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A comparison of several methods of macular hole measurement using OCT and their value in predicting anatomical and visual outcomes

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Ms. Rubina Rahman, Consultant Vitreoretinal surgeon, Calderdale Royal Hospital, Halifax
Dr. John Stephenson, University of Huddersfield

BEAVRS 10th November 2011
Background

\(a = \text{base diameter}\)

\(b = \text{minimum linear dimension (MLD)}^{1}\)

\(e = \text{maximal hole height}\)

\(f = \text{macular hole inner opening}\)

Hole Form Factor (HFF)$^2$

Determine extent of Base diameter (a) and MLD (b)

Hole Form Factor = $(c + d) / a$

No correlation found between HFF and postop gain in lines

Macular Hole Index (MHI)\(^3\)

MHI = e / a

MHI was associated with postoperative vision

Tractional Hole Index (THI)$^4$

THI = $e/b$

THI correlated significantly with postop vision

Basic measurements

- Base diameter (a)
- Minimum linear dimension (b)
- Hole height (e)
- Macular hole inner opening (f)

Derived indices

- Hole Form Factor (c+d/a)
- Macular Hole Index (e/a)
- Tractional Hole Index (e/b)
Study

- Prospective consecutive case series study of 50 eyes from 50 patients, May ‘09 – Jan ‘11
- Idiopathic Stage II (n=8), Stage III (n=38) or Stage IV (n=4) macular hole
- 23-gauge vitrectomy, phaco + IOL, ILM peel with Brilliant Blue G staining and endotamponade with 20% SF$_6$
- No special posturing
- One pseudophake, no significant cataract
Outcome measures

• **Anatomical success:**
  Complete circumferential hole rim reattachment without foveal neurosensory retinal defect demonstrated on OCT

• **Visual success:**
  Gain of two or more Snellen lines at up to a year postop

• **Discharged at 3 months if 6/12 achieved, or at 1 year postop**

• **All patients whose macular holes had failed to close were successfully closed with further surgery**
Results

• 84% (42/50 eyes) achieved macular hole closure
• 76% (38 eyes) achieved ≥2 lines improvement in Snellen acuity
• Binary logistic regression analyses:
  – anatomical success (hole closure Y / N)
  – visual success (2 lines gained Y / N)
Assessment of variables associated with anatomical success

<table>
<thead>
<tr>
<th>Parameter</th>
<th>p-value</th>
<th>Odds ratio</th>
<th>95% CI for odds ratio</th>
<th>Area under ROC curve</th>
<th>95% CI for area under ROC curve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>0.642</td>
<td>0.975</td>
<td>(0.877, 1.084)</td>
<td>0.539</td>
<td>(0.317, 0.760)</td>
</tr>
<tr>
<td>Sex</td>
<td>0.616</td>
<td>0.643</td>
<td>(0.114, 3.610)</td>
<td>0.546</td>
<td>(0.331, 0.760)</td>
</tr>
<tr>
<td>Male - reference category Female</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Axial length (mm)</td>
<td>0.473</td>
<td>0.789</td>
<td>(0.412, 1.510)</td>
<td>0.555</td>
<td>(0.330, 0.780)</td>
</tr>
<tr>
<td>Base diameter (µm)</td>
<td>0.005</td>
<td>0.992</td>
<td>(0.987, 0.998)</td>
<td>0.929</td>
<td>(0.848, 1.000)</td>
</tr>
<tr>
<td>MH inner opening (µm)</td>
<td>0.002</td>
<td>0.984</td>
<td>(0.973, 0.994)</td>
<td>0.943</td>
<td>(0.873, 1.000)</td>
</tr>
<tr>
<td>Min Linear Dimension (µm)</td>
<td>0.002</td>
<td>0.990</td>
<td>(0.984, 0.997)</td>
<td>0.859</td>
<td>(0.735, 0.982)</td>
</tr>
<tr>
<td>Hole height (µm)</td>
<td>0.104</td>
<td>0.992</td>
<td>(0.981, 1.002)</td>
<td>0.679</td>
<td>(0.436, 0.922)</td>
</tr>
<tr>
<td>Macular Hole Index</td>
<td>0.006</td>
<td>7.390¹</td>
<td>(1.757, 31.09)¹</td>
<td>0.909</td>
<td>(0.821, 0.998)</td>
</tr>
<tr>
<td>Tractional Hole Index</td>
<td>0.065</td>
<td>1.279¹</td>
<td>(0.985, 1.660)¹</td>
<td>0.708</td>
<td>(0.517, 0.899)</td>
</tr>
</tbody>
</table>

¹Significant at the 0.05 level
### Assessment of variables associated with visual success

<table>
<thead>
<tr>
<th>Parameter</th>
<th>p-value</th>
<th>Odds ratio</th>
<th>95% CI for odds ratio</th>
<th>Area under ROC curve</th>
<th>95% CI for area under ROC curve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>0.378</td>
<td>0.959</td>
<td>(0.873, 1.053)</td>
<td>0.565</td>
<td>(0.391, 0.738)</td>
</tr>
<tr>
<td>Sex</td>
<td>0.954</td>
<td>1.042</td>
<td>(0.261, 4.155)</td>
<td>0.505</td>
<td>(0.314, 0.619)</td>
</tr>
<tr>
<td>Male - reference category</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Axial length (mm)</td>
<td>0.703</td>
<td>0.892</td>
<td>(0.495, 1.607)</td>
<td>0.542</td>
<td>(0.359, 0.724)</td>
</tr>
<tr>
<td>Base diameter (µm)</td>
<td><strong>0.013</strong></td>
<td><strong>0.996</strong></td>
<td>(<strong>0.993, 0.999</strong>)</td>
<td><strong>0.776</strong></td>
<td>(<strong>0.605, 0.947</strong>)</td>
</tr>
<tr>
<td>MH inner opening (µm)</td>
<td><strong>0.013</strong></td>
<td><strong>0.993</strong></td>
<td>(<strong>0.987, 0.998</strong>)</td>
<td><strong>0.761</strong></td>
<td>(<strong>0.591, 0.931</strong>)</td>
</tr>
<tr>
<td>Min Linear Dimension (µm)</td>
<td><strong>0.018</strong></td>
<td><strong>0.994</strong></td>
<td>(<strong>0.990, 0.999</strong>)</td>
<td><strong>0.717</strong></td>
<td>(<strong>0.540, 0.894</strong>)</td>
</tr>
<tr>
<td>Hole height (µm)</td>
<td>0.281</td>
<td>0.996</td>
<td>(0.998, 1.004)</td>
<td>0.579</td>
<td>(0.379, 0.779)</td>
</tr>
<tr>
<td>Macular Hole Index</td>
<td>0.091</td>
<td>1.510</td>
<td>(0.937, 2.433)</td>
<td>0.782</td>
<td>(0.608, 0.955)</td>
</tr>
<tr>
<td>Tractional Hole Index</td>
<td>0.178</td>
<td>1.130</td>
<td>(0.946, 1.350)</td>
<td>0.615</td>
<td>(0.437, 0.793)</td>
</tr>
</tbody>
</table>
a = Base diameter
f = Macular hole inner opening
Receiver Operating Characteristic (ROC) curve for anatomical success using the Base Diameter parameter

- A base diameter value of 747μm corresponds to 76.2% sensitivity and 100% specificity.
- 10% reduction in the odds of anatomical success for every 13μm increase in base diameter.
Thank you