Trabeculectomy Slows or Reverses the Rate of Visual Field Decay from Glaucoma

Caprioli, De Leon, Azarbod, Chen Morales, Coleman, Nouri-Mahdavi, Yu, Afifi

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- RPB
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S
VF Improvement After Surgery: My Clinical Observations

• Not a rare phenomenon
• Not a learning effect
• Robust decrease in IOP
• IOP often high pre-op
• Damage not too bad
• Patients not too old

Trans Am Acad Ophthalmol Otol 1974

• Acute reduction IOP with Diamox: Improvements with manual static perimetry
• Can’t exclude acute pharmacologic events independent of disease

Trans Am Acad Ophthalmol Otol 1974

The Effect of Change in Intraocular Pressure on the Natural History of Glaucoma: Lowering Intraocular Pressure in Glaucoma Can Result in Improvement of Visual Fields

George L. Spaeth
William and Anna Goldberg Glaucoma Service and Research Laboratories, Wills Eye Hospital, Pennsylvania

• Relationship between IOP and VF damage
• “Unless improvement is noted to accompany lowering of IOP, adequacy of control cannot be...assured”

Trans Ophthalmol Soc UK 1985

Restoration of Retinal Ganglion Cell Function in Early Glaucoma after Intraocular Pressure Reduction

A Pilot Study

Lori M. Vennura, MD, Victor Porciunc, DSc

• PERG, short term
• RGC function partially restored after IOP reduction in glaucomatous eyes with early VF impairment
• No improvement in eyes with normal VF

Ophthalmol 2005
• Substantial VF improvement at 5 years
• Δ MD used as outcome, no rates
• IOP reduction associated with VF improvement

Am J Ophthalmol 2014

• Short term, 3 months
• Δ in TD and PSD probability maps used
• No rates
• “Biomarker” for RGC response to treatment*

Am J Ophthalmol 2015

Problems to overcome:
• Signal/Noise; Variability
• Regression to mean
• Learning effect
• Media effects
  – Cataract
  – Ocular surface

Many tests, Fitted trend, Comparison group
Experience
Magnitude of change
Comparison group
Magnitude of change
No cataract surgery

Approach
• Measure change in rates of individual VF test locations before and after trabeculectomy
  – Long-term (years)
  – Allow for decaying or improving rates
  – Retain spatial information
• Comparison Group, help control for
  – Noise
  – Regression to the mean
Background

A Method to Measure and Predict Rates of Regional Visual Field Decay in Glaucoma

Joseph Caprio,6 Dennis Mock,1 Elena Ritrievi,4 Abdelmonem A. Alfi,7 Fei Yu,1,2 Koorev Nouri-Mahdav7,1 and Anne L. Coleman

Validation of Point-Wise Exponential Regression to Measure the Decay Rates of Glaucomatous Visual Fields

Parham Azarbad,1,2 Dennis Mock,1 Elena Ritrievi,4 Abdelmonem A. Alfi,7 Fei Yu,1,2 Koorev Nouri-Mahdav7,1 and Joseph Caprio

Models of Glaucomatous Visual Field Loss

Andrew Chen,1 Koorev Nouri-Mahdav1, Francisco J. Ottoola,1,2 Fei Yu,1,2 Abdelmonem A. Alfi,7 and Joseph Caprio

Composite Group

Comparison Group

• Open angle glaucoma
  – No intercurrent glaucoma or cataract surgery
  – Clinically “stable”, no ∆ number meds
• NOT a “treatment control”!
• ≥ 8 VFs, ≥ 4 years
  – “Mock surgery” at half follow-up
  – Rates fit for first and second half of follow-up

Trabeculectomy Group

• Open-angle glaucoma
• ≥ 4 VFs before AND after surgery
• ≥ 2 years before AND after surgery
• No intercurrent cataract surgery
• Absence of other VF causes

Methods

• Pointwise exponential regression
• Allow for decay or improvement within testing boundaries, with (-) or (+) rates
• Group analyses:
  – Trabeculectomy group: pre and post surgery
  – Comparison group: pre and post “mock surgery”
• Entire analysis repeated with:
  – Linear model (PLR)
  – Requirement for tighter fits (p < .10)
Methods

- Rates at each location
- Counts of decay and improving
- Locations of decay and improving
- Multivariate regression of potential factors associated with improving
<table>
<thead>
<tr>
<th></th>
<th>Trabeculectomy Group</th>
<th>Comparison Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of eyes</td>
<td>74</td>
<td>71</td>
</tr>
<tr>
<td>Number of patients</td>
<td>65</td>
<td>55</td>
</tr>
<tr>
<td>Age (mean ± SD)</td>
<td>61.4 ± 12.6</td>
<td>62.5 ± 10.0</td>
</tr>
<tr>
<td>VF follow-up duration (Pre/Post)</td>
<td>5.1 ± 2.1</td>
<td>5.4 ± 2.3</td>
</tr>
<tr>
<td>Number of VF’s ± SD</td>
<td>8.9 ± 4.7</td>
<td>9.0 ± 4.4</td>
</tr>
<tr>
<td>Initial MD (mean ± SD)</td>
<td>-7.2 ± 5.3</td>
<td>-5.6 ± 4.3</td>
</tr>
<tr>
<td>Final MD (mean ± SD)</td>
<td>-10.7 ± 6.4</td>
<td>-8.2 ± 5.1</td>
</tr>
</tbody>
</table>

### Pre- and Post-Op IOP Trabeculectomy Group

- **Pre-Op IOP**: Mean 10.0 ± 3.6
- **Post-Op IOP**: Mean 14.3 ± 2.9

### Trabeculectomy Group Exponential vs. Comparison Group Exponential

- **Preoperative**: Trabeculectomy Group has a steeper decline in IOP compared to the Comparison Group.
- **Postoperative**: Both groups show a decrease in IOP, but the Trabeculectomy Group maintains a lower IOP throughout.

### Gray scale of Rates

- **Preoperative** vs. **Postoperative**: The Trabeculectomy Group shows a significant decrease in the gray scale, indicative of improved visual field.
Multivariate Analysis for Improvement (Trabeculectomy)

- Age (baseline) \( p = 0.76 \)
- MD (baseline) \( p = 0.83 \)
- VFI (baseline) \( p = 0.65 \)
- \( \Delta \) IOP \( p = 0.009 \)

What about eyes?

Proportion of eyes with \( \geq 5 \) more locations improving post op: 80%

Proportion of eyes with \( \geq 10 \) more locations improving post op: 57%

Difference from Comparison Group: \( p = 0.0000 \)

\[ X^2 \] for exp, linear, or only best fits

Number of improving locations as a function of IOP reduction after surgery

\[ r = 0.33 \quad p = 0.001 \]
Trabeculectomy Can Improve Long-Term Visual Function in Glaucoma

Summary

- Trabeculectomy slows or reverses glaucomatous VF damage
- Reversal of rates from decay to improvement is common
- Duration of improvement is years
- The proportion of points improving post-op depends on the magnitude of IOP reduction
- Similar results with linear model and requirement for tighter fits

Implications

- Robust IOP reduction can reverse glaucomatous visual loss!
- Hypothesis: Sick but not dead RGCs
  - Prolonged agonal period
  - Opportunity for intervention
  - Reversal of VF loss should be a goal of treatment*
- Regional indices more meaningful than global indices (MD, VFI) when used as treatment outcome measure

Clinical Research Team

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