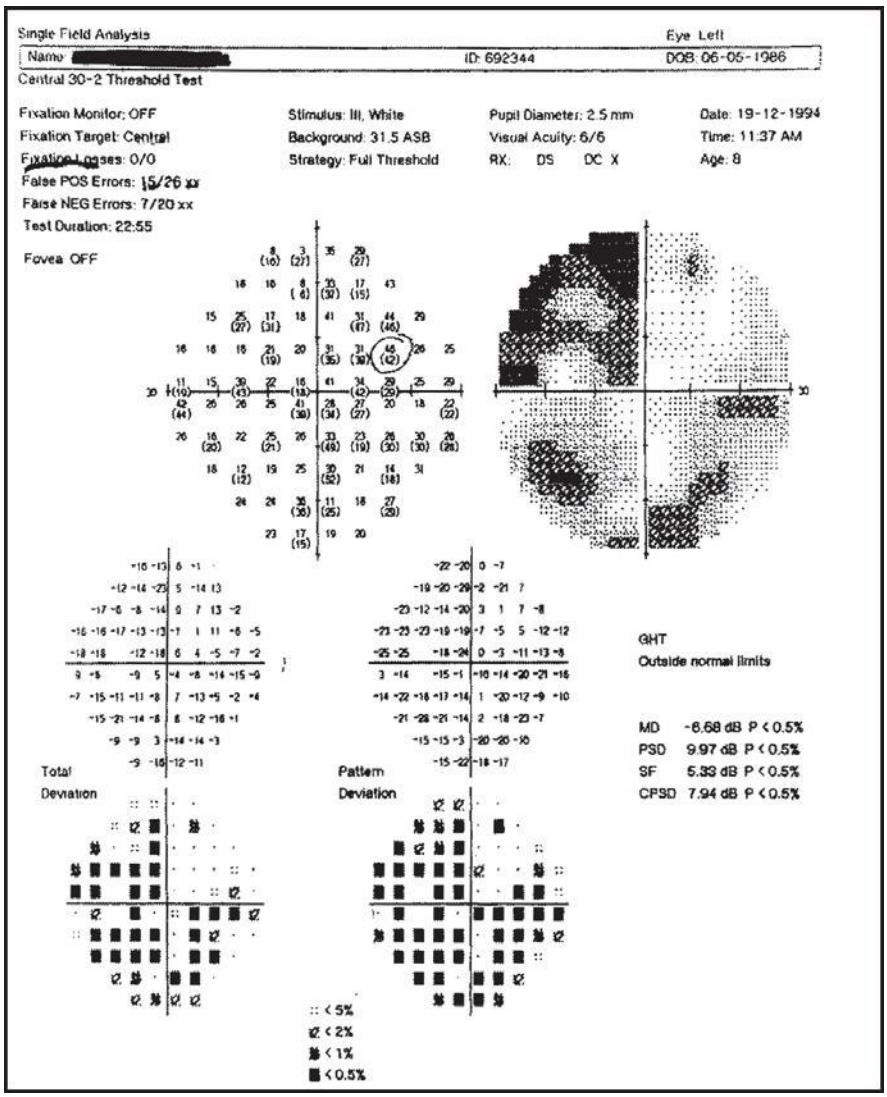
Please note that fixation losses 3/11 xx with size III came down to 0/17 with stimulus size V. So in advanced cases of glaucoma, if there are high fixation losses, you can change the size of the stimulus III to stimulus size V. By changing the size III to size V, you can have better information regarding the status of macular split.

FALSE POSITIVE ERRORS

If the patient pushes the button to the non-projected stimulus it will be recorded as false positive response. The false positive errors are expressed in ratios in non-SITA strategies (Full Threshold strategy and FASTPAC strategy) and in percentanges in SITA strategies (SITA Standard and SITA Fast). The way the false positives are calculated by SITA strategies and non-SITA strategies are different. The false positive responses in non-SITA strategies are calculated as number of times the patient responds during false positive catch trails which are pauses during which non-stimulus is presented. The number of erraneous responses per catch trial is given as ratio. The letter X is printed next to FP ratio when it exceeds 33%. But SITA strategies calculate false positive rates from the responses at unexpected times during the test, i.e. the patient's response to the stimulus may be too early or too late when compared to normal response time. Careful instruction to the patient before the test and encouragement during the test can help to reduce false positive errors. The patient should be told that the machine waits for a time to receive a response after brief stimulus. **Most patients will have some false positive response during the test and up to 20% rate considered to be acceptable**. If the false positive rate exceeds 33%, it is considered to be unacceptable by the machine and indicative of unreliable. With high rate of false positive responses the gray tone printouts show multiple white scotomas corresponding to areas of abnormally high sensitivity.

Normally we see more number of black squares in the total deviation probability plot than the pattern deviation probability plot. But this is one situation where we see more number of black squares in the pattern deviation probability plot than the total deviation probability plot. In high false positive errors, some of the points' retinal sensitivity will be calculated as high values and the 7th best retinal sensitivity values will be more than mean normal value of the same age group of the patient. In this TDNP the seventh best retinal sensitivy value +6. So -6 is added to all the deviation values of total deviation numerical plot to convert it to pattern deviation numerical plot. It means the retinal sensitivity value at each point is decreased by 6 dB when it is converted to pattern deviation numerical plot. By adding -6dB the some of the P values of pattern deviation numerical plots will be changing from $P < 2\%$ or $< 1\%$ to $P < 0.5\%$ represented by black squares. This is the reason why we see more number of black squares in pattern deviation probability plots than the total deviation probability plots. Normally the retinal sensitivity will always be elevated while converting it to PDNP. But in this situation, actually we are decreasing the retinal sensitivity by adding -6 to all the points in the TDNP while converting it to PDNP. So we are decreasing the measured retinal sensitivity by 6 dB.

SINGLE FIELD ANALYSIS PRINTOUT WITH HIGH FALSE (+)VE ERRORS



Name of the patient : X
Age : 8
Visual acuity : 6/6
Refractive error correction for N.V : ——
Pupil size : 2.5 mm
Selection of the test : 30-2 threshold test, strategy full threshold

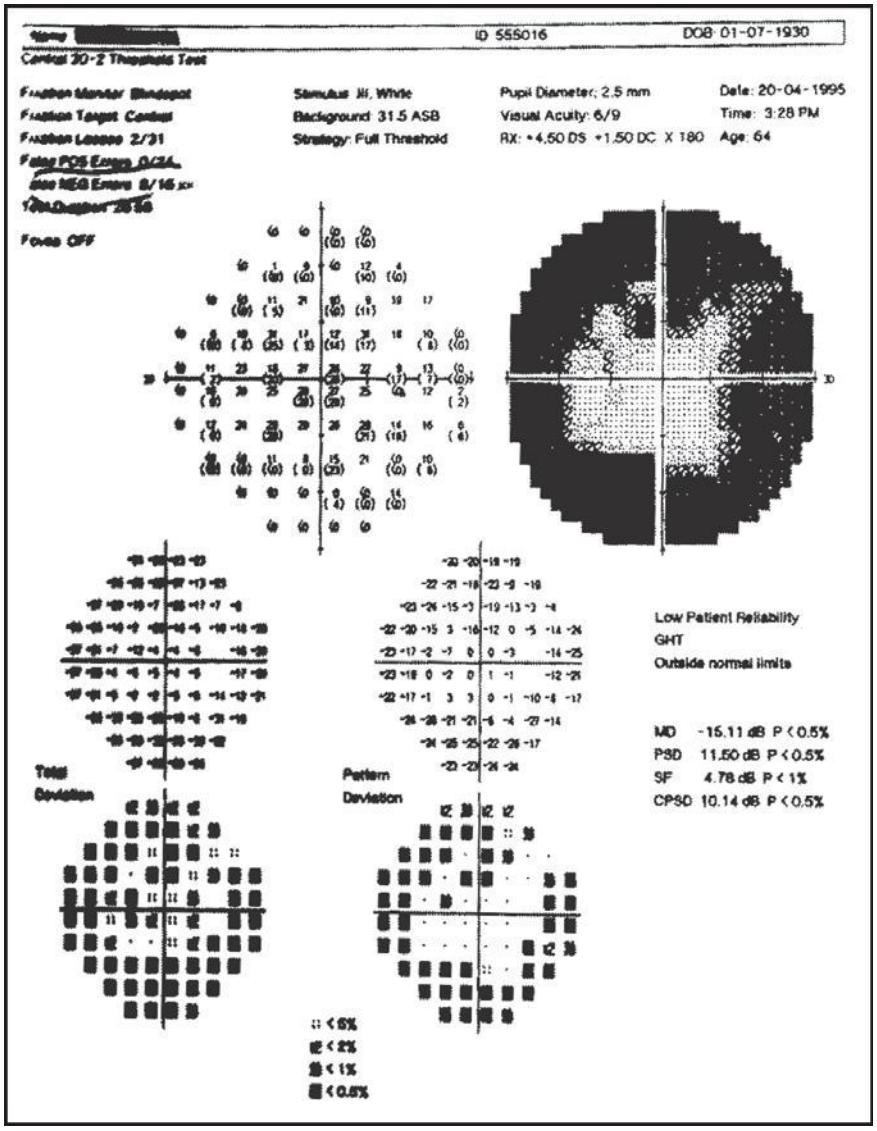
Step 1: Reliability Indices: high false (+)ve errors 15/26xx

Interpretation: Advise to repeat the test, because of high false (+)ve errors > 33% . Usually we do not use the gray scale printout for diagnosis, but fields with false (+)ve errors may produce characteristic changes in the gray scale printout . As shown in the gray scale of above figure, multiple white areas the so called white scotomas are seen. Some of the measured decibel values are in the high 30's and 40's. A parametrically trained youngster may have a foveal threshold of 40 decibel, the thresholds we are seeing in the periphery are not physiological. The White scotomas draw your attention to high false (+)ve responses.

FALSE NEGATIVE RESPONSE

Failure to respond to the brightest stimulus in an area previously determined to have some sensitivity is a false negative response. The false negative responses are expressed in ratios in non-SITA strategies (Full Threshold strategy and FASTPAC strategy) and in percentanges in SITA strategies (SITA Standard and SITA Fast). The way the false negative responses are calculated by SITA strategies and non-SITA strategies are different. I do not want go into details how they are calculated but I want you to remember the following facts. In Full Threshold and FASTPAC strategies, false negative responses are affected by patient's attentiveness, fatigue, hypnosis, and by visual field loss itself. But in false negative responses, in SITA strategies more strongly relate to patient's attention and practically unaffected by visual field loss areas. In general, greater than 20% rate of false negative response is considered to be abnormal though the machine defaults to 33%. **Fields should not be considered unreliable solely upon a false negative response rate, particularly if there is a great deal of pathology. In patients with advanced glaucomatous optic nerve damage we may get more than 50% false response which can be attributed in small shifts in fixation.**

SINGLE FIELD ANALYSIS PRINTOUT WITH HIGH FALSE (-) VE ERRORS



Name of the patient : X
Age : 64
Visual acuity : 6/9
Refractive error correction for N.V : +4.5Dsph-150Dcylx180
Pupil size : 2.5 mm
Selection of the test : 30-2 threshold test, strategy full threshold

Step 1: Reliability Indices: high false (-)ve errors 8/16xx

Interpretation: Advised to repeat the test because of high false (-)ve errors >33%

COMMENT: The gray scale in above figure shows the typical CLOVER LEAF PATTERN fairly characteristic of a fatigue field with high false negatives. Here, initially the patient performs well and then becomes progressively less responsive. When we get edge scotomas, we should always check the false negative error index, size of the pupil and position of the correcting lens. Usually edge scotomas are due to high false negative responses or small pupil or due to edge of refractive error correction glasses. The peripheral points will be tested after testing the central points. This is the reason why we see edge scotomas in fatigued patients because of high false negative errors.

LENS RIM ARTEFACTS

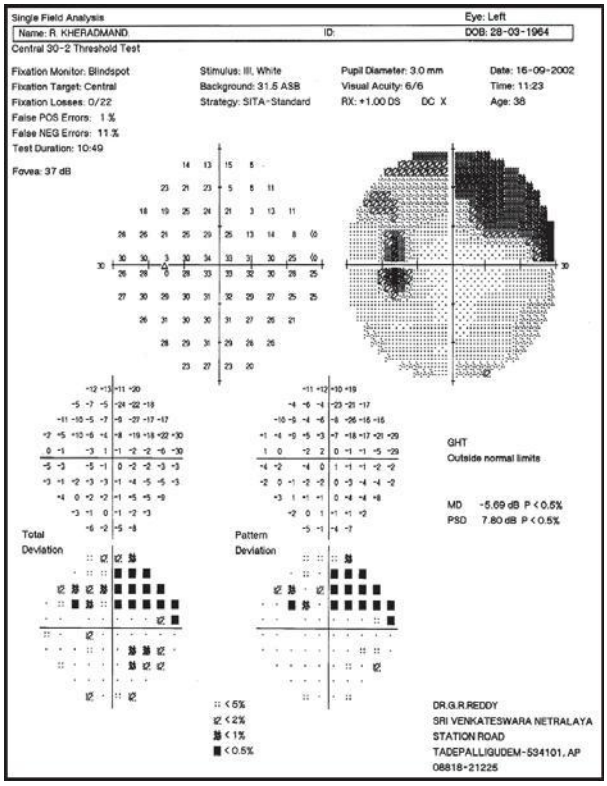
LENS RIM ARTEFACTS

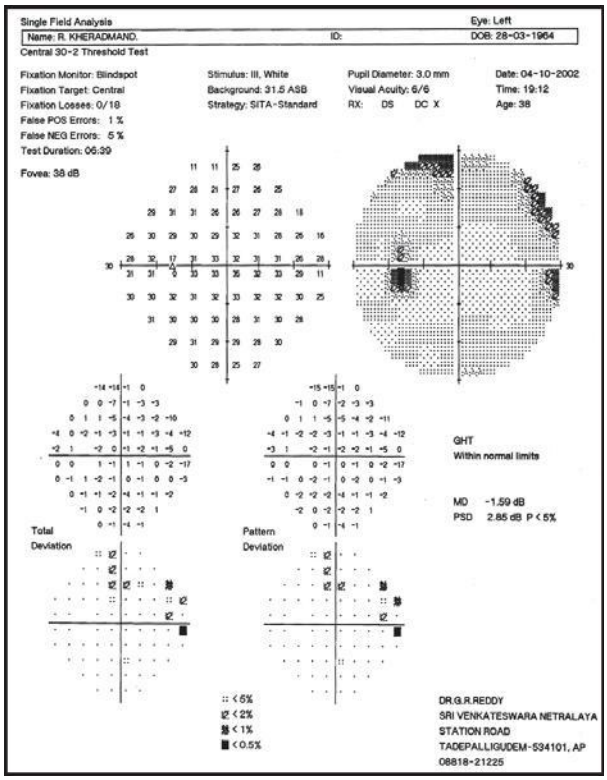
The most important point one should know is many a time we will be observing pseudo field defects due to lens rim. So it is very important to recognize these artefacts.

i. Typical lens rim artefacts are easily recognized because they tend to be absolute and sharply demarcated. Some times arcuate scotomas start from blind spot may appear due to lens rim and usually they do not widen on the nasal side of its course and will disappear on subsequent tests with appropriate positioning of the lens.
ii. When the lens is too far from the eye or not properly centred, its rim can produce a sharply demarcated absolute defect.
iii. If the lens is not placed sufficiently close to eye, it may produce sometimes double arcuate scotoma.

From these points we understand the importance of positioning the lens in the most appropriate position to avoid these rim artefacts.

LENS RIM ARTEFACTS





Name of the patient: Kheradmand.
Indication for field: Assemetry of C/D ratio left > right.
Gonioscopy: Open angle
IOP: Both eyes 16 mm of Hg
Total deviation: Upper nasal scotoma
Pattern deviation: Upper nasal scotoma
PSD : 7.80 dB P < 0.5 %
GHT: Outside normal limits
All the above criterias are fulfilling the Anderson criteria to label as glaucoma field defect.

Because of false -ve errors 11% and as the disc changes are not explaining the field defect, asked to repeat the fields without near vision correction.

<u>Repeated field:</u>

Showed absence of the above upper nasal scotoma. When the localized scotomas are not in the arcuate area and when the field changes are not corresponding to the disc changes, one should not diagnose glaucoma on visual field defects alone without clinical evidence.

Thinking that the scotoma in the first field may be due to the rim of the correcting lens, the repeated test was conducted without near vision correction as the patient's age is 38 years.

5 Visual Field Loss in Glaucoma

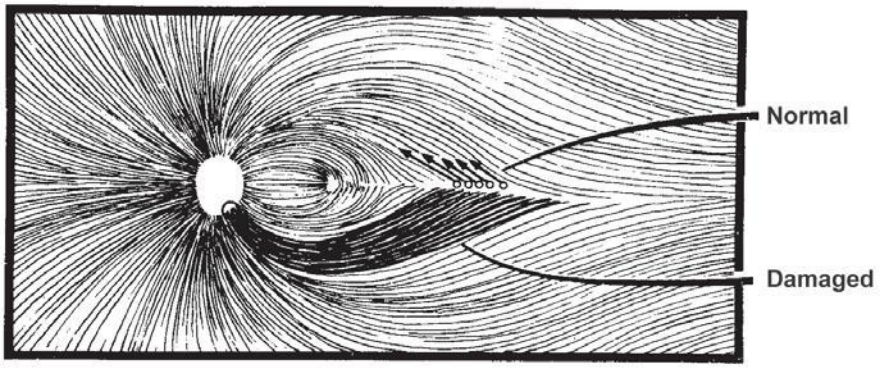


FIGURE 5.1

The localized nature of a typical glaucomatous visual field loss and rarities of uniform diffuse involvement have important diagnostic consequences. Arcuate scotomas and nasal steps are characteristic features of glaucoma. In glaucoma when bundles of nerve fibers are damaged at the optic disk, the region of the visual field supplied by these fibers loses its visual sensitivity. The result is either a scotoma or a localized depression. Typically the nerve fiber bundles entering the upper and the lower pole of the disk are first affected in glaucoma. The nerve fiber bundle defects are the classic and typical glaucomatous field defects. Usually the upper half of the field is more affected than the lower half. The degree of damage at the upper pole of the optic disk usually differs from the degree of damage at the corresponding sector of the lower pole. Therefore, the threshold values at locations at the upper and lower hemifields are likely to deviate from normal values unequally. To recognize, the presence of mild localized glaucomatous visual field loss, it is often useful to compare corresponding parts of the upper and the lower hemifields by visual inspection or by statistical means (Glaucoma hemifield test).

Asymmetry of field losses above and below the horizontal meridian facilitates detection and diagnosis of glaucoma. Isolated paracentral defects occur as the initial glaucoma field defects in about 40% of the patients. Other early manifestations of glaucoma damage include arcuate defects, nasal steps and temporal wedge defects. The temporal wedge defects are produced due to the damage of nerve fibers on the nasal side of the disk that occur as the initial defects in glaucoma in less than 3% of the patients. The asymmetry across the nasal horizontal meridian produces the nasal step. So attention to the nasal horizontal meridian is one means of recognizing very early glaucomatous optic nerve damage. Very slight damage to one pole of the disk may produce a subtle but recognizable difference in sensitivity above and below the nasal

horizontal meridian even if the threshold values are within the normal range in both the locations. The short-term fluctuation (SF) is very important in evaluating glaucoma patients and particularly in glaucoma suspects increasing SF rate may be the earliest sign of glaucomatous optic nerve damage. Rarely the MD index would fall outside normal range by virtue of glaucoma without first producing one of the diagnostic sign of a localize defect.

How advanced is the disease?

The severity of glaucomatous disease is graded into 3 stages (early defect, moderate defect and severe defect) based on the following factors.

1. The number of axons damaged indicated by MD value.
2. Visual acuity which is effected by the location of the defect (If the defect is nearer or at fixation).

The criteria to label as early defect:

1. The MD is better than -6.00dB
2. Twenty-five percent of the points (18 points out of 76 points of 30-2) in total deviation plot should have P value 5% and less than 10 points have P value 1%
3. No point in the central 5° has sensitivity less than 15dB.

A moderate defect exceeds 1 or more of the criteria required to keep it in the early defect category but does not meet the criteria to be severe. A severe defect has any of the following:

1. An MD index worse than -12dB
2. More than 50% of the points (38 out of 76 points of 30-2) in total deviation plot should have P value 5%.
3. More than 20 points depressed at P value 1%.
4. A point in the central 5 degrees with the 0dB sensitivity or points closer than 5 degree fixation under 15dB sensitivity in both the upper and lower hemifields.

Change analysis printout helps us in giving the above data more efficiently.

The following criteria will help us to pickup early field defects due to glaucoma

Criteria for focal depression

Three minimal criteria (Anderson's criteria) to pick up early abnormality

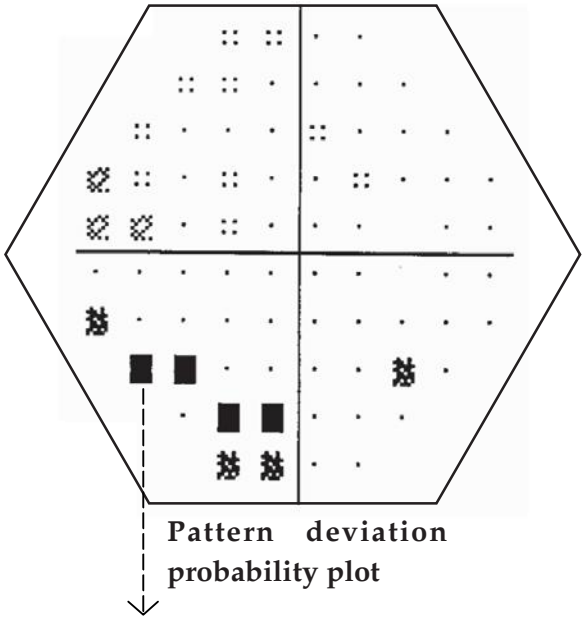
1. Three non-edge adjacent points in total or pattern deviation probability plot
   Two points P < 5%
   One point P < 1%
2. PSD P < 5% two consecutive tests
3. G.H.T - Abnormal consecutive tests.

Criteria for early generalized depression

Comparing MD index with the other eye.

1. A 2 dB difference of the mean deviation index
2. 1.5dB difference in MD index in the two consecutive tests
3. An average difference as small as 1dB in four consecutive tests
4. High SF

Anderson's criteria to detect early localized field defect due to glaucoma



Pattern deviation probability plot

Three criteria (Anderson's criteria) to pickup early or minimal abnormality

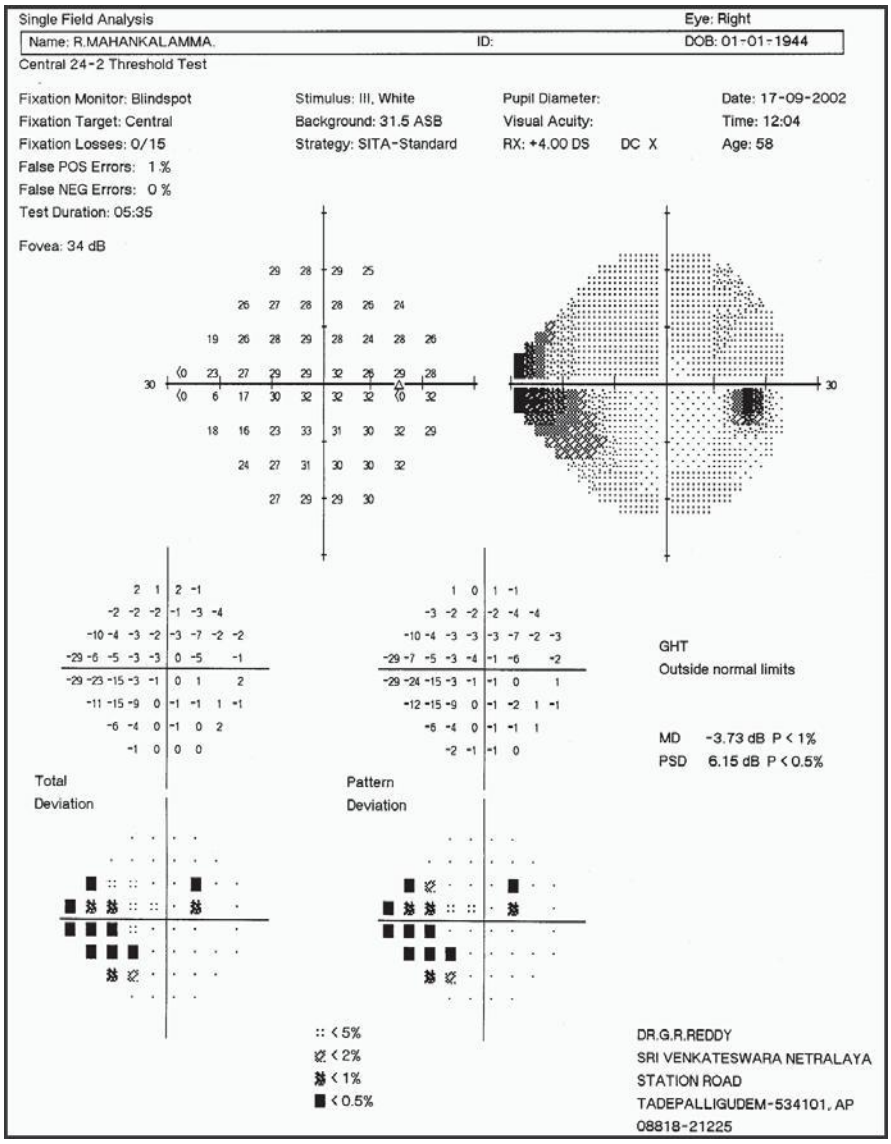
1. Three non-edge adjacent points in total or pattern deviation probability plot. The points must be in a cluster in an expected locations.

Two points P < 5%
One point P < 1%
2. PSD P < 5%
3. G.H.T. abnormal

The edge points in 30-2 fields will not be considered as defective. The edge points of 24-2 should be considered with a great caution if they exist without non-edge points.

Please note that the non-edge points of either total deviation or pattern deviation probability plots can be considered because in localized field defects both the probability plots look similar.

SINGLE FIELD ANALYSIS PRINTOUT OF EARLY GLAUCOMA—NASAL STEP



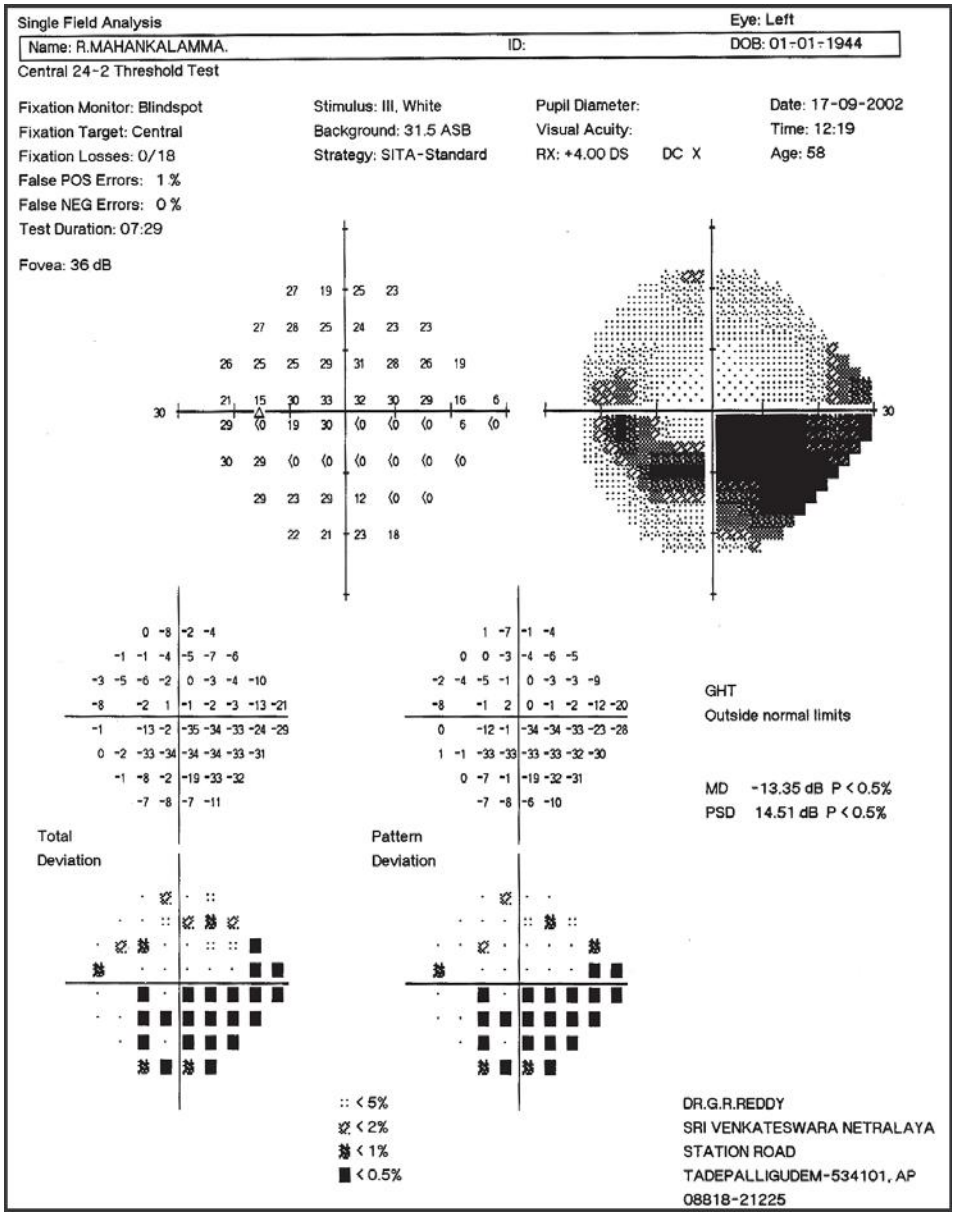
R. Mahankalamma
Right eye field
Selection of the test :
24-2 SITA Standard
Reliability : Good

A case of localized field defect :

1. The total deviation probability plot and pattern deviation probability plot look identical.
2. PSD 8.15 dB P < 0.5%
3. MD -3.73 dB P < 1%

Total deviation probability plot		Identical field defect in the upper and lower nasal
Pattern deviation probability plot		quadrants on either side of horizonal meridian producing nasal step
PSD	:	8.15 dB P < 0.5%
MD	:	-3.7 dB P < 1%
GHT	:	Outside normal limits
Interpretation	:	Glaucoma field defect (early nasal step)

SINGLE FIELD ANALYSIS PRINTOUT OF THE SAME PATIENT—LEFT EYE



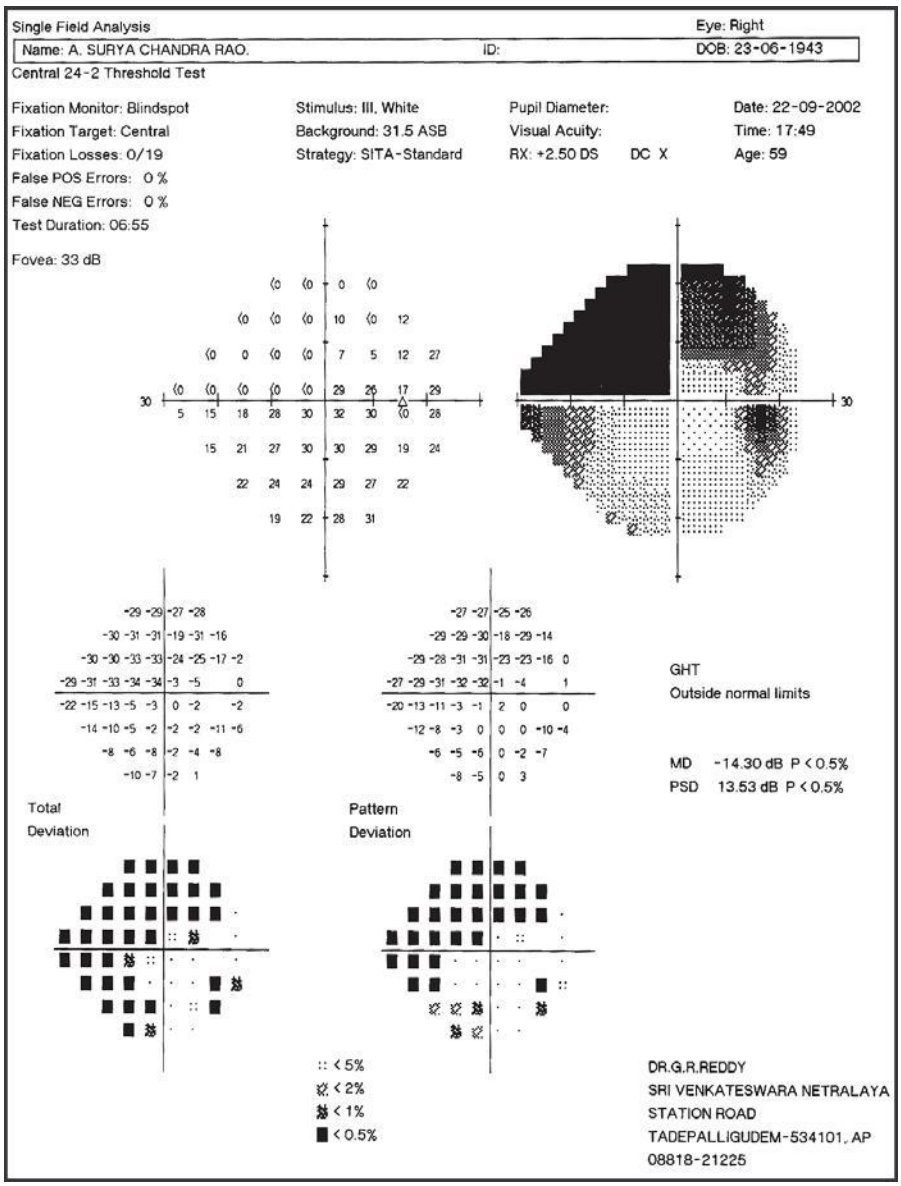
R. Mahankalamma
Left eye field
Selection of the test :
24-2 SITA Standard
Reliability : Good

A case of localized field defect :

1. The total deviation probability plot and pattern deviation probability plot look identical.
2. PSD 14.51 dB P < 0.5%
3. MD -13.35 dB P < 0.5%

Total deviation probability plot Pattern deviation probability plot	}	Identical field defect in the lower nasal quadrant in arcuate pattern and nasal step.
PSD	:	14.51 dB P < 0.5%
MD	:	13-35 dB P < 0.5%
GHT	:	Outside normal limits
Interpretation	:	Glaucoma field defect—lower arcuate scotoma.

SINGLE FIELD ANALYSIS PRINTOUT OF CHRONIC ANGLE CLOSURE GLAUCOMA—RIGHT EYE



A. Suryachandra Rao
Right eye field
Selection of the test :
24-2 SITA Standard
Reliability : Good

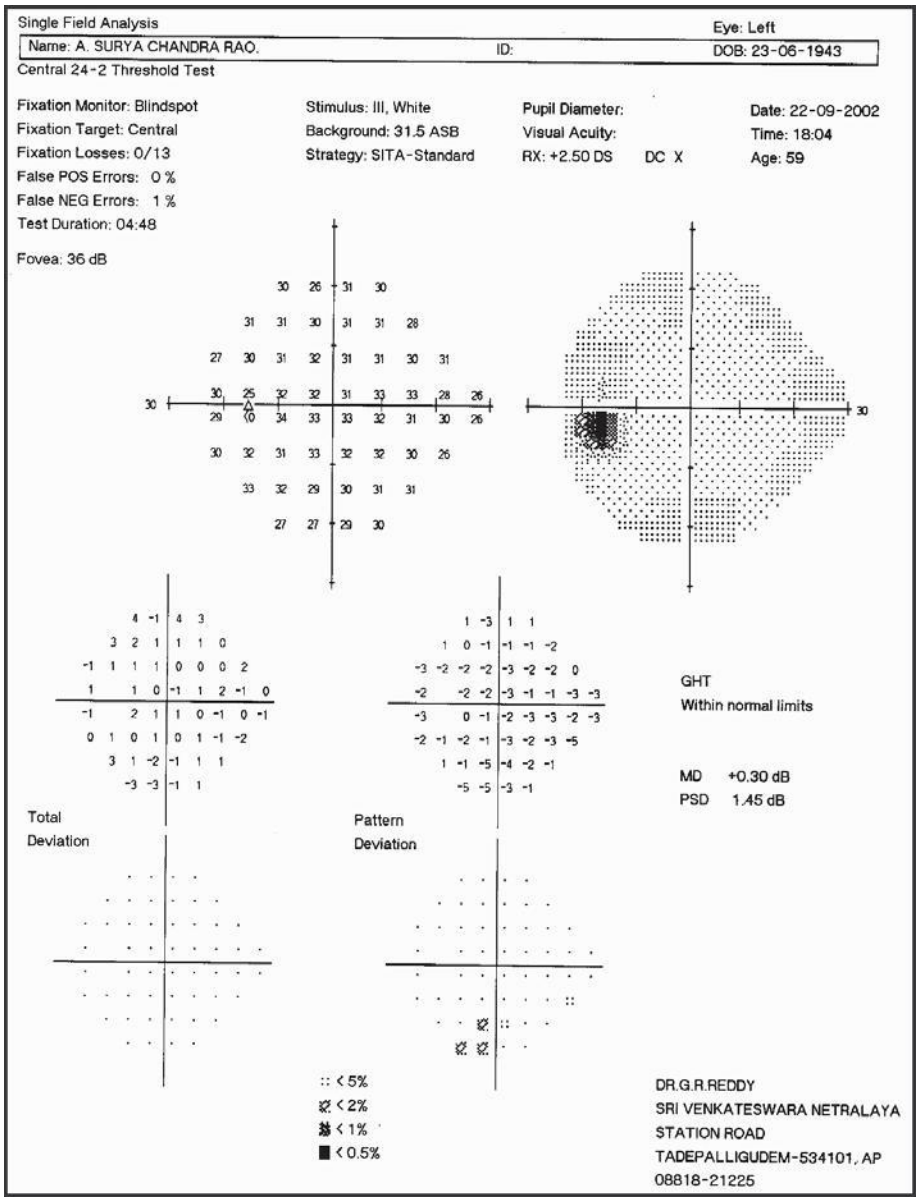
Diagnosis : Chronic angle closure glaucoma with CD ratio 0.7 and IOP 30 mm Hg without treatment.
Gonioscopy: Narrow angle. (Grade 0 to Grade 1)

A case of localized field defect:

1. The total deviation probability plot and pattern deviation probability plot look identical.
2. PSD 13.53 dB P < 0.5%
3. MD -14.30 dB P < 0.5%

Total deviation probability plot Pattern deviation probability plot	}	Identical field defect in the upper and lower nasal quadrant in arcuate pattern and nasal step and part of upper temporal field is affected
PSD	:	13.53 dB P < 0.5%
MD	:	14.30 dB P < 0.5%
GHT	:	Outside normal limits
Interpretation	:	Glaucoma field defect showing upper arcuate field defect and also lower nasal arcuate—Forming nasal step.

SINGLE FIELD ANALYSIS PRINTOUT OF PREGLAUCOMA OF THE SAME PATIENT—LEFT EYE



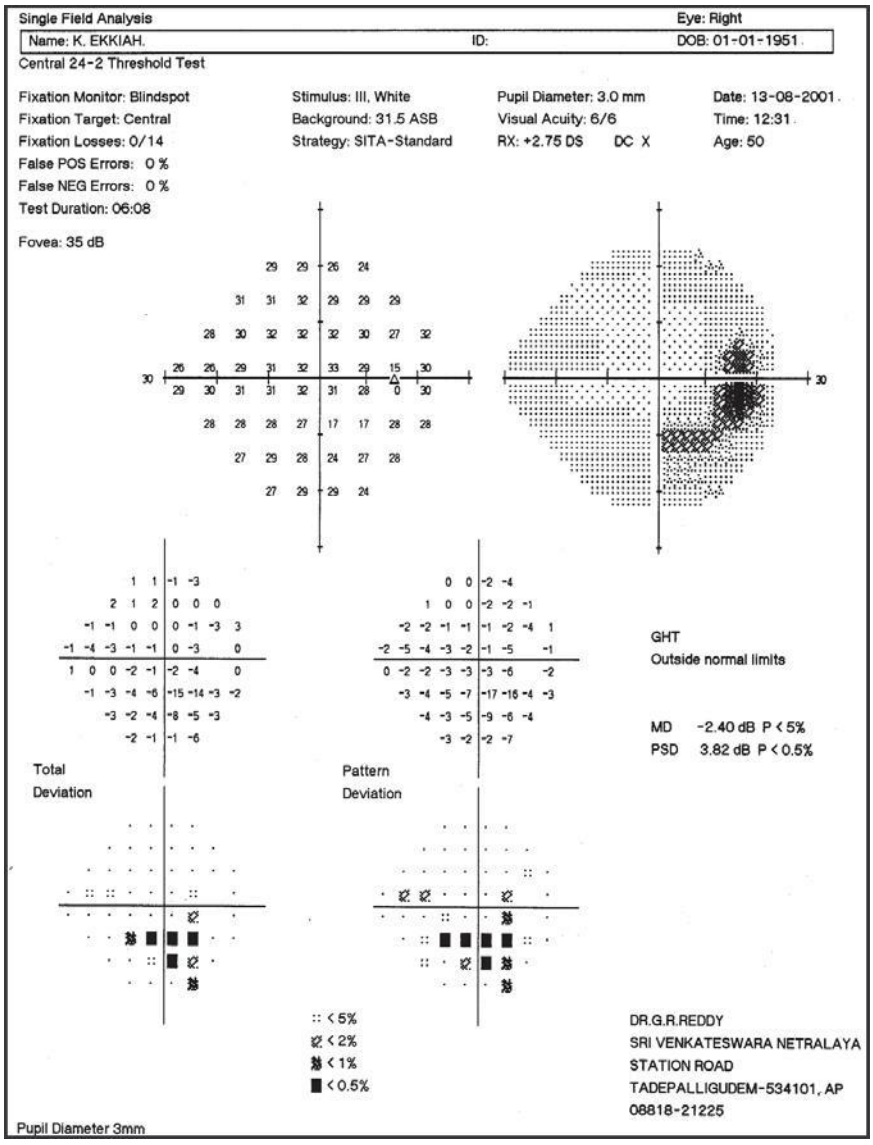
A. Suryachandra Rao
Left eye field
Selection of the test :
24-2 SITA Standard
Reliability : Good

Diagnosis : Preglaucoma
Gonioscopy Narrow angle.
(Grade 1 to Grade 2)

No field defect is seen

Total deviation probability plot Pattern deviation probability plot	}	No field defect is seen
PSD	:	1.45 dB
GHT	:	Within normal limits
Interpretation	:	Normal field.
Diagnosis	:	Preglaucoma
Advised	:	YAG - P.I.

SINGLE FIELD ANALYSIS PRINTOUT OF EARLY GLAUCOMA



A case of localized field defect :

1. The total deviation probability plot and pattern deviation probability plot look identical.
2. PSD 3.82 dB P < 0.5%
3. MD -2.4 dB P < 5%

Patient data:

Name of the patient : K. Ekkiah Age: 50

Visual acuity : 6/6 (+0.25DSph)

Refractive error correction for N V :+2.75DSph Pupil size: 3 mm

Indication for field: Glaucoma suspect

Selection of the test: 24-2 SITA Standard

Step 1: Patient data was correctly entered in the printout

Step 2: Selection of the test is proper (it is always better to select central 30-2 with full threshold strategy in glaucoma suspect cases)

Visual acuity: 6/6 Foveal threshold: 35 dB

Comment: The near vision refractive error correction is proper.

Reliability Indices :

Fixation losses : 0/14 False (+) ve error: 0% False (-)ve error:0%

Comment : Excellent reliability

Interpretation: ——

Total deviation probability plot
Pattern deviation probability plot } Localized scotomas in the lower quadrant if seen

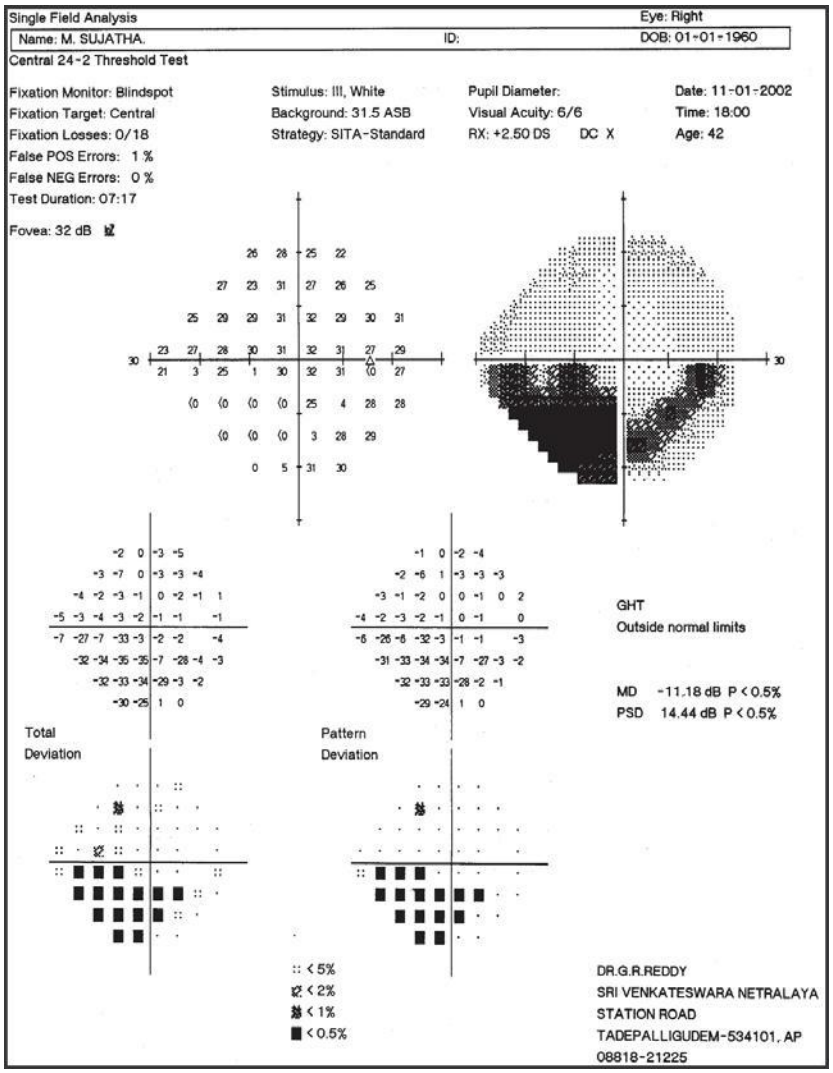
Global indices MD : -2.40 dB P value less than 5%
PSD : 3.82dB P value less than 0.5%

G.H.T : Outside normal limits.

Anderson criteria: All the above findings are fulfilling the Anderson's minimum criteria to label as early focal depression due to glaucoma.

Final interpretation report: Early glaucoma field defect present. In the form of early lower arcuate scotoma starting from blind spot.

SINGLE FIELD ANALYSIS PRINTOUT OF KNOWN PATIENT OF GLAUCOMA



A case of localized field defect:

1. The total deviation probability plot and pattern deviation probability plot look identical.
2. PSD: 14.44 dB P < 0.5%
3. MD: -11.1118 dB P < 0.5%

Patient data:
Name of the patient :M. Sujatha Age:42
Visual acuity :6/6
Refractive error correction for NV : +2.50DSph Pupil size: 3 mm
Indication for field: Chronic angle closure glaucoma with 0.6 cup.
Selection of the test : 24-2 SITA Standard
Step 1: Patient data correctly entered.
Step 2: Selection of the test is proper
Visual acuity : 6/6 Foveal threshold: 32dB
Comment : Refractive error correction for NV is proper.

Reliability Indices

Fixation losses : 0/18 False (+) ve error: 0% False (-)ve error:0%

Comment: Excellent reliability

Interpretation:

The total deviation probability plot
The pattern deviation probability plot
} Localized deep scotomas in the lower nasal quadrant in arcuate pattern is seen.

Global indices

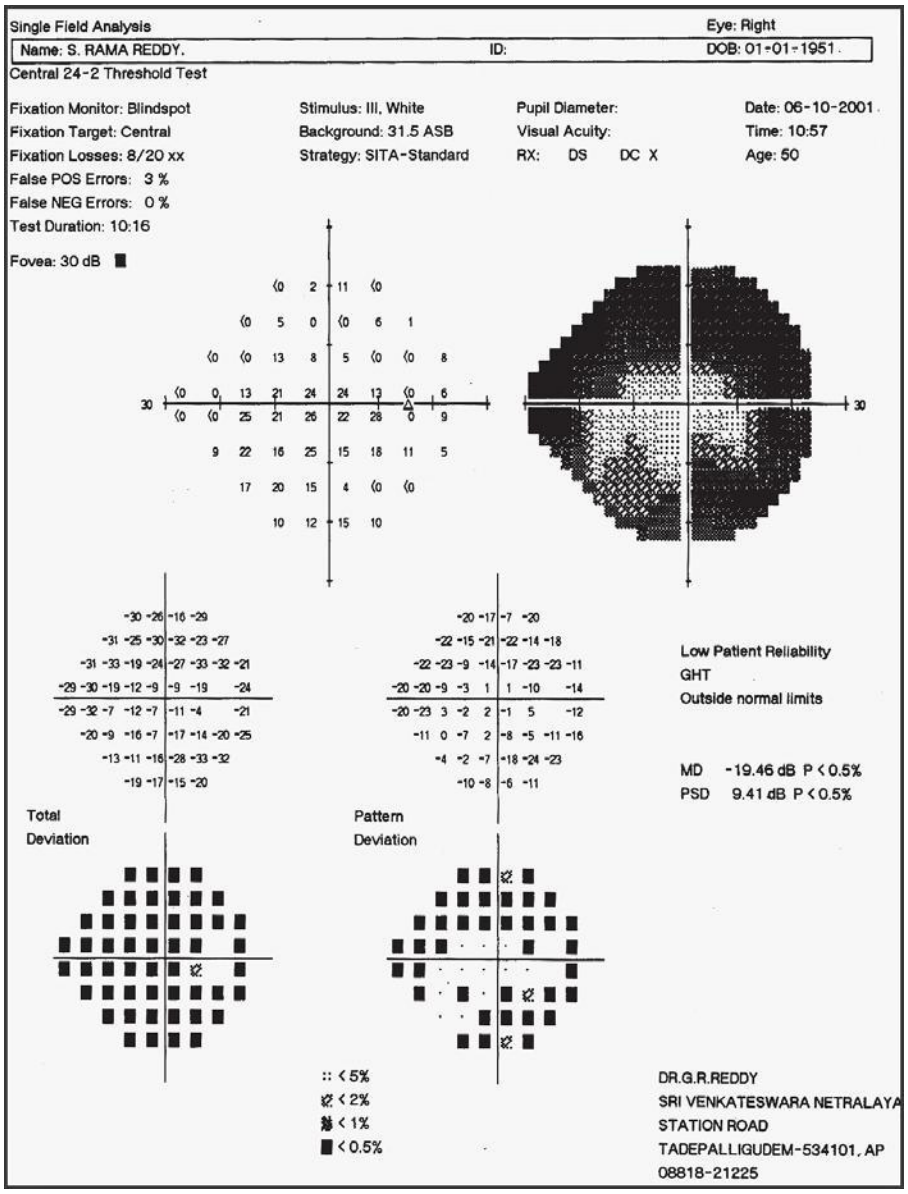
MD : -11.18dB P value less than 0.5 %
PSD : 14.44 dB P value less than 0.5%

G.H.T: outside normal limits

Anderson criteria : Non-edge scotomas, MD, PSD and GHT are fulfilling the criteria to label as focal visual field defect due to glaucoma.

Final interpretation report: Visual field defect in lower arcuate area is present due to glaucoma.

SINGLE FIELD ANALYSIS PRINTOUT IN ADVANCED GLAUCOMA

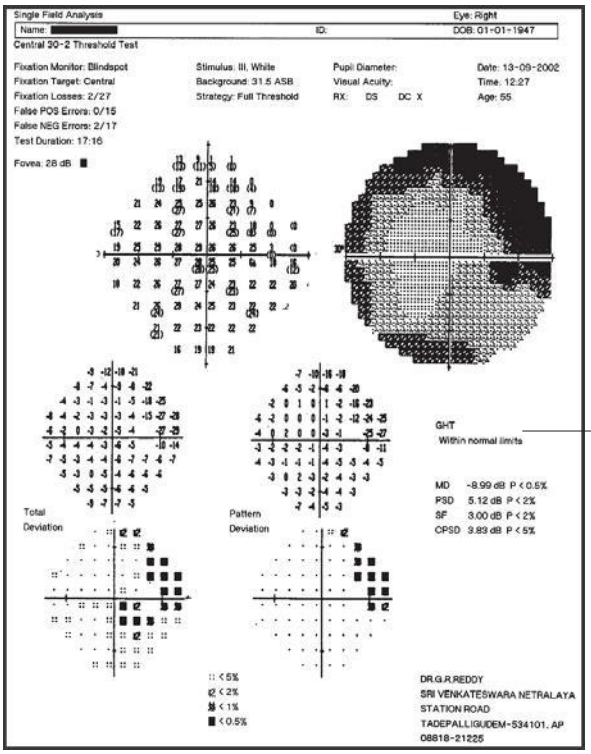


Patient data:
Name of the patient :
S. Rama Reddy
Age: 50
Visual acuity : Not recorded
Refractive error correction for NV : Not recorded
Pupil size: 3 mm
Indication for field: Advanced glaucoma with 0.8 cup
Selection of the test : 24-2 threshold test - SITA standard

Step 1: Patient data is correctly entered (visual acuity and refractive error correction were not entered)
Step 2: Selection of the test is proper. But 10-2 Full Threshold strategy or 10-2 SITA Standard is more appropriate test in advanced glaucoma, as this test will give better information regarding macular split.

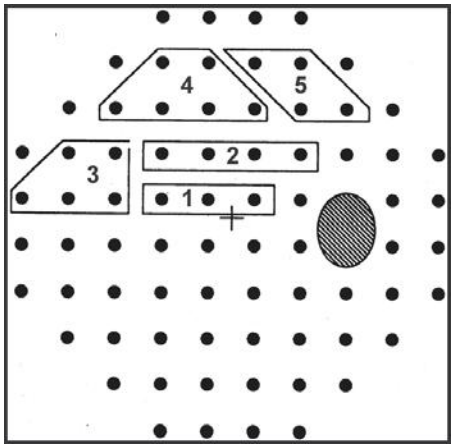
Test reliability : Unreliable test: Fixation loses 8/20xx
Visual acuity : Not recorded Foveal threshold: 30dB
Comment: As foveal threshold is 30dB we presume that refractive error correction for near vision is proper
Reliability indices :
Fixation losses : 8/20xx False (+) ve error:3% False (–)ve error:0%
Comment: High fixation loses. Test is unreliable
Interpretation: Advise to repeat the test. Sometimes in advanced glaucoma cases, we will get high fixation losses.

SINGLE FIELD ANALYSIS PRINTOUT WITH WEDGE SCOTOMA (TEMPORAL WEDGE IN EARLY GLAUCOMA)



GHT within normal limits

Name of the patient	:	XXXX
Reliability	:	Good
Total deviation probability plot	:	Scotomas in the upper temporal field.
Pattern deviation probability plot	:	Similar type of depth defects as in TDPP.
MD value	:	- 6.12 P<1%
PSD value	:	7. 34 P< 2%



<u>Glaucoma Hemifield test: within normal limits</u>

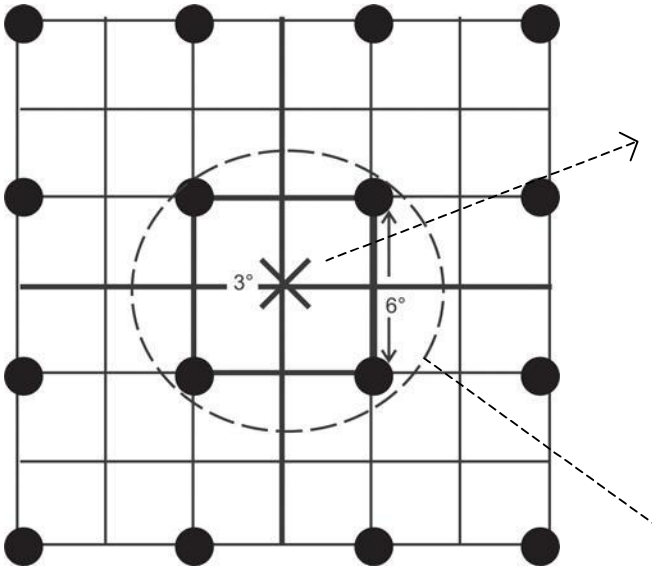
This is the field of known patient of POAG, the disk showing nasal pallor, intraocular tension more than 26 mm of Hg.

Still glaucoma hemifield test is within normal limits - How it is possible?

Please note that in GHT test, the area temporal to the blind spot was not included for comparative analysis. So, any scotoma temporal to blind spot will not be analyzed by the GHT test.

THE IMPORTANCE OF SELECTION OF THE TEST 10-2 IN ADVANCED CASES OF GLAUCOMA

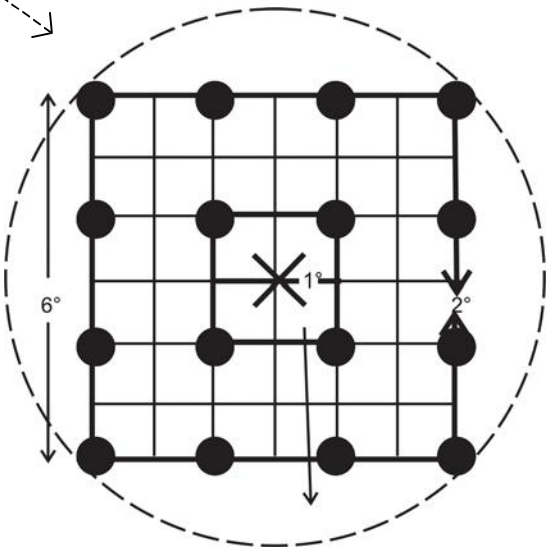
Because of the following reasons, central 10-2 field should be selected in all advanced cases of glaucoma.



If some central field is preserved, for example, 30-2 Central field/ 24-2 Central field:
3° bare area around fixation spot is not tested.
If the field defect extends from the periphery upto 3° from the fixation spot, the computer presumes that the untested 3° bare area is also affected and gives a printout as if the central untested 3° is also affected.

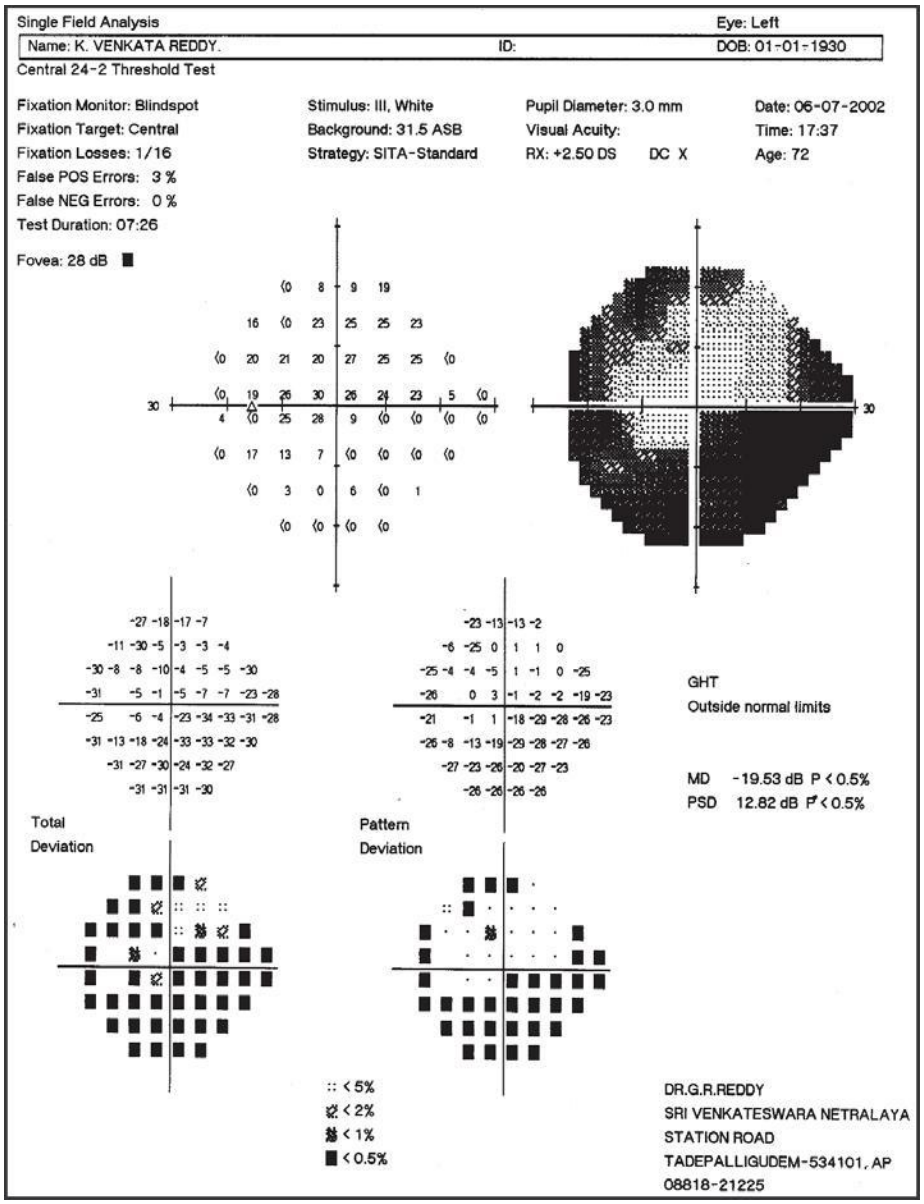
3° bare area of 30-2 and 24-2 in 10-2 field.

Whereas in 10-2 Central Field
Only one degree of bare area is left surrounding the fixation spot. From this we understand, most of the central space surrounding the fixation spot is tested in 10-2 field. If the field defect is progressing towards the fixation center upto 1° from the fixation spot, the computer presumes that the untested 1° bare area is also affected and hence we get a printout as if the central untested 1° is also affected. So the most important fact one should notice is to get the macular split the field defect should extend at least upto 1° from the fixation point and hence 10-2 test became the test of choice in advanced cases of glaucoma.



only 1° bare area is not tested surrounding the fixation spot 10-2 central field.

24-2 CENTRAL FIELD IN ADVANCED CASES OF GLAUCOMA—CASE- I (LEFT EYE)



24-2 Central field

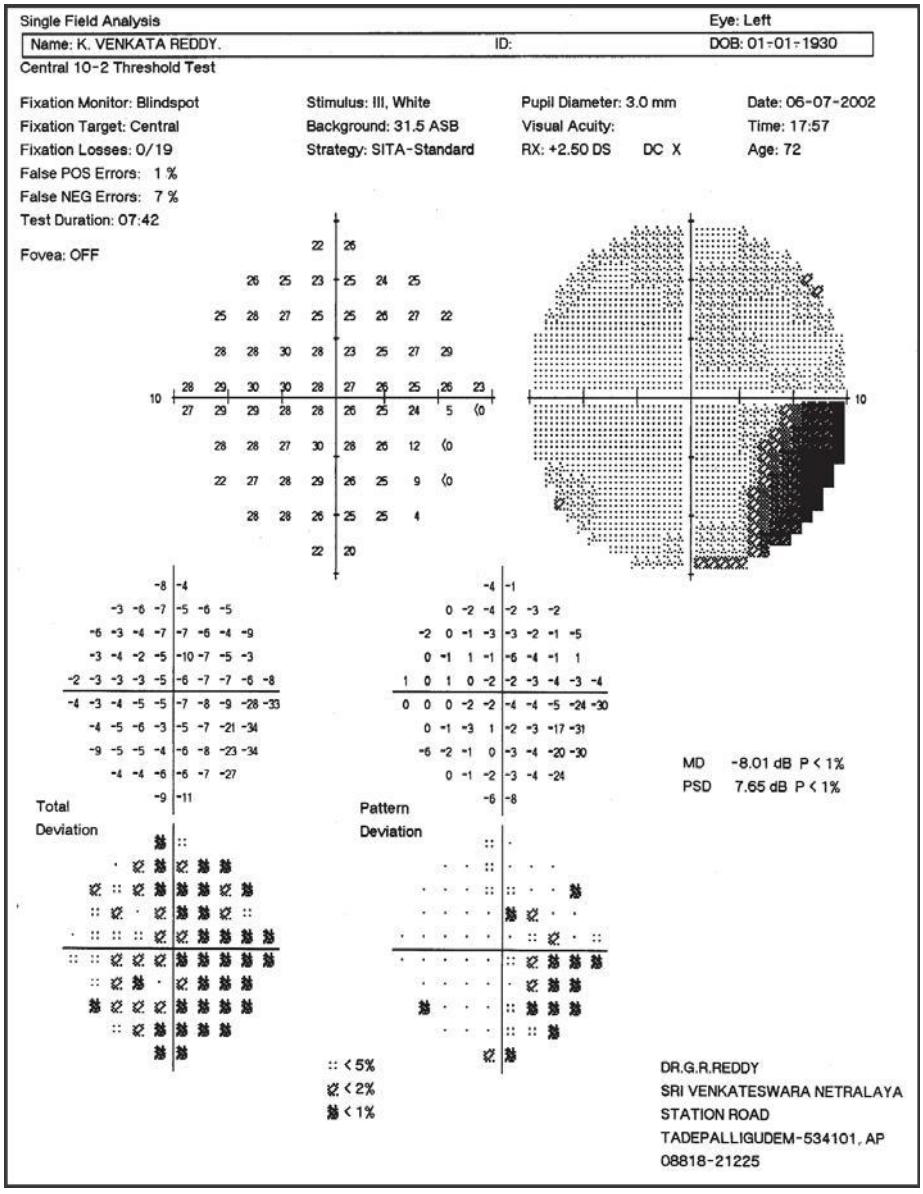
K. Venkata Reddy
Left eye field
Selection of the test :
24-2 SITA Standard
Reliability : Good

A case of irregular generalized field defect

1. Generalized depression in the total deviation probability plot and localized field defect in the pattern deviation probability plot.
2. PSD : 12.82 dB P < 0.5%
3. MD : -19.53 dB P < 5%

Total deviation probability plot } Generalized depression in total deviation probability plot and
Pattern deviation probability plot } lower arcuate field defect in the pattern deviation probability plot.
PSD : 12.82 dB P < 0.5%
MD : –19.53 dB P < 5%
GHT : Outside normal limits
Interpretation : Glaucoma field defect (advanced).

10-2 CENTRAL FIELD OF THE SAME PATIENT (LEFT EYE)



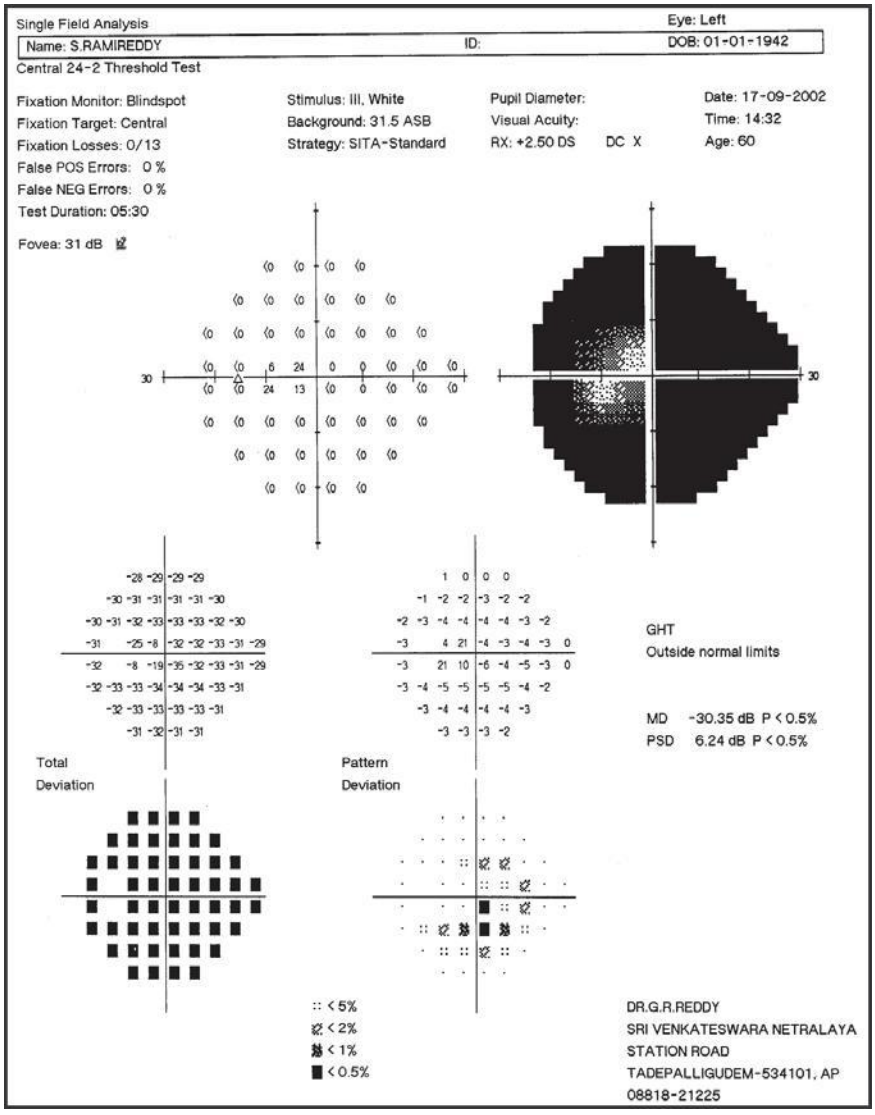
10-2 Central field of the same patient

Because there is macular split in 24-2 field, 10-2 field was advised to know exactly the status of the macular split

The single field analysis printout with 10-2 is showing very good 5° field without macular split which was shown in 24-2 central field.

How important is the selection of 10-2 Central threshold test in advanced cases of glaucoma is shown here.

24-2 CENTRAL FIELD IN ADVANCED CASES OF GLAUCOMA CASE—II (LEFT EYE)



24-2 Central field

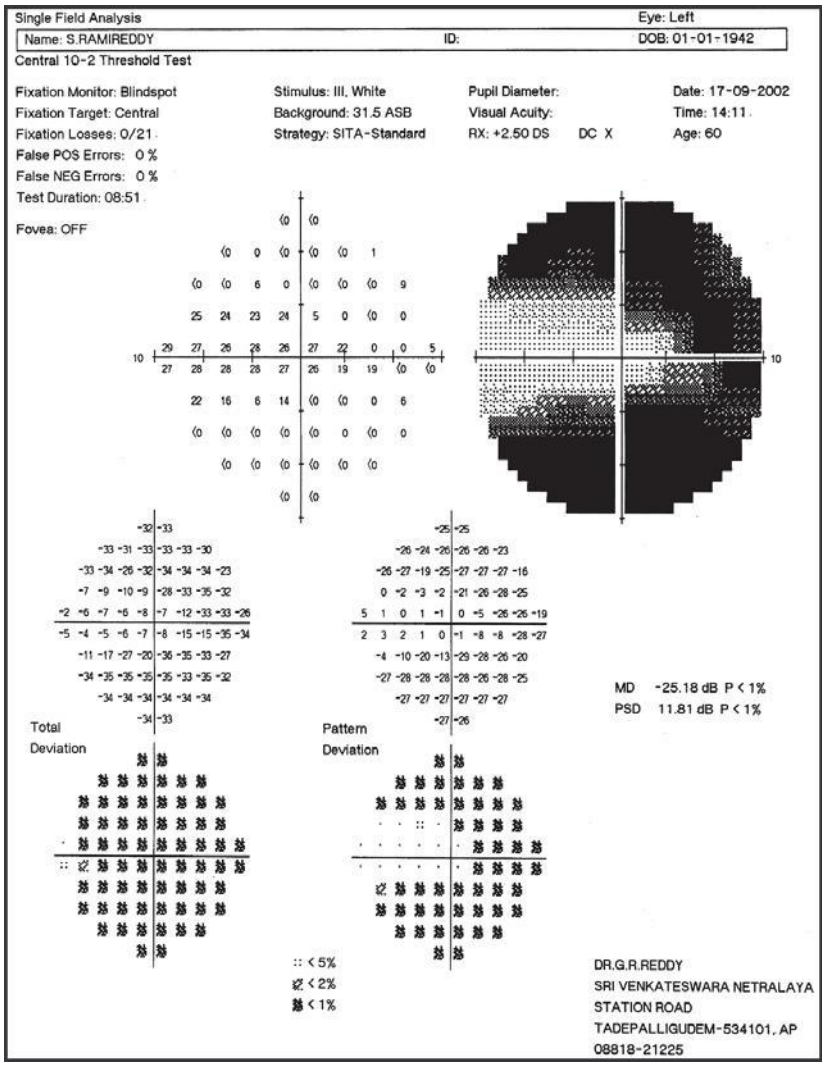
S. Rami Reddy
Left eye field
Selection of the test : 24-2
SITA Standard
Reliability : Good

A case of uniform generalized field defect

1. Generalized depression in the total deviation probability plot and almost normal pattern deviation probability plot.
2. PSD : 6.24 dB
   P < 0.5%
3. MD : 30.35 P < 0.5%

Total deviation probability plot	:	Generalized depression with macular involvement.
Pattern deviation probability plot	:	No scotoma indicates gross uniform reduction in the retinal sensitivity.
PSD	:	6.24 dB p < 0.5%
MD	:	30.35 P < 0.5%
GHT	:	Outside normal limits
Interpretation	:	Advanced glaucoma field defect.

10-2 CENTRAL FIELD IN ADVANCED CASES OF GLAUCOMA OF THE SAME PATIENT—LEFT EYE



10-2 Central field of the same patient

Because of total macular involvement in 24-2 central field, 10-2 central field is advised to know about the macular status.

The single field analysis printout with 10-2 is showing no macular split. Still there is good field around fixation.

To know the macular status is very important criteria to take the decision for antiglaucoma surgery. If there is no macular split, the prognosis will be good.

How important is the selection of 10-2 central threshold test in advanced cases of glaucoma is shown here.

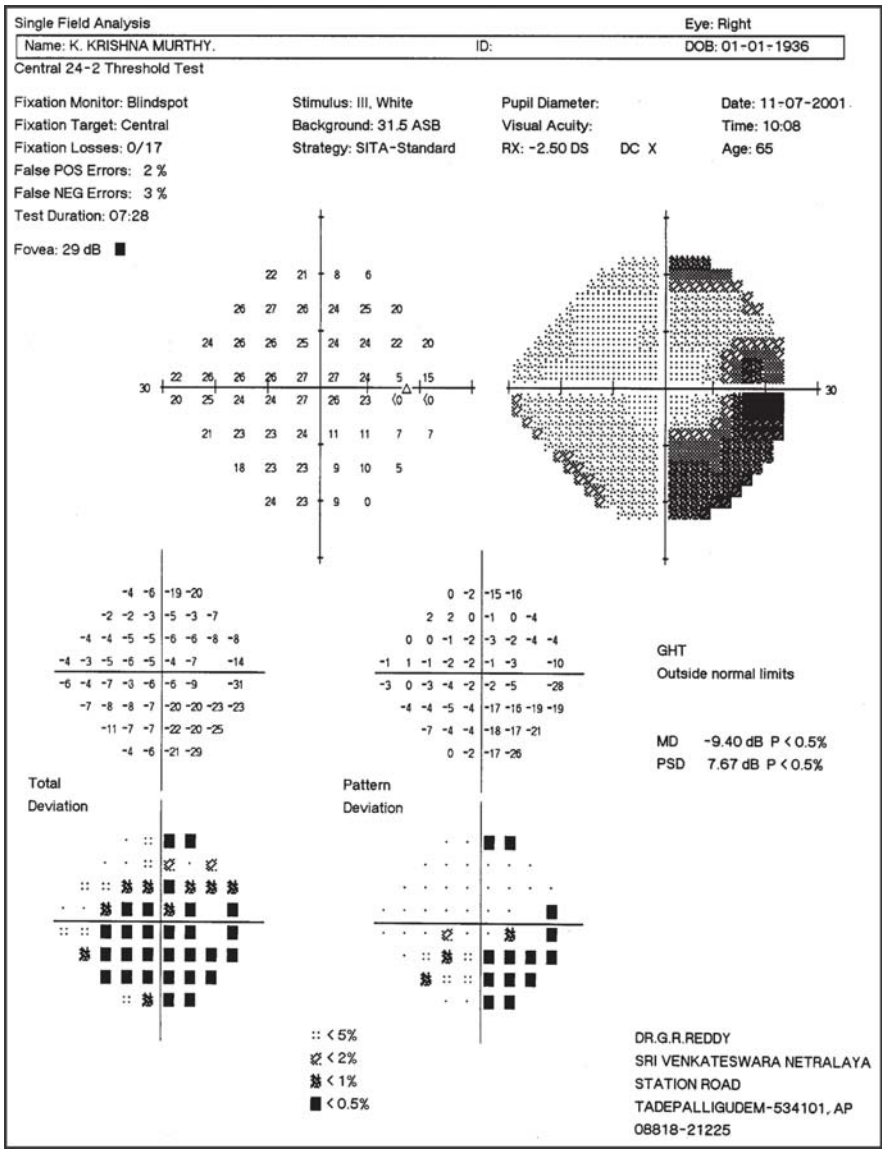
VISUAL FIELD DEFECTS IN COMBINED CASES OF CATARACT AND GLAUCOMA

When the patient is having both cataract and glaucoma, the visual field testing is very important. It gives the following information -

1. How much field is affected
2. How much field is retained around the fixation point
3. This information helps us to explain the prognosis to the patients about the visual outcome after surgery. Usually cases of glaucoma associated with cataract will produce irregular generalized field defect.

Here I am presenting 4 cases of the visual field defects due to cataract associated with glaucoma. In the combined cases of cataract and glaucoma, the single field analysis printout will show the following features. The total deviation probability plot shows generalized depression and the pattern deviation probability plot shows localized scotomas in arcuate area and the extent of scotoma depends on the damage of the optic nerve. The mean deviation index and PSD will be very high.

SINGLE FIELD ANALYSIS PRINTOUT IN A CASE OF CATARACT AND GLAUCOMA—CASE 1



Patient data
Name of the patient :
K. Krishna Murthy
Age : 65
Visual acuity : 6/18
Refractive error correction for N.V : -2.50DSph
Pupil size: 4 mm

Indication for field: Suspicious case of glaucoma with intra-ocular pressure in mid 20's

Selection of the test: 24-2 SITA Standard

Step 1: Patient data correctly entered
Step 2: Selection of the test is proper.
Test reliability : Good
Visual acuity : 6/18 Foveal threshold: 29dB
Comment: Near vision correction is proper as foveal threshold is corresponding to visual acuity
Reliability indices
Fixation losses :0/17 False (+) ve error: 2% False (-)ve error:3%
Comment: Good reliability

Interpretation: This visual field is the best example of a combined case of cataract and glaucoma. If the patient is having both cataract and glaucoma the total deviation probability plot shows diffuse scotomas and the pattern deviation probability plot shows localized scotomas usually in the arcuate area. The most important point we must notice regarding the black square (the symbol that is given to the 'P' value less than 0.5%) is that it usually represents the decibel deviation of total deviation numerical plot >-6dB. So the point of the retina represented by black square lost its sensitivity minimum by -6dB. So it can also be -10 dB, -15dB, -20dB or -30dB. But all these decibel deviations are represented by black squares. So the depth of scotoma is not known. Only the depth of the scotoma (the exact degree of the decibel deviation of the black square at that point) is known from total deviation numerical plot.

In this field printout

1. The total deviation probability plot contains 28 black squares.
2. The black squares according to their decibel deviations of total deviation numerical plot are divided into two groups

Group-1: The black squares with decibel deviations equal to or < -11dB=14 in number

Group-2: The black squares with decibel deviations equal to or > -12dB=14 in number

All the 28 black squares shown in total deviation probability plot include the decibel deviations from - 6dB onwards. But only the decibel deviations >-12dB are shown in pattern deviation probability plot. To get a scotoma in pattern deviation probability plot there should be irregular depth of field defects in the total deviation probability plot. If there is uniform degree of field loss we do not see any scotoma in the pattern deviation probability plot. If there is a irregular depth of field loss the superficial and moderate degree of scotomas are eliminated and the defect depth of deep scotomas are adjusted and the resultant new localized scotomas are highlighted in the pattern deviation probability plot. This is the basic concept behind the two probability plots in the single field analysis. In this example the decibel deviations equal to or < -11dB are eliminated and only the decibel deviations equal to or greater than - 12dB are highlighted in the pattern deviation probability plot.

Global indices

MD : –9.4dB P value < 0.5%

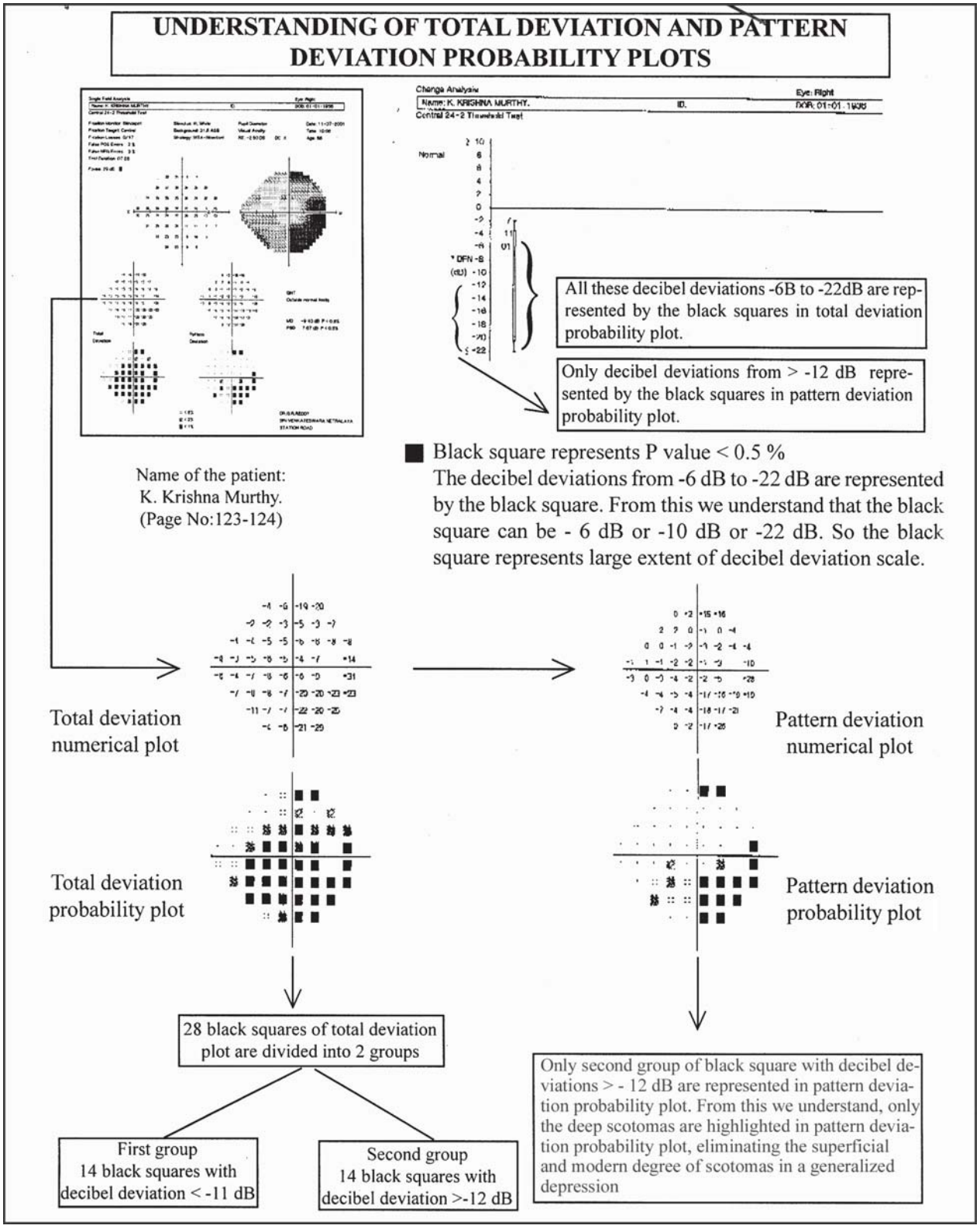
PSD :7.67dB P value< 0.5%

Comment : Generalized depression with deep localized scotoma (generalized depression is indicated by MD value and the localized scotoma is represented by PSD)

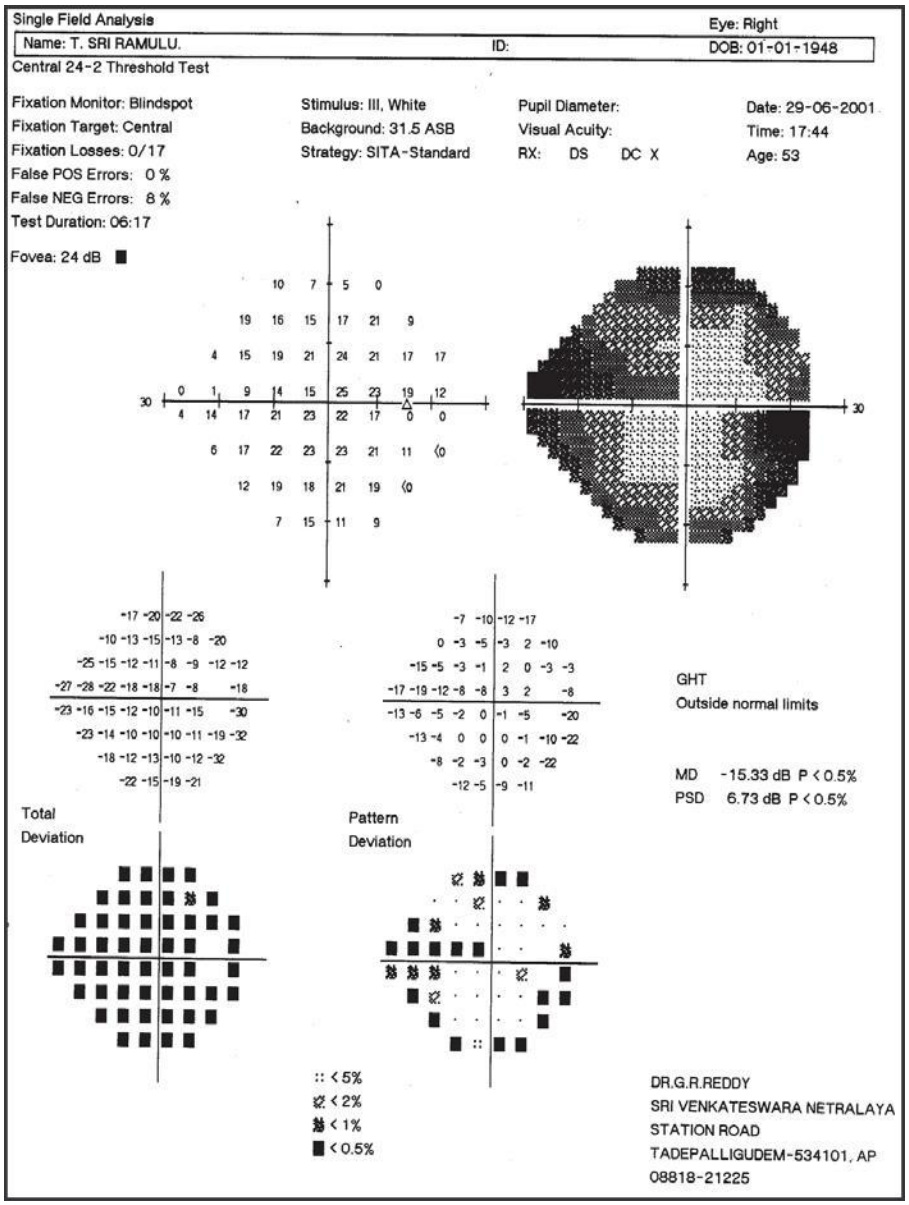
G.H.T : Outside normal limits.

Final interpretation report: Generalized depression due to cataract shown in the total deviation probability plot and dense lower temporal arcuate scotoma due to glaucoma is shown in pattern deviation probability plot.

UNDERSTANDING OF TOTAL DEVIATION AND PATTERN DEVIATION PROBABILITY PLOTS



SINGLE FIELD ANALYSIS PRINTOUT IN A CASE OF CATARACT AND GLAUCOMA—CASE II



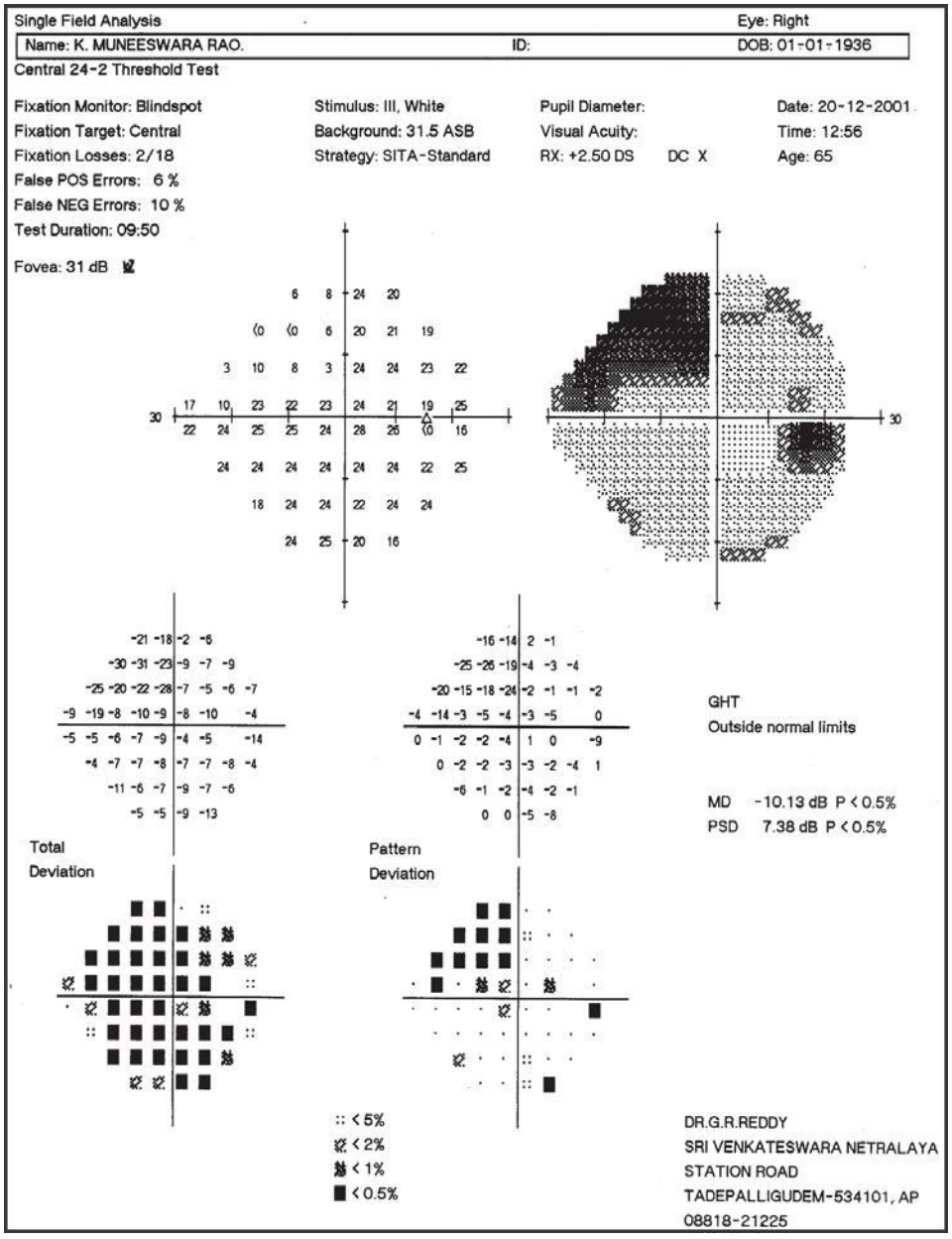
T. Sri Ramulu
Right eye field
Selection of the test :
24-2 SITA Standard
Reliability : Good

A case of irregular generalized field defect

1. Generalized depression in the total deviation probability plot and localized field defect in the pattern deviation probability plot.
2. PSD : 6.73 dB P < 0.5%
3. MD : -15.33 dB P < 0.5%

Total deviation probability plot	:	Generalized depression
Pattern deviation probability plot	:	Typical glaucomas field defect with nasal step
PSD	:	6.73 dB p < 0.5%
MD	:	–15.33 dB P < 0.5%
GHT	:	Outside normal limits
Interpretation	:	Glaucoma field defect in a cataract patient.

SINGLE FIELD ANALYSIS PRINTOUT IN A CASE OF CATARACT AND GLAUCOMA—CASE III



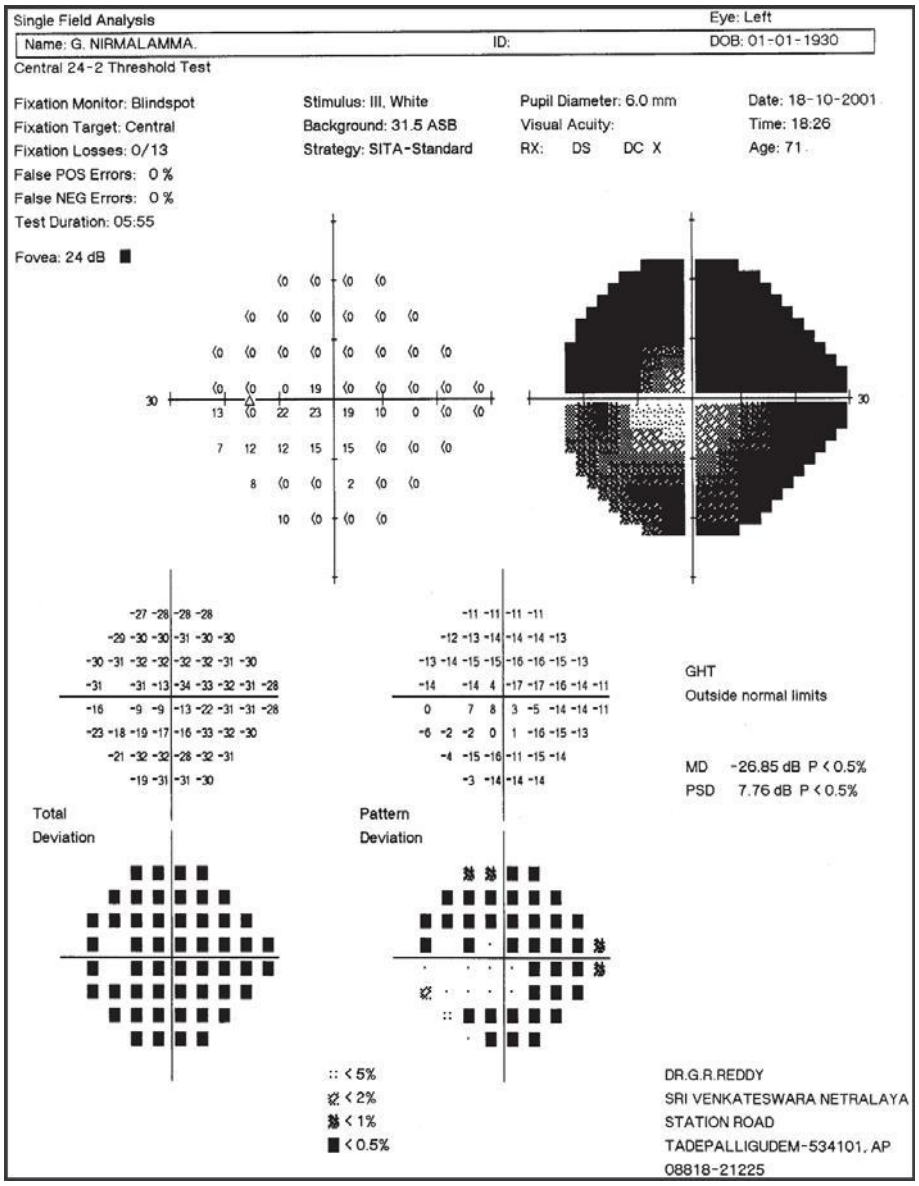
K. Muneeswara Rao
Right eye field
Selection of the test :
24-2 SITA Standard
Reliability : Good

A case of irregular generalized field defect

1. Generalized depression in the total deviation probability plot and localized field defect in the pattern deviation probability plot.
2. PSD : 7.38 dB
   P < -0.5%
3. MD : -10.13 dB
   P < 0.5%

Total deviation probability plot	:	Generalized depression
Pattern deviation probability plot	:	Upper nasal arcuate defect
PSD	:	7.38 dB p < 0.5%
MD	:	–10.13 dB P < 0.5%
GHT	:	Outside normal limits
Interpretation	:	Glaucoma field defect in a cataract patient.

SINGLE FIELD ANALYSIS PRINTOUT IN A CASE OF CATARACT AND GLAUCOMA—CASE IV



G. Nirmalamma
Left eye field
Selection of the test :
24-2 SITA Standard
Reliability : Good

A case of irregular generalized field defect

1. Generalized depression in the total deviation probability plot and localized field defect in the pattern deviation probability plot.
2. PSD : 7.76 dB P < 0.5%
3. MD : -26.85 dB P < 0.5%

Total deviation probability plot	:	Generalized depression
Pattern deviation probability plot	:	Typical glaucomas field defect with biarcuate field defect
PSD	:	7.76 dB P < 0.5%
MD	:	–26.85 dB P < 0.5%
GHT	:	Outside normal limits
Interpretation	:	Advanced glaucoma field defect in a cataract patient.

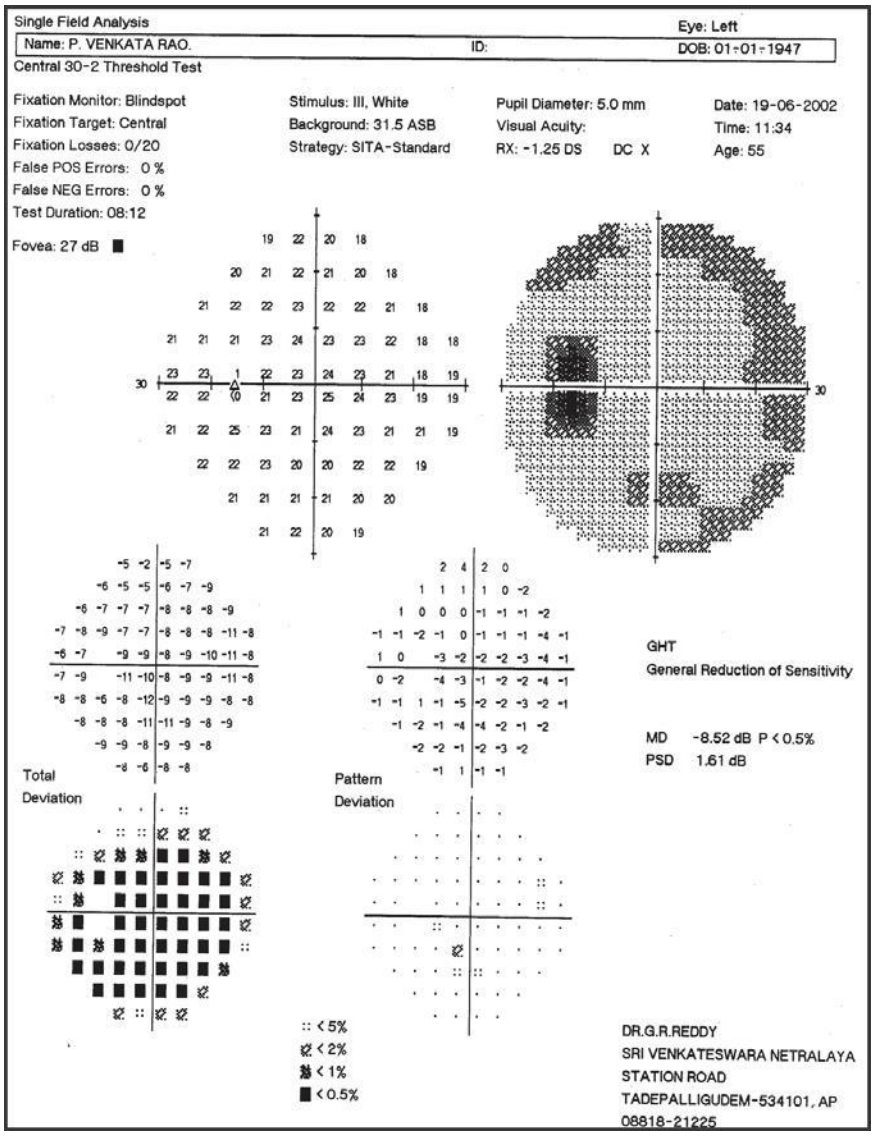
THE VISUAL FIELD DEFECTS DUE TO CATARACT WILL SHOW THE FOLLOWING FEATURES

Usually in pure cases of cataract we don't ask for field testing. But when we suspect glaucoma either on the basis of IOP or on the basis of cup/ disk ratio of optic nerve head or any other suspicious cause only then! we ask for field testing. If cataract is associated with glaucoma, the field charts play a major role in making the final diagnosis. Usually pure cataracts will produce a field defect of uniform generalized depression. But if it is associated with glaucoma, or any retinal disease, we see irregular generalized field defects. Usually pure cases of cataract will produce uniform generalized field defect but sometimes we may see few scotomas in the pattern deviation probability plot along with generalized depression in the total deviation probability plot. But the scotomas in the pattern deviation will not have any specific pattern as we see in cases of glaucoma.

Here, I showed three cases of visual field defects due to cataract. The single field analysis printout shows the following characteristics.

The total deviation probability plot shows uniform generalized depression and almost normal pattern deviation probability plot. The mean deviation (MD) index will be high, the PSD will be low and GHT will be labelled as generalized depression.

SINGLE FIELD ANALYSIS PRINTOUT IN A CASE OF CATARACT—CASE I



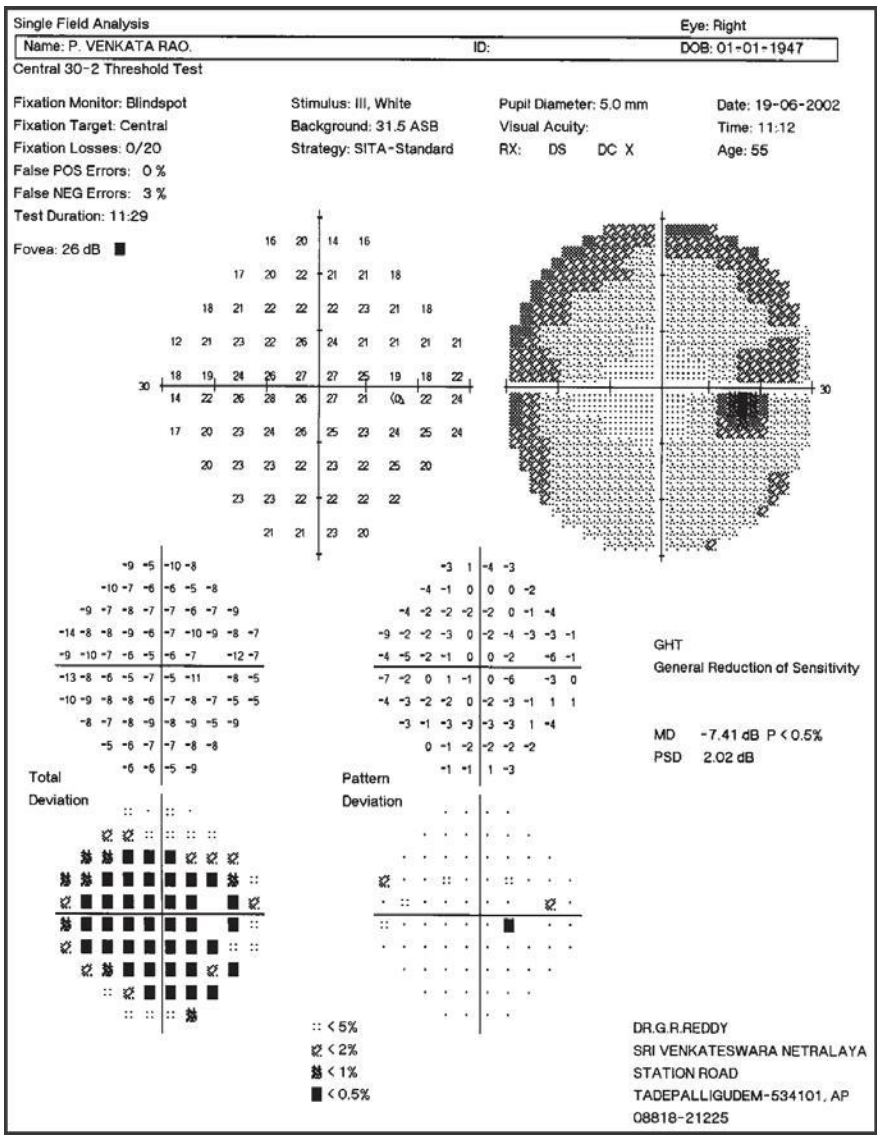
P. Venkata Rao
Left eye field
Selection of the test :
30-2 SITA Standard
Reliability : Good

A case of uniform generalized field defect

1. Generalized depression in the total deviation probability plot and
   almost normal pattern deviation probability plot.
2. PSD : 1.61 dB
3. MD : -8.52 dB P < 0.5%

Total deviation probability plot	:	Generalized depression
Pattern deviation probability plot	:	No field defects seen.
PSD	:	1.61 dB
MD	:	–8.52 dB P < 0.5%
GHT	:	Generalized reduction in sensitivity
Interpretation	:	Typical single field analysis printout of a cataract patient.

SINGLE FIELD ANALYSIS PRINTOUT IN A CASE OF CATARACT—CASE II



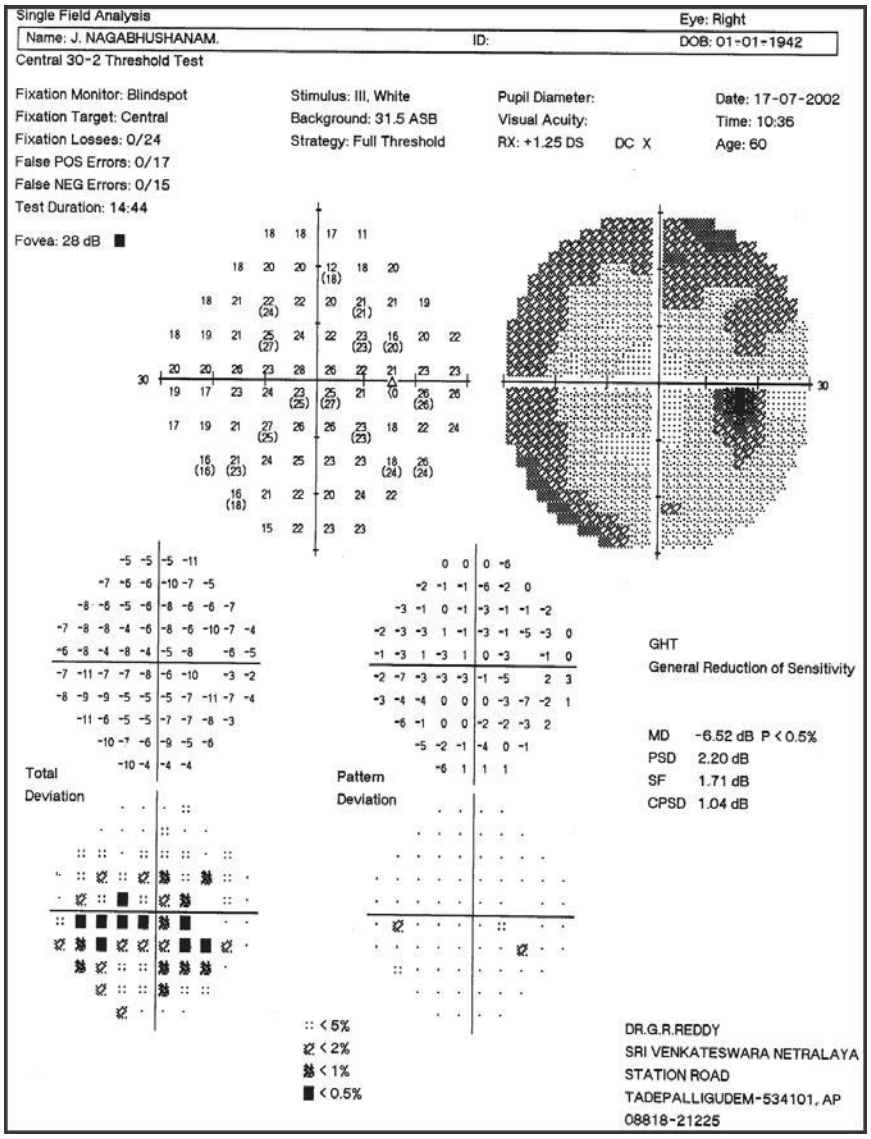
P. Venkata Rao
Right eye field
Selection of the test :
30-2 SITA Standard
Reliability : Good

A case of uniform generalized field defect

1. Generalized depression in the total deviation probability plot and almost normal pattern deviation probability plot.
2. PSD : 2.02 dB
3. MD : -7.41 dB P < 0.5%

Total deviation probability plot	:	Generalized depression
Pattern deviation probability plot	:	No field defects seen.
PSD	:	2.02 B
MD	:	-7.41 dB P < 0.5%
GHT	:	Generalized reduction in sensitivity
Interpretation	:	Typical single field analysis printout of a cataract patient.

SINGLE FIELD ANALYSIS PRINTOUT IN A CASE OF CATARACT—CASE III

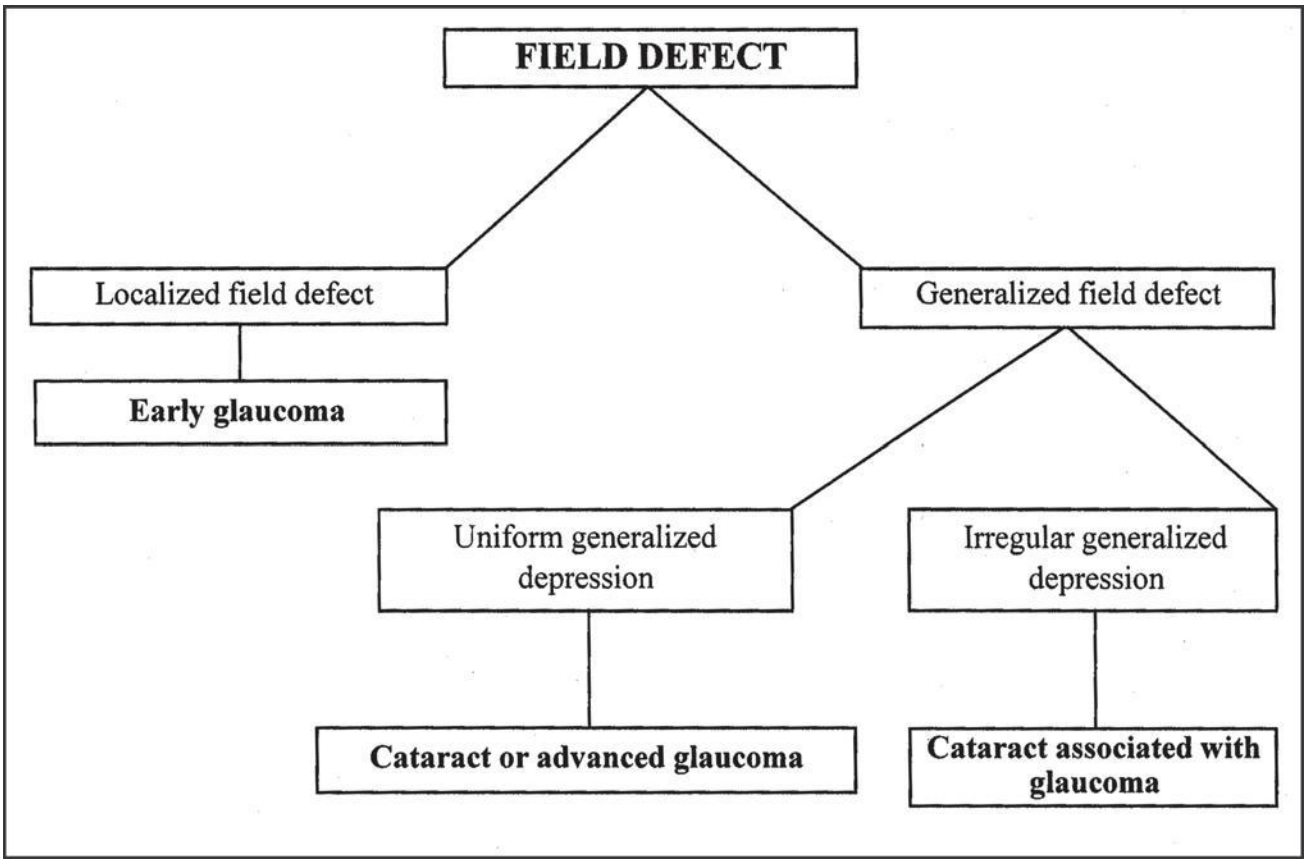


J. Nagabhushanam
Right eye field
Selection of the test :
30-2 Full Threshold
Reliability : Good

A case of uniform generalized field defect

1. Generalized depression in the total deviation probability plot and almost normal pattern deviation probability plot.
2. PSD : 2.20 dB
3. SF : 1.71 dB
4. CPSD : 1.04 dB
5. MD : -6.52 dB P < 0.5%

Total deviation probability plot	:	Generalized depression
Pattern deviation probability plot	:	No field defects seen.
PSD	:	2.20 dB
SF	:	1.71 dB
CPSD	:	1.04 dB
MD	:	-6.52 dB P < 0.5%
GHT	:	Generalized reduction in sensitivity
Interpretation	:	Typical single field analysis printout of a cataract patient.



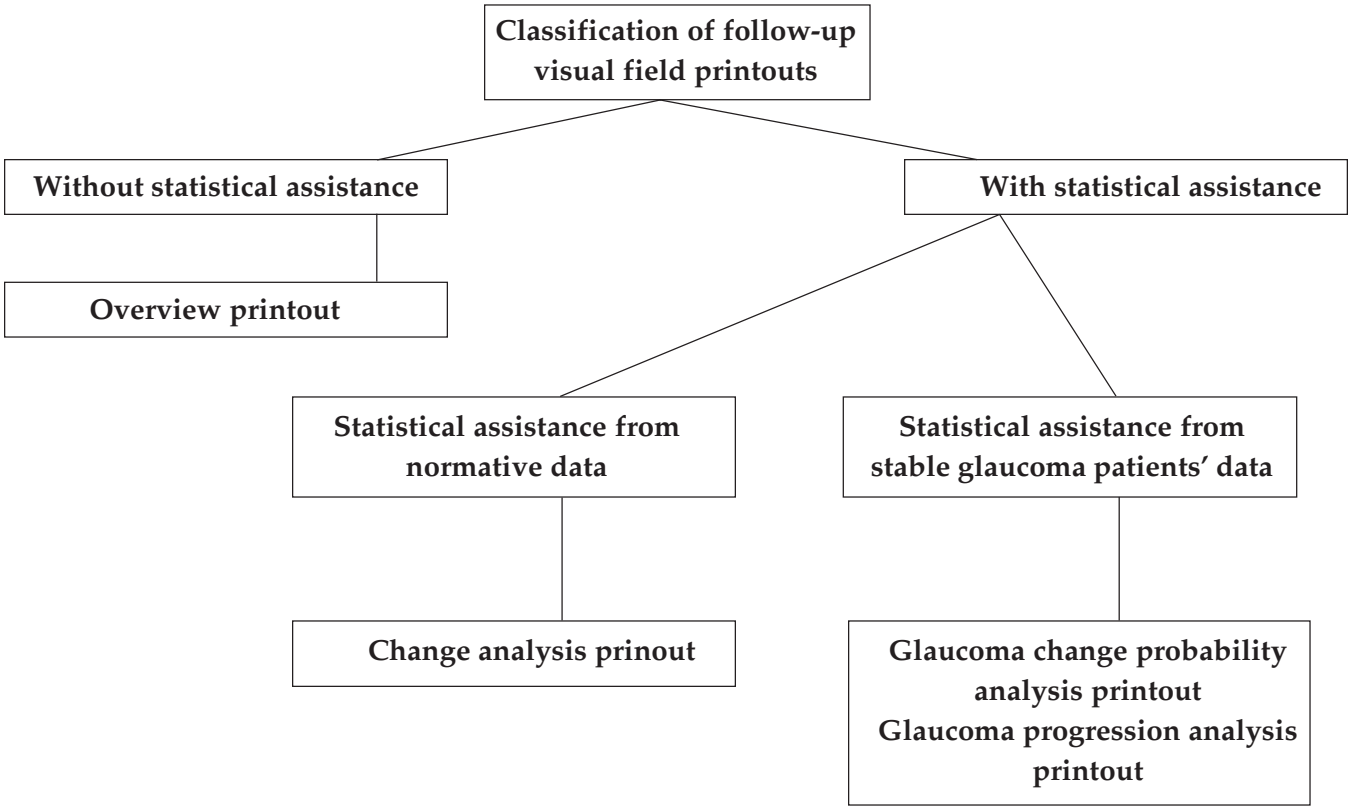
THE FEATURES IN SINGLE FIELD ANALYSIS PRINTOUT IN CASES OF CATARACT, CATARACT + GLAUCOMA, ADVANCED STAGE OF GLAUCOMA

	Type of field defect	Probability plots	MD index	PSD	GHT
Early glaucoma	Localized scotoma	The total deviation probability plot and pattern deviation probability plot look identical.	Moderately elevated	High	Outside normal limits
Advanced glaucoma	Uniform generalized depression	Generalized depression in the total deviation probability plot and almost normal pattern deviation probability plot	High	Low	Outside normal or reduction in the general sensitivity
Cataract	Uniform generalized depression	Generalized depression in the total deviation probability plot and almost normal pattern deviation probability plot.	High	Low	Generalized reduction of sensitivity
Cataract + glaucoma	Irregular generalized depression	Generalized depression in the total deviation probability plot and localized field defect in the pattern deviation probability plot.	High	High in early stage of glaucoma	Border line or outside normal limits

6 Follow-up Visual Field Examination

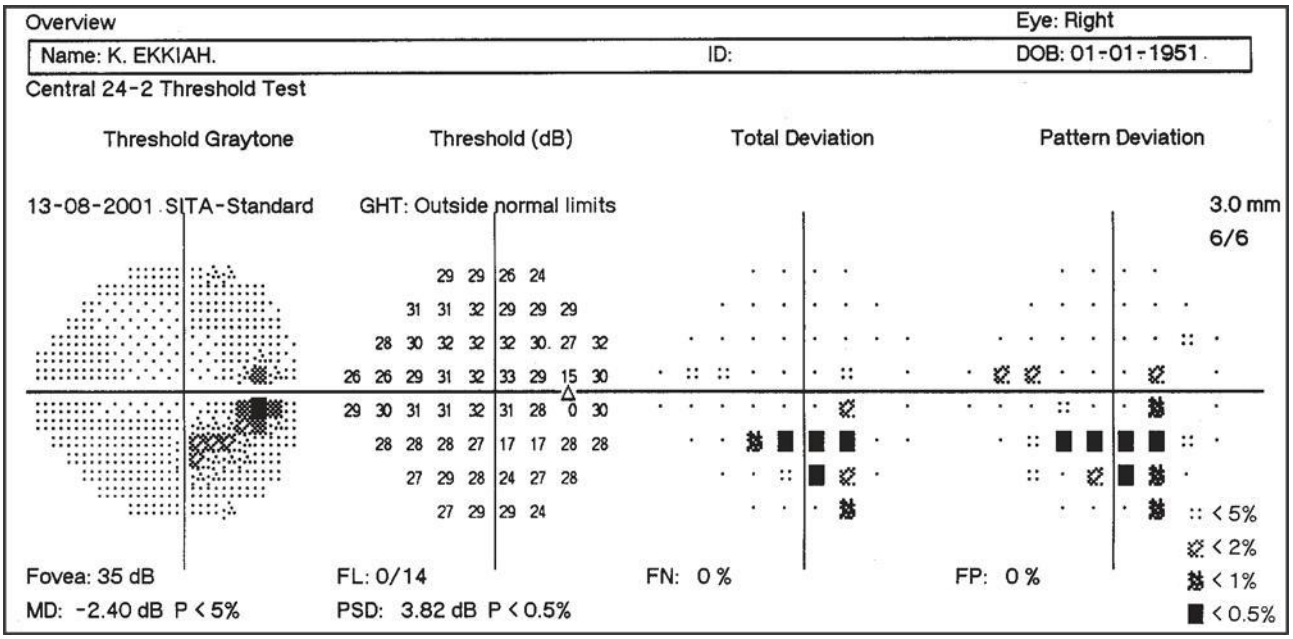
To know whether the disease is stable or progressing, we must have a baseline field and the follow-up fields. The most important point to be remembered is the follow-up tests should be conducted by the same testing strategy used in the baseline field test. During the interpretation of these follow-up tests, we should always keep in mind the effect of pupil size, refractive error correction and long-term fluctuation. There is nothing like a fixed time interval for follow-up visual field examination. The frequency of the visual field examination depends on clinical circumstances. The Humphrey field analyzer has the STATPAC to print the follow-up fields in four formats:

i. **Overview printout**
ii. **Change analysis printout**
iii. **Glaucoma change probability analysis printout**
iv. **Glaucoma progression analysis printout.**



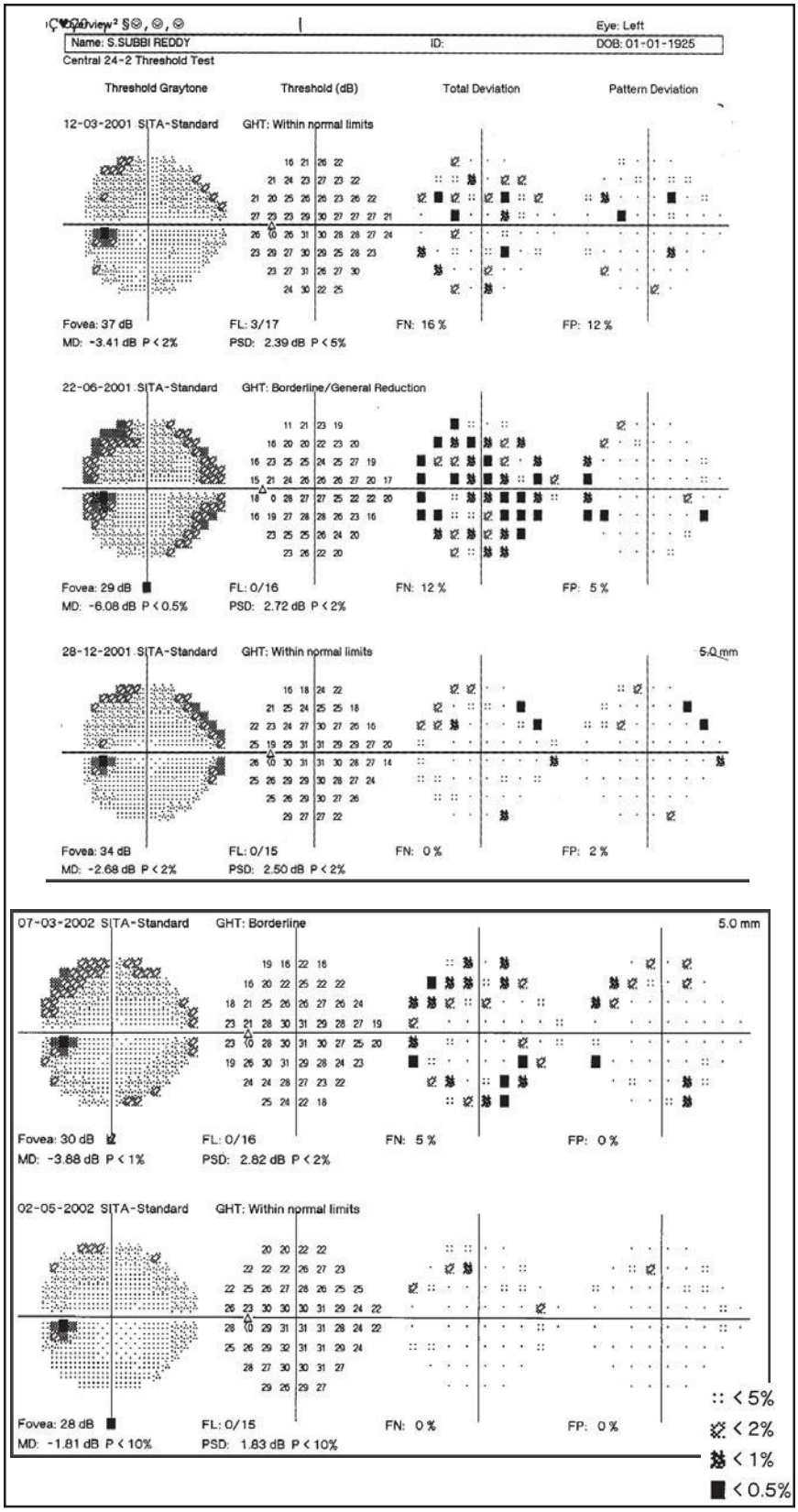
OVERVIEW PRINTOUT

The main advantage of the overview printout is to present all the single field analysis examinations of up to 16 tests on a single page. The tests are automatically printed in a chronological order. So it is easier to review the results of a series of tests without much difficulty. The overview printout consists of all the data that is present in the single field analysis printout except for the visual acuity and refractive error correction. The most important thing is to know that the overview printout does not give any additional information over the single field analysis printout. (All the data of the single field analysis printout is printed in a limited space in the overview printout format). The overview printouts must be analyzed for change by the use of experienced judgment without statistical assistance.



The patient's name, the eye tested, date of birth, the selection of the test will appear on the top of the test. **The overview printout presents the results of each test in four plots—gray scale, RAWdata, total deviation probability plot and pattern deviation probability plot.** The foveal threshold, the reliability parameters and global indices are also printed at the bottom of each test. The main advantage of overview printout is to glance the number of tests of chronological order on a single paper so that it is easy to compare the tests to one another. The most practical point one should remember is that results from 30-2 and 24-2 may be presented in the same printout. The STATPAC does not combine 10-2 with any other test patterns. The legend to the probability symbols appear at the bottom of the printout.

The refractive error correction and visual acuity will not be mentioned in the overview printout.

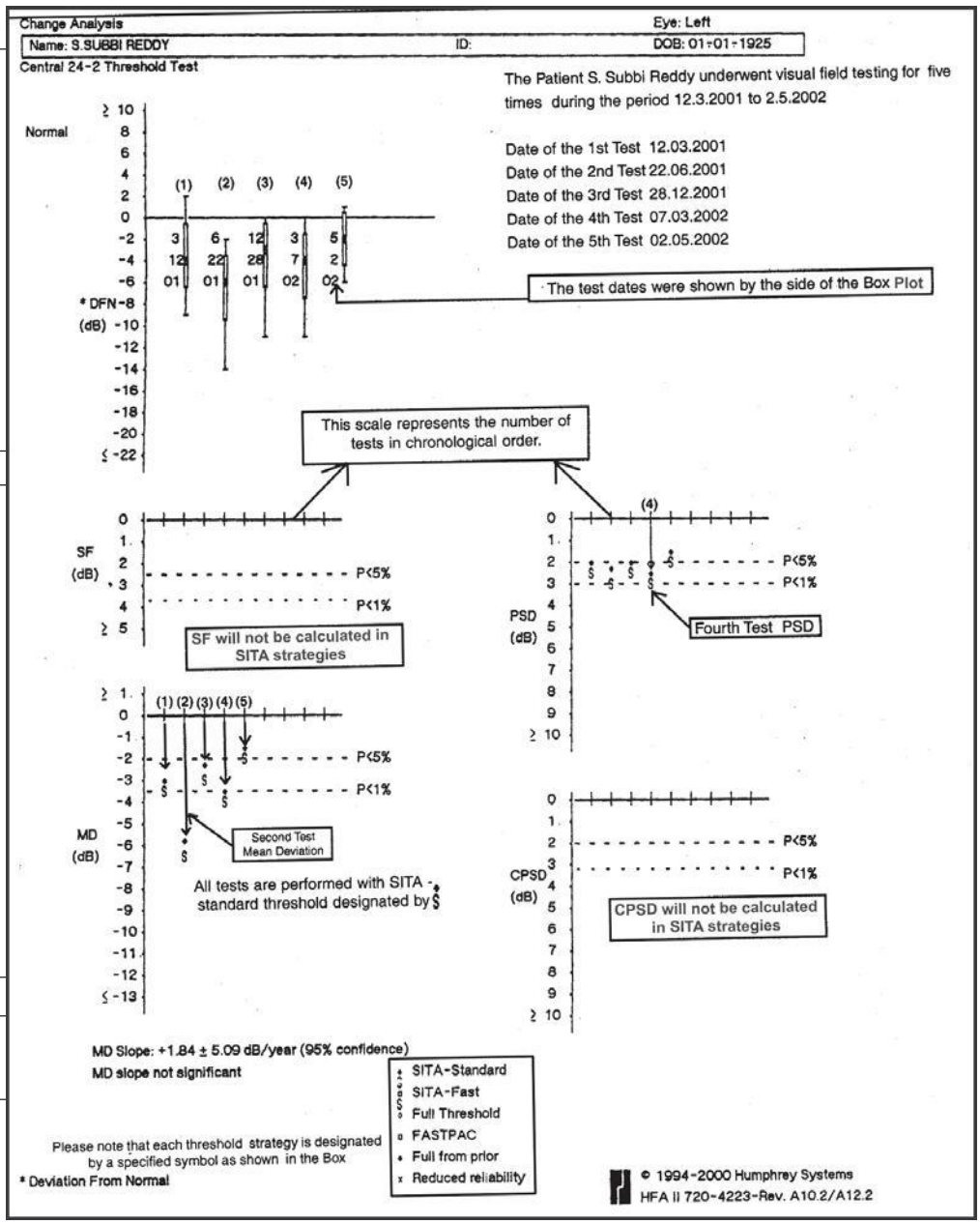


OVERVIEW PRINTOUT

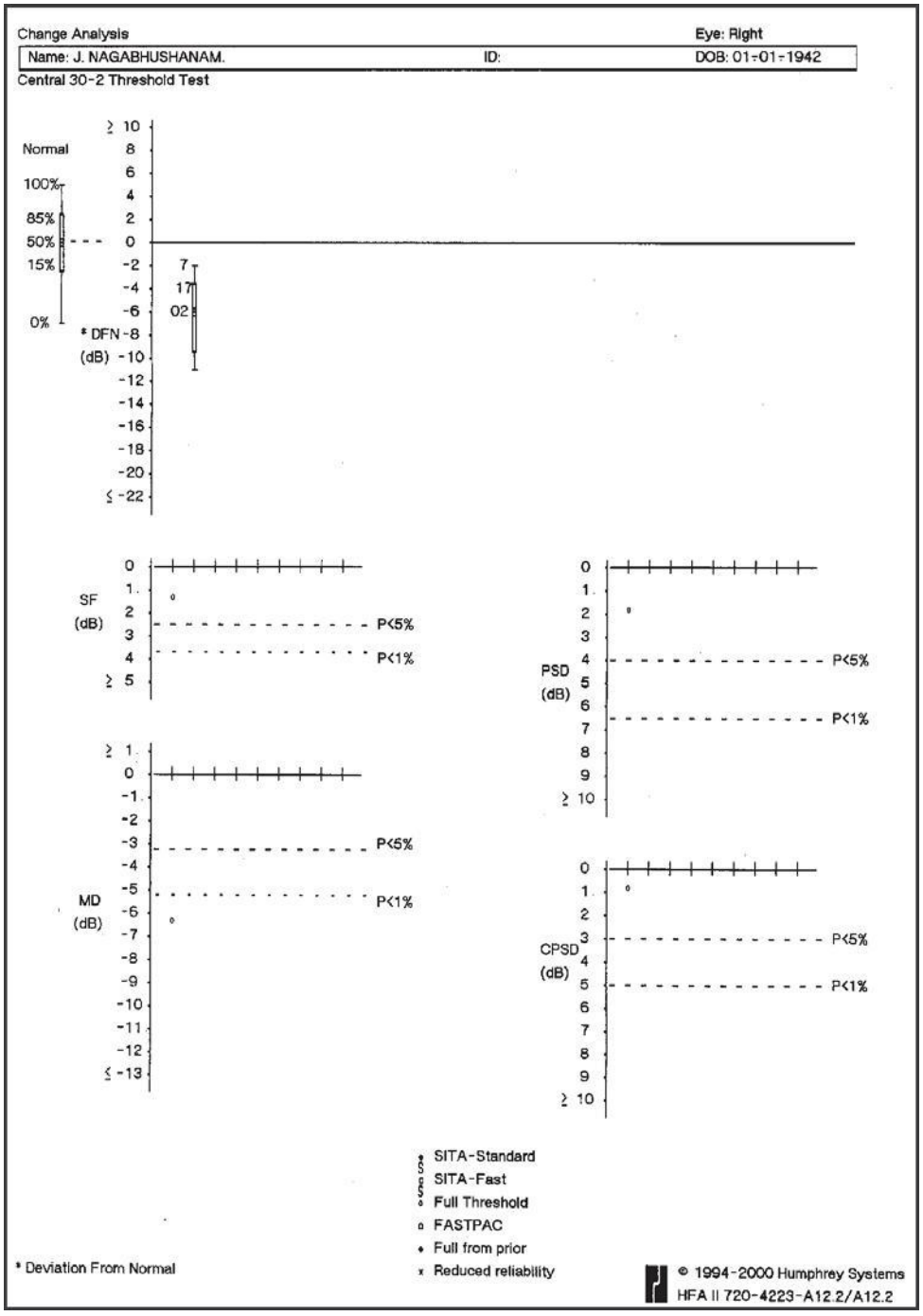
This is the overview printout of a known patient of POAG whose intraocular pressure (IOP) is under control with medical management. He underwent central threshold tests five times during the period from 12-3-2001 to 2-5-2002. All these test reports are presented on the single sheet as overview printout. The overview printout gives all the information that is present in the single field analysis printouts. The overview printout does not contain information about the visual acuity and the refractive error correction for the near vision. It also does not give any additional information over single field analysis printout unlike the change analysis printout, the glaucoma change probability analysis printout and glaucoma progression analysis printout. Strictly speaking, the overview printout does not come under follow-up tests because it is not analyzing the follow-up tests with one another.

CHANGE ANALYSIS PRINTOUT

Like the over view printout, the change analysis printout shows more than 10 test results on one sheet. The STATPAC produces analytical summary of changes in the patient's visual field from the time of earliest test included in the summary to the time of the most recent test included. The change analysis printout consists of three components: (i) a box plot with its relation to the dB scale, (ii) the summary of the global indices, and (iii) linear regression analysis of mean deviation. The indices are the same four presented in the single field analysis. But this time, they are plotted overtime to indicate the changes in the patient's visual field.

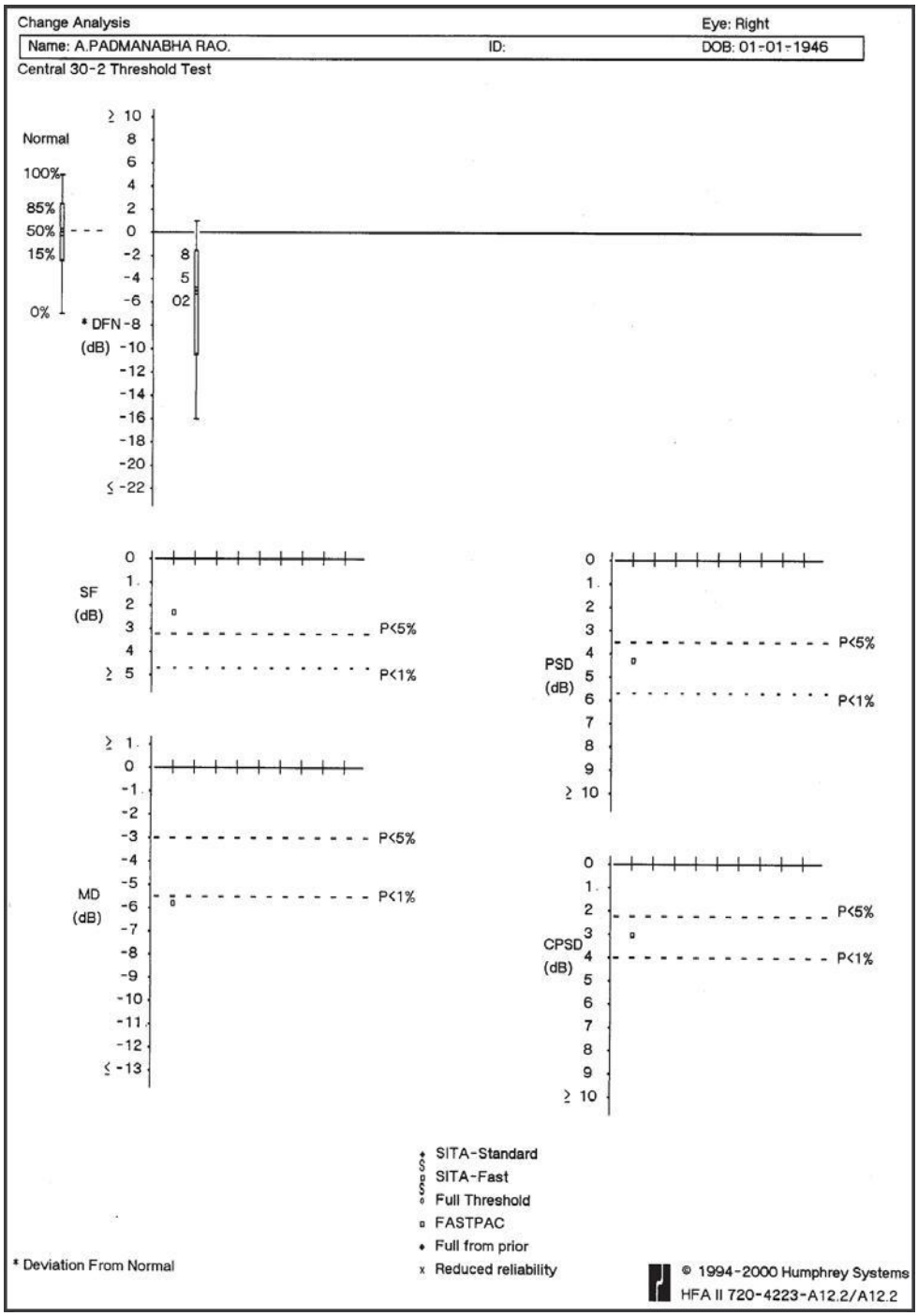


CHANGE ANALYSIS PRINTOUT OF FULL THRESHOLD STRATEGY



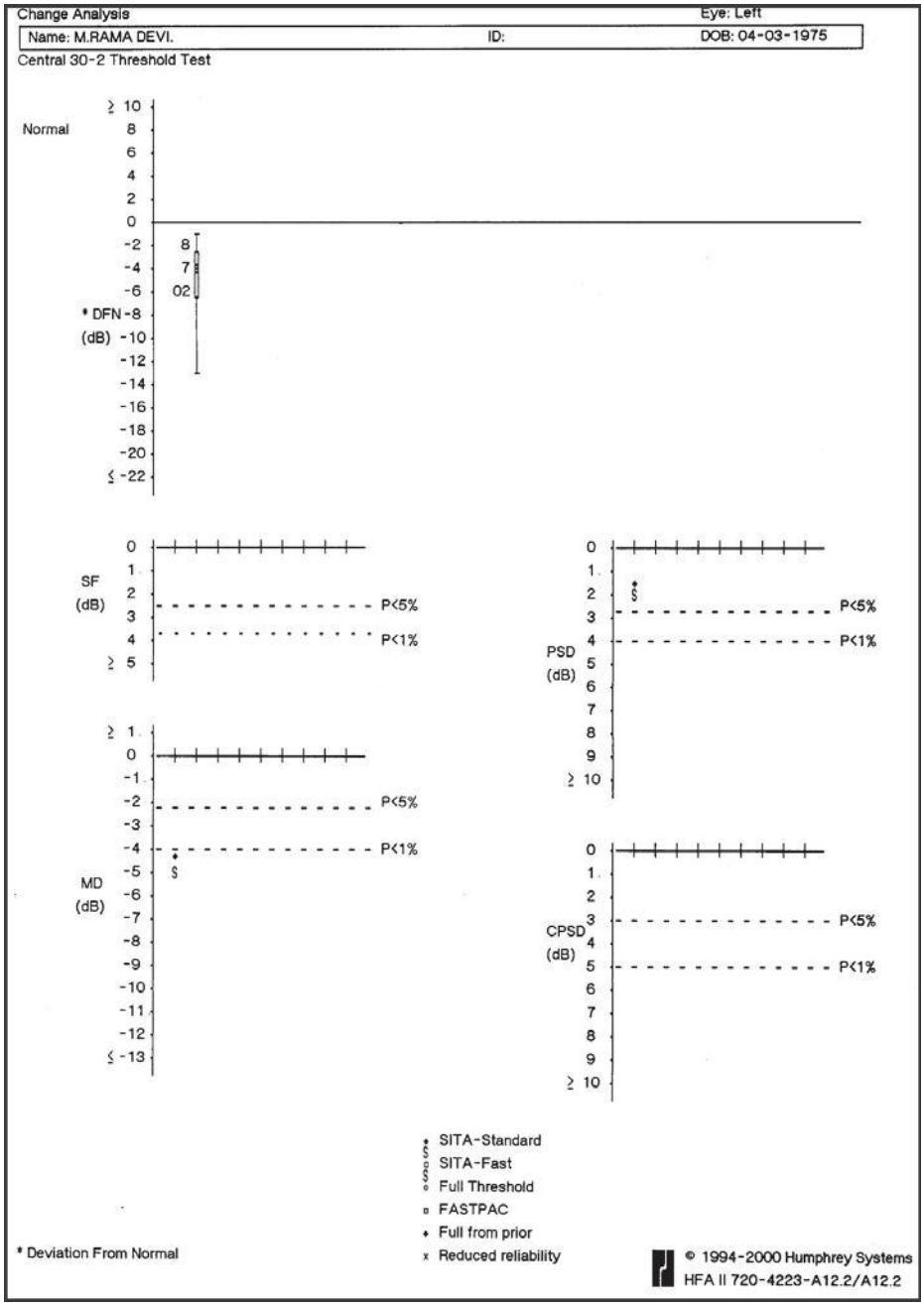
Change analysis printout of full threshold strategy will contain normal box plot display on the left side of the dB scale. All the components of the global indices (mean deviation, PSD, SF, CPSD) are represented in graphic forms.

CHANGE ANALYSIS PRINTOUT OF FASTPAC STRATEGY



Change analysis printout of FASTPAC strategy will contain normal box plot display on the left side of the dB scale. All the components of the global indices (mean deviation, PSD, SF, CPSD) are represented in graphic forms.

CHANGE ANALYSIS PRINTOUT OF SITA-STANDARD STRATEGY

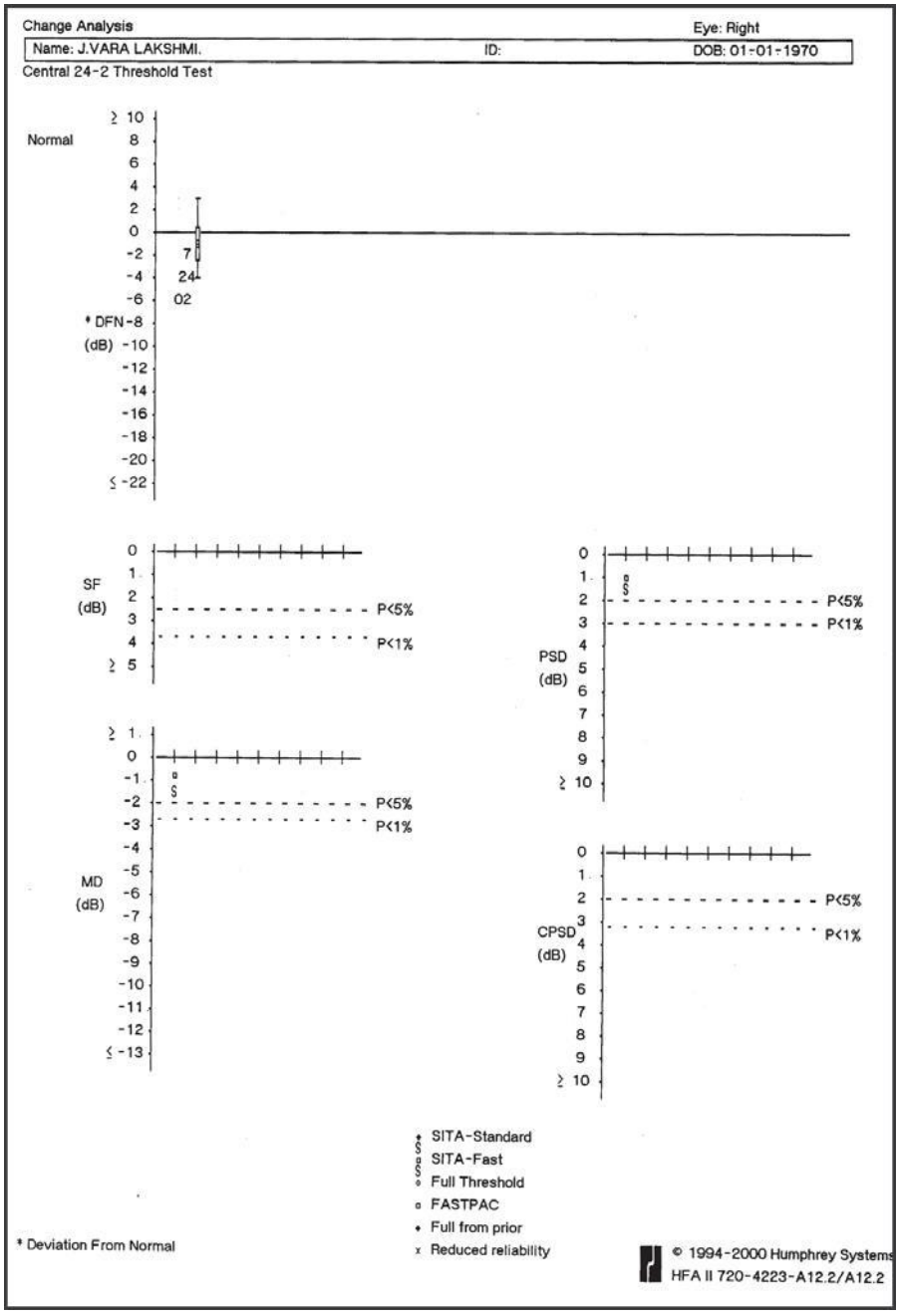


Change analysis printout of SITA-Standard strategy will not contain normal box plot display on the left side of the dB scale.

The values of mean deviation and PSD are represented in graphic forms.

Change analysis printouts of SITA strategies do not calculate SF and CPSD and hence they will not be represented in the graphic forms.

CHANGE ANALYSIS PRINTOUT OF SITA-FAST STRATEGY



Change analysis printout of SITA-Fast standard strategy will not contain normal box plot display on the left side of the dB scale.

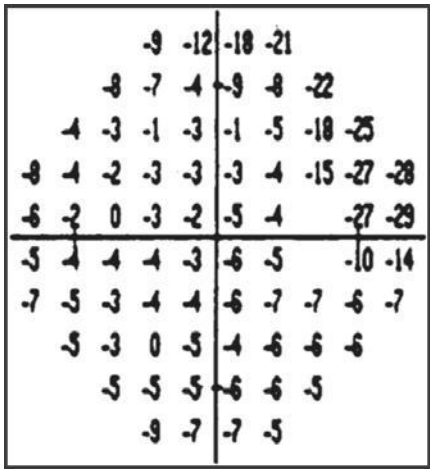
The values of mean deviation and PSD are represented in graphic forms.

Change analysis printouts of SITA strategies do not calculate SF and CPSD and hence they will not be represented in the graphic forms.

Box plot

The box plots are helpful in making a quick determination about the nature and the extent of visual field analysis overtime. The box plot is a modified histogram that gives a five number summary of test results. To interpret box plot, one should have a very clear concept about how the box plot is being constructed.

Total deviation numerical plot:



Construction of the box plot

The basis for the construction of the box plot is the total deviation numerical plot (TDNP) of the single field analysis printout. The deviations displayed in TDNP are ranked according to the degree of deviation. The decibel deviations (from age-matched normal) are arranged according to their sensitivities in chronological order and they are divided into three groups. These three groups constitute the box plot.

The vertical rectangle (box) represents the range of deviations for 70 percent of the locations. The median deviation value (not to be confused with the mean deviation global index) is indicated by a flanked heavy bar in the box. The extremes of the deviations are shown with the extended vertical lines above and below the box, incorporating 15 percent of points in each direction. The ends of the vertical lines thus indicate the total range of deviations from normal values for all points included in the analysis.

Take for example in the 30-2 field the test points are 76.

1st Group:
15% best points are represented by upper tail.

The best sensitivity point (100th percentile) in the field analysis.
11 points represent the upper tail
(15% of 76 test points = 11 points)
11th best point (85th percentile)

70% next best points are represented by rectangular box.

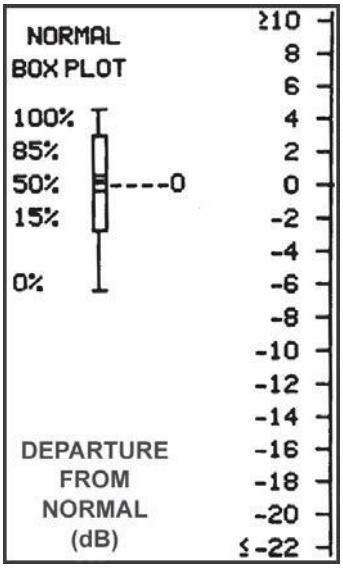
52 points will be represented by the box.
(70% of 74 test points = 52 points)

63rd ranked point (15th percentile)
11 points represent the lower tail
(15% of 74 test points = 11 points)

The worst 15% points represented by lower tail.

76th least sensitivity point (0 percentile) field analysis.

Normal position of the box plot in relation to decibel scale



In normal visual field, it would not be expected that the threshold sensitivity estimated could be exactly equal to the average normal values at all locations. At a fewer locations, the estimate may be slightly better than the normal values; and at other points, the estimate may be slightly worse. Experience shows that the majority are close to mid-normal value as the deviations are typically near zero dB for a median (50th percentile) point in the normal field.

In 30-2 central field, 70 percent of the points range from approximately 3 dB above to 3 dB below the average normal value. All deviations including 30 percent of outer layers are expected to fall within the ten decibel range from 4 dB to – 6 dB.

For interpretation, the main points to be noted are:

1. Overall shape of the box—how elongated or compact it is.
2. The location of the three dark lines inside the box that indicate the median.
3. The length of the upper and the lower tails.
4. Length of the box proper.
5. The top and the bottom end points of a line along which the box lies, the position of the box plot in relation to decibel scale.

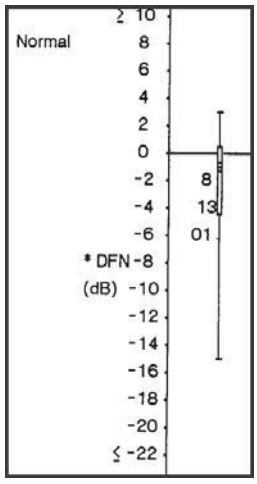
The change analysis printouts of SITA strategies do not contain the normal box plot figure left to the dB scale unlike what we see the normal box plot left to the dB scale with full threshold and FASTPAC change analysis printout.

Interpretation of the box plot analysis printout (change analysis printout)

The change analysis printout is not a substitute for single field analysis printout. The change analysis printout should always be attached with single field analysis printout for its interpretation. In isolation, we cannot interpret the change analysis printout for the following reasons:

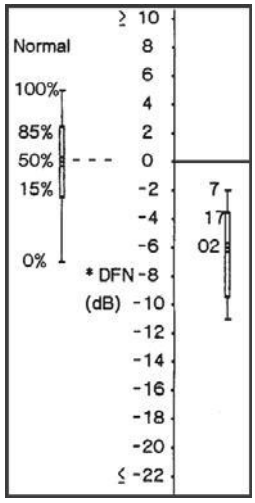
1. It does not contain details of the patient's data like visual acuity, pupil size, near vision correction.
2. Foveal threshold of the patient is not recorded
3. Reliability indices are not recorded. Only the selection of the test and date of birth of the patient are recorded in the printout. So we do not know whether the change analysis printout is reliability or not. That is why, it should always be attached to the single field analysis printout. The other pitfalls of change analysis printout are that, all the points of the total deviation probability plot will be analyzed without eliminating the edge scotoma of 30-2 central field. Sometimes the edge scotomas may give an impression as a localized scotomata represented by the long lower tail of the box plot.
4. The change analysis printout does not show the location of the scotoma whether they are in the arcuate area, nearer to fixation or at fixation.

FIELD DEFECTS: BOX PLOT ANALYSIS



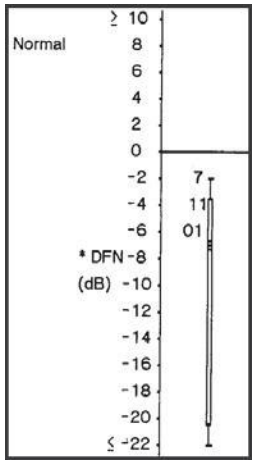
LOCALIZED FIELD DEFECT

In localized depression, some points will have normal sensitivity value. So, the upper tail position of the box plot will always be normal. The length of the other components of the box plot depends on the size of the field defect. If only 15 percent of the points lose their retinal sensitivity, we see the lengthening of the lower tail of the box plot without any shift of the box plot from its normal position. If 50 percent of the points lose their retinal sensitivity, we see the lengthening of the lower tail and lower half of the box without any shift of the box plot from its normal position. Hence, the most important point to be noted in localized depression is the change in the length of the box plot without shift in the position of the upper tail.



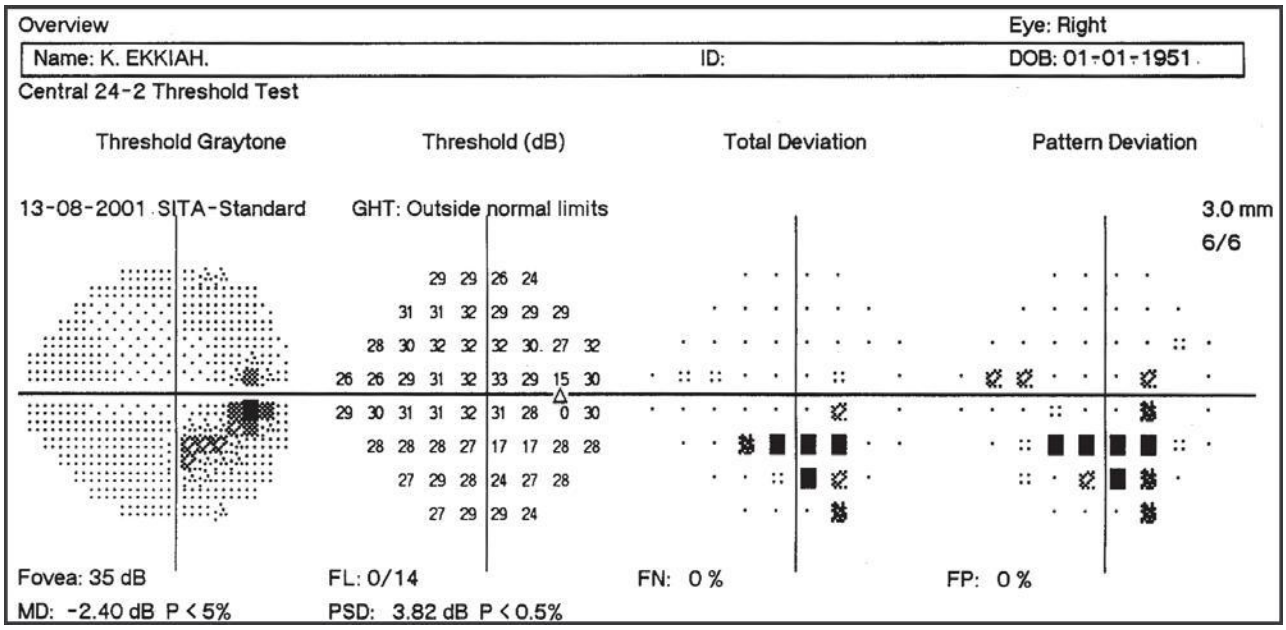
UNIFORM GENERALIZED DEPRESSION

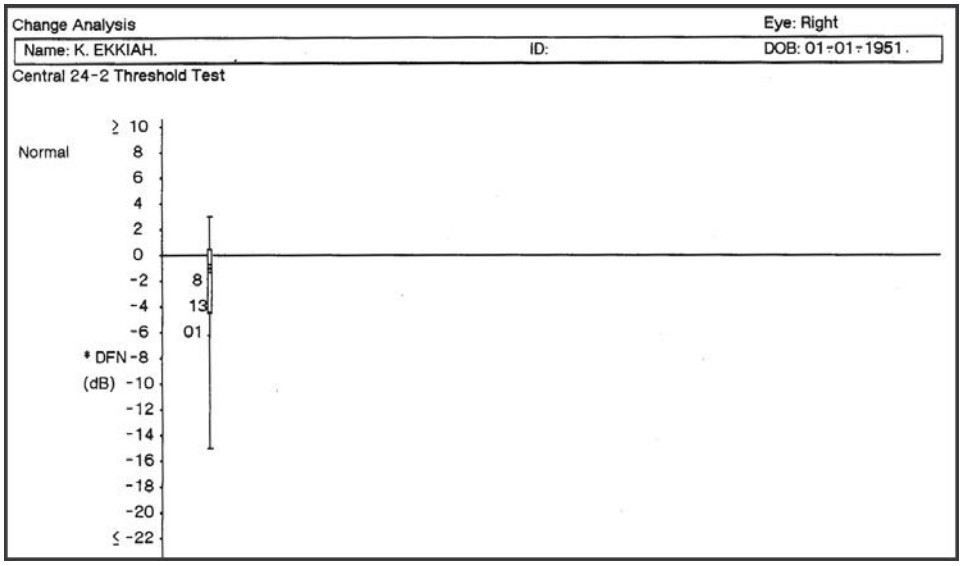
The entire box plot is shifted downwards and the shift depends on the degree of field loss, but the length of the box plot is not changed, which means all the points lost their sensitivity equally. The most important point to be noted in uniform generalized depression is the length of the box plot is unaltered.



IRREGULAR GENERALIZED DEPRESSION

The entire box plot is shifted downwards along with change in the length of the box plot. Because the loss of retinal sensitivity of all points is not equal, the length of each component of box plot will be different. The most important point to be noted in irregular generalized depression is the length of the box plot is altered.





Example: 1

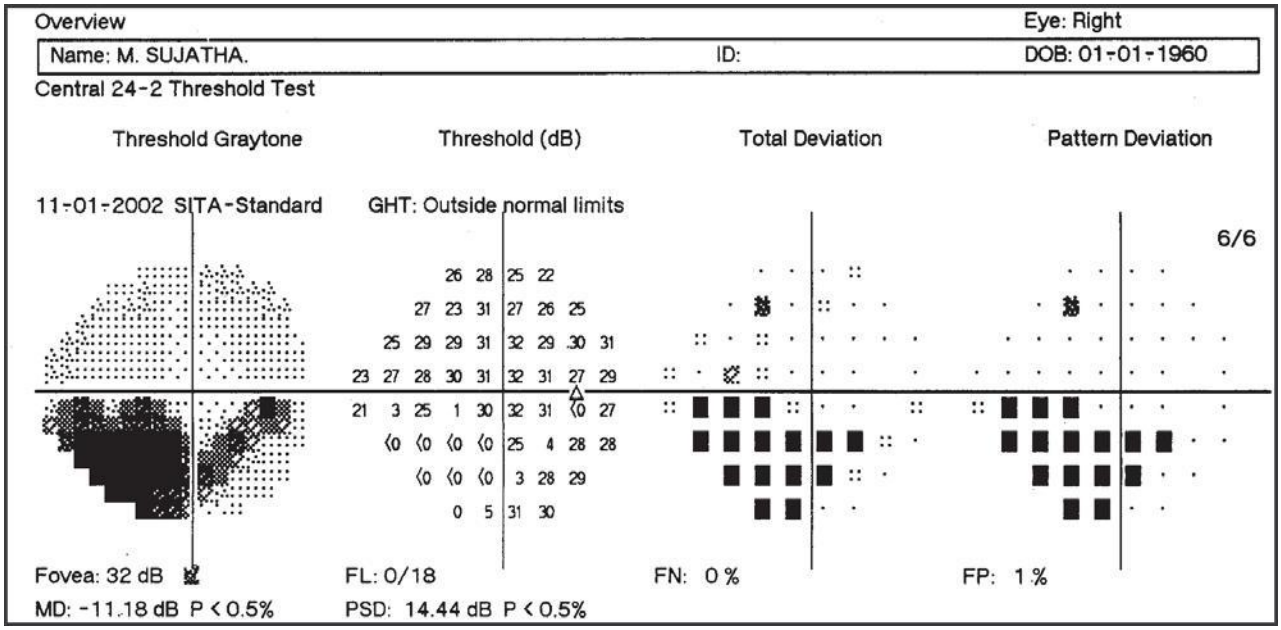
CHANGE ANALYSIS PRINTOUT OF LOCALIZED FIELD DEFECT IN EARLY GLAUCOMA

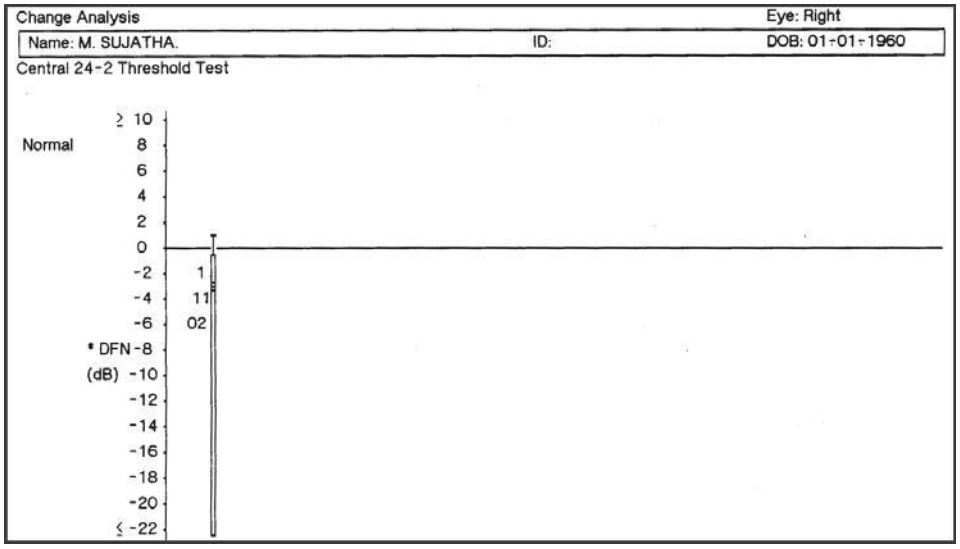
The box plot is extending from + 3 dB to –15 dB with 50th percentile point is at –1 dB.

85th percentile point is just above 0 dB and 15th percentile point is at –5 dB.

Except for the lengthening of the lower tail, the other components of the box plot are almost within normal limits. That indicates that almost 85 percent of the points are almost within in normal limits except for the 15 percent of the points represented by the lower tail. The 15 percent of the points of the decibel deviations varying from –5dB to –10dB. This is the best example of a localized scotomata.

I am giving seven examples of the change analysis printout of different cases with their interpretation. For better understanding, the overview printout of each case is also displayed above the change analysis printout.





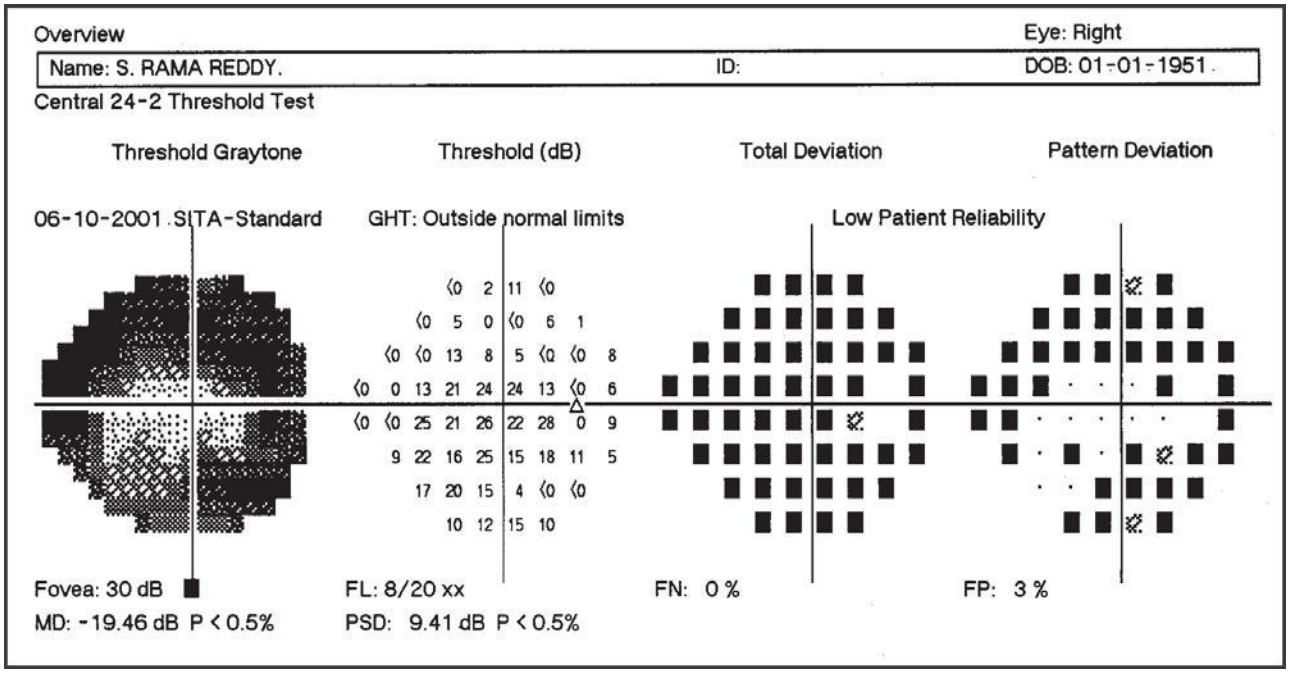
Example: 2

CHANGE ANALYSIS PRINTOUT OF LOCALIZED FIELD DEFECT IN A KNOWN PATIENT OF GLAUCOMA

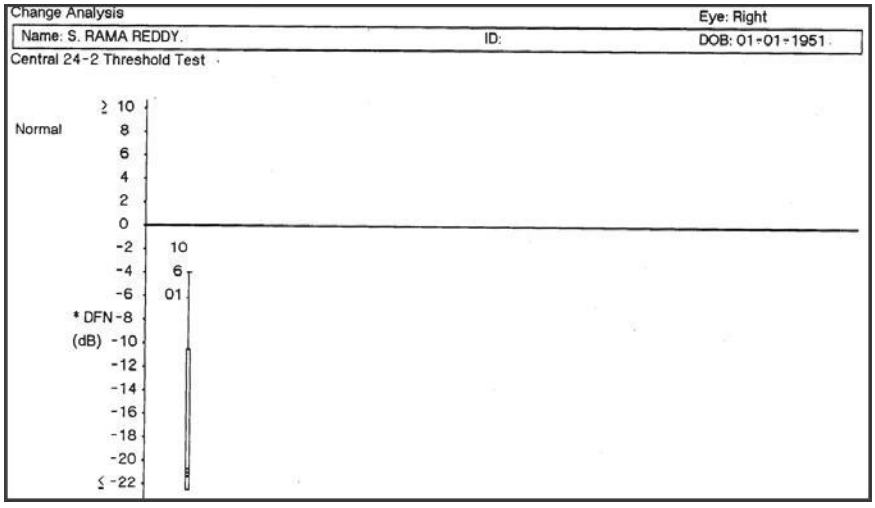
The box plot is extending from + 1 dB to –22 dB with 50th percentile point is at –3 dB. (Almost half of the points' retinal sensitivity is within normal limits).

85th percentile point is just above –1 dB and 15th percentile point is at –22 dB.

The special feature of this example: (i) absence of lower tail which indicates 15 percent of the points are severely affected, (ii) the length of the lower half of the rectangular box is elongated from –3 dB to –22 dB. indicating the 35 percent of the points represented by the lower half of the rectangular box have very wide variation in their decibel deviations, and (iii) The 50 percent of the points are almost within the normal limit represented by the upper tail and upper half of the rectangular box. This is the best example for the wide variations in the retinal sensitivity in about the half of the visual field.



For better understanding the overview printout of each case is also displayed above the change analysis printout.



Example: 3

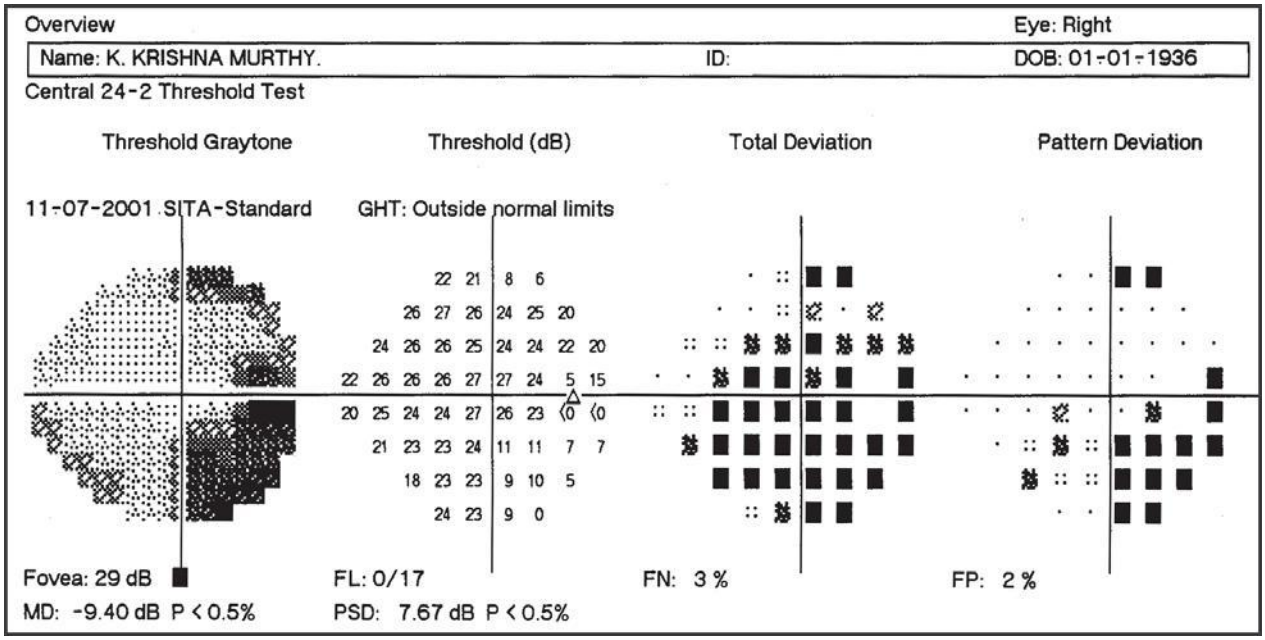
CHANGE ANALYSIS PRINTOUT OF IRREGULAR GENERALIZED DEPRESSION IN A CASE OF ADVANCED GLAUCOMA

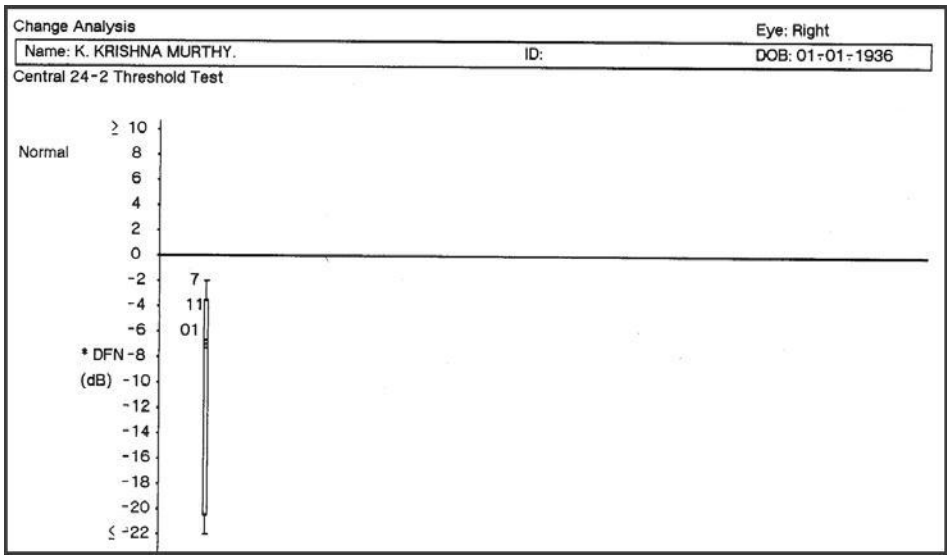
The box plot is extending from –4dB to –22 dB with 50th percentile point is at –21 dB.

85th percentile point is –11 dB and 15th percentile point is at –22 dB.

In this example, almost all points are severely affected. The special features of this box plot analysis are:

1. Absence of lower tail and absence of almost the lower half of the rectangular box (indicating 50 percent of the points are severely affected whose deviation values are –20).
2. Lengthening of the upper tail and lengthening of the upper half of the box proper indicating that 50 percent of the points are having wide variations in their decibel deviations. So this field will have high MD value and also high PSD because of wide variations in 50 percent of the points.





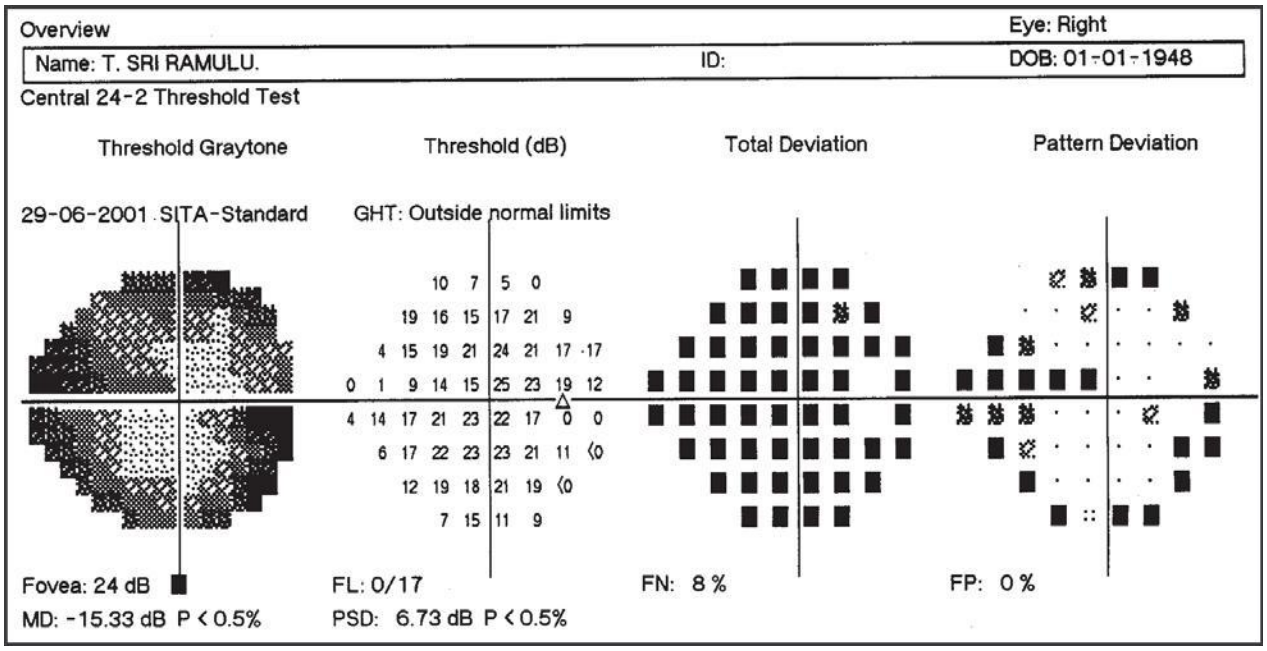
Example: 4

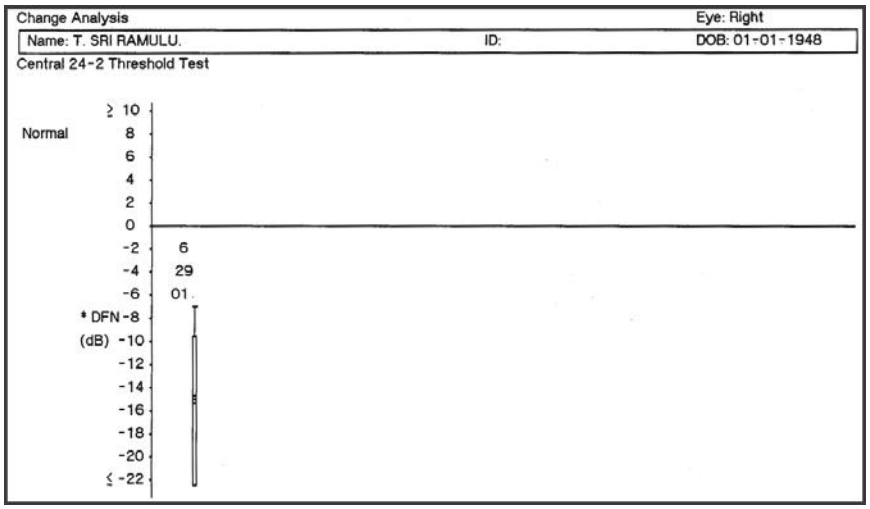
CHANGE ANALYSIS PRINTOUT OF AN IRREGULAR GENERALIZED DEPRESSION IN A KNOWN PATIENT OF CATARACT AND GLAUCOMA

The box plot is extending from –2 dB to –22 dB with 50th percentile point is at –7 dB.

85th percentile point is just above –4 dB and 15th percentile point is at –21 dB.

In this example, almost all points are affected. The special feature of this box plot is lengthening of lower half of the box proper indicating 35 percent of points have wide variations in their decibel deviations. Fifteen percent of the points represented by the lower tail have a very small range in their decibel deviations varying from –21 to –22. This box plot analysis is indicating that there is a generalized depression with localized scotoma.





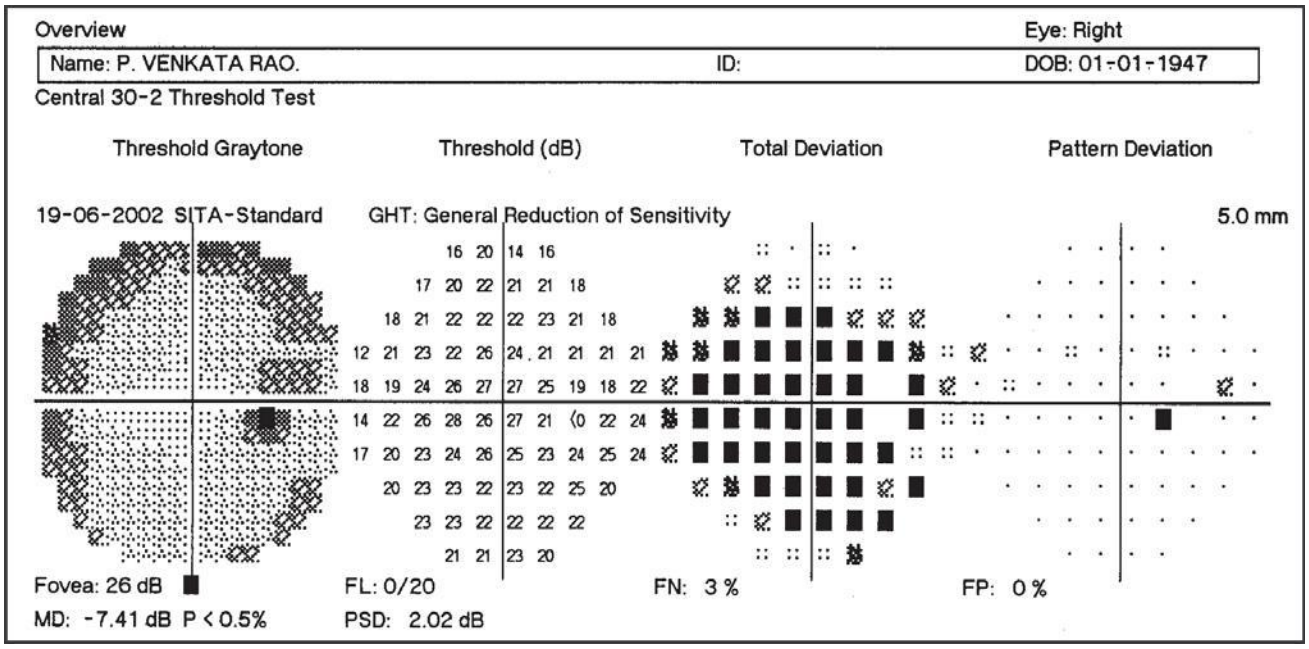
Example: 5

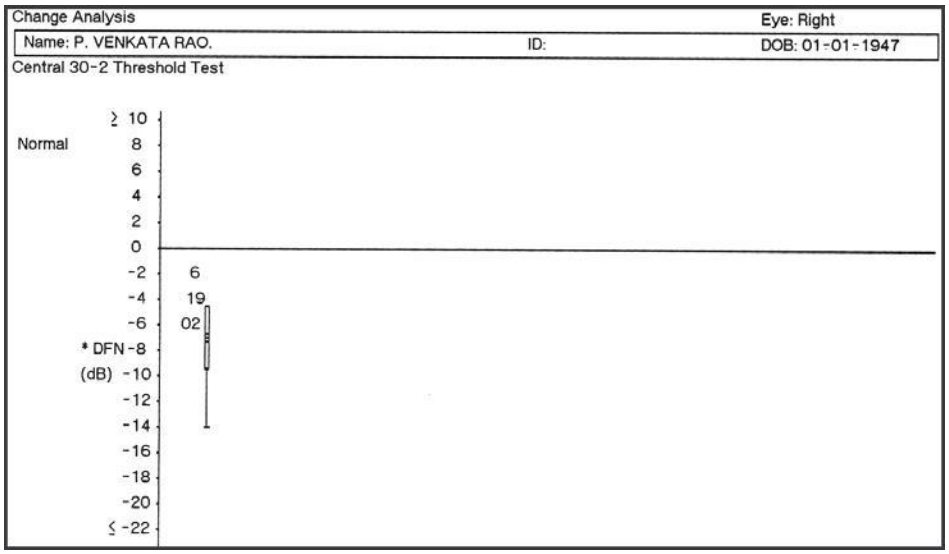
CHANGE ANALYSIS PRINTOUT OF AN IRREGULAR GENERALIZED DEPRESSION— A CASE OF CATARACT AND GLAUCOMA

The box plot is extending from –7 dB to –22 dB with 50th percentile point is at –16 dB.

85th percentile point is –10 dB and 15th percentile point is at –22 dB.

In this example, all points are severely affected. The special feature of this change analysis printout is lengthening of the upper and lower half of the rectangular box proper to equal extent (extending from –10 dB to –22 dB is the percentile point at –15 dB). Absence of the lower tail indicates that 15 percent of the points are equally affected beyond –22 dB.

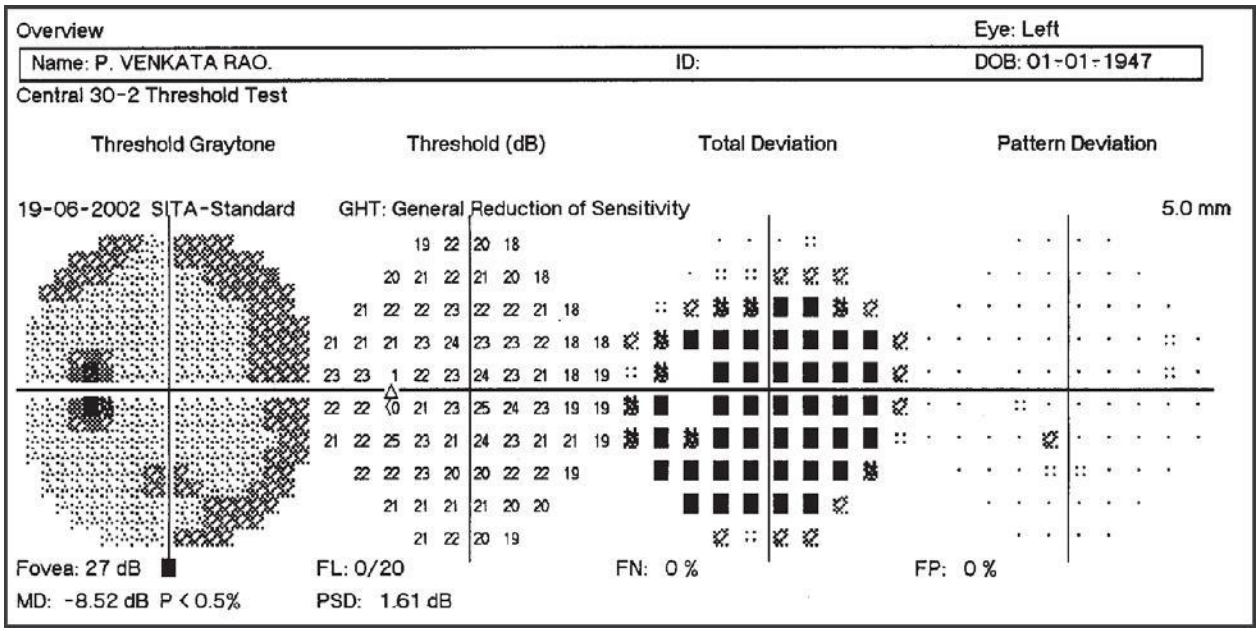


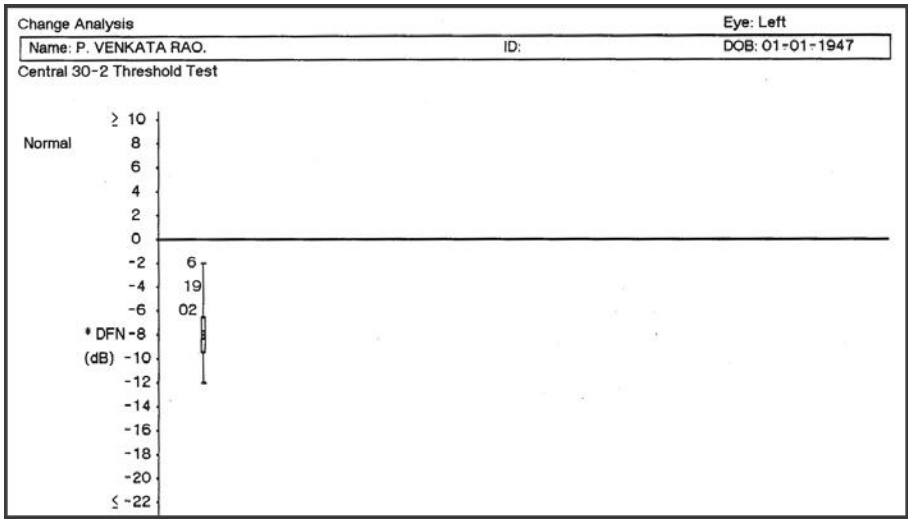


Example: 6

CHANGE ANALYSIS PRINTOUT OF UNIFORM GENERALIZED FIELD DEFECT IN A CASE OF CATARACT

1. The shape of the box plot is almost normal except for absence of upper tail.
2. The decibel deviations are varying from –4 dB to –14 dB.
3. The best threshold point is having decibel deviation –4 dB.
4. The worst point is having decibel deviation –14 dB.
5. Fifteen percent of the best points represented by the upper tail points are having –4 dB deviations.
6. Seventy percent of the next best points represented by the rectangular box have the decibel deviations varying from –4 dB to –10 dB.
7. Fifteen percent of the worst points represented by the lower tail have the decibel deviations varying from –11 dB to –14 dB.





Example: 7

CHANGE ANALYSIS PRINTOUT OF UNIFORM GENERALIZED FIELD DEFECT IN A CASE OF CATARACT

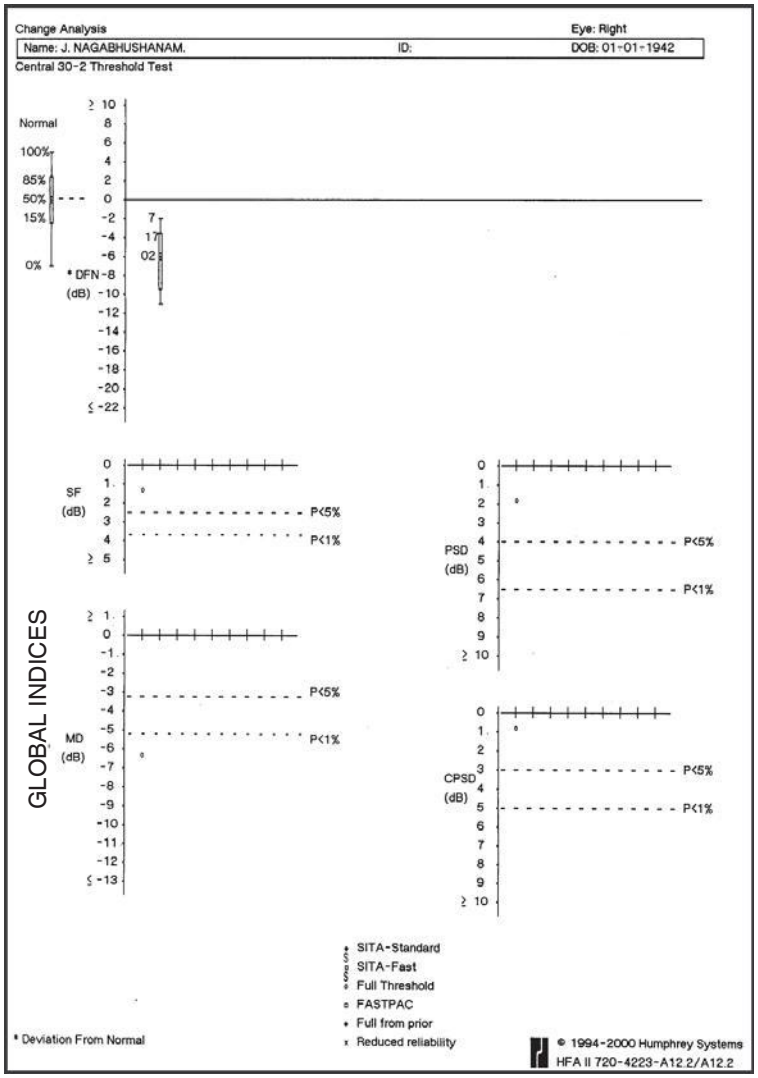
Change analysis printout:

1. The shape of the box plot is almost normal except for little lengthening of the upper tail.
2. The decibel deviations are varying from –2 dB to –12 dB.
3. The best threshold point is having decibel deviation –2 dB.
4. The worst point is having decibel deviation –12 dB.
5. Fifteen percent of the best points represented by the upper tail have the decibel deviations varying from –2 dB to –7 dB.
6. Seventy percent of the next best points represented by the rectangular box have the decibel deviations varying from –8 dB to –10 dB.
7. Fifteen percent of the worst points represented by the lower tail have the decibel deviations varying from –10 dB to –12 dB.

CHANGE ANALYSIS SUMMARY OF GLOBAL INDICES

The lower half of the change analysis printout displays summaries of global indices, MD (Mean deviation), PSD (Pattern standard deviation), SF (Short-term fluctuation), and CPSD (Corrected pattern standard deviation) for the tests shown in the box plot.

The summary of results are presented chronologically and in the same order as in the box plots. Thus, the test dates may be taken from the box plot. To facilitate interpretation, the P < 5% and P < 1% limits for the normal population are shown as dashed reference lines. If, for example, the symbol indicating a test appears above the 5 percent line, the index value on the test is not significant at the 5 percent level. If it falls below the 5 percent line, the index value is significant at the 5 percent level. Similarly, if the symbol falls below the 1 percent line, the index value is significant at the 1percent level. That is, less than 1percent of the normal population has an index value as large as or larger than that found in the test.



LINEAR REGRESSION ANALYSIS OF MEAN DEVIATION

To calculate linear regression analysis of mean deviation index, the STATPAC requires a minimum of 5 tests of the same strategy; and if mixed strategies are used, minimum of six test results are required for linear regression analysis of mean deviation.

The STATPAC calculates the changes in the mean deviation index from the first test to the latest test and expresses it in dB units per year and compares the patients' mean deviation index change per year to the expected small decay seen in an age-matched normal population (approximately 0.08 to 0.1 dB per year). One of the two messages **MD slope significant** or **MD slope not significant** will be printed below the MD plot. The largest P value the STATPAC programmed to consider is 5 percent. A linear regression analysis tests the hypothesis that a slope is zero, that means there is no change in the patients' visual field. If this hypothesis is not rejected, the message MD slope not significant appears with P value 5%.

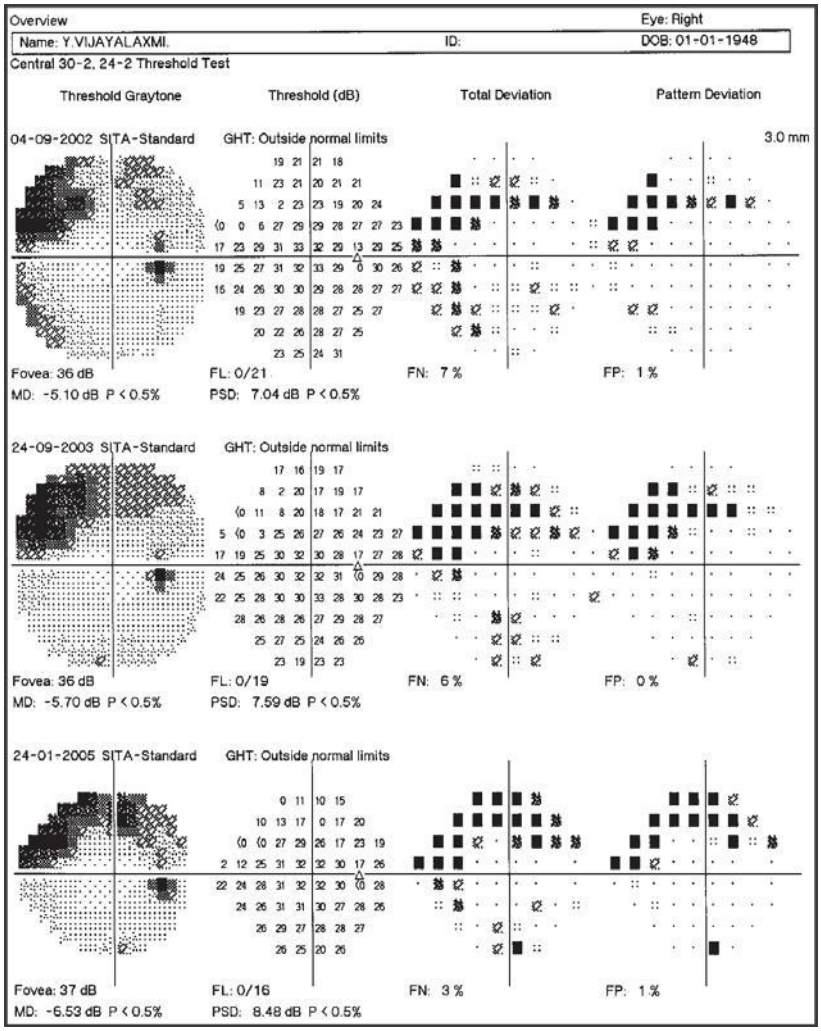
If the hypothesis is rejected after analysis at P value < 5% level, the message MD slope significant appears and analysis continues at the 1% or 0.1% levels of significance. The result is then displayed, has been significant at P value < 5%, P value < 1% or P value < 0.1%. It also calculates the magnitude of the slope in dB per year with 95% confidence.

If larger number of tests are analyzed, the small changes in mean deviation can be detected very easily. A low number of observations involves a high-risk of failure to detect the deterioration over time. This is the reason why the STATPAC will not perform linear regression analysis of mean deviation, less than 5 test results.

> The normal change in mean deviation index per year will be around 0.06% to 0.1%. If the patient's mean deviation index is changed more than 0.1 dB per year, we have to consider the change in mean deviation is significant. Any change in mean deviation index < 0.1 dB per year is not significant.

Please note that in change analysis follow-up test, the change in mean index of the patient is compared to a change in mean deviation index of normal population (normative data). In glaucoma change probability analysis and glaucoma progression analysis (GPA), the change in mean deviation index is compared to change in mean deviation index in stable glaucoma patient group.

I am giving the overview printouts and their corresponding box plot analysis component of 4 cases in the following pages.



Case - 1

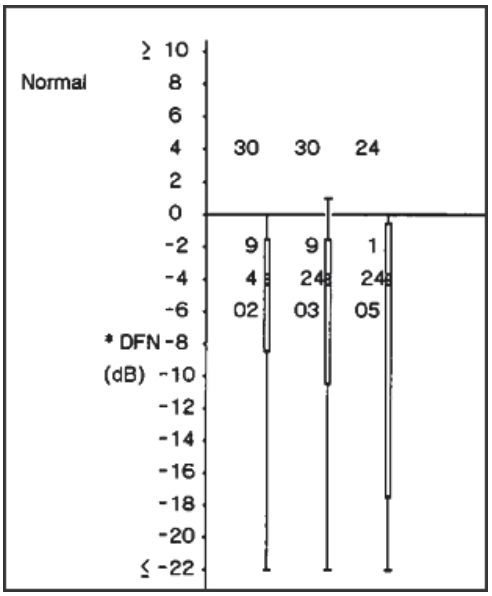
The overview printout of a known patient of POAG under medical treatment.

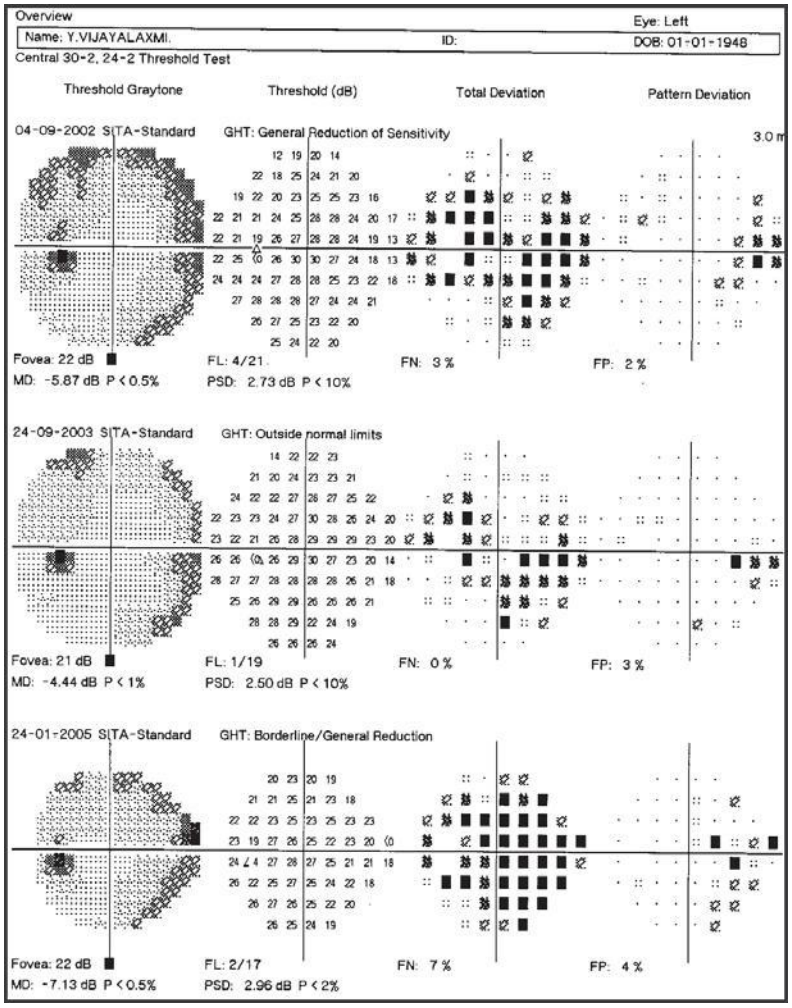
Follow-up period from 4-9-2002 to 24-1-2005 (2½ years follow-up)

	FL	FN	FP	MD	PSD
I Test	0/22	7%	1%	–5.10	7.04
II Test	0/19	6%	0%	–5.70	7.59
III Test	0/10	3%	1%	–6.53	8.48

Two years follow-up of a case of POAG whose IOP under control with monotherapy. During these 2 years, the mean deviation index is changed by 1.43 dB. (Usually, the change in the mean deviation index per year is 0.1 dB. The change of mean deviation index more than 0.1 dB is considered to be significant.)

During these 2½ years follow-up, there is a definite progression in the field defect. In the first test, the worst 15 percent of the points are varying from –9 to –22. In the 3rd test, the worst 15% of the points are varying from –18 to –22. In the first test, the next best 35 percent of the points are varying from –4 to –11. In the 3rd test, the next best 35 percent of the points are varying from –4 to –8. The real progress is better appreciated in change analysis printout than the overview printout.





Case - 2

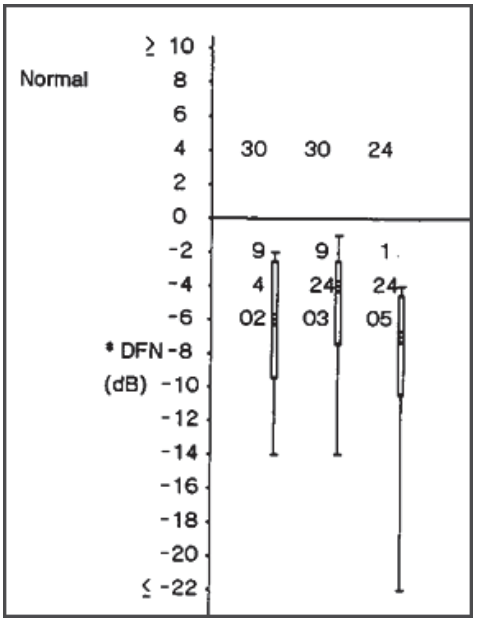
The overview printout of a known patient of POAG under medical treatment.

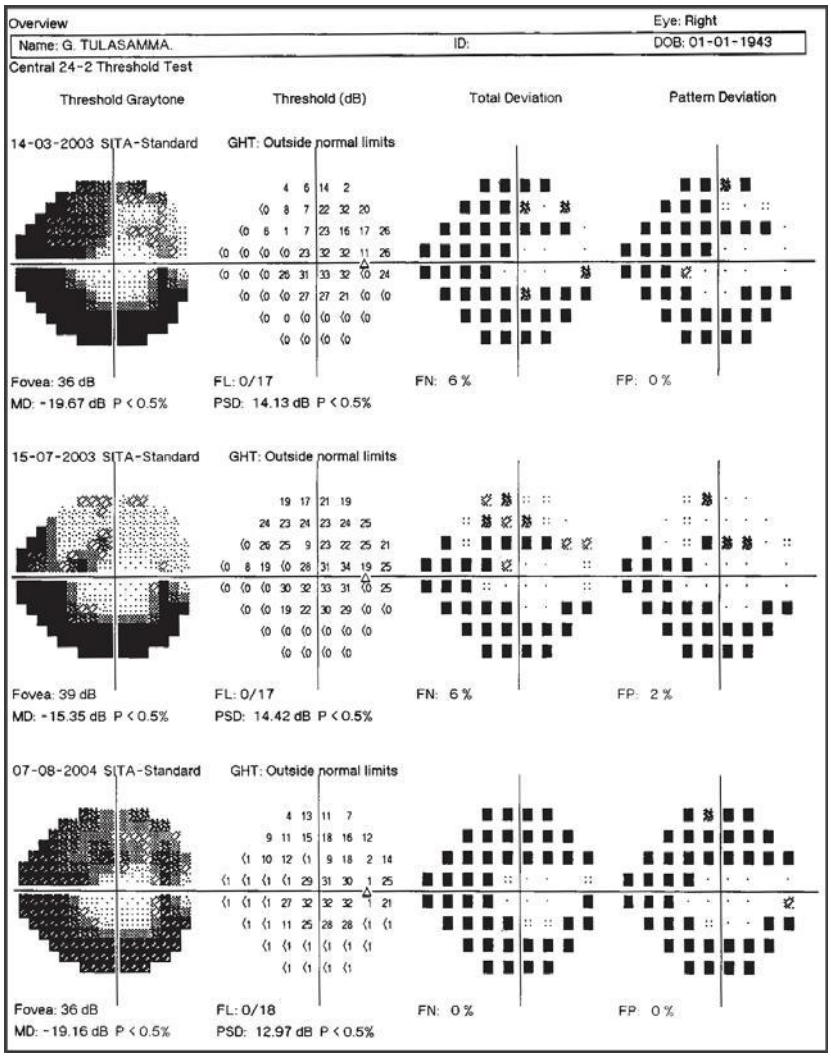
Follow-up period from 4-9-2002 to 24-1-2005 (2½ years follow-up)

	FL	FN	FP	MD	PSD
I Test	4/21	3%	2%	–5.87	2.73
II Test	1/19	0%	3%	–4.44	2.50
III Test	2/17	7%	4%	–7.13	2.96

This is the overview printout of a known case of POAG whose IOP is under control with monotherapy. The important change in the follow-up fields is the change of mean deviation index from –5.87 to –7.13, without much change in the PSD value. It indicates that there is a uniform generalized decrease in the retinal sensitivity and it is corresponding to the lenticular changes developed during period of 2½ years.

The change analysis printout showed definite progression in the field defect. In the 3rd test (24-1-2005), the worst 15 percent of points are varying from –12 to –22 and the next best 35 percent of the points are varying from –8 to 2 –12 and this change is mainly due to generalized loss of retinal sensitivity due to cataract.





In the change analysis printout, the 2nd test (15-7-2003) 50 percent of the worst points are showing the deviation –10 to –22. Whereas in the first and the third tests, 50 percent of the worst points are showing the deviations –22. This much change in the retinal sensitivity value is brought out by 2 percent of false-positive errors. This is a very good example to know how important are reliability indices before interpreting the visual field printouts.

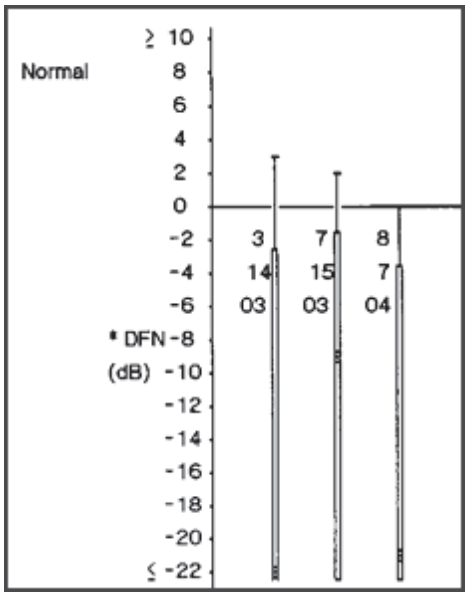
Case - 3

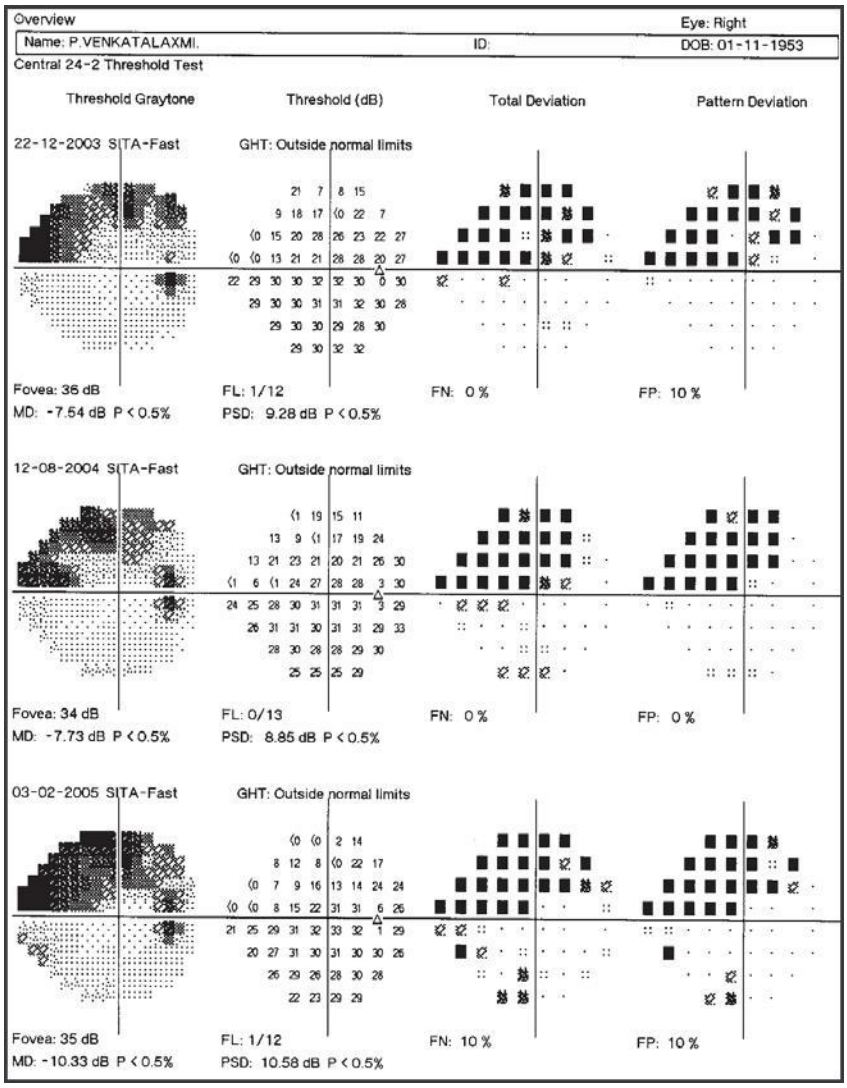
The overview printout of a known patient of POAG under medical treatment.

Follow-up period from 14-03-2003 to 07-08-2004 (1½ years follow-up)

	FL	FN	FP	MD	PSD
I Test	0/17	6%	0%	–19.67	14.13
II Test	0/17	6%	2%	–15.35	14.42
III Test	0/18	0%	0%	–19.16	12.97

In this follow-up test, we concentrate on the reliability factors and their effect on the measured retinal sensitivity. In the first 2 tests, FL and FN are 0.17 and 6 percent respectively and the FP is 0 percent for the first and the third test and 2 percent for the 2nd test. The 2 percent false-positive errors changed the mean deviation index from –19.67 dB to 15.35 dB. From this, we understand how much attention one should give even to the minimum percentage errors of FL, FN, and FP





Case - 4

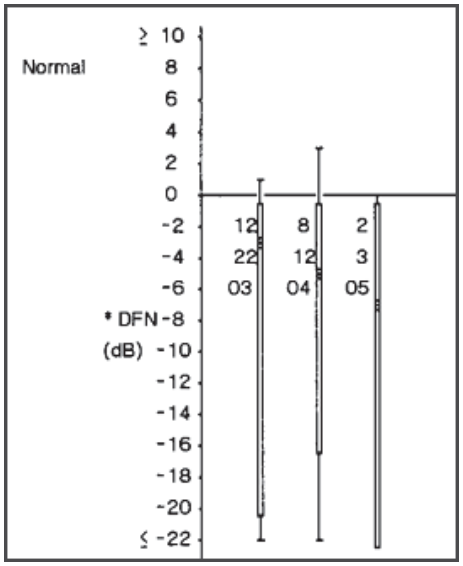
The overview printout of a known patient of POAG under medical treatment.

Follow-up period from 22-12-2003 to 03-02-2005 (1 year follow-up).

	FL	FN	FP	MD	PSD
I Test	1/12	0%	10%	–7.54	9.28
II Test	0/13	0%	0%	–7.73	8.85
III Test	1/12	10%	10%	–10.33	10.58

In this follow-up fields, if we concentrate our attention on the probability plots, we think that the fields are stable. But if we see the mean deviation index, there is a difference of –2.79 dB between the first and the 3rd test and the difference is mainly due to the deepening of the defect depths of already existing scotoma, without producing new scotoma. That is why, there is no much change in the PSD value.

In the 3rd test, 15 percent of worst points are –22 dB and the next best 35 percent of the points have the retinal sensitivity varying from –7 to –22. Whereas in the first test, 15 percent of the points have the retinal sensitivity from –20 to –22 and the next best 35 percent of the points have the retinal sensitivity –4 to –20; but by seeing the probability plots, we cannot make out such a difference in retinal sensitivity existing between the first and the 3rd test. That is why, we should always see the global indices, the total deviation numerical plot along with the probability plots, before we make any comment on the progression of the field defect.



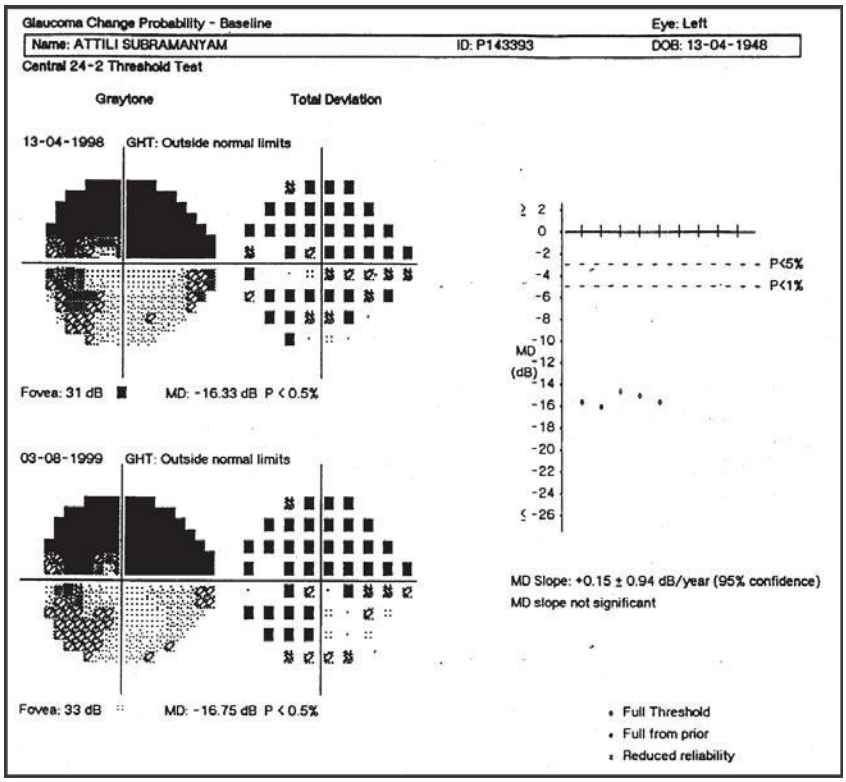
GLAUCOMA CHANGE PROBABILITY ANALYSIS

The glaucoma change probability analysis is designed to facilitate interpretation of central 30-2 and central 24-2 threshold follow-up tests in patients with suspect or manifest glaucoma. It is intended to allow maximum use of available test results. Essentially, this program provides a point-by-point statistical analysis of how much change a given field has undergone when compared to the baseline field created for that patient and also when compared to the database of the stable glaucoma patients. Thus, it is disease-specific analysis relevant only to glaucoma evaluation. The glaucoma change probability analysis works from the baseline data for the individual patient to create change probability maps and to calculate significance limits for measured changes in mean deviation.

Step 1: ESTABLISHING THE BASELINE DATA (TOTAL DEVIATION NUMERICAL PLOT)

The first step in glaucoma change probability analysis is the establishment of baseline test data (Total deviation numerical plot). In general, the glaucoma change probability analysis will use the average of the first two selected tests as baseline and all subsequent tests are as follow-up. But there are two exceptions: (i) If only two tests are selected, the first test will form as baseline and the second test as follow-up, and (ii) If the mean deviation of the first test falls significantly below the regressional line of those of the other tests (P value less than 5%), and 5 or more tests are analyzed, the STATPAC will discard the first test and use a second or third test to calculate the patient's baseline and analyses the subsequent tests as follow-up tests.

GLAUCOMA CHANGE PROBABILITY—BASELINE PRINTOUT

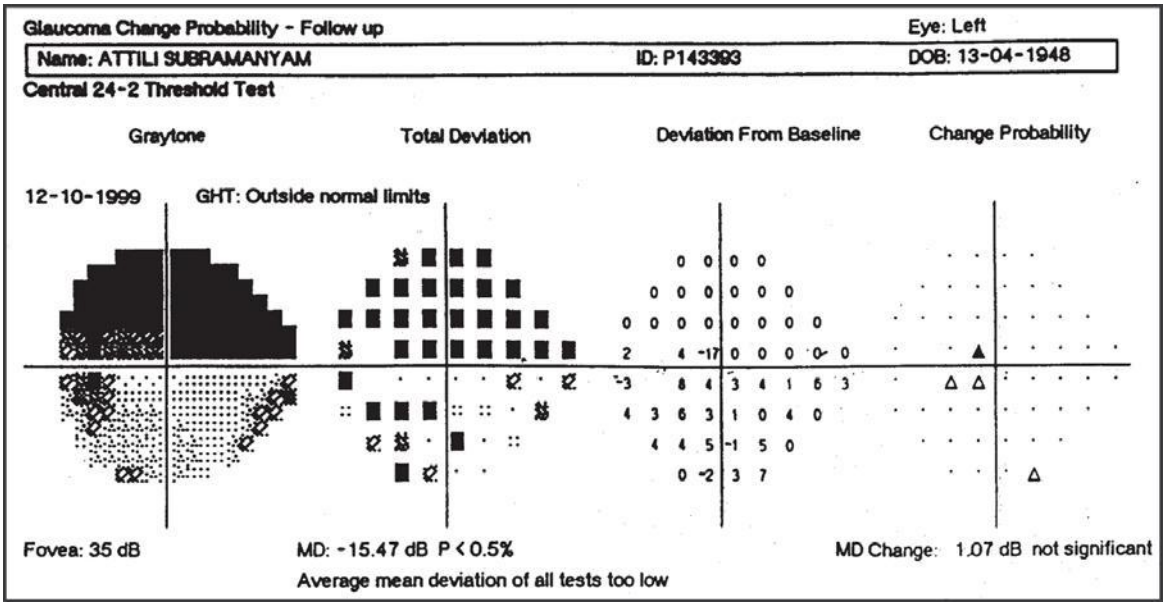


The components of the glaucoma change probability analysis baseline printout:

i. Patient data:
(Name and age of the patient),
ii. Selection of the test,
iii. Foveal sensitivity on/off
iv. Test data (gray scale, total deviation, mean deviation, GHT analysis, linear regression of mean deviation analysis)

STEP 2: ESTABLISHING THE DECIBEL DEVIATION PLOT

Now the follow-up test results (Total deviation numerical plot) are compared to the baseline total deviation numerical plot and calculates the difference between the baseline and the follow-up test total deviation numerical plot and plots the difference as deviation from baseline plot in the follow-up test printouts.



The components of the glaucoma change probability analysis follow-up tests:

i. Patient data: (Name & age of the patient)
ii. Selection of the test,
iii. Foveal sensitivity on/off
iv. Mean deviation
v. GHT analysis
vi. Follow-up test data—grayscale, total deviation, deviation from baseline and change probability plot.
vii. MD change.

The main drawback of glaucoma change probability analysis is that the comparisons are made between the raw data (the total deviation numerical plots). Because the raw data (total deviation numerical plot) are affected by both transient and progressive generalized changes (e.g. those caused by learning effects, long-term fluctuation, or media change), we do not know whether the changes are either due to disease progression or due to long-term fluctuation. In order to avoid this drawback, the glaucoma progression analysis (GPA) is introduced by Humphrey. In GPA, the comparisons are made between the baseline pattern deviation numerical plot and the pattern deviation numerical plot of the follow-up test.

Step 3: ESTABLISHING THE CHANGE PROBABILITY PLOT

Now each deviation from the baseline is compared to inter-test variability typical of stable glaucoma patient and then shows a plot of point locations (change probability plot) which have changed significantly. The change probability plot consists of four symbols:

i. ▲ Black solid triangle identifies a degree of deterioration found less than 5 percent of the time at that location in medically stable glaucoma patient, i.e. deterioration significant at the 5 percent level. (a deterioration was seen at that point less than 5% of the time in stable glaucoma eyes).

ii. Δ Open triangle identifies improvement significant at the 5 percent level (an open triangle means the converse: at that point comparable improvement in glaucomatous eyes appeared less than 5% of the time).
iii. ▲ Single solid dot indicates no significant change.
iv. "X" signifies that the program was unable to determine whether the encountered change is significant or not.

Since wide fluctuations of the test points are commonly seen in glaucomatous eyes, up to four open and four black triangles may appear in stable eyes without indicating deterioration. The meaning of other combinations—such as six black triangles and five open—has not been statistically determined.

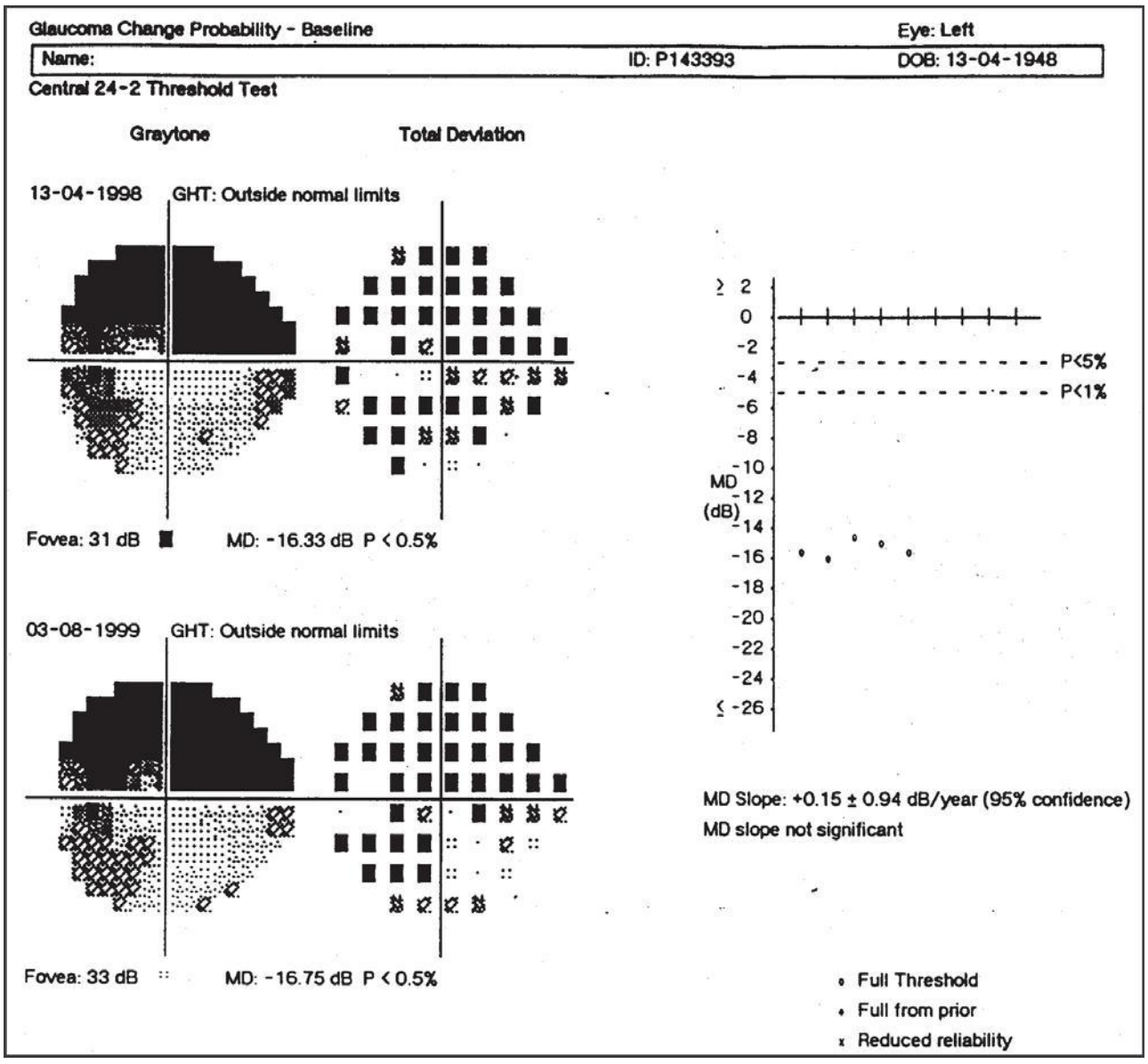
CHANGE IN MEAN DEVIATION

The STATPAC also evaluates the significance of change in mean deviation over time. The objective is to highlight those clinical cases where the mean deviation changes more than those typically observed in stable glaucoma patients. The amount of change in decibels is printed under the message MD change. If the MD change is significant at the 10%, 5% or 2.5% level that P value is printed along with a solid triangle ▲ to indicate degradation or an open triangle Δ to indicate improvement. If the amount of change is not judged to be significant, the words non-significant follow the decibel value.

THE SUMMARY OF GLAUCOMA CHANGE PROBABILITY ANALYSIS

1. Establishing the baseline total deviation numerical plot.
2. By comparing the follow-up test total deviation numerical plot with the baseline total deviation numerical plot, the decibel deviation plot will be established.
3. The decibel deviation plot is compared to inter-test variability typical of stable glaucoma patient and then shows a plot of locations which have changed significantly (change probability plot).
4. The change of mean deviation from the baseline till the recent test will be calculated and the changes in mean deviation will be compared to mean deviation changes observed in stable glaucoma patients. The amount of change in decibels is printed under the message MD change. If the MD change is significant at the 10%, 5% or 2.5% level that P value is printed along with a solid triangle ▲ to indicate degradation or an open triangle Δ to indicate improvement. If the amount of change is not judged to be significant, the words non-significant follow the decibel value.

GLAUCOMA CHANGE PROBABILITY—BASELINE PRINTOUT



The components of the glaucoma change probability analysis baseline printout:

i. Patient Data: DOB: 13-04-1948

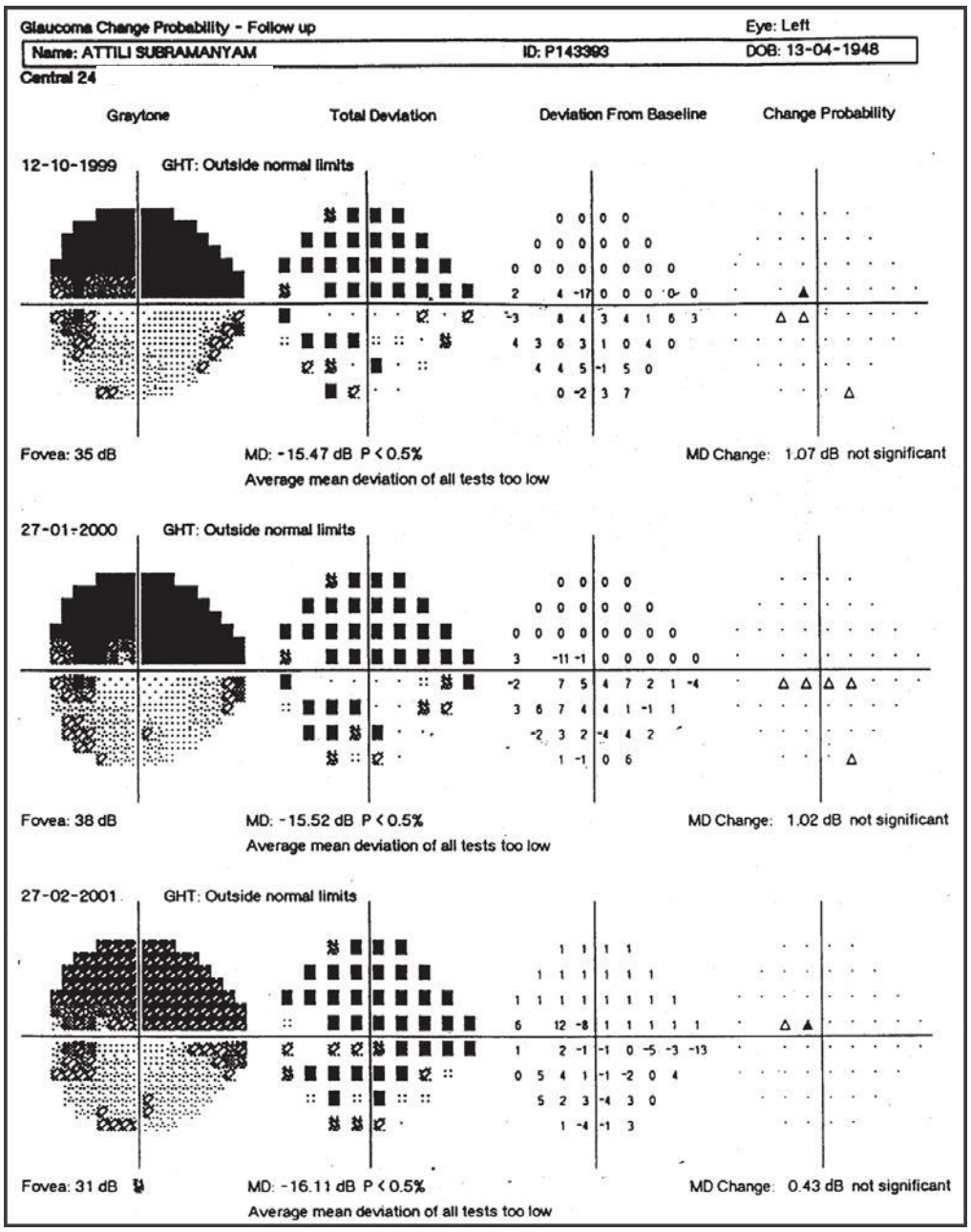
ii. Selection of the test: 24-2 Full Threshold

iii. Foveal sensitivity: 31 dB

iv. Test data:
GHT analysis outside normal limits

v. MD slope—not significant.

GLAUCOMA CHANGE PROBABILITY ANALYSIS FOLLOW-UP



The components of the glaucoma change probability analysis follow-up tests:

i. Patient Data: Name: DOB:

ii. Selection of the test: 24-2 Full Threshold

iii. GHT analysis: Outside normal limits

iv. Change probability plot: There are no significant changes in the progression of the disease

v. MD change: Non-significant.

GLAUCOMA PROGRESSION ANALYSIS (G.P.A)

To analyze glaucoma progression, Humphrey introduced a new software—glaucoma progression analysis (GPA). It is introduced to overcome the drawback of glaucoma change probability analysis. The main drawback of glaucoma change probability analysis is that the comparisons are made between the raw data (TDNP) of the baseline and the follow-up tests. As the raw data (TDNP) is affected by both transient and progressive generalized changes (e.g. those caused by learning effects, long-term fluctuation or media changes), we do not know whether the changes are either due to disease progression or due to long-term fluctuation. The SITA strategies do not have glaucoma change probability analysis option. In order to avoid these drawbacks, the glaucoma progression analysis (GPA) is introduced by Humphrey. In GPA, the comparisons are made between the baseline pattern deviation numerical plot and the pattern deviation numerical plot of the follow-up test. The SITA strategies have the GPA option. GPA uses SITA and pattern deviation to identify glaucoma-specific progression.

Step 1 : ESTABLISHING THE BASELINE DATA (PATTERN DEVIATION NUMERICAL PLOT)

The first step in glaucoma progression analysis is the establishment of baseline data (pattern deviation numerical plot). If the patient undergoes the field test for three or more times, the field analyzer generates the baseline printout depending on the data of the first 2 tests.

Step 2: ESTABLISHING THE DECIBEL DEVIATION PLOT IN FOLLOW-UP TEST PRINTOUT

Now the follow-up test result (pattern deviation numerical plot) is compared to the baseline pattern deviation numerical plot and calculates the difference between the baseline and the follow-up test pattern deviation numerical plots and plots the difference as deviation from the baseline plot in the follow-up test printout.

Step 3: ESTABLISHING THE PROGRESSION ANALYSIS PLOT IN FOLLOW-UP TEST PRINTOUT

Now each deviation from the baseline is compared to inter-test variability typical of stable glaucoma patient and then shows point locations in progression analysis plot which have changed significantly. The progression analysis consists of four symbols.

Symbols:

- ◭ = Progression at 95% significance level
- Δ = Progressing point repeated in 2 consecutive exams
- ▲ = Progressing point repeated in three consecutive exams
- X = Progressing point repeated in three consecutive exams.

The criteria for identifying progression in visual fields:

- ▲ Minimum of three tests required: 2 baseline and 1 follow-up exam
- ▲ Each follow-up compared to average thresholds of 2 baseline exams
- ▲ Additional follow-up compared both to baseline and 2 most recent follow-ups.

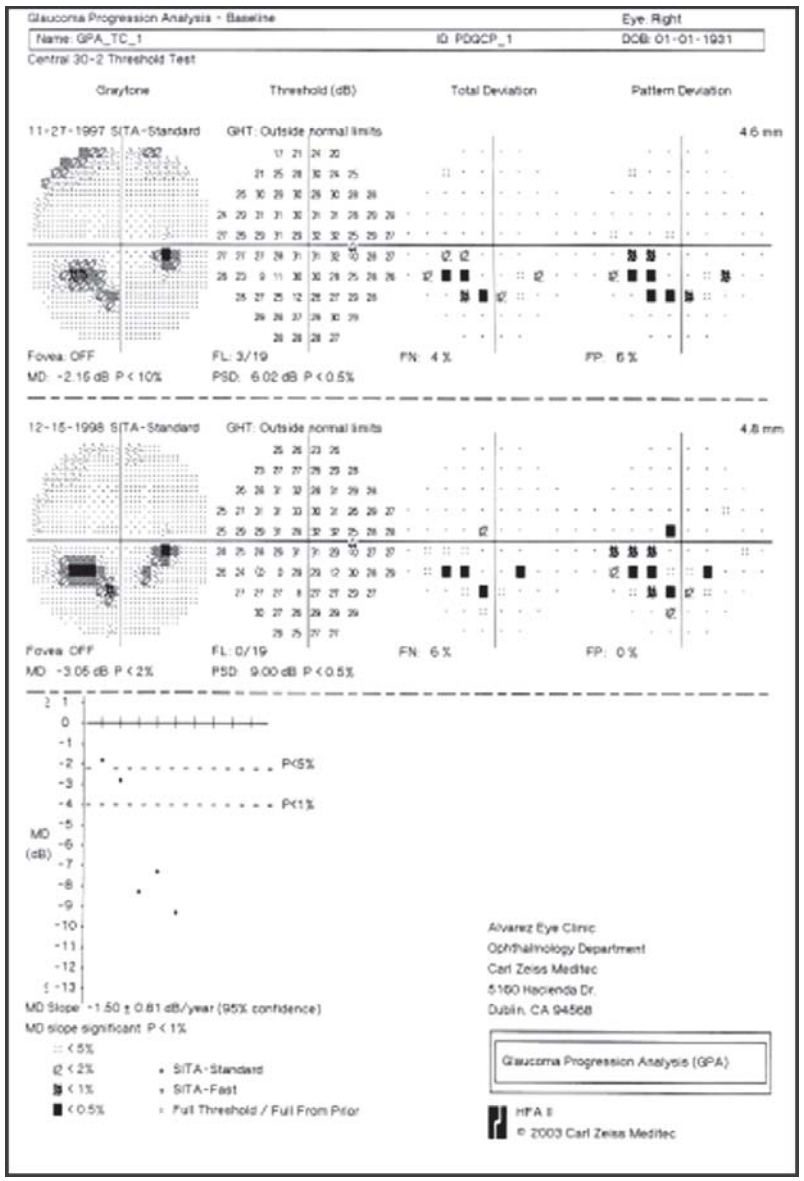
GPA alert TM: Three ◭ in one exam denotes "possible progression" and three ▲ indicates likely progression.

GLAUCOMA PROGRESSION ANALYSIS—BASELINE PRINTOUT

The GPA consists of two components:

1. The data of the first 2 tests is presented in baseline printout just as overview printout of the two tests.
2. The change in mean deviation is presented in baseline printout just as linear regression analysis of mean deviation of change analysis printout.

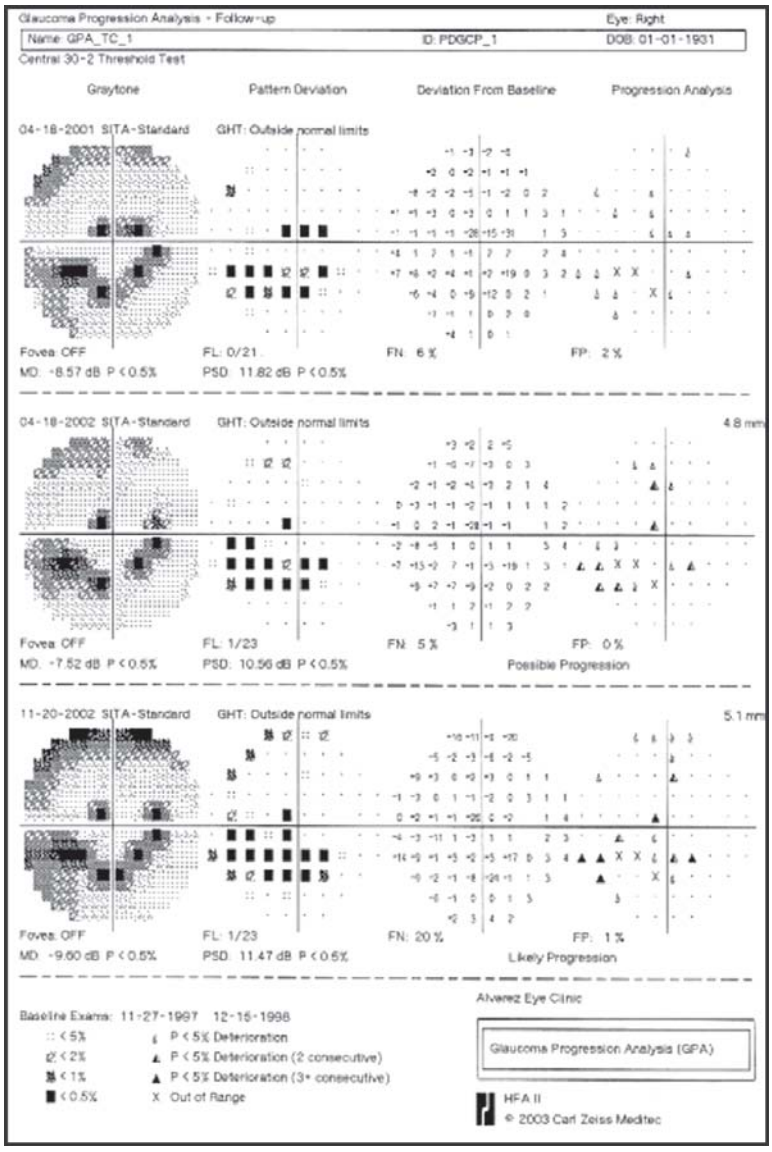
So the baseline printout of GPA is nothing but the combination of the overview printout and linear regression analysis of mean deviation of change analysis printout.



The patient's name, the eye tested, date of birth, the selection of the test will appear on the top of the GPA printout. **The baseline printout of GPA presents the results of each test in four plots—gray scale, RAWdata, total deviation probability plot and pattern deviation probability plot.** The foveal threshold, the reliability parameters and global indices are also printed at the bottom of each test.

The linear regression analysis of mean deviation component of GPA consists of the value of mean deviation index of the baseline tests and the follow-up tests and the STATPAC calculates linear regression analysis of mean deviation.

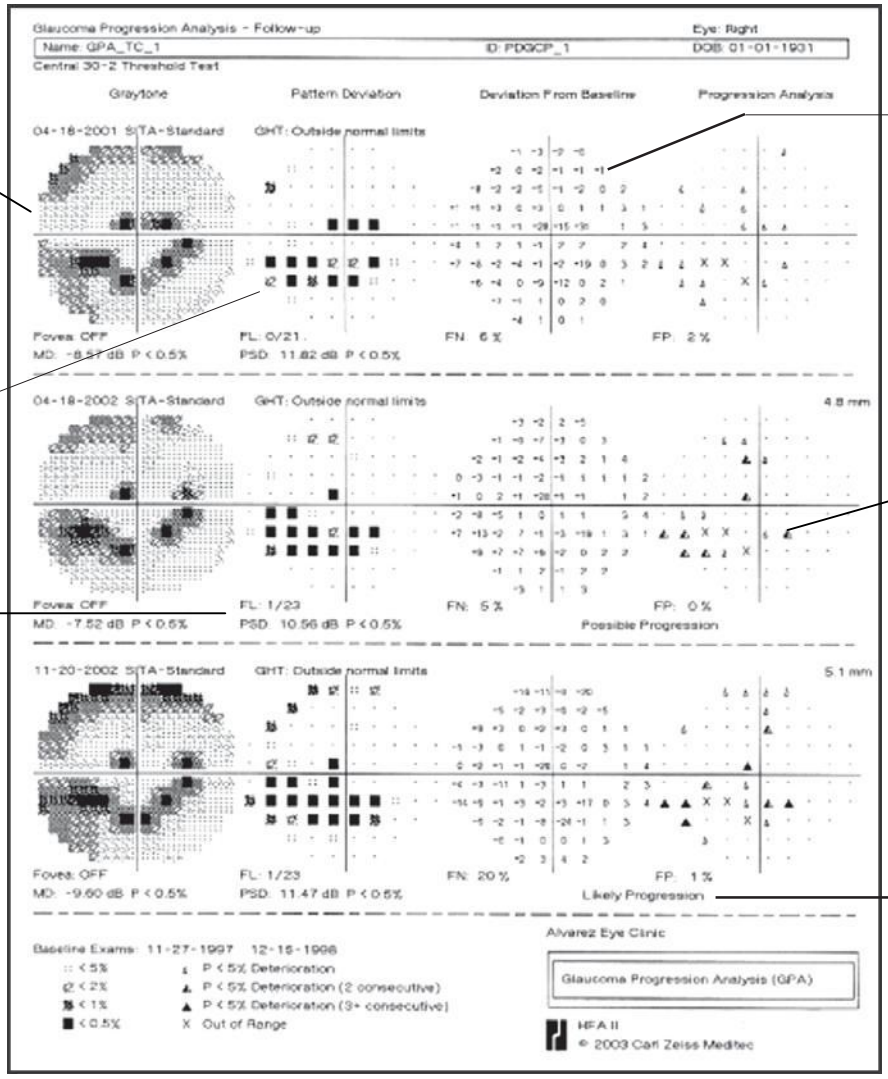
GLAUCOMA PROGRESSION ANALYSIS FOLLOW-UP PRINTOUT



The components of the GPA follow-up printout:

i. Patient Data : Name: DOB: Eye tested:
ii. Selection of the test: 24-2 SITA-Standard.
iii. Gray scale, pattern deviation probability plot, deviation from baseline plot, progression analysis plot.
iv. Reliability indices - FL, FN, FP.
v. Mean deviation
vi. PSD
vii. GHT analysis
viii. Plain language interpretation of analysis "Possible Progression" or "Likely Progression".

GPA FOLLOW-UP PRINTOUT OVERVIEW



Gray scale

Deviation from baseline (dB)

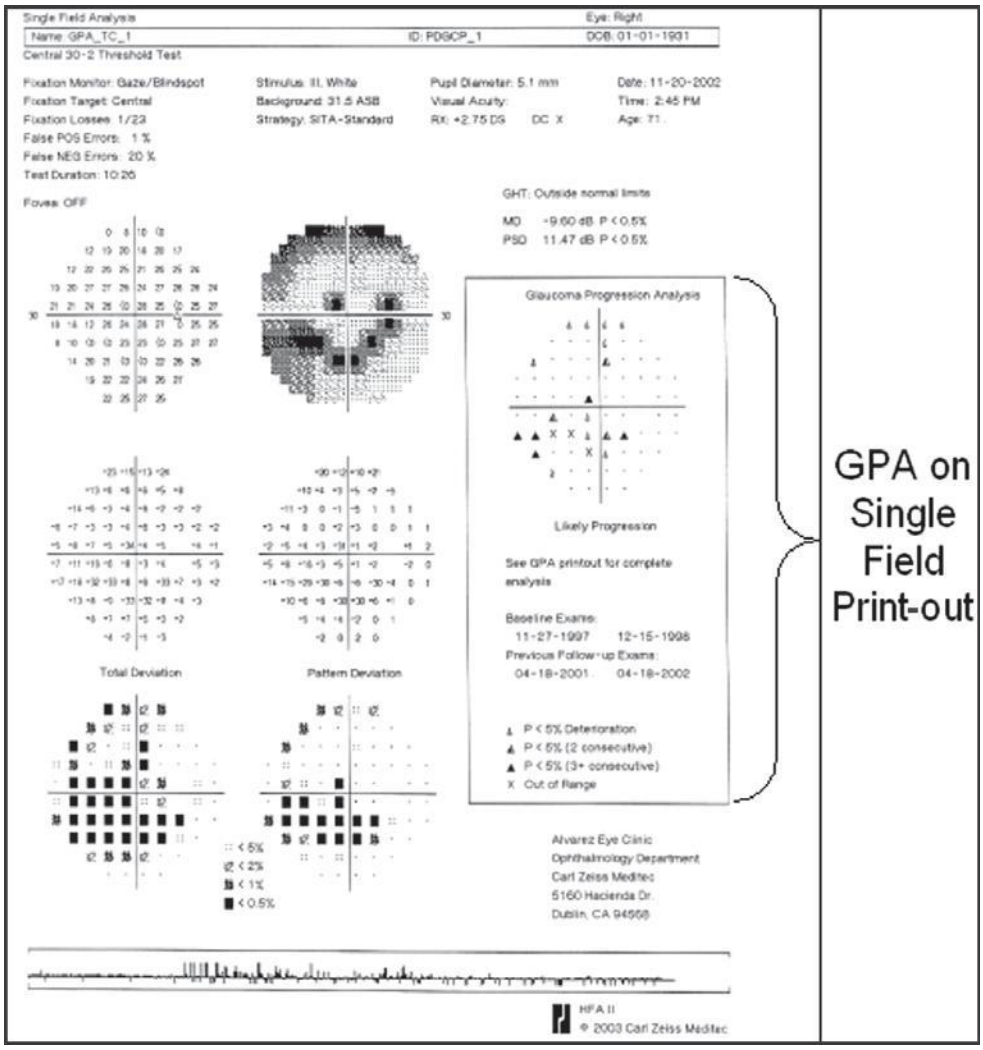
Pattern deviation plot

Unique symbols to identify changing points in the field

Reliability indices for each exam

Plain language interpretation of analysis: "Possible Progression" or "Likely Progression"

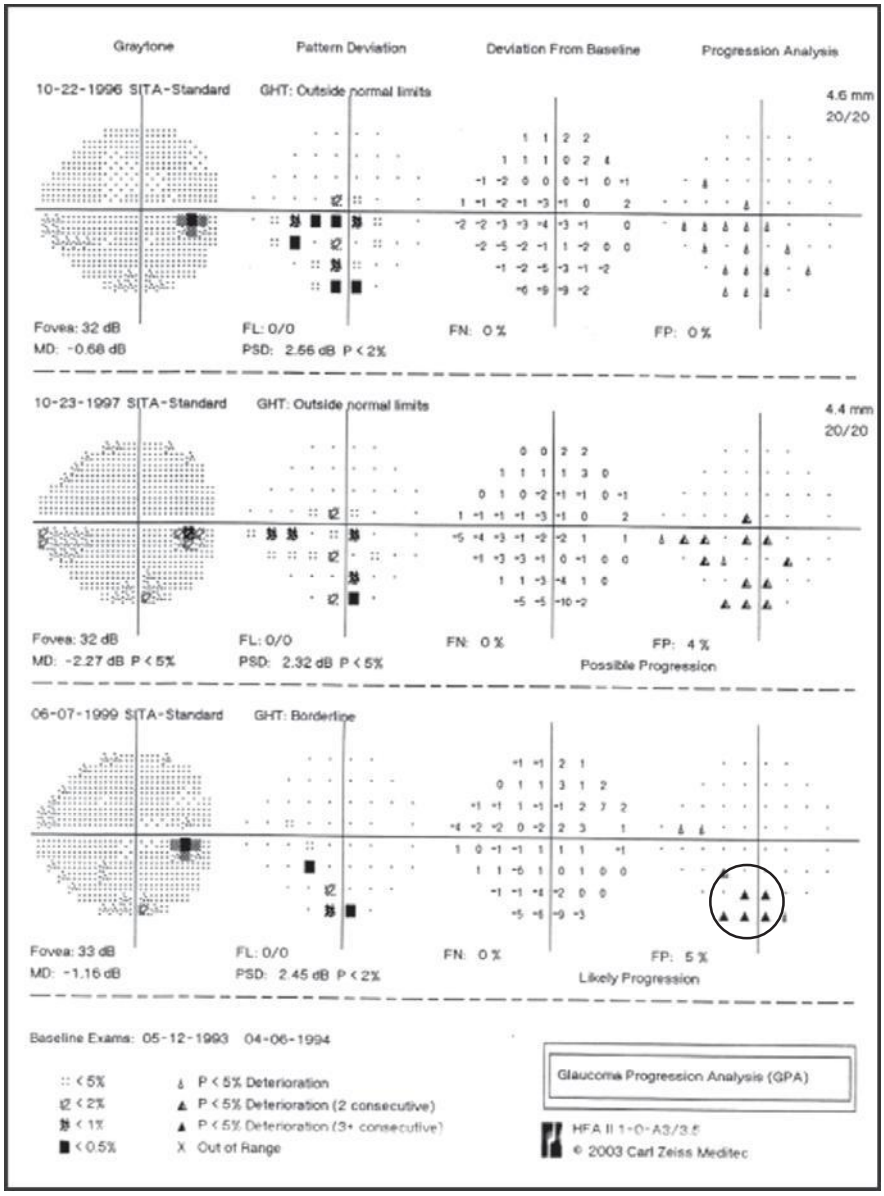
SINGLE FIELD ANALYSIS WITH GPA RESULTS



▲ The new look in the standard of care!
▲ Once GPA is set up for a patient, progression is automatically identified at each visit.
▲ Original single field analysis will be printed if GPA has not been set up.

GLAUCOMA PROGRESSION ANALYSIS FOLLOW-UP PRINTOUT

CASE EXAMPLE : FINDING PROGRESSION'



Changing points

Repeatable change

GPA Alert TM confirms repeatable, consistent change at five points in the field

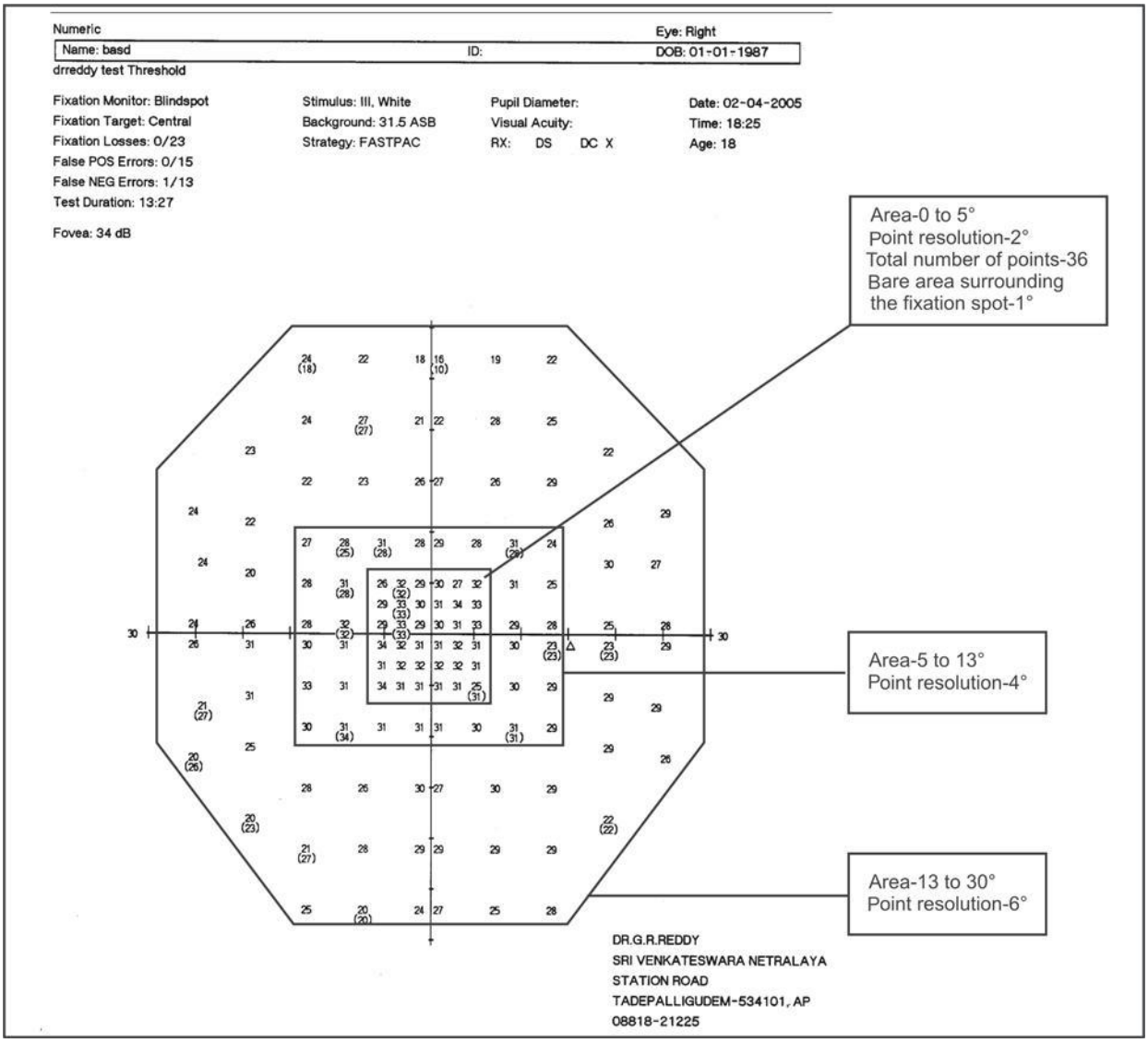
7 Custom Tests

The custom test is an important feature of many automated static field analyzers. This is one area which was neglected by many ophthalmologists. Many ophthalmologists are not using the custom test option given by standard field analyzers. The custom test allows the opthalmologists to focus in an area where the first test indicated defects. Especially for the follow-up tests, we can design a custom point pattern where we want to concentrate more. In 30-2 and 24-2, we know the distance between the point to point is 6°. During the follow-up tests the field defect has to progress for distance of 6° to affect the next point. Till then, it does not show any progression in field defect. We can design custom point pattern depending upon the first field. We can create points seperated by 1° in an area where we are expecting the progress of the disease; but unfortunately, many opthalmologists are not using custom tests. We can even create our own point pattern and we can save the point pattern and we can use the point pattern whenever we want and the results can be saved and can be printed. The printout format of the custom test will be without STATPAC analysis, because there is no normative data available to the custom tests. The SITA-Standard and SITA-Fast strategies are not available for custom tests. Only full threshold and FASTPAC are available for custom tests.

I created a custom threshold test pattern with the following features:

1. Central 30° area was selected.
2. Points were created on either side of horizantal and vertical meridian and distance between point and the meridian being 1°.
3. Within 5° around fixation points were created with 2° resolution (nearly 36 points within 5° area around fixation point)
4. In the area between 5° and 15° points were created with 4° resolution.
5. In the area between 15° and 30° points were created with 6° resolution.
6. This point pattern can be used to know the field status of glaucoma patient, irrespective of the stage of glaucomatous optic nerve damage.

CUSTOM TEST PRINTOUT



This is to tell you that we can create the point patterns as we like and we can get the retinal sensitivity at those points. In the follow-up tests, we should always create the new points adjacent to the existing scotoma to know even the minor progression of the field defects. Because there is no normative data available to the custom tests, we do not get STATPAC analysis printouts. Never tell no progrssion is seen until it is proved by custom tests.

8 Screening Tests

Till now we talked about central threshold tests with different test strategies to detect glaucoma field defects. Now I will deal in brief with the screening tests used in glaucoma survey projects.

Like the threshold tests (for example, 24-2 SITA-Standard, 24-2 is point pattern component and SITA-Standard is test strategy component), the screening tests also have two components, the point pattern component and test strategy component.

The point pattern component of screening tests are divided into 4 major groups.

Group I —Glaucoma test point pattern
Group II —Central test point pattern
Group III —Full field test point pattern
Group IV —Peripheral field test point pattern.

Again each group has different test point patterns as shown in the following table:

Test Point Patterns of Screening tests

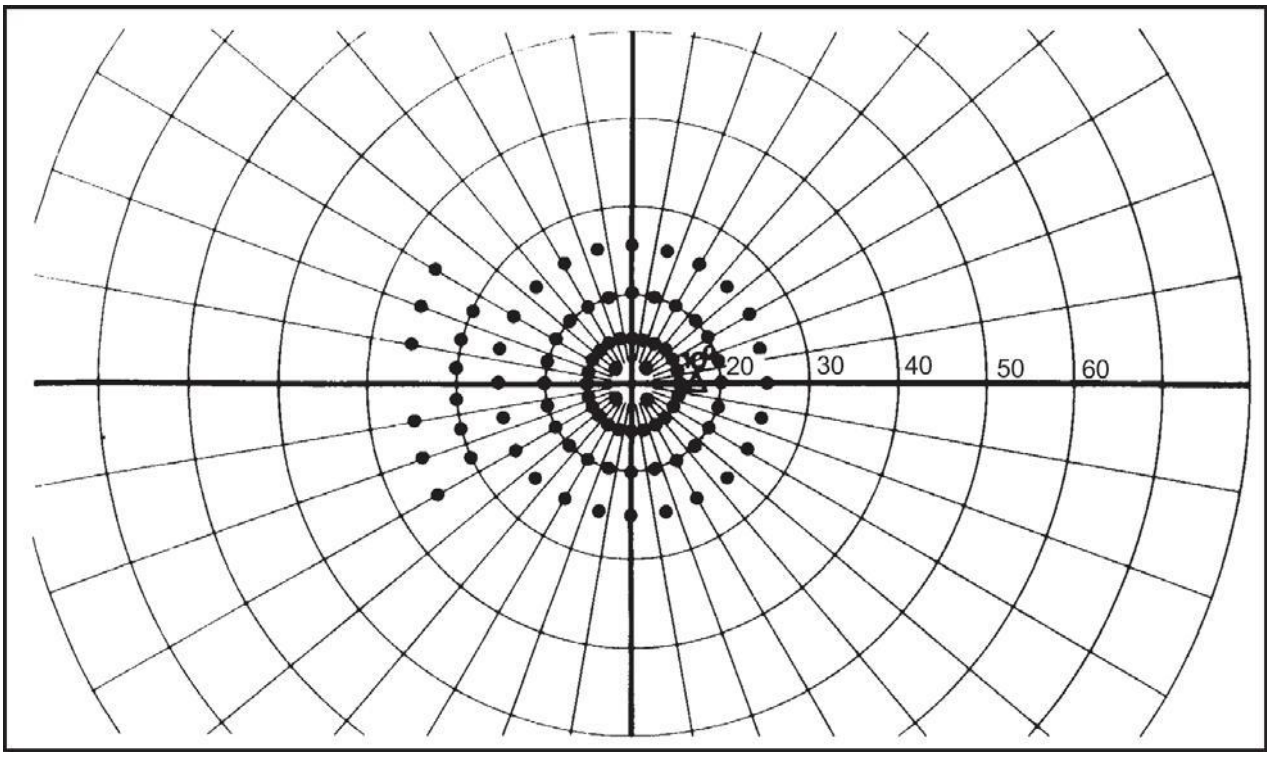
Glaucoma test pattern	Armaly central Armaly full field Nasal step
Central test pattern	Central 40 Central 76 Central 80 Central 166
Full field test pattern	Full field 81 Full field 120 Full field 246
Peripheral field	Peripheral field 68

Out of the above 11 test point pattern screening tests, we will talk about glaucoma screening tests. The glaucoma screening tests emphasize points surrounding the horizontal meridian with the largest concentration of points on the nasal side.

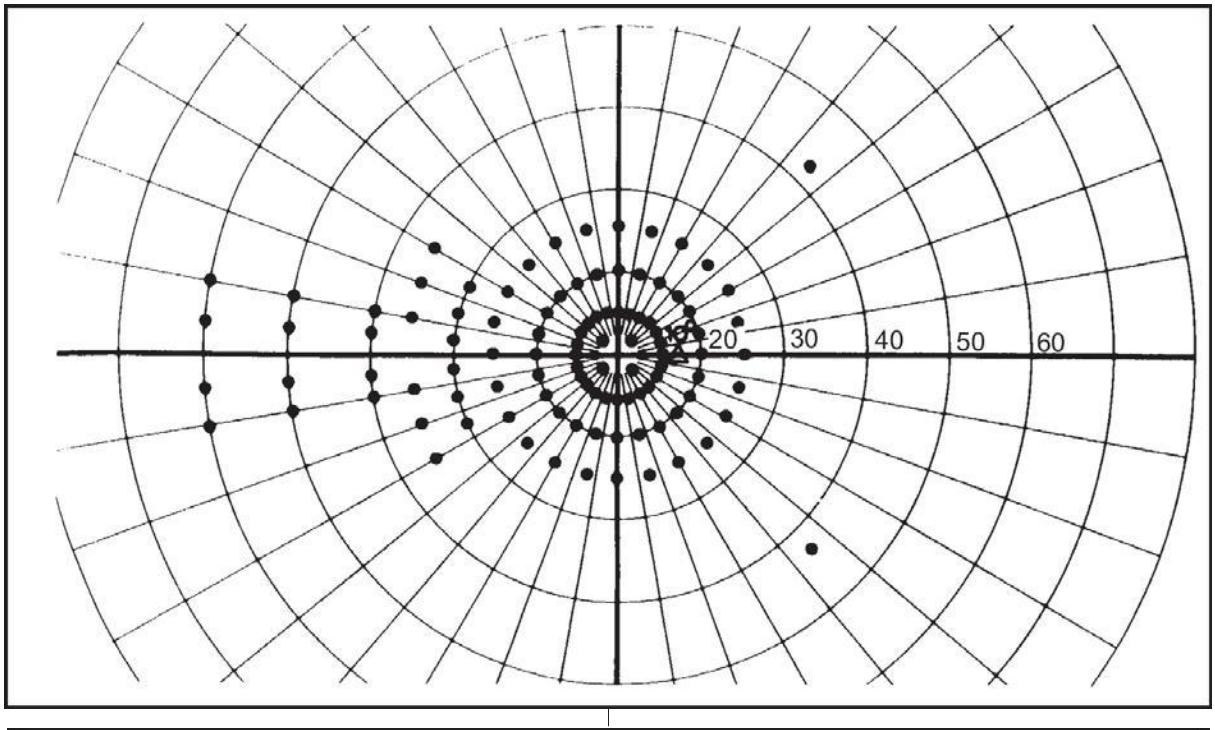
GLAUCOMA SCREENING TEST POINT PATTERNS

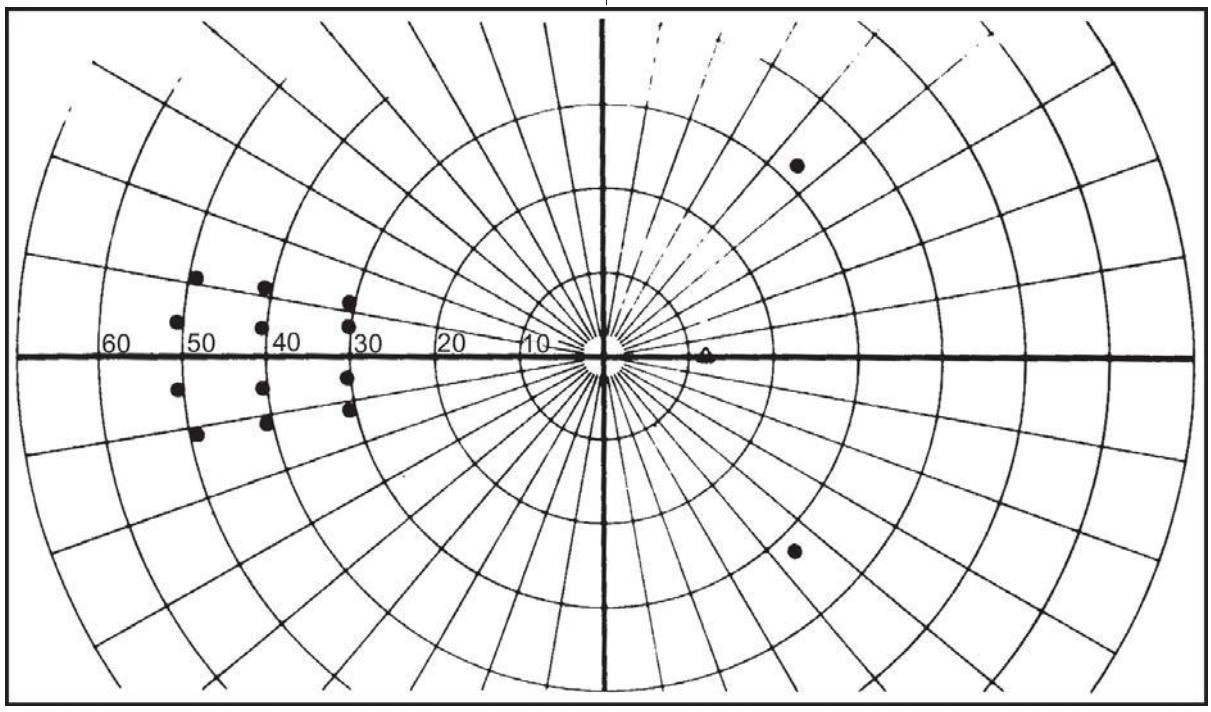
Test	No. of points	Typical test time
Armaly central	84	5-6 min
Armaly full field	98	7-8 min
Nasal	14	2-3 min

ARMALY CENTRAL SCREENING TEST POINT PATTERN RIGHT EYE



ARMALY FULL FIELD SCREENING TEST POINT PATTERN RIGHT EYE





NASAL STEP SCREENING TEST POINT PATTERN RIGHT EYE

SCREENING TEST STRATEGIES

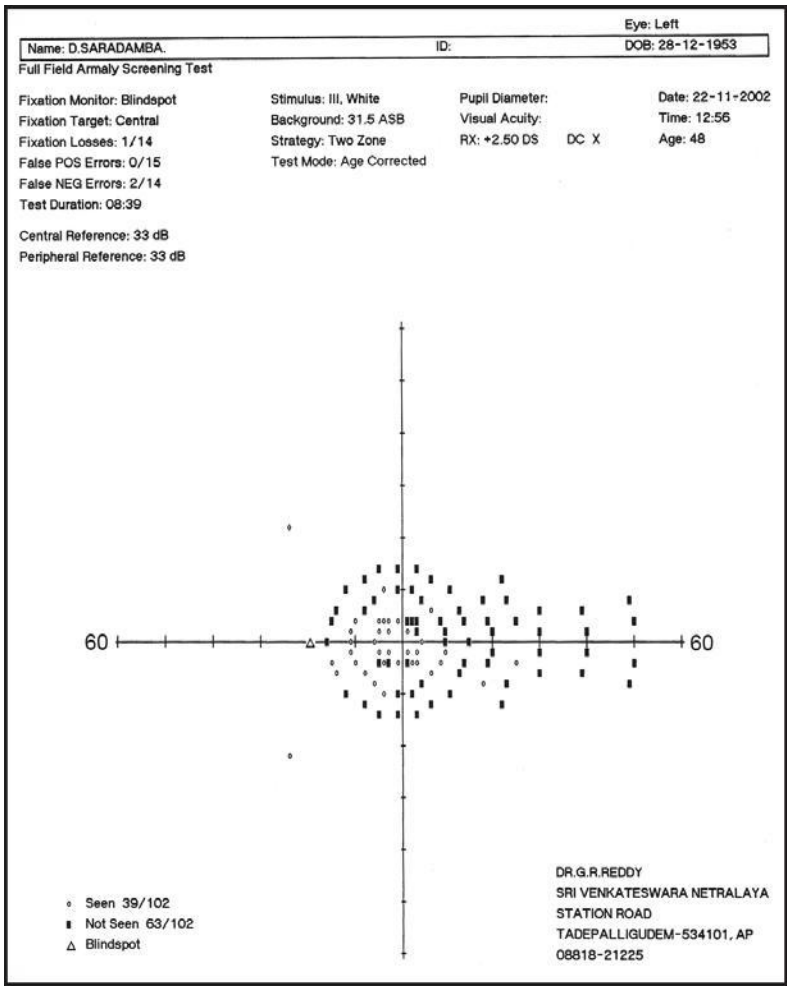
The screening test strategies are suprathreshold strategies. Till now we talked about threshold strategies (Full Threshold, FASTPAC, SITA-Standard and SITA-Fast). For screening tests, suprathreshold tests are used instead of threshold test strategies.

The Humphery field analyzer has four screening test strategies as shown below:

1. Two-zone strategy (threshold-related strategy).
2. Three-zone strategy.
3. Quantify defects screening strategy.
4. Single intensity strategy.

TWO-ZONE STRATEGY

Two zone strategy is the first phase for both the three-zone strategy and quantify defects screening strategy.



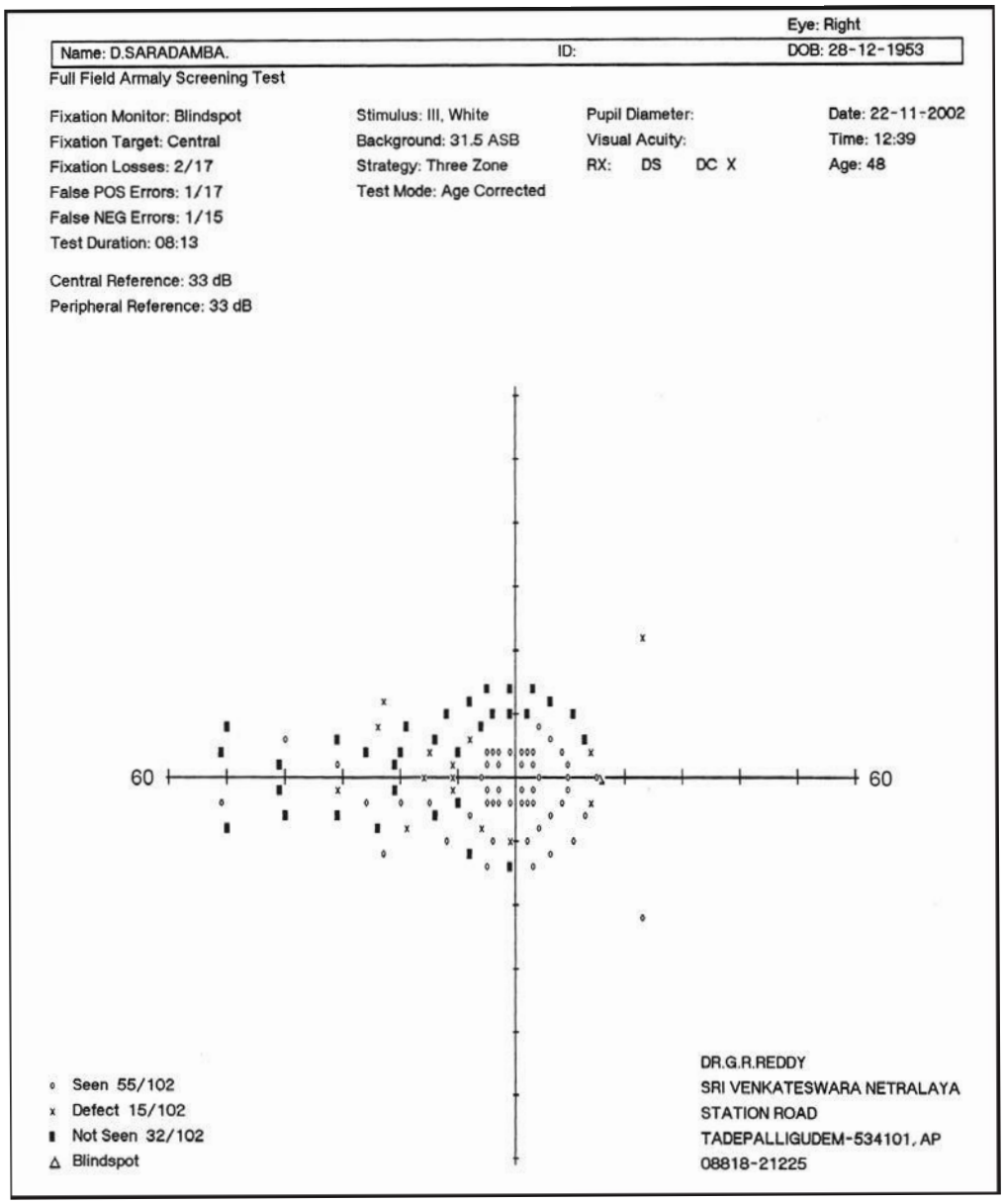
1st step of two-zone strategy:
Determination of the patient's threshold of four paracentral points in each quandrant. It uses these values to calculate a 'central reference level'.

2nd step of two-zone strategy:
In the screening phase of the test, each point in the selected test pattern is exposed to a stimulus 6 dB brighter than the expected threshold for that point. Points not seen in the first stimulus are retested for second time with the same stimulus intensity. That completes the second phase of the test. If the tested point is seen, it is labeled as open circle 'O'. If the tested point is not seen even for the second stimulus, it is labeled as black square.

THREE-ZONE STRATEGY

The three-zone strategy is the continuation of the two-zone strategy.

The points that are failed to respond upon two presentations of the suprathreshold stimulus are now exposed to 10,000 asb units of light intensity (maximum intensity of light projected by Humphery field analyzer)

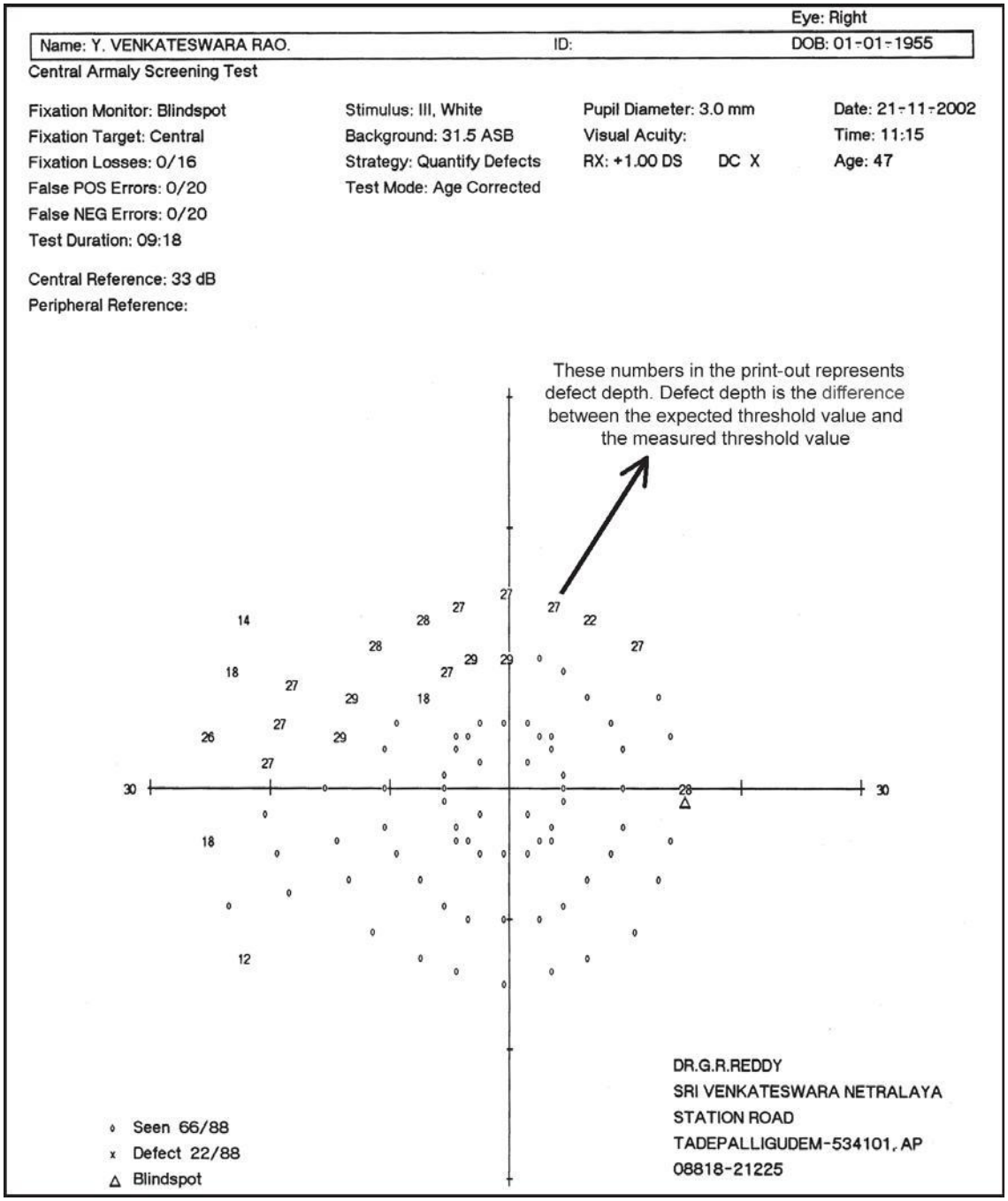


Points missed twice with the stimulus 6 dB brighter than expected but responded to 10,000 asb units of light intensity are marked as 'X' - and written as 'defect'.

Points missed with maximum intensity of light (10,000 asb light intensity) are indicated by black squares ■ and labeled as 'Not seen' on the printout.

QUANTIFY DEFECTS SCREENING TEST STRATEGY

It is also a continuation of the two-zone test. The points that are failed to respond upon two presentations of the suprathreshold are now subjected to threshold determination strategies. Each point threshold value is determined and the defect depth will be labeled at each test point. The defect depth is the difference between the expected threshold value based on the constructed patient profile and the measured threshold value.

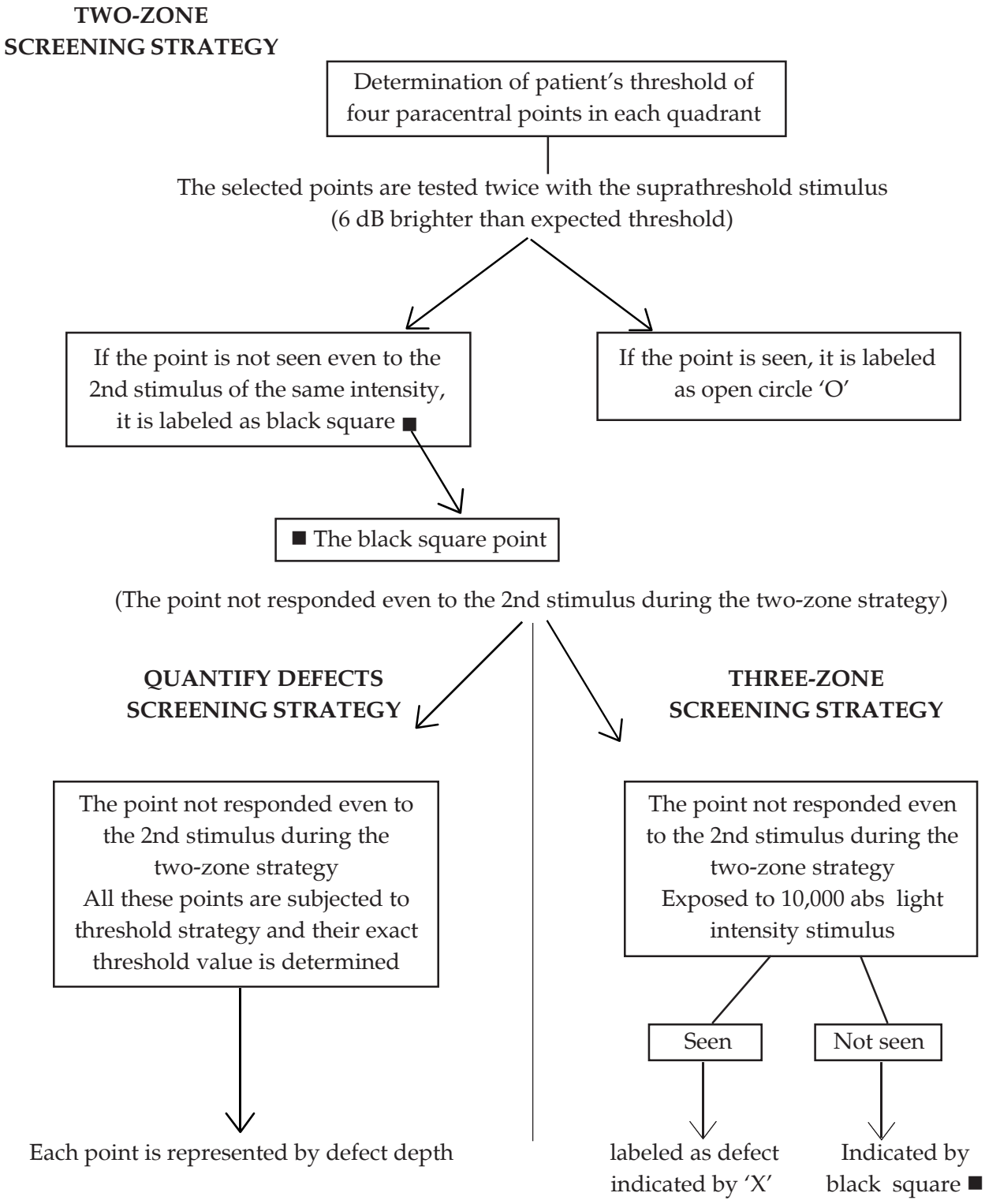


SINGLE INTENSITY TEST STRATEGY

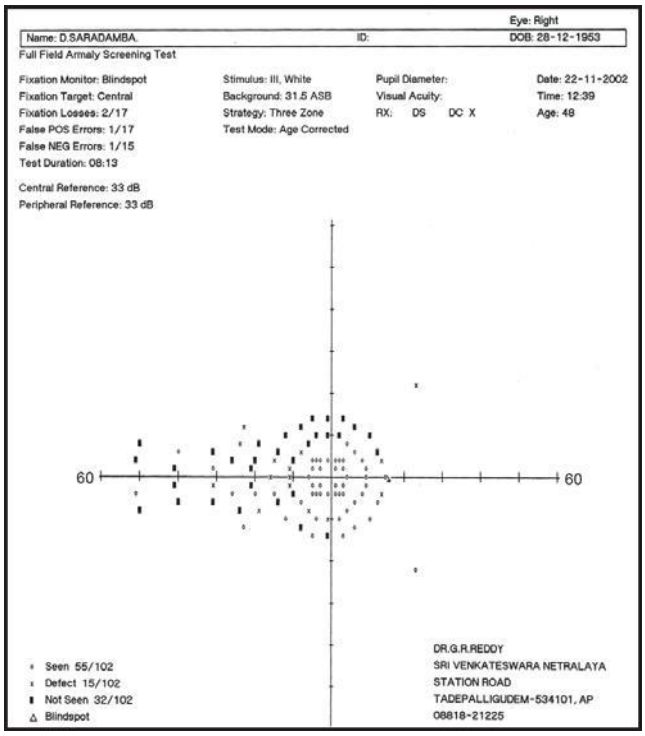
This is not a commonly done test stategy. It is the fastest test strategy available. Each point in the selected test grid is tested with specific stimulus intensity, regardless of its location in the field. Missed points are tested from second time with the same stimulus intensity. Points are labeled as seen or missed in the printout.

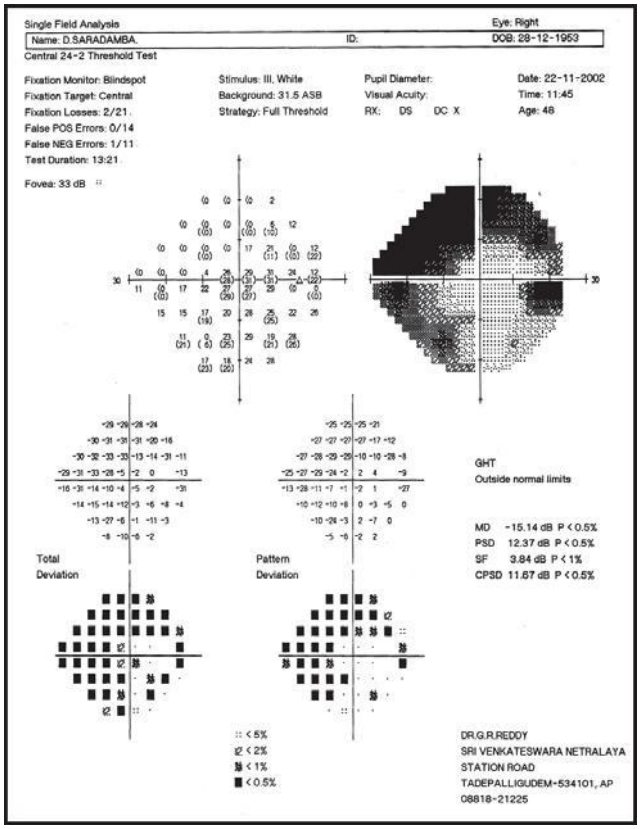
	SUPRATHRESHOLD TEST STRATEGIES			
Test point patterns	**Two-zone strategy**	**Three-zone strategy**	**Quantify defects strategy**	**Single intensity strategy**
ARMALY CENTRAL	Armaly central Two-zone strategy	Armaly central Three-zone strategy	Armaly central Quantify defects strategy	Armaly central Single intensity strategy
ARMALY FULL FIELD	Armaly full field Two-zone strategy	Armaly full field Three-zone strategy	Armaly full field Quantify defects strategy	Armaly full field Single intensity strategy
NASAL FIELD	Nasal Two-zone strategy	Nasal Three-zone strategy	Nasal Quantify strategy	Nasal Single intensity strategy

SCREENING TEST STRATEGIES



SCREENING TEST AND THRESHOLD TEST—RIGHT EYE





Name of the patient : D. Saradamba
Age : 48 years

Screening Test
Armaly full field
Test strategy : Three zone
Central reference : 33 dB
Not seen points 32/102
Mainly upper nasal arcuate pattern defect is seen.

Advised central threshold test

Selection of the test

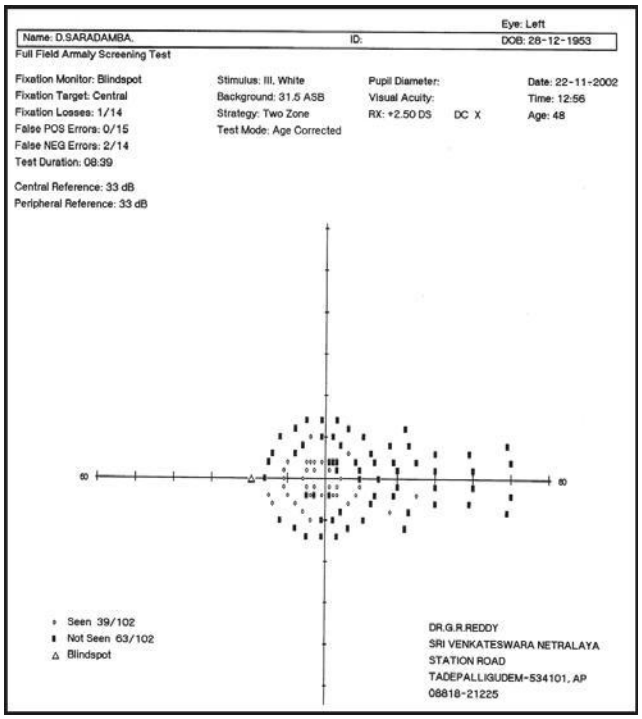
Central 24-2 threshold test

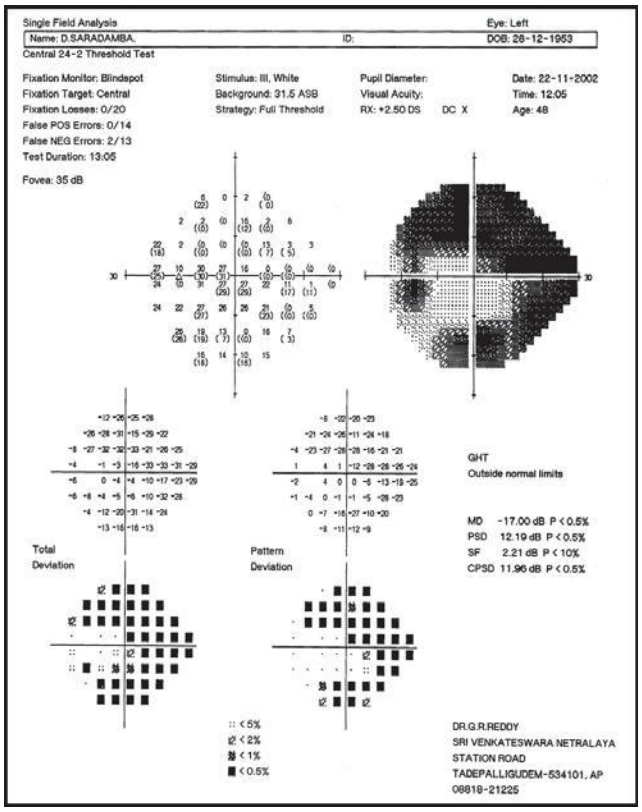
Test Strategy—Full threshold

Reliability good

Probability plots are showing biarcuate scotoma corresponding to the screening test printout results.

SCREENING TEST AND THRESHOLD TEST—LEFT EYE





Name of the patient : D Saradamba
Age : 48 years

Screening Test
Armaly Full field
Test strategy : Two-zone
Central reference : 33 dB
Not seen points 63/102
Almost 2/3 of the points are not seen almost, all nasal points are totally involved. Biarcuate pattern field loss is seen.

Advised central threshold test

Selection of the test

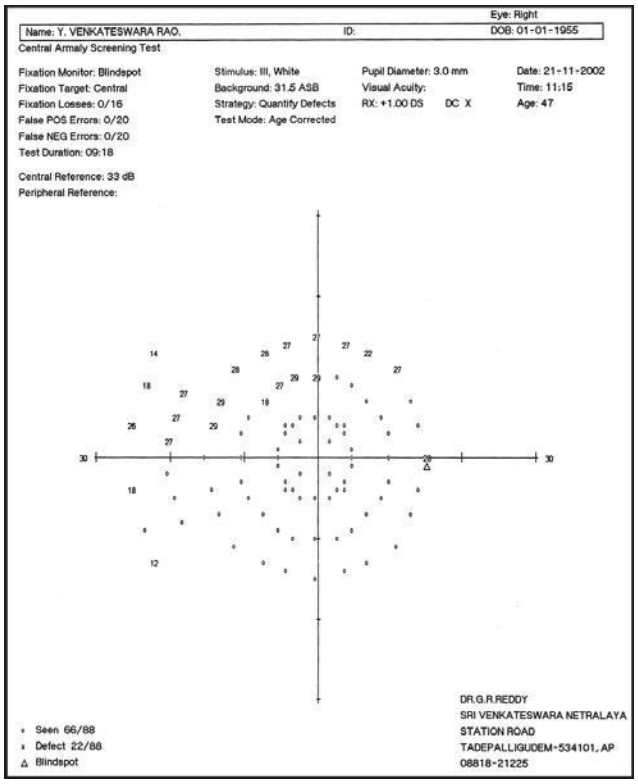
Central 24-2 threshold test

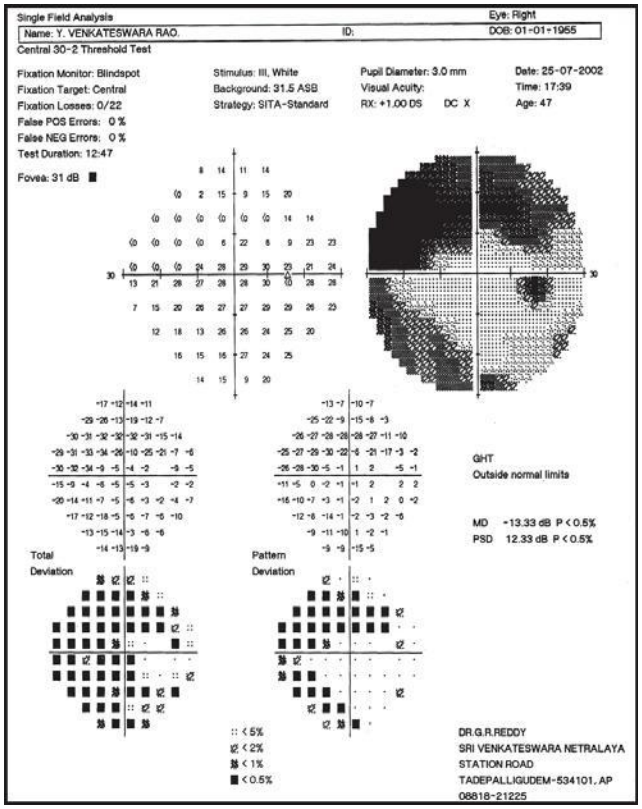
Test strategy—Full `hreshold

Reliability good

Probability plots are showing biarcuate scotoma corresponding to the screening test printout results.

SCREENING TEST AND THRESHOLD TEST—RIGHT EYE





Name of the Patient : Y. Venkateswara Rao
Age : 47 years

Screening Test
Armaly central field
Test Strategy : Quantify defects
Central reference : 33 dB
defect points 22/68

Predominantly upper nasal points are more involved and showing upper nasal arcuate pattern defect.

Advised central threshold test

Selection of the test

Central 30-2 threshold test

Test strategy-SITA standard

Reliability good

Both probability plots are showing biarcuate scotoma corresponding to the screening test printout results.

9 Short Wavelength Automated Perimetry (Blue-Yellow Perimetry)

The short wavelength automated perimetry (SWAP) was developed to detect early field defects of glaucoma.

The technique uses an intense yellow background and blue stimuli to isolate the blue cone system for testing. The green and red cone pigments are bleached by the intense yellow background where as the blue cones are much less affected. The sensitivities of green and red systems are markedly reduced where as the blue system is left largly unaffected and thus fully sensitive to the test stimuli.

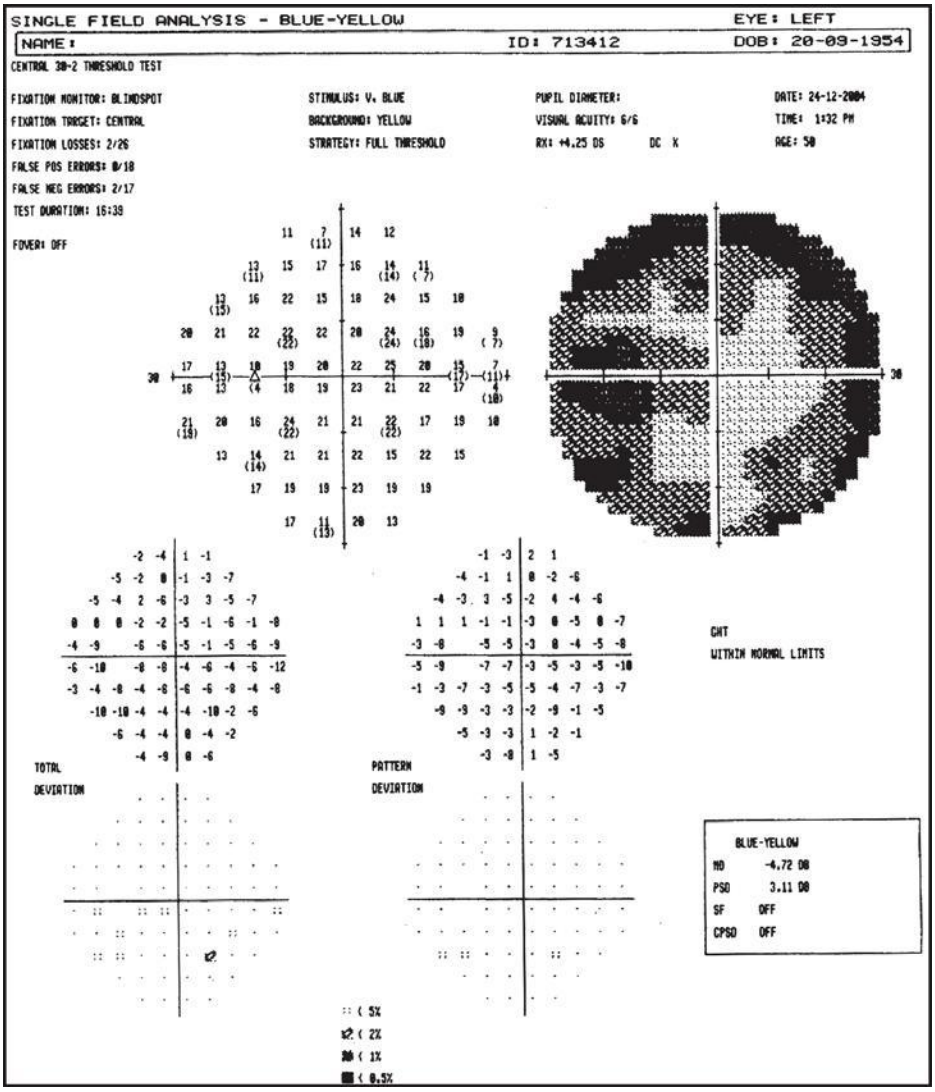
The patients who have significant signs of and risk factors for glaucoma – including raised intraocular pressure suspicious optic disc, disparity of C:D ratio of both eyes, an unexplained hemorrhage near the disc, etc and normal standard white on white perimetry, should be subjected to SWAP perimetry. The normative data is now available to SWAP perimetry so that the STATPACK analyses the raw data and the single field analysis printout of SWAP perimetry exactly looks like the single field analysis printout of white on white perimetry of Humphrey field analyzer except for the global indices will be boxed. The main disadvantages of the SWAP perimetry are:

1. It takes more time than the standard and conventional white on white perimetry.
2. The stimuli of SWAP perimetry are more difficult to discern with certainty.
3. The mean normal SWAP threshold values are lower than for white stimuli and the SWAP gray scale is darker in its appearance and may mislead clinicians accustomed to the gray scale for white on white perimetry.
4. The patients with significant cataract may produce profoundly depressed fields that are difficult to interpret, however, mild to moderate cataracts do not prevent useful SWAP testing.

SWAP testing is perhaps the most carefully evaluated new diagnostic method and many questions remain that only will be answered with broader clinical experience.

Please note the size V is the size of the stimulus and the normative data is available for the tests conducted with size V in SWAP perimetry.

SWAP - SINGLE FIELD ANALYSIS PRINTOUT



Important points to be noted:

Reliability indices are expressed in ratios, gray scale looks darker, when compared to standard white on white perimetry the standard size of the stimulus - size V blue, global indices are present within the box.

Selection of the test : 30-2 threshold test

Reliability indices : Good

Mean deviation : – 4.72 dB

PSD : + 3.11 dB

GHT : Within normal limits

Total deviation probability plot and pattern deviation plot are not showing any abnormality.

10 Visual Field Testing With Frequency Doubling Technology

Frequency doubling technology (FDT) perimetry is a recently developed method for determining glaucomatous visual field loss. In this perimeter we determine the contrast threshold (the minimum contrast necessary for stimulus detection) for each of the target locations in the display.

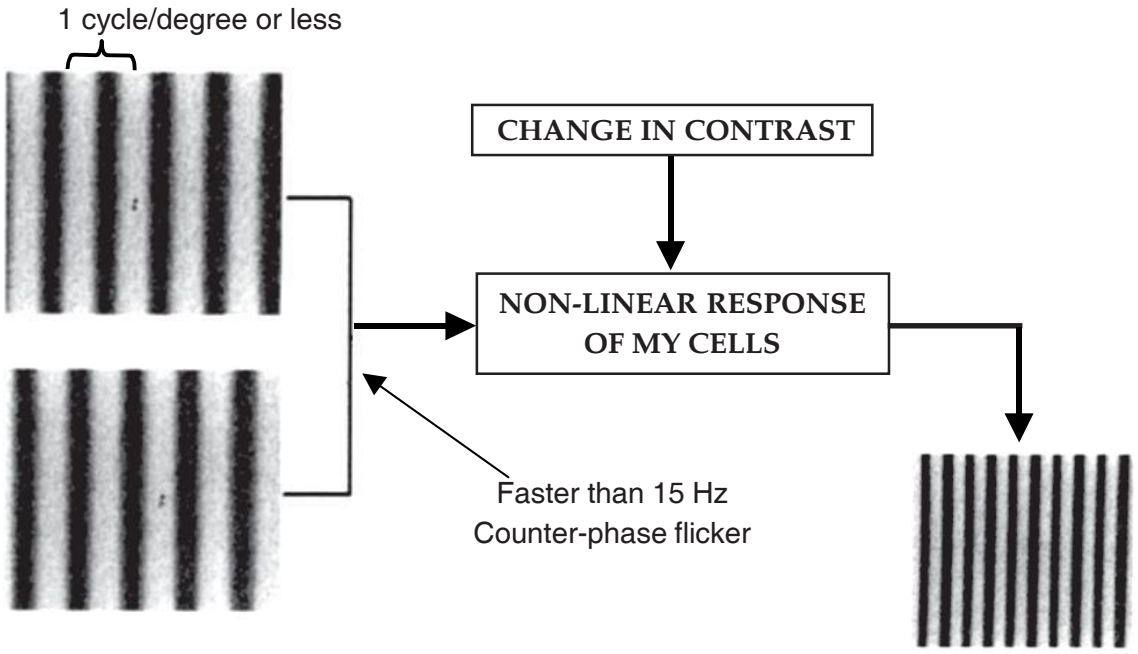
It is now known that there are two major groups of retinal ganglion cells (retinal nerve fibers). One group, which constitutes the majority of retinal ganglion cells, project to the Parvocellular layers of lateral geniculate nucleus. These nerve fibers are thus called Parvocellular or P-cells and they tend to have relatively smaller diameter axons and slower conduction velocities. P-cells tend to be more responsive to high spatial frequencies (fine details or smaller objects) and low temporal frequencies (steady or constant stimulus presentations and lower flicker rates). Various types of P-cells are believed to be responsible for the processing of color vision, visual acuity and form vision.

The other major group of ganglion cells project to the magnocellular layers of the lateral geniculate nucleus. These fibers are called magnocellular or M-cells, and they tend to have relatively larger diameter axons and faster conduction velocities. The M-cells constitutes approximately 15% of the total number of ganglion cells in the human eye. The M-cells tend to be more responsive to low spatial frequencies (broad patterns or larger objects) and high temporal frequencies (high rate of flicker or sudden stimulus changes). Because of this, M-cells are believed to be primarily responsible for the processing of motion and high frequency flicker information.

The stimulus used in frequency doubling technology incorporates a very low spatial frequency (0.25 cycles per degree) in conjunction with a high temporal frequency (25 Hz counter phase flicker). It is therefore optimally designed for stimulating M-cell nerve fibers. A subgroup of the M-cells have non-linear response properties to stimulus contrast and it is believed that the frequency doubling technology reflects the activity of this subgroup response to contrast.

Visual field testing with frequency doubling technology is mainly used to pickup early field defects of glaucoma

THE NON-LINEAR RESPONSE OF MY CELLS TO CHANGE OF CONTRAST CONVERTING THE LOW SPATIAL FREQUENCY SINUSOIDAL GRATING AS UNDERGOES HIGH TEMPORAL FREQUENCY COUNTER-PHASE FLICKER TO FREQUENCY DOUBLING ILLUSION



The stimulus display consists of a low spatial frequency (0.25 cycles per degree) sinusoidal grating (broad, fuzzy light and dark stripes) that undergoes rapid (25-Hz) counter-phase flicker (i.e, light bars become dark and *vice versa* with alternations every 20 milliseconds

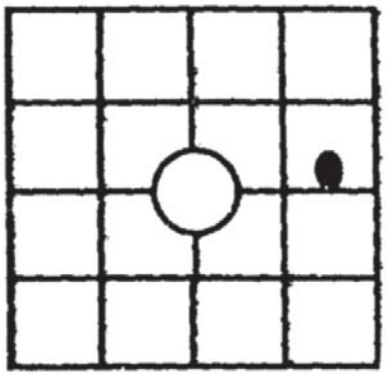
The stimulus appears to have twice as many light and dark bars as are physically present. This phenomenon is known as frequency doubling illusion, in reference to the fact that the spatial frequency of the grating appears to be doubled

It is this non-linear response to contrast that is believed to produce the frequency doubling appearance. Illusion stimulates response from low redundancy My ganglion cells, thought to be first cells damaged by glaucoma

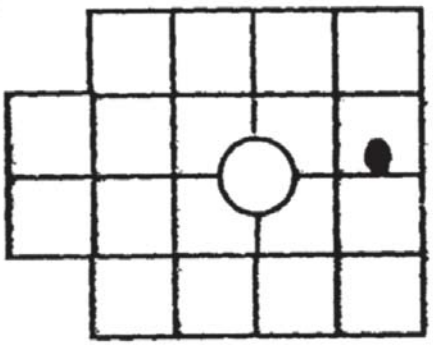
THRESHOLD TEST PATTERNS OF HUMPHREY FDT MATRIX

The Humphrey FDT matrix offers many test patterns in threshold tests. The entire test area is divided in to squares. The important point to be noted are the size of the square and the number of the squares to be tested. The test patterns of Humphrey FDT matrix are as followed.

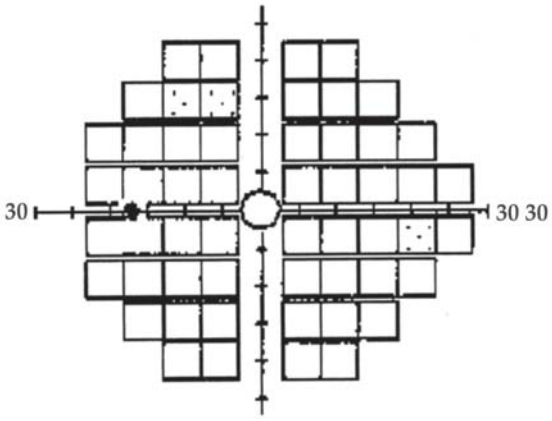
1. C-20 point pattern – 17 squares, size of the square 10°×10°
2. N-30 point pattern – 19 squares, size of the square 10°×10°
3. C-24-2 point pattern – 55 squares, size of the square 5°×5°
4. C-30-2 point pattern – 69 squares, size of the square 5°×5°
5. C-10-2 point pattern – 44 squares, size of the square 2°×2°
6. Macula point pattern – 16 squares, size of the square 2°×2°



C-20 point pattern – the C – 20 stands for the area of the field to be tested (20 degrees to either of the fixation point in both horizontal and vertical directions. It consists of sixteen squares measuring 10°×10° and one central circle point. So the total number of testing areas are 17.



C – 20 pattern consists of seventeen points to be tested (sixteen squares measuring 10°×10° and one 5° diameter circle at the center) so the total number of testing areas are 19.



C-24 point pattern – it consists of 55 number of squares each measuring 5°×5°.

FDT MATRIX CONTRAST THRESHOLD TESTING STRATEGIES

In this perimetry we determine a contrast threshold for each of the target locations in the display to findout the minimum contrast necessary for stimulus detection the Humphrey FDT Matrix offers the following contrast threshold strategies.

The standard full threshold strategy

1. Modified binary search (MOBS) (full threshold FDT perimetry)

Newear contrast threshold testing strategies

1. Rapid efficient binary search (REBS)
2. ZIPPY estimation of sequential testing

Modified binary search (MOBS) (full threshold FDT perimetry)

The frequency doubling technology full threshold test is performed by determining a contrast threshold (the minimum contrast necessary for stimulus detection) for each of the target locations in the display. This is accompanied by means of a staircase or bracketing procedure. If a stimulus is detected, its contrast is decrease for the next presentation; if the stimulus is not detected, contrast is increased for the next presentation. The particular type of staircase procedure used by frequency doubling technology is called a modified binary search or MOBS. This procedure is used because it is more accurate and efficient than traditional staircases. Each stimulus is presented for a maximum of 720 milliseconds; stimulus contrast is increased gradually from zero to the contrast selected for the trial. If the stimulus is not seen, it remains at this contrast for up to 400 milliseconds and then gradually decreased to zero during the final 160 milliseconds. This is done to avoid abrupt, large changes in stimulus contrast that may produce spurious responses. Between stimulus presentations, there is a variable random wait interval of up to 500 milliseconds to reduce anticipation and rhythmic responses by the patient.

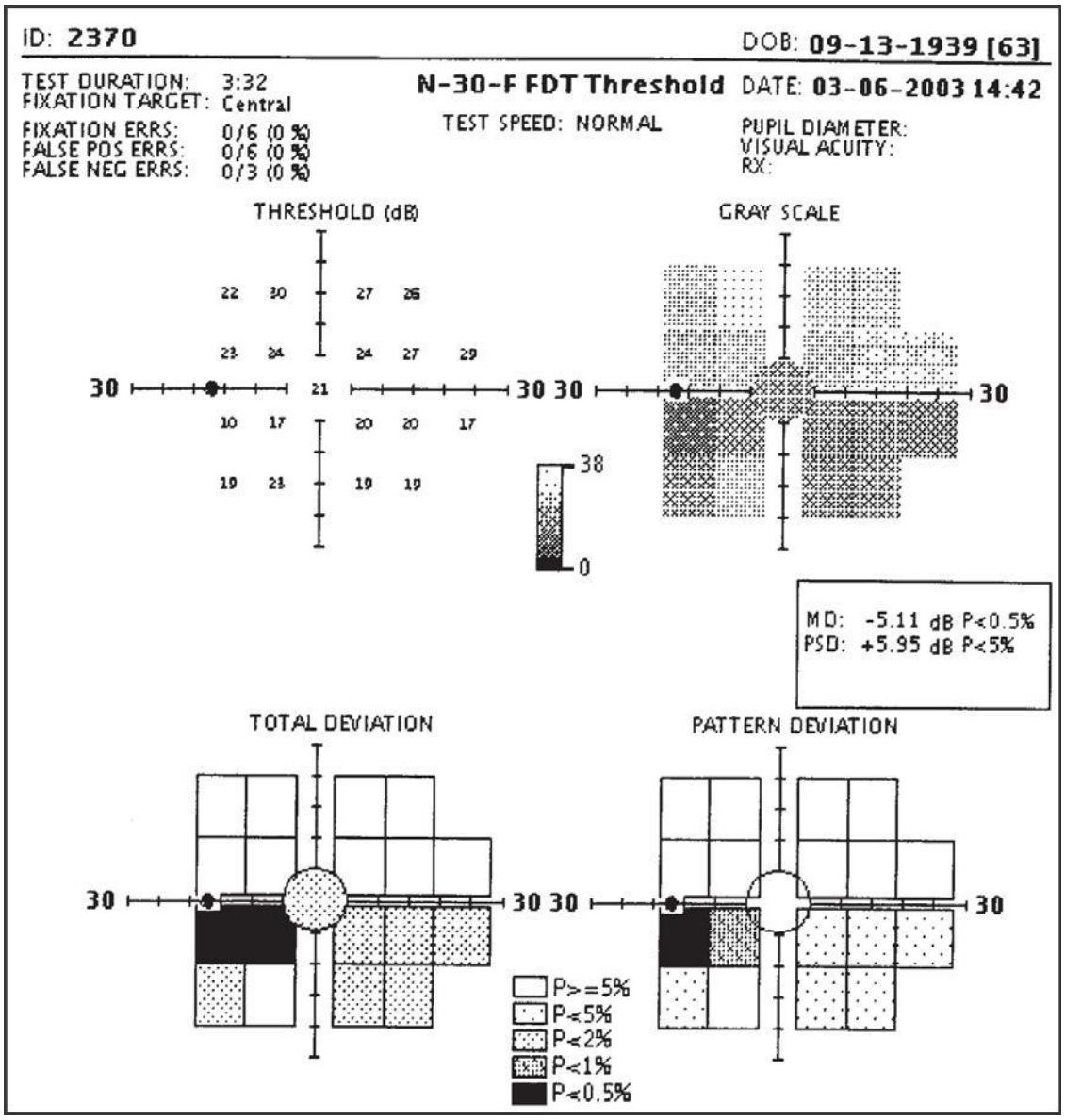
Rapid efficient binary search (REBS) and ZIPPY estimation of sequential testing

The test time for full threshold FDT perimetry can be approximately halved, by using either the ZEST or REBS procedure, without affecting the accuracy or reliability of the measurements. These findings in normal subjects and patients with glaucoma provide clinical conformation of our previous investigations of these test strategies that use computer simulation.

THE STATISTICAL ANALYSIS PACKAGE

To assist the interpretation of the full threshold test results produced by frequency doubling technology, a statistical model, derived from a large normative data base, is provided. The age eye adjusted normative data base has been used to generate probability levels for each test locations. In the initial versions of the frequency doubling technology software, only the total deviation plot was available. The pattern deviation plot is a new addition contained in the FDT windows in the 95 PC software. The normative data base is used to calculate visual field indices – mean deviation and pattern standard deviation.

HUMPHREY MATRIX N-30 THRESHOLD FIELD PRINTOUT



Selection of the test: N-30 FDT threshold

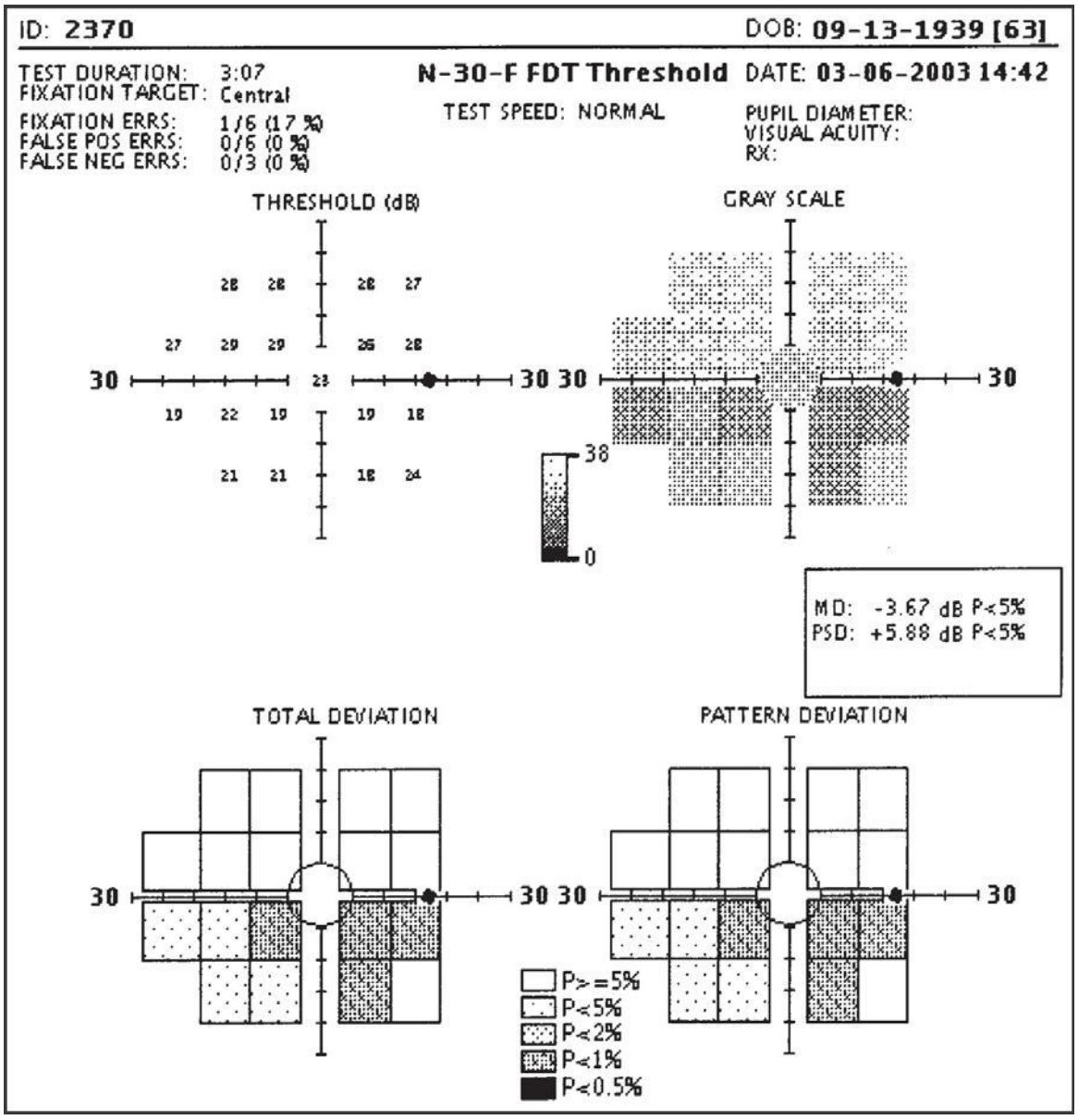
Reliability indices: excellent

Mean deviation: –5.11 dB, P<0.5%

PSD: +5.95 dB, P<5%

Total deviation probability plot and pattern deviation plot are showing symmetrical lower horizontal localized field defect.

HUMPHREY MATRIX N-30 THRESHOLD FIELD PRINTOUT



Selection of the test : N-30 FDT threshold

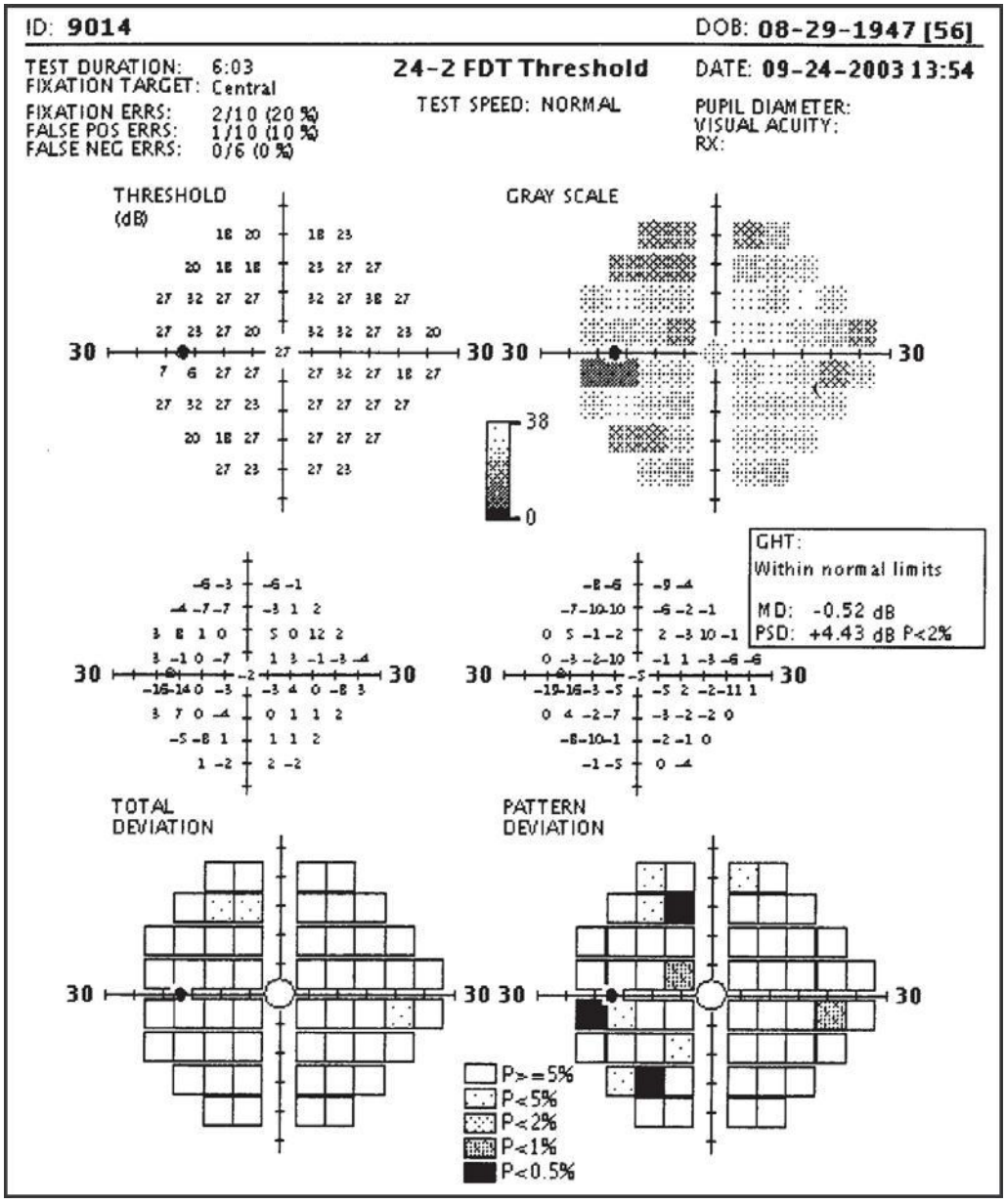
Reliability indices : Good

Mean deviation : –3.67 dB, P < 5%

PSD : +5.88 dB, P < 5%

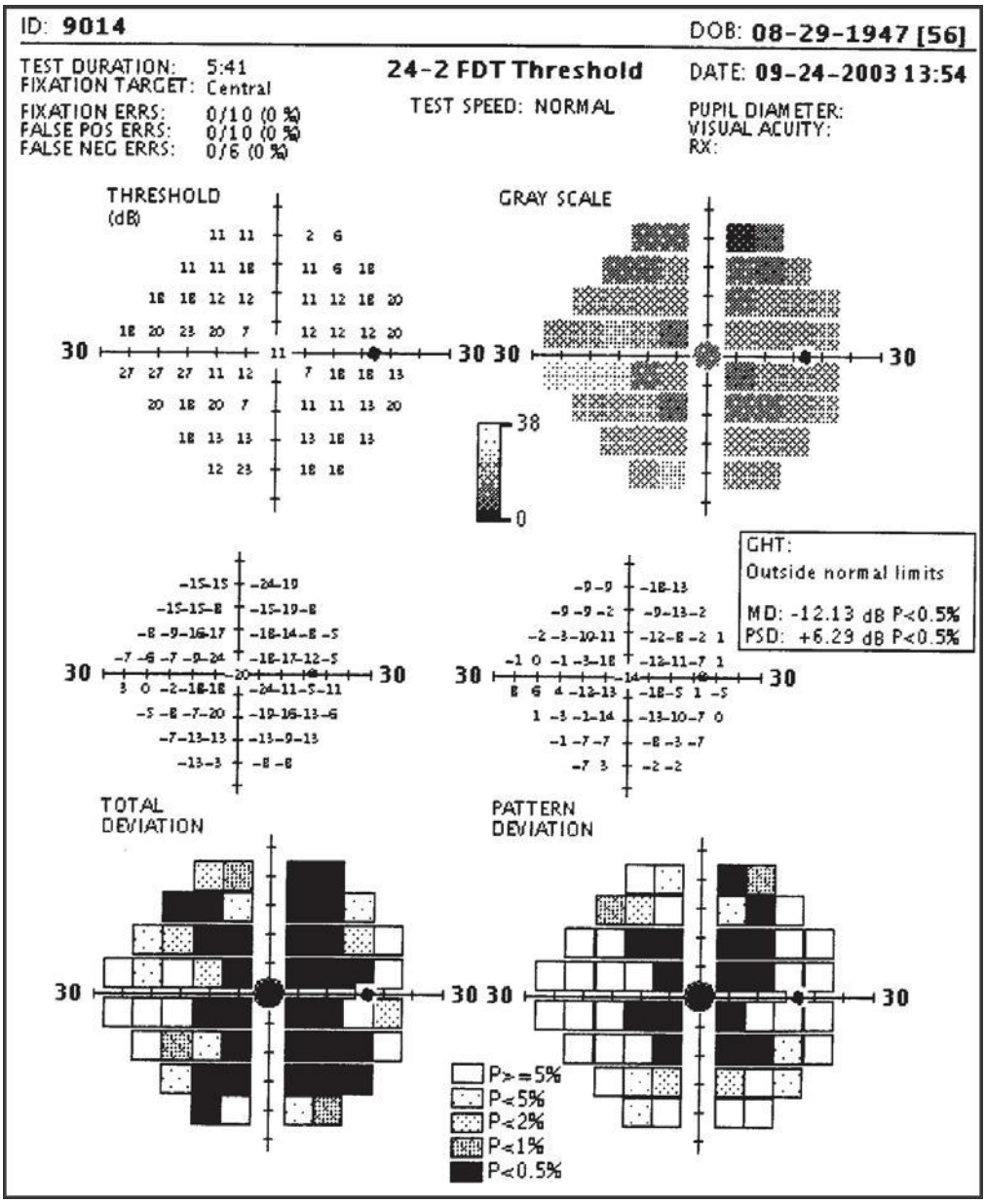
Total deviation probability plot and pattern deviation plot are showing symmetrical lower horizontal localized field defect.

HUMPHREY MATRIX 24-2 VISUAL FIELD PRINTOUT



Selection of the test : 24-2 FDT threshold
Reliability indices : Good
Mean deviation : –0.52 dB
PSD : +4.43 dB, P < 2%
GHT : Within normal limits
Total deviation probability plot – is almost in normal limits
Pattern deviation probability plot – because of false positive 10% and fixation loss 20%, the pattern deviation probability plot is showing more abnormal P value squares

HUMPHREY MATRIX 24-2 VISUAL FIELD PRINTOUT



Selection of the test : 24-2 FDT threshold
Reliability indices : Good
Mean deviation : –12.13 dB P < 0.5%
PSD : +6.29 dB, P < 0.5%
GHT : Outside normal limits
Total deviation probability plot and pattern deviation plot are almost symmetrical showing abnormal areas on either side of the vertical axis.

11 Visual Field Defects Due to Occlusive Vascular Disorders of the Visual Pathway, A Case of Bitemporal Hemianopia and Coloboma of Disc and Retina

In this chapter I am presenting six cases of visual field defects of clinical importance. The first four cases are due to occlusive vascular disorders to the visual pathway.

Case Histories

Case I and Case II: Both these patients are known diabetic. Presented with defective vision in their left eyes.

Fundus: Both eyes showed pale disc edema with background diabetic retinopathy. Visual fields of the both the patients showed altitudinal field defects (Page no. 193 and 194). Pale disc edema and altitudinal field defects are suggestive of anterior ischemic optic neuropathy (AION). Later the diagnosis was confirmed by FA.

Case III: Complaint: Difficulty while walking down the steps. Left eye fundus: showed occlusion of the upper branch of central retinal artery.

Visual field: Lower half of the field defect with fovea sparing (Page No. 195).

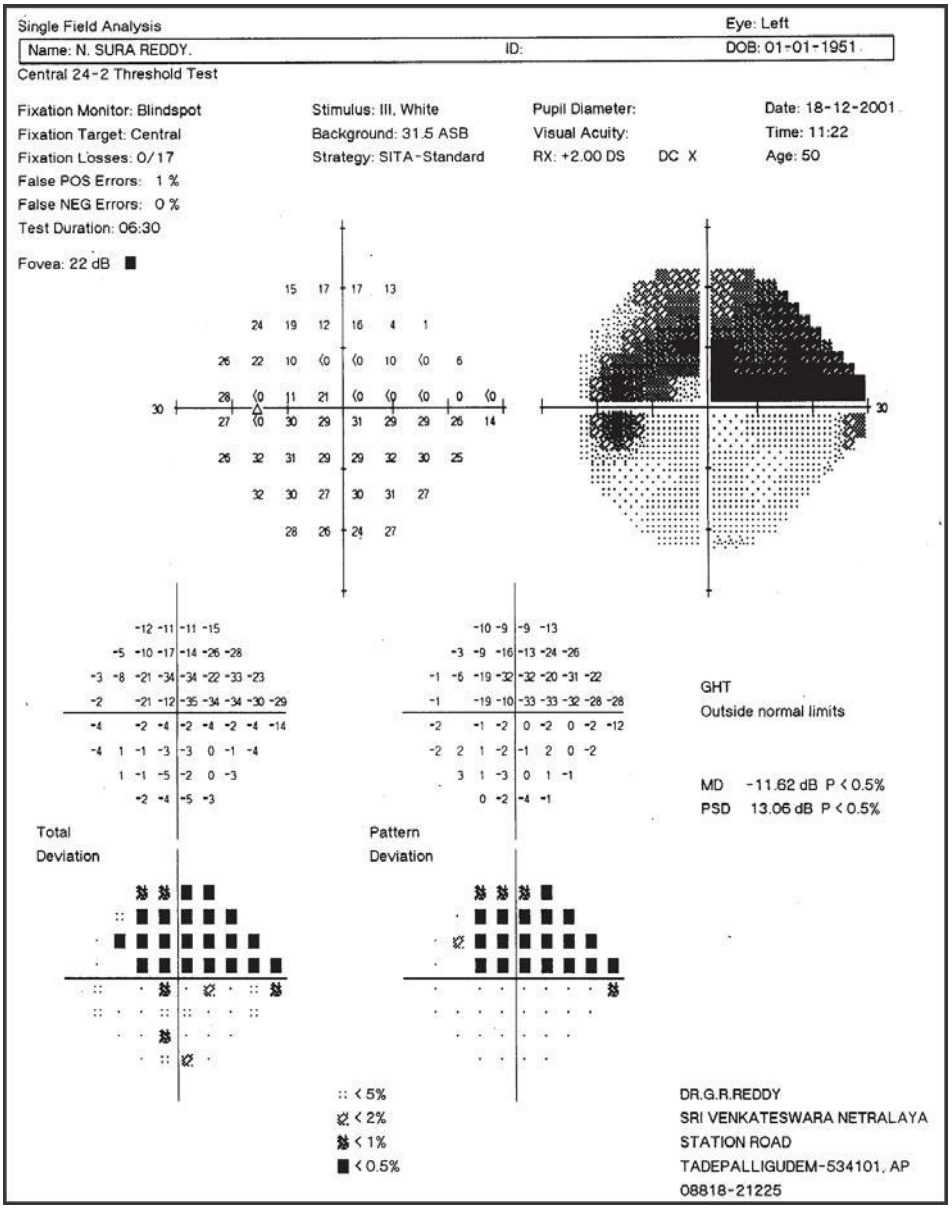
Case IV: Complaint: Ataxic gait, fundus- within normal limits. Field- Field showed left homonymous hemianopia (Page No. 196).

Diagnosis: Right posterior cerebral artery occlsion. Later the diagnosis was confirmed by CT scan brain. which showed right occipital lobe infarct.

CASE V: Complaint – unable to appreciate the side vision – OU.
OU - Fundus revealed mild palor of the optic disc especially the nasal side of the disc.
Fields showed bitemporal hemianopic defect.
CT brain showed ? Anterior communicating artery aneurysm (Page No. 197).

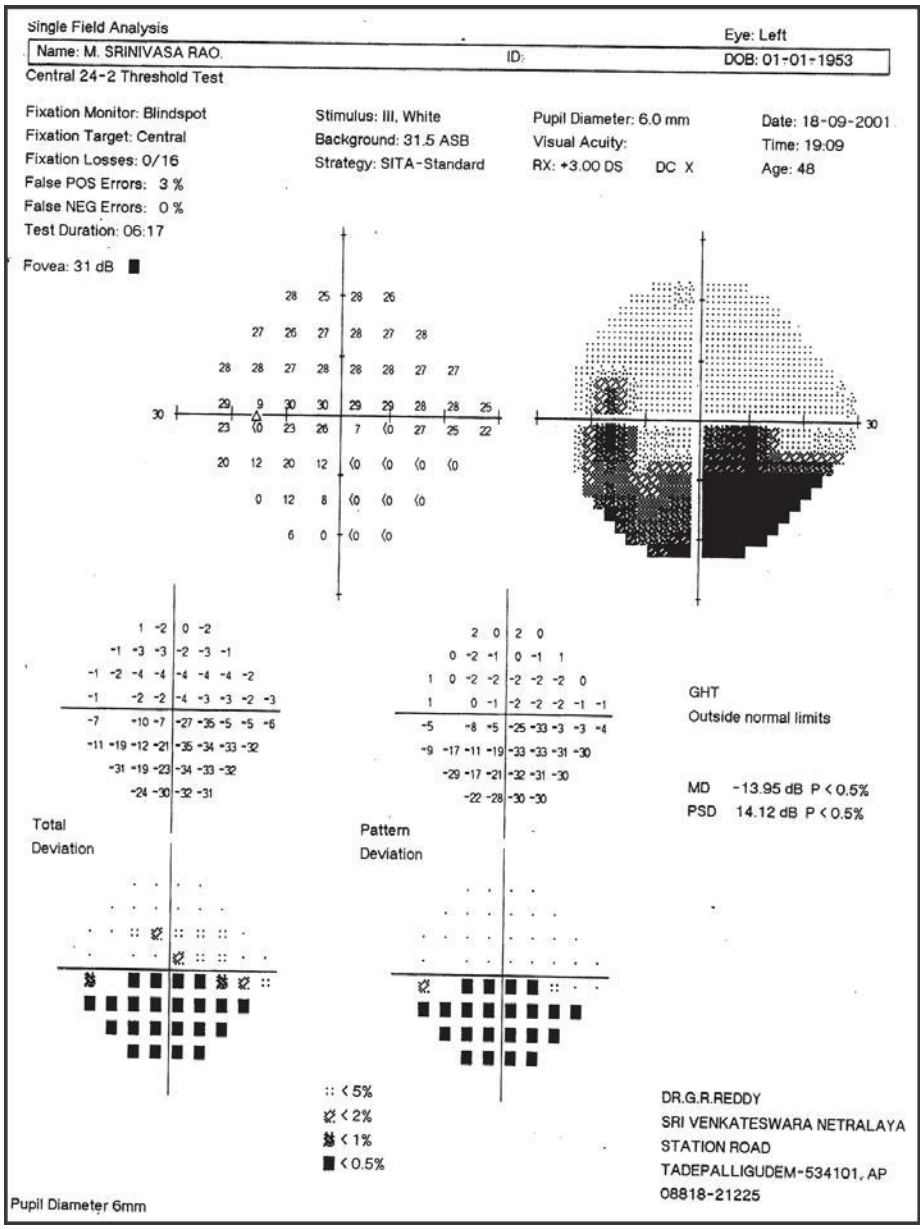
CASE VI: Case of coloboma of lower half of the disc and retina (Page No. 198).

SINGLE FIELD ANALYSIS PRINTOUT OF AION (CASE NO.1)



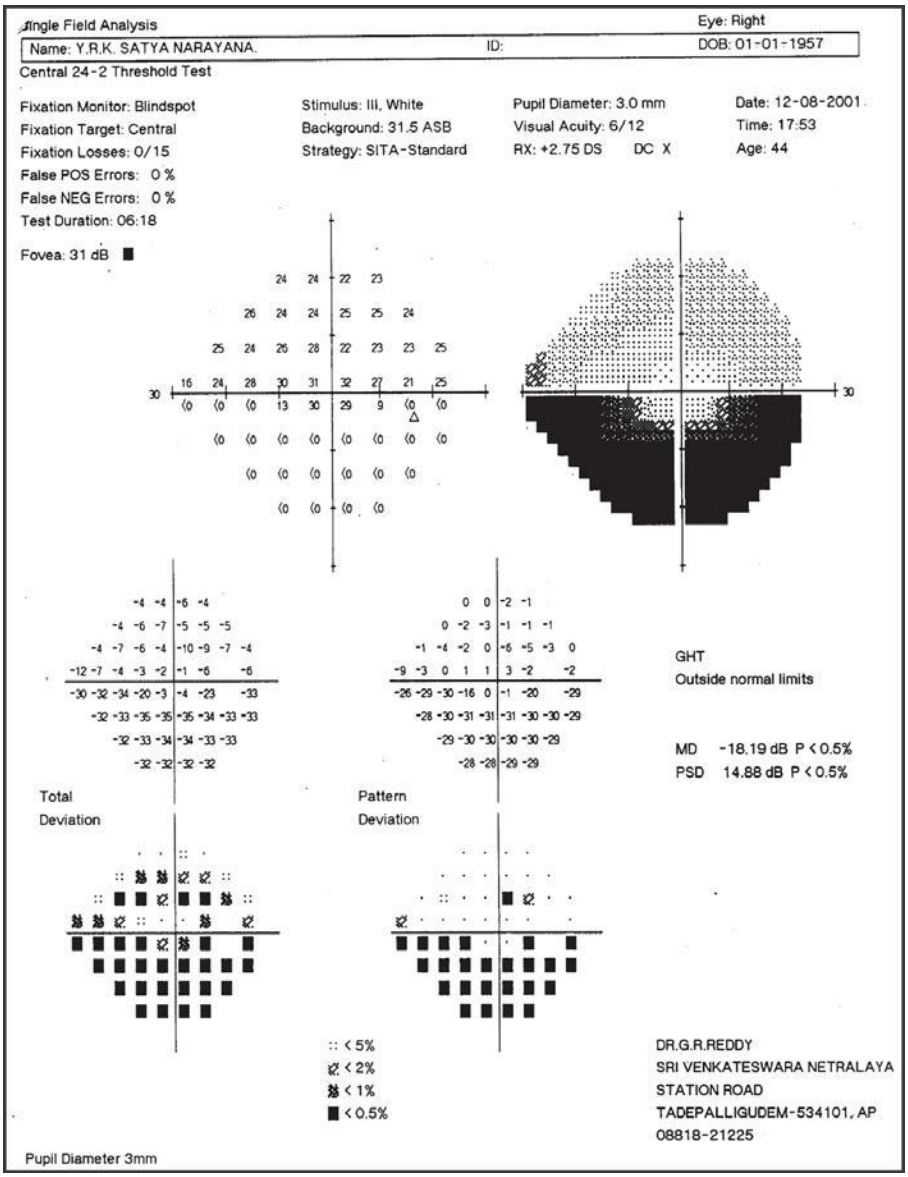
Selection of the test	:	24-2 SITA Standard
Reliability	:	Good
Total deviation	:	Upper horizontal field defect
Pattern deviation	:	Upper horizontal field defect
PSD	:	13.06 dB P value < 0.5%
Mean deviation index	:	– 11.62 dB P value < 0.5%
Interpretation	:	AION (fields are suggestive of anterior ischemic optic neuropathy - corresponding to the disc appearance).

SINGLE FIELD ANALYSIS PRINTOUT OF AION (CASE NO.2)



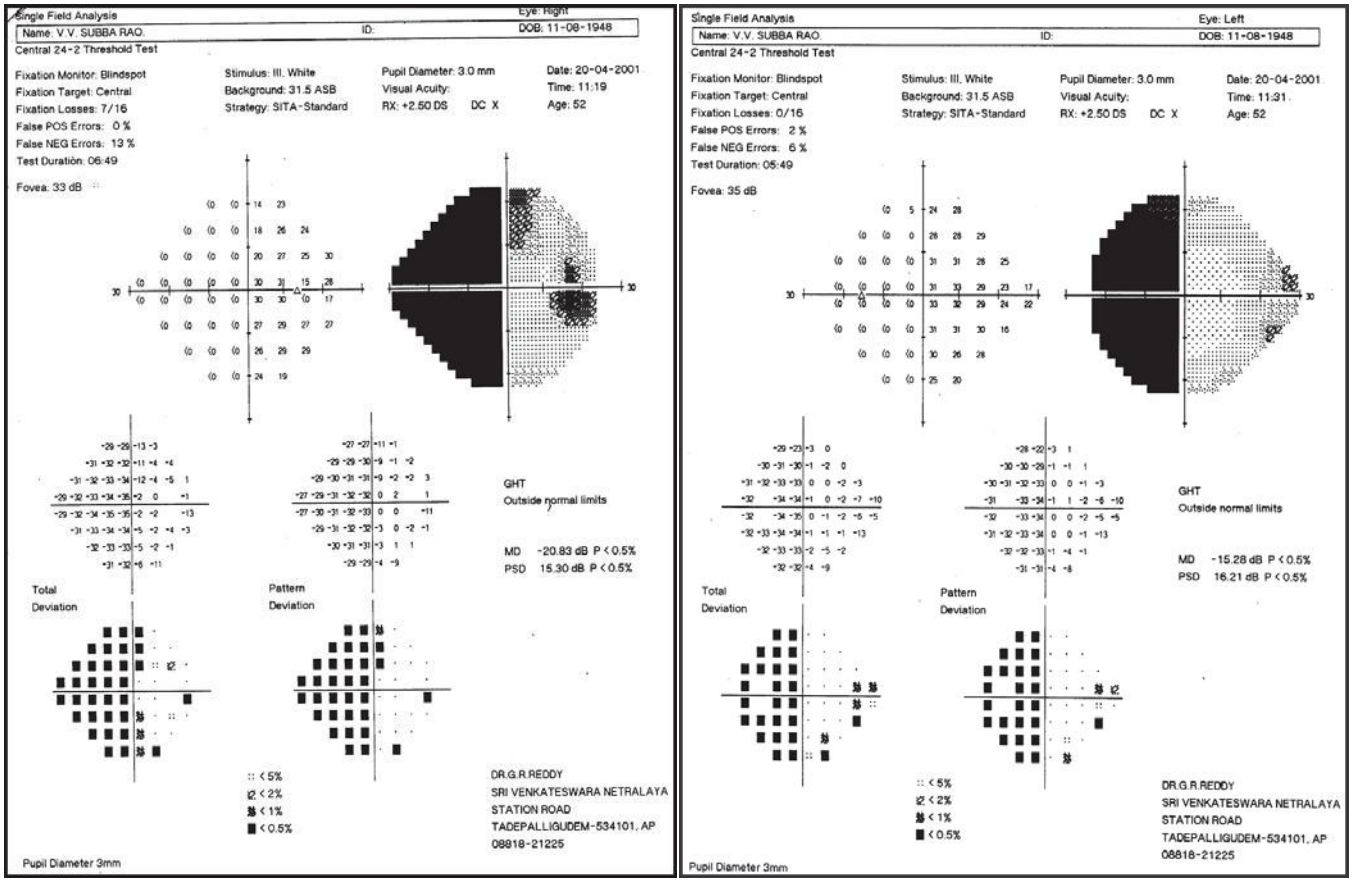
Selection of the test	:	24-2 SITA Standard
Reliability	:	Good
Total deviation	:	Lower horizontal field defect
Pattern deviation	:	Lower horizontal field defect
PSD	:	14.12 dB P value < 0.5%
Mean deviation index	:	– 13.95 dB P value < 0.5%
Interpretation	:	AION (fields are suggestive of anterior ischemic optic neuropathy - corresponding to the disc appearance).

SINGLE FIELD ANALYSIS PRINTOUT OF OCCLUSION OF UPPER BRANCH OF C.R.A. (CASE NO.3)



Selection of the test	:	24-2 SITA Standard
Reliability	:	Good
Total deviation	:	Lower horizontal field defect and fews scotomas in the upper horizontal field
Pattern deviation	:	Lower horizontal field defect
PSD	:	14.88 dB P value < 0.5%
Mean deviation index	:	– 18.19 dB P value < 0.5%
Interpretation	:	Occlusion of upper branch of CRA (Field defects are corresponding to the fundus changes).

SINGLE FIELD ANALYSIS PRINTOUT OF RIGHT POSTERIOR CEREBRAL ARTERY OCCLUSION (CASE NO.4)



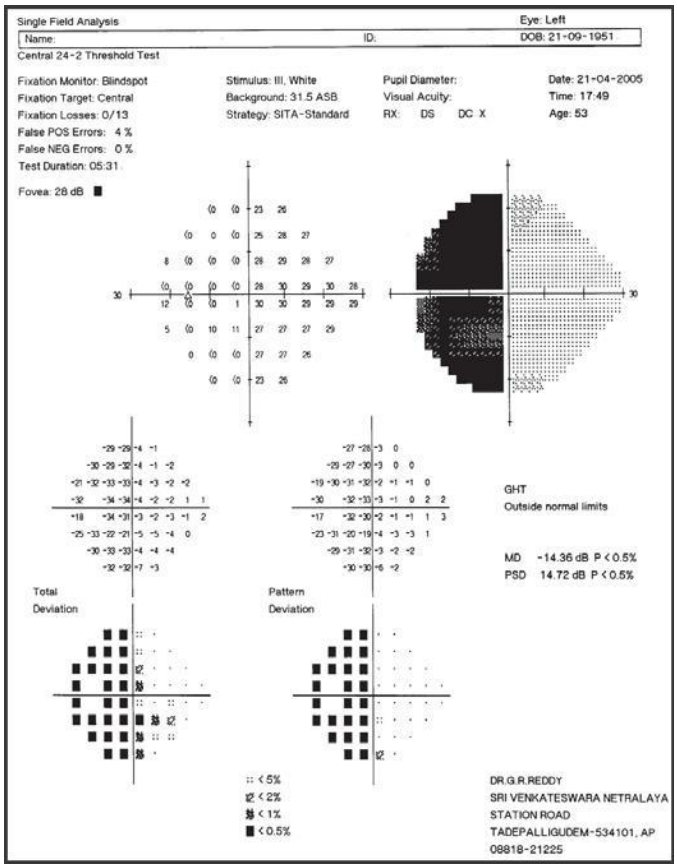
RIGHT EYE **LEFT EYE**

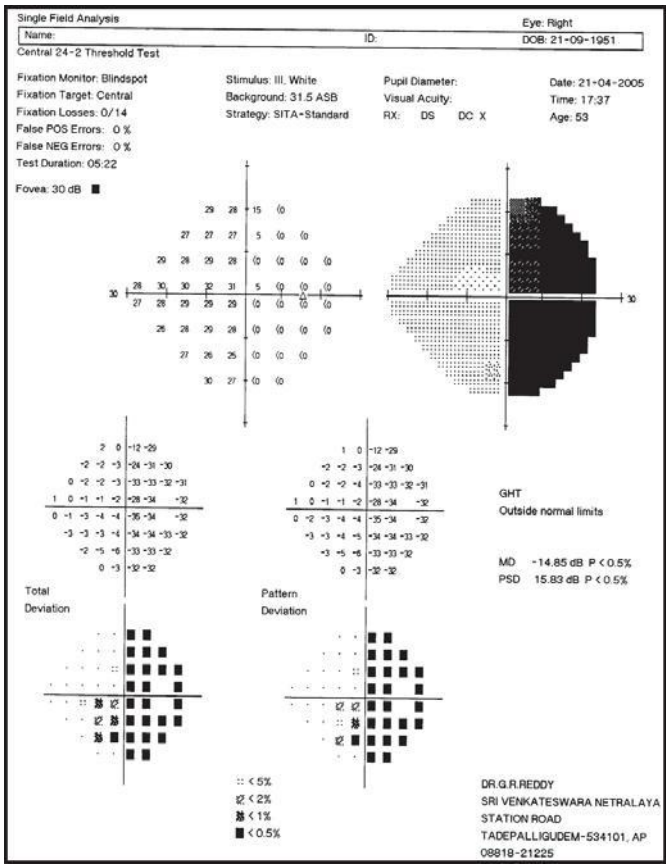
Left Homonymous Hemianopia

Case IV: Complaint: Ataxic gait fundus- within normal limits. Field- Field showed left homonymous hemianopia.

Diagnosis: Right posterior cerebral artery occlusion. Later the diagnosis was confirmed by CT scan brain, which showed right occipital lobe infarct.

FIELD CHART OF BITEMPORAL HEMIANOPIA



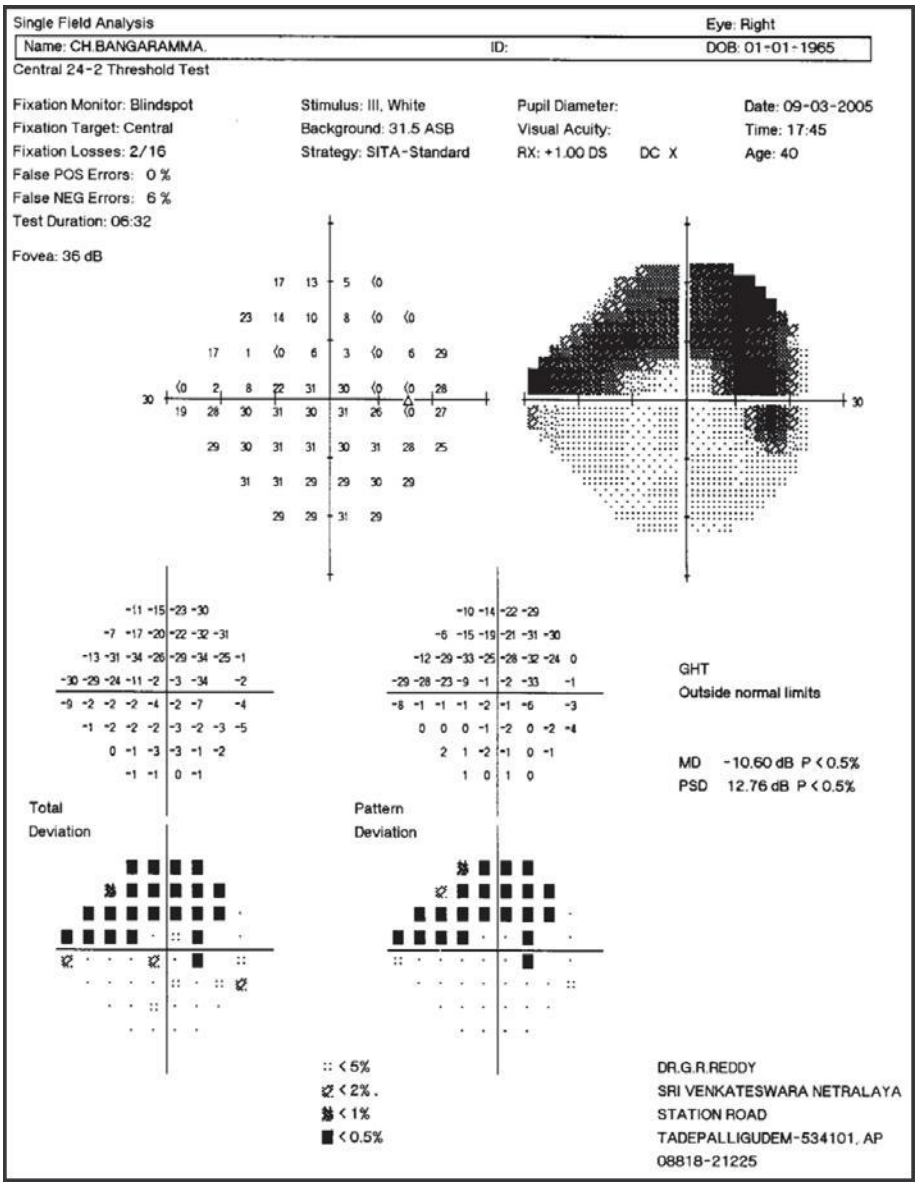


LEFT EYE **RIGHT EYE**

Bitemporal Hemianopia

In this case I am showing bitemporal hemianopia. The CT showed a big aneurysm pressing the central fibers of optic chiasma. The aneurysm is thought to be arising from Anterior communicating artery.

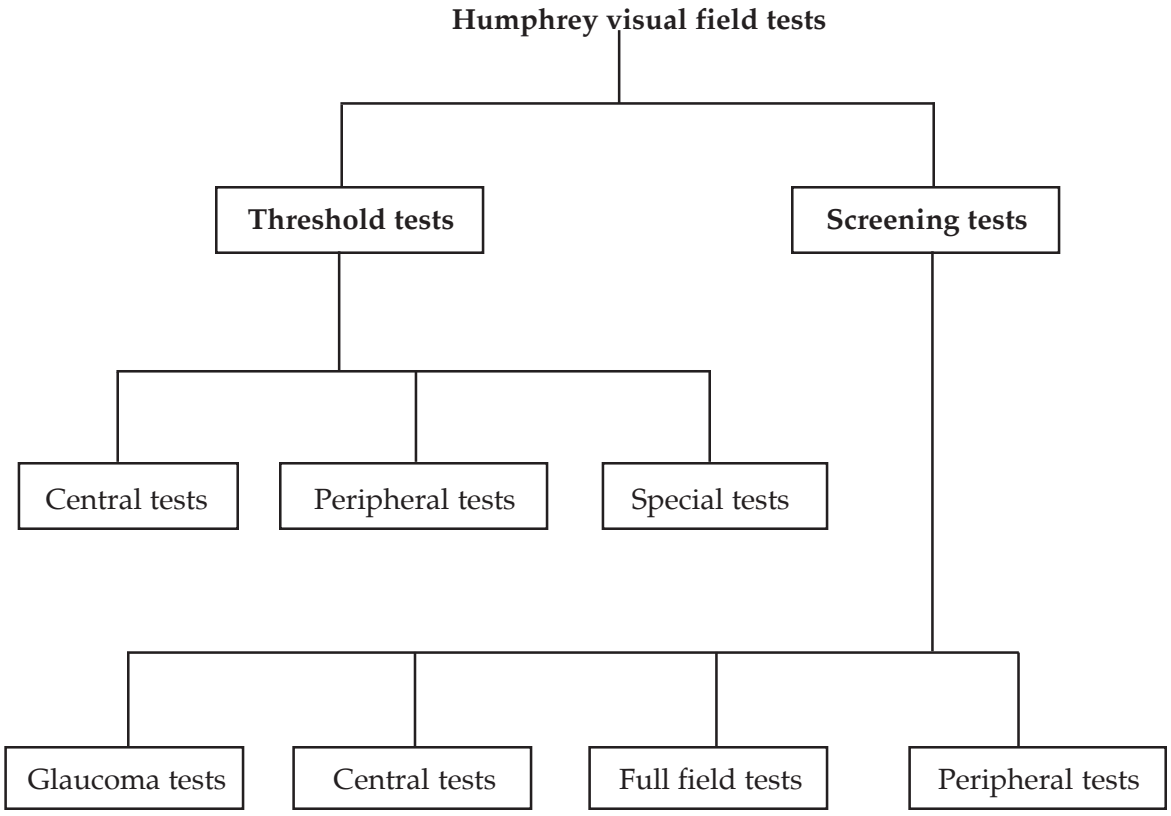
SINGLE FIELD ANALYSIS PRINTOUT OF COLOBOMA OF LOWER HALF OF THE DISC AND RETINA



The field defect is corresponding to the coloboma of the fundus. The student should not be blamed if he says " I'm seeing a localized field defect in the upper arcuate area most probably due to glaucomatous optic nerve damage" when he is not given the fundus picture. From this case, one should understand how important is to correlate the fields with the fundus picture.

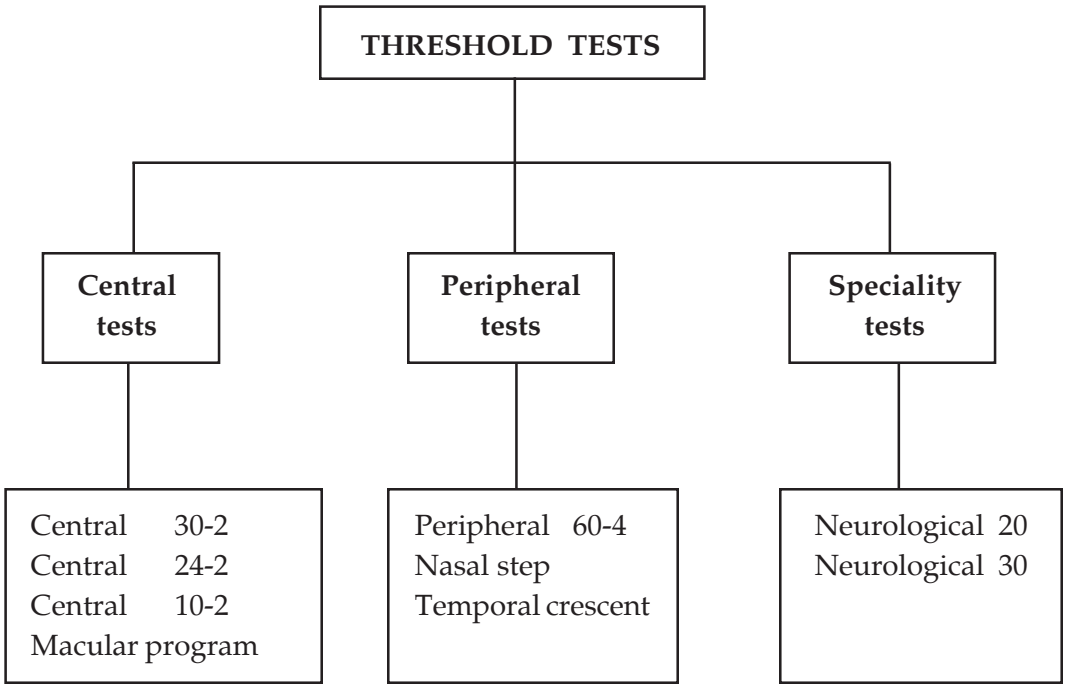
12 Important Clues in Operating Humphrey Field Analyzer

In order to fill the main menu of the Humphrey field analyzer we have to know the available tests in the Humphrey field analyzer. So, I am here with giving the available tests of Humphrey field analyzer.



This is a broad classification chart of Humphrey field tests. Again each group contains a number of different test point patterns and each test can be conducted with different test strategy.

The three broad groups of the threshold test are again subdivided according to the test point pattern and their location.

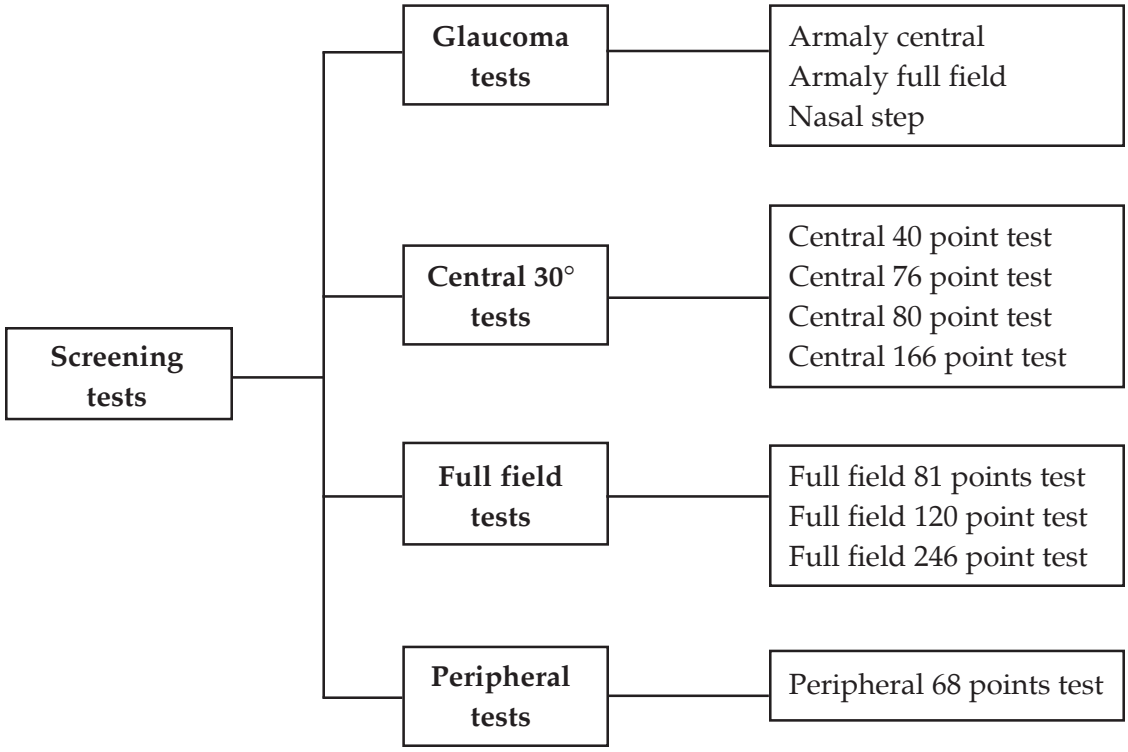


Each of the above test can be conducted with

any of the threshold - strategies.

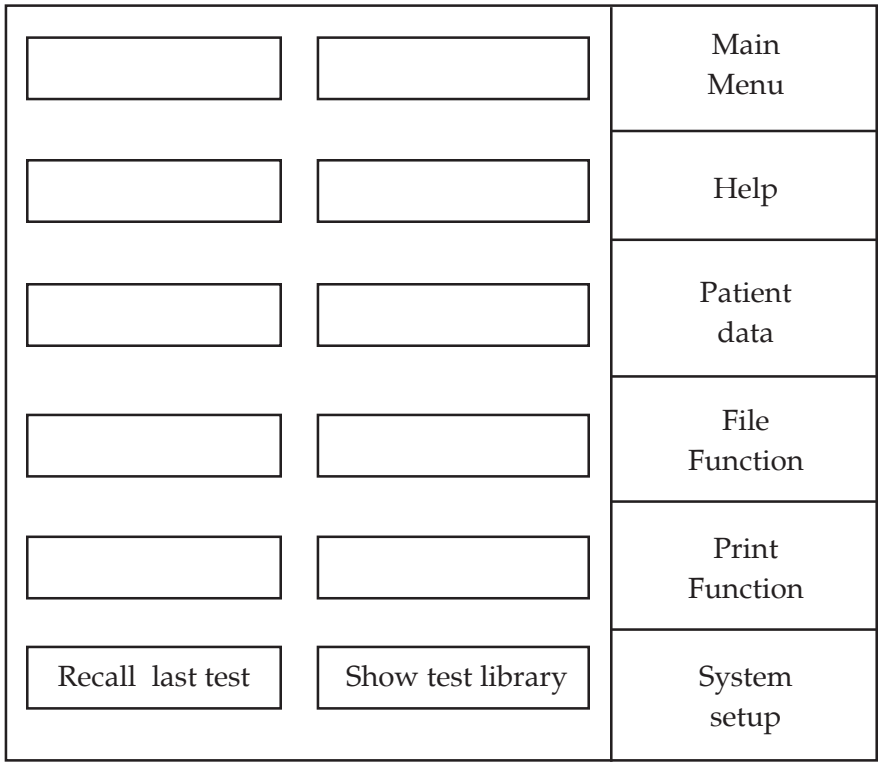
(Full Threshold, FASTPAC, SITA-Standard or SITA-Fast).

The four broad group of the screening tests are again subdivided according to the point pattern.



Each of the above test can be conducted with any of the supra threshold test strategies.— Two zone test strategy, Three zone test strategy, quantify defects test strategy, Single intensity test strategy.

THE MAIN MENU SCREEN OF THE HUMPHREY FIELD ANALYZER



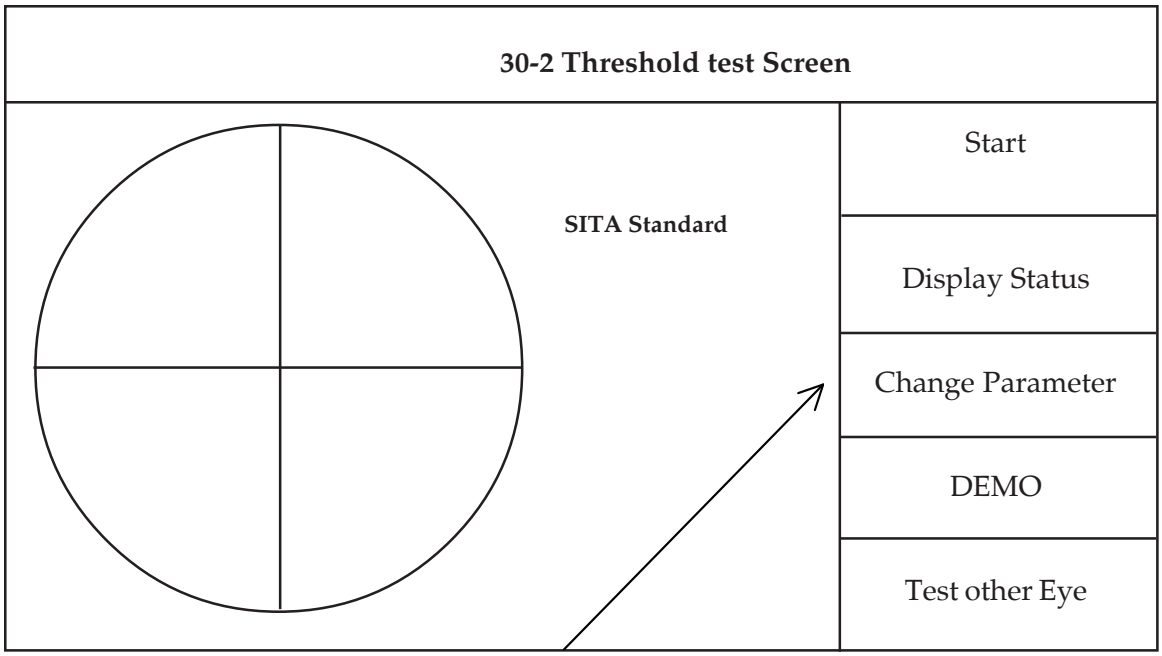
There are ten boxes on the main menu screen to be filled by commonly used tests. So, we have to select ten important tests from threshold tests and screening tests. As you already know each test has two components—the test point pattern component and test strategy component. While selecting the test for main menu the test point pattern component is very important and you can select any test strategy that is available to threshold tests and screening test. This is very important point to be noted. With the help of **change parameter** button seen on the test screen, one can alter the test strategy to any available test strategy to that selected point pattern of test (Threshold or supra threshold). With the help of **change parameter** button we cannot alter the test point patterns. We should keep this point in mind while selecting the tests of Main Menu.

Main Menu		
30-2 central SITA standard	Nasal step SITA standard	**Main Menu**
24-2 central SITA standard	Armaly Central Three Zone	**Help**
10-2 central SITA standard	Armaly Full Field Three Zone	**Patient data**
Macula SITA standard	Neurological 30 SITA standard	**File Function**
Peripheral -64 SITA standard	Full field - 81 Three zone	**Print Function**
Recall last test	Show test library	**System setup**

I selected 10 important tests to the main menu of my Humphrey field analyzer.

Please note that I selected SITA standard strategy for all threshold tests and three zone tests for all screening tests.

The selection of test point pattern is important. Please note the point patterns of threshold tests or supra threshold tests are not repeated in the above boxes. You will see 30-2 only once. Like that 24-2 or 10-2 or Armaly Central, but the test strategy SITA standard is seen in all the tests because we can alter it to any test strategy as already discussed.



This Change Parameter Button is very important. With the help of this button we can change

1. **Test strategy**
2. **Size of the stimulus**
3. **Test speed**
4. **Fovea on/off**
5. **Fluctuation on/off**
6. **Fixation target.**

By selecting the 1st box of the main menu, 30-2 Threshold test will appear on test screen. The SITA test strategy is seen in small letters. With the help of change parameter button the test strategy SITA Standard can be altered to SITA Fast or Full Threshold or FASTPAC.

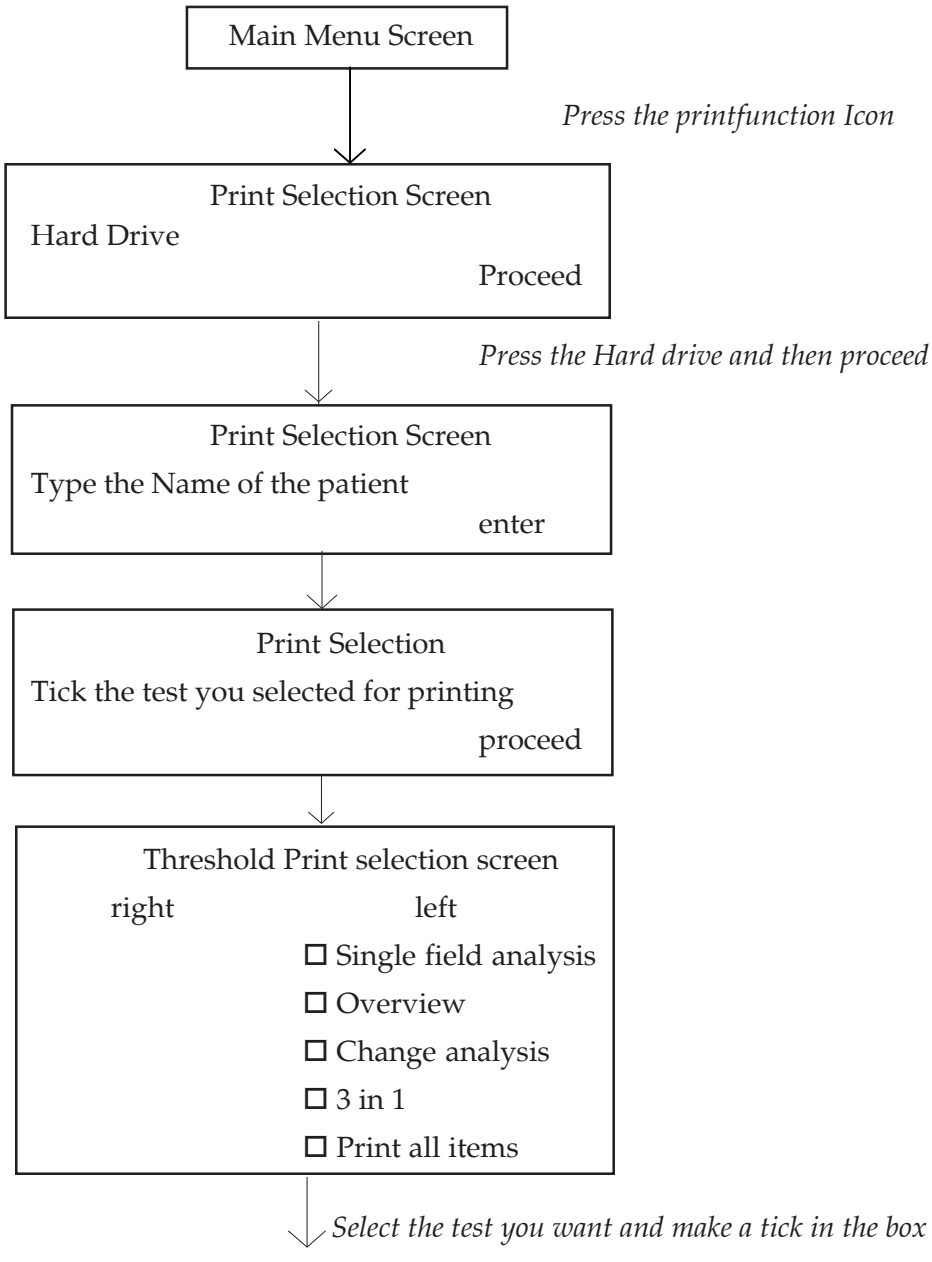
The 30-2 test point pattern can not be changed to 24-2 test point pattern with the help of change parameter button. If we want 24-2 test point pattern, we have to go back to main menu and select 24-2 point pattern test. This is a very important point to be noted.

With the help of change parameter button you can alter fixation point, test speed, and stimulus size. You can also make fovea off or on with the help of change parameter button seen on test screen.

A) PRINTING PREVIOUSLY SAVED TEST RESULTS

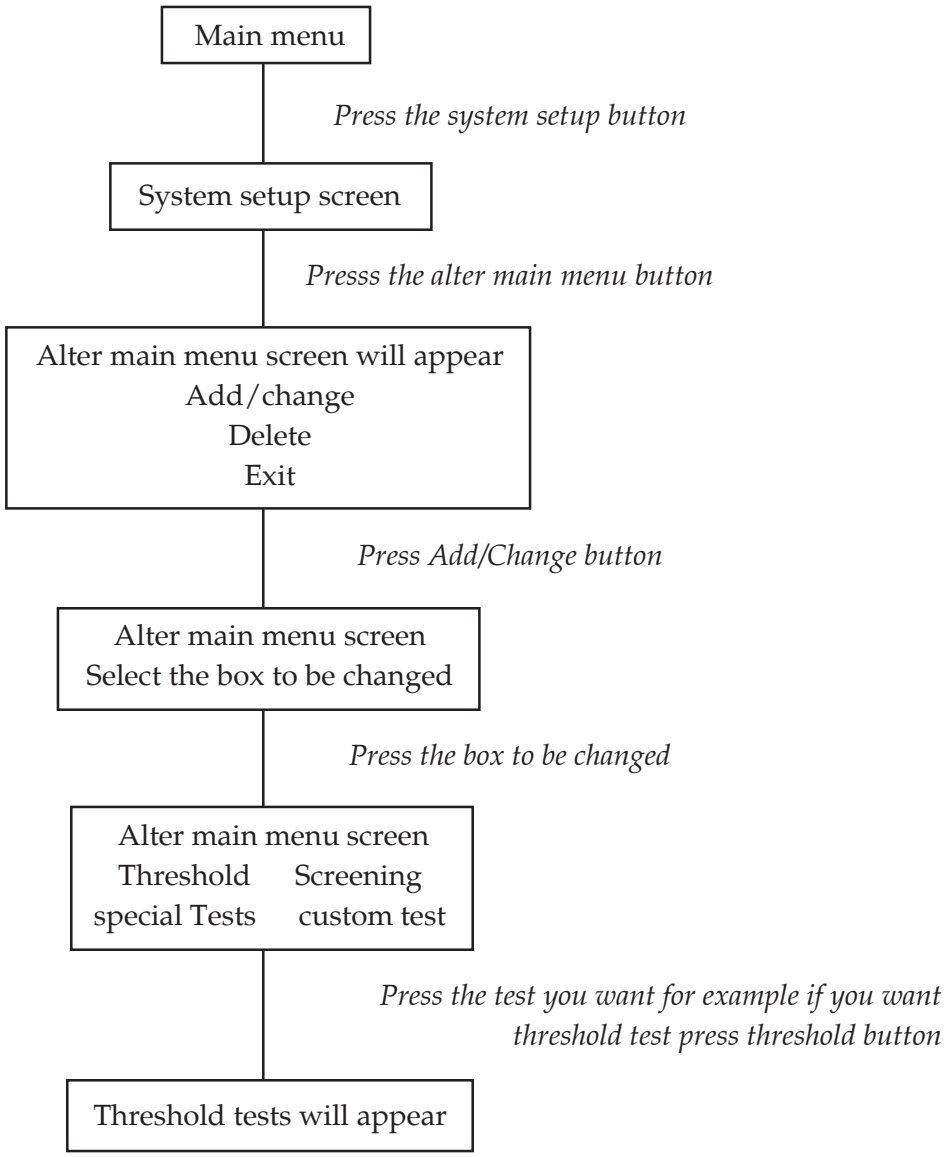
You can obtain printouts at any time convenient to you , if you store the results on the disc.

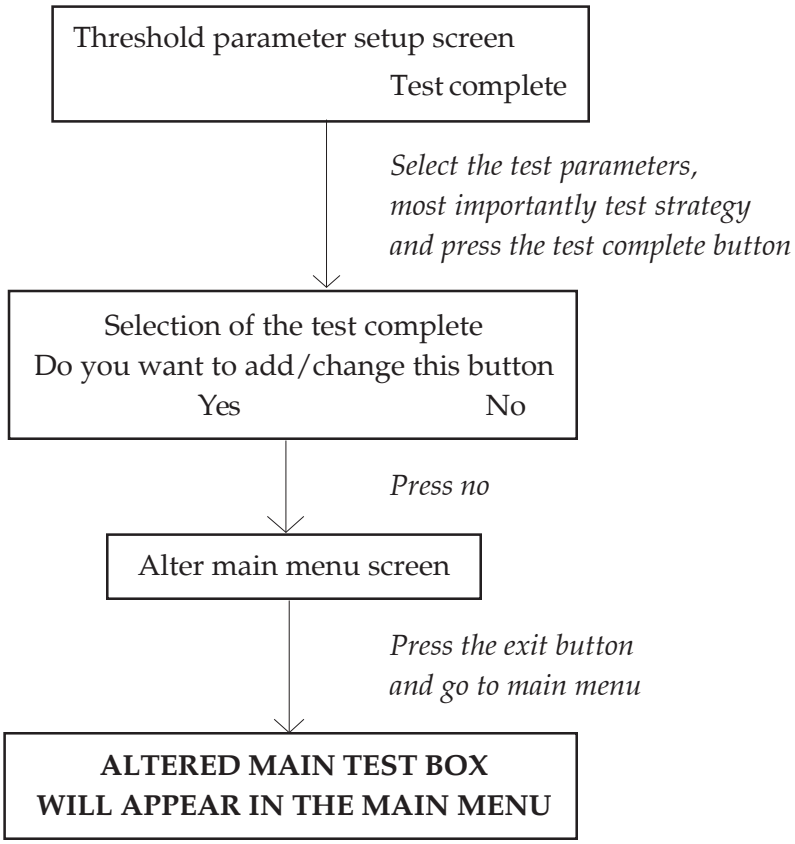
You begin the process by selecting the Print function icon from the Main Menu Screen.



B) ALTER THE MAIN MENU

If you want to change or add to any particular test in the main menu, start the process by pressing the system setup button in the main menu.




Threshold parameter setup screen
Test complete
Select the test parameters,
most importantly test strategy
and press the test complete button
Selection of the test complete
Do you want to add/change this button
Yes
No
Press no
Alter main menu screen
Press the exit button
and go to main menu
ALTERED MAIN TEST BOX
WILL APPEAR IN THE MAIN MENU

Glossary

Box Plot: The decibel deviations of a total deviation numerical plot of the single field analysis printout are divided into three groups according to their degree of decibel deviations. And these 3 groups constitute the box plot. The best 15% sensitive points are represented by upper tail, the next 70% best points are represented by box proper and the least 15% sensitive points are represented by lower tail.

Catch Trial: This entire category includes fixation losses, false positive errors and false negative errors. They are called catch trials. Because they moniter patient reliability and attentiveness. If any one of these parameters falls outside the established norms, an 'xx' will be printed alongside the associated fraction numbers to indicate a statistically significant error rate.

Central Reference Level (CRL): Hypothetical threshold sensitivity at the center of the field, ignoring foveal peak. It may be a value projected on the basis of the normal slope of the "hill of vision" and empirically determined thresholds at 4 to 5 locations or an assigned value (by age, or as a minimal value). It is used to determine expected threshold values throughout the field to guide testing or to calculate defect depth.

Change Analysis: A printout that displays statistical summaries of a series of field tests in the form of box plots and a summary of 4 global indices. The indices are the same four presented in the single field analysis, but this time they are plotted overtime to indicate changes in the patients visual field.

Corrected Pattern Standard deviation: It is one of the four global indices. It is the corrected form of pattern standard deviation by removing the effect of short-term fluctuation from the PSD, we get the CPSD. So, CPSD depends on the both PSD and SF (CPSD - PSD - SF).

0 Decibel: The maximum intensity of light that is projected by any perimeter is designated as 0 decibel.

Decible: In the context of perimetry, the intensity of light is expressed as 0,1 log unit attenuation of the maximum available stimulus (10000 asb for the current Humphrey perimeters).

Defect Depth: It is the difference of threshold at a location between the measured threshold value, and the calculated CRL or the assigned threshold value, (by age or as a minimal value).

False Negative Rate: (FN): The frequency at which the patient fails to respond to stimuli that are expected to be visible. The basis of the calculation and the interpretation of the result is not identical to SITA and non-SITA strategies.

False Positive Rate: (FP): The frequency with which the patient responds to the stimuli, that actually could not have been seen. The manner of determining the rate differs in the SITA and non-SITA strategies, but the interpretation is the same.

FASTPAC: Threshold Algorithm in which stimuli are presented in 3 dB steps, and the threshold value is assigned based on the first cross over form seeing to non-seeing or *vice versa*.

Fixation Losses Rate: (FL): With the blind spot method of Heijl - Krakow, the number of times the patient responds per catch trial in which a stimulus is presented in the expected position of the physiological blind spot.

Glaucoma Change Probability Printout: Comparison of threshold data in a follow-up field to baseline, in which points are highlighted if they change by amounts that are larger than the typically seen in stable glaucoma patients. Similarly MD values changing by more than typical values are also figured.

Glaucoma Hemifield Test (GHT): Plain language analysis of a single threshold 30-2 or 24-2 test analysis is based on normative data base and a pathological model for glaucoma field loss.

Global Indices: Single numerical values which each characterize certain aspects of visual fields. For Humphrey parameters, MD, PSD, SF and CPSD are the global indices.

Gray Scale: Threshold sensitivity values displayed as shades of gray, smoothed with interpolated values between actual test locations.

Long-term Fluctuations: True changes in threshold sensitivity overtime, after removal of variability due to single measurement error.

Macular Test: A pattern for threshold testing that includes the foveal point and 16 locations, 2° apart in a 4×4 grid centering on the point of fixation. In the HFA -1 each point is tested in triplicate and the HFA -1 non-SITA strategies, each point is tested twice.

Mean Deviation (MD): The weighed average of the total deviation values in a visual field tests. Deviations near the center of the field are counted more heavily than those at the edge.

Overview Printout: Summary printout in which the whole series of test results are shown chronologically. Gray scale, threshold value map, total deviation probability map and pattern deviation probability plot for each field are displayed in a horizontal plot along with reliability parameters, global indices and foveal threshold.

Pattern Deviation Decibel and Probability Plots: Display of localized loss of each test points after removal of effects of any generalized loss. Pattern deviation dB values are the total deviation dB values minus the general height. The pattern deviation probability map highlights locations where deviation exceeds those found in fewer than 5%, 2%, 1% or 0.5% of normal sensitivity.

Pattern Standard Deviation (PSD): The global indices that represents the standard deviation around the mean of total deviation. It is the index of localized field loss.

Short-term Fluctuation: The test- re test (the intra test) variability of the threshold sensitivity values obtained on repeat testing within the same testing session, representing measurement error, SF is expressed as the standard deviation of distribution of repeat values obtained on replicate testing at a location of visual field.

SWAP: Short Wave length Automated Perimetry: Test that isolates the blue-sensitive portion of the visual system for testing, also known as blue-yellow perimetry.

Single Field Analysis: Basic STATPAC display of the results of a single field examination, showing threshold sensitivity values, reliability parameters, global indices and the statistical calculations to compare the results with the range of values expected from the eyes with no ocular disease.

STATPAC: Trademark for Humphrey software that performs a series of statistical calculations on the visual field results, with displays that include single field analysis, change analysis, glaucoma change probability and overview printouts.

SITA: Swedish Interactive Thresholding Algorithm: Recently available strategy to measure the threshold sensitivity and reliability parameters efficiently, to achieve optimal measurements with minimal time.

Total Deviation Value and Probability Maps: The total deviation decibel values are the difference between the measured threshold sensitivity and age corrected normal sensitivity at each location. The total deviation probability map highlights locations where deviation exceeds those found in fewer than 5%, 2%, 1% or 0.5% of normal.

Bibliography

1. Anderson DR, Vincent Michael Patella. Automated Perimetry (2nd Edition).
2. Humphrey field analyzer II- User's Guide
3. Mare F Lieberman, Michael V Drake. Computerized perimetry, a simplified guide.
4. Nei T Choplin, Russel P Edwards. Visual field testing with Humphrey field analyzer.
5. Ravi Thomas MD, Ronnie George, Do - Interpreting automated perimetry Indian Journal of Ophthalmology, June 2001
6. The field analyzer primer - Humphrey Systems.