VISUAL FIELD INTERPRETATION IN GLAUCOMA

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FINANCIAL DISCLOSURE
In the past, I have received consulting or speaking fees from Carl Zeiss Meditec, Alcon Laboratories, Pfizer, and Inspire.

Visual Field Interpretation
- Methods of Data Presentation
- Systematic Strategy for Interpreting Visual Field / Recognizing Visual Field Loss
- Diagnostic Criteria for Glaucoma
- Classification of Visual Field Loss
- Identifying Progression
- Alternative Perimetry
RELIABILITY

• CATCH TRIALS
  – FIXATION LOSSES (20%)
  – FALSE POSITIVES (20%)
  – FALSE NEGATIVES (33%)

• GAZE TRACKER

METHODS OF DATA PRESENTATION

• GRAYSCALE
  – GIVES A PICTURE RESEMBLING ISOPTERS IN A GRAY TONE
  – QUICKLY IDENTIFIES OVERALL DEPRESSIONS

• NUMERIC GRID
  – RAW DATA (THRESHOLD LEVELS)
METHODS OF DATA PRESENTATION

- **TOTAL DEVIATION PLOT**
  - Difference between patient’s responses and age-matched normal population
- **TOTAL DEVIATION PROBABILITY PLOT**
  - Significance of the total deviation plot

- **PATTERN DEVIATION**
  - Adjusts the total deviation for the overall height of the hill of vision
  - Can be adjusted up or down
- **PROBABILITY PLOT**
METHODS OF DATA PRESENTATION

• GLOBAL INDICES
  – SINGLE NUMBER REPRESENTATIONS OF THE VISUAL FIELD
  – OVERALL GUIDELINES TO HELP ASSESS FIELD
  – PROBABILITY VALUES GIVEN WHEN NUMBERS REACH SIGNIFICANT VALUES
GLOBAL INDICES

• MEAN DEVIATION (MD)
  – HEIGHT OF THE HILL OF VISION
  COMPARED TO AGE-MATCHED
  NORMALS

• PATTERN STANDARD DEVIATION
  (PSD)
  – DEGREE TO WHICH THE SHAPE OF THE
  VISUAL FIELD DIFFERS FROM
  REFERENCE FIELD
  – DOES NOT CHANGE WITH MEDIA

GLAUCOMA HEMIFIELD TEST

• Mirror Image Analysis
  Compares Superior to
  Inferior Field
  – Within Normal Limits
  – Borderline
  – Outside Normal Limits
  – Abnormally High
  Sensitivity
  – General Reduction In
  Sensitivity

INTERPRETATION OF THE
AUTOMATED VISUAL FIELD

• RELIABILITY
  – MUST KNOW WHETHER OR NOT THE
  DATA YOU ARE ANALYZING IS
  RELIABLE
  • FIXATION LOSSES (20%)
  • FALSE POSITIVES (20%)
  • FALSE NEGATIVES (33%)
RECOGNIZING VISUAL FIELD DEFECTS

• GRAYSCALE: NOT APPROPRIATE FOR MAKING DIAGNOSIS
• MUST CONCENTRATE PRIMARILY ON THE DEVIATION PLOTS AND GLOBAL INDICES, SOME ATTENTION TO RAW (THRESHOLD) DATA

RECOGNIZING VISUAL FIELD DEFECTS

• USING RAW DATA (THRESHOLD) NUMBERS):
  – CENTRAL FOUR POINTS
  – POINTS ACROSS THE HORIZONTAL MIDLINE, ESPECIALLY IN NASAL HEMIFIELD
RECOGNIZING VISUAL FIELD DEFECTS

• USING THE TOTAL OR PATTERN DEVIATION PLOTS:
  – FIND MOST DEPRESSED POINTS;
  – EXAMINE POINTS SURROUNDING THOSE
  – LOOK FOR PATTERNS CONSISTENT WITH GLAUCOMA
    • NASAL STEP
    • ARCUATE BUNDLE
    • PARACENTRAL

• Look at Global Indices & GHT
  – For diagnosis, look to see if they reach statistical significance
  – For following over time, look for change
RECOGNIZING VISUAL FIELD DEFECTS

• SCOTOMAS AND DEPRESSIONS IN AREAS KNOWN FOR GLAUCOMA (PARACENTRAL, NASAL STEP, ARCUATE BUNDLE)

RECOGNIZING VISUAL FIELD DEFECTS

ALWAYS:
1. LOOK AT BOTH FIELDS TOGETHER
2. LOOK AT FIELD WITH RELATION TO OTHER CLINICAL FINDINGS - DOES THIS MAKE SENSE, IS IT CONSISTENT WITH THE DIAGNOSIS OF GLAUCOMA?
3. DON'T OVERLOOK OTHER CAUSES OF VISUAL FIELD DEFECTS

KEY POINTS TO INTERPRETATION

• MAKE SURE YOU ARE LOOKING AT TRUSTWORTHY DATA
• WILL PROBABLY TAKE 3-4 TESTS TO ACHIEVE APPROPRIATE BASELINE
• MAKE SURE IT MAKES SENSE WITH OTHER CLINICAL FINDINGS
STRATEGY DECISIONS

- 30-2 vs. 24-2
- Size III vs. Size V
- 24-2 vs. 10-2
- SITA-Standard vs. SITA-Fast (vs. Threshold or FastPac)

30-2 versus 24-2

24-2 versus 10-2
Customizable Test Grids

- Octopus perimetry allows custom test grids to decrease separation between points in areas of concern

Minimum Criteria for Diagnosis of Glaucoma VF Defect (HODAPP, ET AL, 1993)

1. GHT OUTSIDE NORMAL LIMITS ON AT LEAST TWO OCCASIONS

-OR-

Minimum Criteria for Diagnosis of Glaucoma VF Defect (HODAPP, ET AL, 1993)

2. CLUSTER OF 3 OR MORE NON-EDGE POINTS (in a typical location for glaucoma), ALL OF WHICH ARE IDENTIFIED AS SIGNIFICANT, WITH AT LEAST ONE AT THE p<1% ON TWO CONSECUTIVE TESTS

- (ON 24-2, USE ALL POINTS)

-OR-
Minimum Criteria for Diagnosis of Glaucoma VF Defect (HODAPP, ET AL, 1993)

3. (C)PSD FLAGGED AT p<5% OR WORSE ON TWO CONSECUTIVE FIELDS
   - USE PSD IF NO SHORT TERM FLUCTUATIONS USED
CLASSIFICATION OF FIELD LOSS
(Hodapp, et al)

- MILD (all 3 criteria must be met):
- FOR 24-2 SITA STANDARD
  - MD DEPRESSED BY <-5dB AND
  - ON PD PLOT, <25% (14) POINTS ARE
    DEPRESSED BELOW THE 5%
    SIGNIFICANCE LEVEL and fewer than
    half of those points are depressed
    below the 1% LEVEL AND
  - NONE OF CENTRAL FOUR POINTS
    HAS SENSITIVITY OF <20dB

CLASSIFICATION OF VISUAL FIELD LOSS

- MODERATE (24-2 Sita)
  - MD -5dB TO -10dB OR
  - ON PD PLOT, <50% (14-28) POINTS ARE
    DEPRESSED BELOW 5% LEVEL, OR 8-
    16 POINTS ARE BELOW THE 1% LEVEL
    OR
  - CENTRAL POINTS BETWEEN 10-20dB
    IN ONE HEMIFIELD (NO POINTS IN
    CENTRAL 5 DEGREES WITH <10dB)
CLASSIFICATION OF VISUAL FIELD LOSS

• SEVERE (24-2 Sita)
  – MD DEPRESSED BY MORE THAN -10dB OR
  – ON PD PLOT, GREATER THAN 50% (28) POINTS ARE DEPRESSED BELOW 5% OR MORE THAN 16 POINTS ARE BELOW THE 1% LEVEL OR
  – BOTH HEMIFIELDS IN THE CENTRAL 5 DEGREES HAVE <20dB OR
  – ANY POINT IN THE CENTRAL 5 DEGREES HAS A VALUE <10dB
INTERPRETATION TEMPLATE

- Look at reliability
- Look at central levels
- For variations of >4dB across horizontal midline nasally
- Total / pattern deviation plot - most depressed point and surrounding points
- Global indices (MD, PSD, GHT)

FOR THE RECORD

- Statement with respect to reliability
- Statement with respect to pattern, depth, and size of visual field loss
- Statement that correlates other examination findings with visual field

IDENTIFYING PROGRESSION

- Much more difficult than detecting loss
- Background of dynamic “noise”
- No algorithm uniformly agreed upon for detecting change
- Three main changes:
  - Deepening of defect
  - Enlargement of defect
  - New defect
IDENTIFYING PROGRESSION

- Long-term fluctuation
  - The single biggest problem in determining progression
  - Deeper defects: more long term fluctuation
  - More advanced glaucoma: more long term fluctuation, more fatigue

IDENTIFYING PROGRESSION

- Overview printout
  - Grayscale
  - Threshold values
  - Total and pattern deviation plots
  - GHT, global indices, reliability
OVERVIEW

Overview Plot

IDENTIFYING PROGRESSION

- Total /Pattern Deviation Probability Plots
  - Once a black box...
- Grayscale
- Threshold values
NTGS Criteria for Progression

• Previously normal area (baseline):
  – Three contiguous points, same side of horizontal meridian now abnormal
    • One point changed by 10dB on total deviation plot
    • Two points changed by 5dB on total deviation plot

• Previously abnormal area (baseline of 3 tests averaged):
  – Two contiguous points same side of horizontal meridian decrease by ≥ 10dB or 3x avg STF in baseline
  – Suspected point’s value must be lower than ANY value obtained for that point in the baseline tests

• TO CONFIRM, CHANGE MUST BE PRESENT IN FOUR OUT OF FIVE CONFIRMING TESTS
GUIDED PROGRESSION ANALYSIS (GPA)

- Humphrey Field Analyzer
  - Based on results of GLAUCOMA patients from mild to advanced disease
  - Patients took 12 different visual field tests within a 4 week period
  - Developed a model for what is "expected" test-test variation for patients with glaucoma

GPA

- Uses 2 baseline exams (any strategy)
  - Follow up tests must be SITA-Standard or SITA-Fast (all same strategy)
- Symbols used on Follow Up Tests
  - Open Triangles
  - Half Triangles
- Messages
  - Possible Progression
  - Likely Progression
  - Rate of Progression
CRITERIA FOR CHANGE

- Minimum of three tests required: 2 baseline and 1 follow-up exam
- Each follow-up compared to averaged thresholds of 2 baseline exams
- Additional follow-up compared both to baseline and to 2 most recent follow-ups
- Symbols:
  - ▲: Progression at 95% significance level
  - ▲ - ▲: Progressing point repeated in two consecutive exams
  - ▲ - ▲ - ▲: Progressing point repeated in three consecutive exams
- GPA Alert™: Three ▲ in one exam denotes “Possible Progression” and three ▲ indicates “Likely Progression”

HFA Guided Progression Analysis
New global metric - VFI - optimized for progression analysis

- Visual Field Index
- Calculated for all available reliable fields.
- Age-adjusted & center-weighted to better reflect ganglion cell loss.
- Reduced sensitivity to cataracts.
- 100% = normal function
- 0% = perimetric blindness

Elements of GPA 1-Page Summary Report

- Baseline Tests
- VFI (Trend Analysis)
- Today’s VF
ALTERNATIVE PERIMETRY

- Frequency Doubling Perimetry (FDP, FDT)
  - Matrix
- Short Wavelength Automated Perimetry (SWAP)
- Static vs. Kinetic
- Heidelberg Edge Perimetry
- GATE strategy

Frequency Doubling Technology (FDT)

- Based on frequency doubling illusion
  - Low spatial frequency grating flickered at high temporal frequency (>15Hz) – image is seen as a doubled spatial grating

The VFI Bar
- Historical and projected VFI loss
FDT

- Originally thought to target My cells
- Now thought to preferentially stimulate the magnocellular processing system
- Original test: up to 19 test points, 10° x 10° in threshold or screening mode
- Reported to have high specificity and sensitivity for detection of glaucoma
- Resistant to blur, illumination, small pupils, etc.
- No advantage for following for progression

FDT as a screening tool for glaucoma

- There is significant evidence in the literature that FDT is a sensitive test that is able to detect early glaucomatous defects.
- In most of the studies, there are very strict inclusion/exclusion criteria, including experience with perimetry, clear media, low refractive errors
Flicker Perimetry - Octopus

Matrix – Hybrid FDT/SAP

- Uses FDT stimulus presentation
- Smaller 5° targets presented in 24-2 pattern

Humphrey Matrix Test Strategies

<table>
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<th>Name</th>
<th>Type</th>
<th>Time, m</th>
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<td>N-30-1 (-5)</td>
<td>Screening</td>
<td>&lt; 1</td>
<td>19, 8° x10°</td>
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<tr>
<td>24-2</td>
<td>Screening</td>
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<td>Threshold</td>
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<td>Threshold</td>
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<td>69, 5° x5°</td>
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<td>N-30-F</td>
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<td>19, 8° x10°</td>
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<tr>
<td>10-2</td>
<td>Threshold</td>
<td>4</td>
<td>44, 2° x2°</td>
</tr>
<tr>
<td>Macula</td>
<td>Threshold</td>
<td>1.5</td>
<td>16, 2° x2°</td>
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Short Wavelength Automated Perimetry (SWAP)

- Large blue target presented on bright yellow background
- Theory: selectively tests blue cones and the koniocellular pathway
- Several studies: SWAP detects defects earlier than SAP
- Limitations: cataract/media opacity, compressed dynamic range, increased test time
- Indications: glaucoma suspect who has normal SAP
- Available in HFA and Octopus perimeters

Traditional SWAP Weaknesses Compared to W-W

- More time consuming, 15-17% longer using the same threshold strategy (Wild et al 1998)
- General depression of the hill of vision smaller dynamic range (no benefit of SWAP in patients with moderate to advanced field loss)
- More sensitive to cataract
- Larger intersubject variability wider normal limits for threshold values

Expected Improvements with SITA SWAP: Speed and Sensitivity

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<th>Fastpac</th>
<th>SITA</th>
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<td>7:50</td>
<td>3:56</td>
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<tr>
<td>Stimulus</td>
<td>V, Blue</td>
<td>V, Blue</td>
<td>V, Blue</td>
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<tr>
<td>Background</td>
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</tbody>
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Slide courtesy of Boel Bengtsson Dept of Ophthalmology, Malmo University Hospital, Sweden
Heidelberg Edge Perimetry (HEP)

- Disclaimer: device not FDA-approved and not commercially available in the US
- A type of flicker perimetry based on an illusionary stimulus
  - "Flicker-defined form"
  - 5° stimulus shown on background of flickering dots
  - Stimulus is flickered in counterphase at high temporal frequency
  - Phase difference between background and stimulus gives rise to an illusionary "edge" or border (circle)
  - Reported to detect early, pre-SAP defects
  - Defects are deeper than SAP

Stimulus - Flicker Defined Form (FDF)

Contour-Illusion Stimulus

Phase 1 + Phase 2 = Illusory "Edge" or Contour

Data Display – OU Results
OU Printout

Patient and Test Information
Est. Sensitivity
Grayscale
Total Deviation
Pattern Deviation
Reliability Parameters

A Combined Approach to Structure & Function

Structure Function Map

Structure & Function Map

Legend:
- Within Normal Limits
- Borderline
- Outside Normal Limits

Inner Ring:
- HRT MRA
- Structure Classification

Outer Ring:
- HEP
- Function Classification
Structure Function Reports: HRT & HEP

HEP
- Combined structure-function plot
  - Initially with MRA baseline data
  - Eventually hope to include progression analysis
- Currently available in several European countries
- Hope to have roll-out in USA in 2010

THANK YOU FOR YOUR ATTENTION.

QUESTIONS????

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