Surgical Management of Co-existing Glaucoma and Cataract

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Scope

• What are the options?
• How is it done?
• What to look out for and how to get out of trouble?

Co-existing glaucoma and cataract

Options

• Combined or sequential surgery?
  – Phacotrabeculectomy or phacoemulsification alone?
  – Phacotrabeculectomy or trabeculectomy alone?
  – Glaucoma surgery first or cataract surgery first?

Coexisting Cataract and Glaucoma

What are the options?

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Options for Glaucoma Surgery

“Traditional” Filtering surgery
• Trabeculectomy
• Drainage devices

Minimally/ Micro invasive
• Enhance conventional outflow
  – Goniosynechialysis
  – iStent
  – Hydrus
  – Trabectome
  – Excimer laser trabeculotomy
• Enhance uveoscleral outflow
  – CyPass
• Subconjunctival space drainage
  – AqueSys
• Decrease aqueous production
  – Endoscopic cyclophotocoagulation

Phacotrabeculectomy vs Phacoemulsification

Phacoemulsification alone leads to reduction of IOP
• Angle closure glaucoma
  – ≥6 mmHg
  – Provided <180° PAS
• Open angle glaucoma
  – ~ 1.5 mmHg
  – Higher the pre-op IOP, greater the IOP lowering

Phacotrabeculectomy vs Trabeculectomy

• IOP lowering better in trabeculectomy
  – Trab: 41% (10.9 ± 8.3 mmHg)
  – Phacotrab: 30% (6.2 ± 7.0 mmHg) (p=.003)
• More complications in phacotrabeculectomy
• More 5-FU injections post phacotrabeculectomy

<table>
<thead>
<tr>
<th></th>
<th>Trabeculectomy</th>
<th>Phacotrabeculectomy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post-op IOP</td>
<td>13</td>
<td>15</td>
</tr>
<tr>
<td>IOP decrease</td>
<td>10</td>
<td>6 – 7</td>
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<tr>
<td>Remarks</td>
<td>Gradual decrease in effect over time</td>
<td>One-site vs two-site</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Similar IOP lowering</td>
</tr>
<tr>
<td></td>
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<td>- Operating time shorter</td>
</tr>
<tr>
<td></td>
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<td>- Less endothelial cell loss</td>
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</tbody>
</table>

Phacoemulsification after Trabeculectomy

Leads to reduced trabeculectomy function
• Especially if within 6 months of trabeculectomy
• Risk of bleb failure ~2x if interval <6 months
• Increase in IOP of 2 mmHg in first 12 months after phacoemulsification
  – IOP increase lower when IOP before phaco was < 10 mmHg
• Change in bleb characteristics
  – More vascularized, less prominent

1Murphy et al, Can J Ophthalmol 2006
2Lochhead J, Br J Ophthalmol 2003
3Chang L, J Glaucoma 2006
Phacotrabeculectomy vs Consecutive Trabeculectomy-Phacoemulsification

- Phacoemulsification >6 months after trabeculectomy
- Similar success rates¹

¹Donoso R, J Cataract Refract Surg 2000

Phacoemulsification Alone

- Pros
  - Cataract surgery in PACG eyes can be difficult
  - Easier to do as a single procedure
  - Cataract surgery often opens up the drainage angle
  - May result in good IOP control
- Cons
  - May get post-operative pressure spike
    - Wipe out in advanced glaucoma
  - May require glaucoma surgery later
    - Patient will have two operations instead of one
  - Meta-analysis
    - Insufficient evidence to recommend cataract surgery alone in advanced PACG as effective in providing long term IOP control¹

¹Freidman et al. Cochrane Database Sys Review

Phacotrabeculectomy

- Pros
  - One procedure results in opening of drainage angle and lowering of IOP
  - Early glaucoma surgery in patients presenting with advanced glaucoma is beneficial¹,²
  - More effective than phaco alone in controlling IOP in CACG with cataracts³
- Cons
  - Long term results of phacotrabeculectomy compared to trabeculectomy in pseudophakic eyes
  - May not provide significantly lower IOP compared to phaco alone
  - Complications during cataract surgery detrimental to the trabeculectomy function
  - More postoperative complications³
  - Giving a patient a bleb for life when may not be needed

¹Stead et al. BJD 2010
²National Institute or Health and Clinical Excellence Guidelines 2009
³Tham et al. Ophthalmology 2009

Tham et al. Ophthalmology 2009

Mean IOP (mmHg)

Pre-op 1 3 6 9 12 15 18 21 24

Follow-up Duration / months

Phaco Group
Phaco-trabeculectomy Group
Phaco-trabeculectomy with 7 hypotony cases excluded
Single, or Combined?

• On balance
  – Separating the procedures is likely to result in better long term IOP control
  – In advanced glaucoma (extensive visual field loss threatening fixation) >>> phacotrabeculectomy
  – In moderate or mild glaucoma >>> cataract surgery
• Also consider glaucoma medications
  – Efficacy
  – Side effects
  – Compliance

Novel IOP-lowering Procedures

• Enhance conventional outflow
  – Goniosynechialysis
  – iStent
  – Hydrus
  – Trabectome
  – Excimer laser trabeculotomy
• Enhance uveoscleral outflow
  – Cypass
• Drainage into subconjunctival space
  – Aquesys
• Decrease aqueous production
  – ECP

Conventional Glaucoma Surgery

• Establish a direct communication between the AC and subconjunctival space
• Complications related to
  – Bleb: leaks, infection, scarring, dysesthesia
  – Plate & tube: exposure, migration, infection, cornea decompensation

Minimally Invasive Glaucoma Surgery

• MIGS
• Newer techniques
• Less invasive procedure
• Less conjunctival scarring
• Remove/ bypass site of greatest aqueous outflow resistance
  – Juxtacanalicular TM
Ideal MIGS

- Ab interno approach
- Minimal trauma/ destruction of target tissue
- Rapid post-op recovery
- Safe
- Effective long-term IOP reduction
- Does not prevent/ complicate subsequent conventional glaucoma surgery

Goniosynechialysis

- In angle closure
- Breaking of PAS, opening TM

<table>
<thead>
<tr>
<th>Country</th>
<th>Study</th>
<th>Eyes</th>
<th>Follow up (months)</th>
<th>IOP reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Thailand</td>
<td>Prospective</td>
<td>52</td>
<td>21</td>
<td>16.5</td>
</tr>
<tr>
<td>2 UK</td>
<td>Retrospective</td>
<td>15</td>
<td>6</td>
<td>13.3</td>
</tr>
<tr>
<td>3 Iran</td>
<td>Retrospective</td>
<td>11</td>
<td>8</td>
<td>26</td>
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<tr>
<td>4 Japan</td>
<td>Retrospective</td>
<td>34</td>
<td></td>
<td>25</td>
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<tr>
<td>5 Australia</td>
<td>Retrospective</td>
<td>51</td>
<td>26</td>
<td>10</td>
</tr>
</tbody>
</table>

Teekhasaenee et al. Ophthalmology 1999
Maeda et al. J Glaucoma 2014
Microbypass Trabecular iStent

- Heparin coated titanium
- Ab interno implantation
- Bypass trabecular resistance
- Improves TM outflow facility
- Requires visualisation of TM
- OAG

iStent Results

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Number of eyes</th>
<th>Followup (months)</th>
<th>IOP reduction (mmHg)</th>
<th>IOP reduction (%)</th>
<th>Postop. IOP (mmHg)</th>
<th>Reduction in meds (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spiegel et al. [14]</td>
<td>2007</td>
<td>6</td>
<td>12</td>
<td>4.9 ± 2.6</td>
<td>24.2</td>
<td>15.3 ± 3.7</td>
<td>0.5 ± 0.3</td>
</tr>
<tr>
<td>Buchaca et al. [15]</td>
<td>2011</td>
<td>10</td>
<td>12</td>
<td>6.6 ± 5.4</td>
<td>27.3</td>
<td>19.9 ± 2.3</td>
<td>1.8 ± 0.1</td>
</tr>
<tr>
<td>iStent/Phaco</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Spiegel et al. [16]</td>
<td>2008</td>
<td>48</td>
<td>6</td>
<td>5.7 ± 3.8</td>
<td>26.5</td>
<td>15.8 ± 3.0</td>
<td>1.5 ± 0.7</td>
</tr>
<tr>
<td>Spiegel et al. [17]</td>
<td>2009</td>
<td>42</td>
<td>12</td>
<td>4.4 ± 4.5</td>
<td>21.3</td>
<td>16.9 ± 1.2</td>
<td>1.0 ± 0.7</td>
</tr>
<tr>
<td>Fernández-Barrientos et al. [18]</td>
<td>2010</td>
<td>17</td>
<td>12</td>
<td>6.57 ± 2.95</td>
<td>27.2</td>
<td>17.6 ± 2.8</td>
<td>1.12 ± 0.48</td>
</tr>
<tr>
<td>Fea [19]</td>
<td>2010</td>
<td>12</td>
<td>15</td>
<td>3.2 ± 3.0</td>
<td>17.3</td>
<td>14.8 ± 1.2</td>
<td>2.0 ± 0.9</td>
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<tr>
<td>Samuelson et al. [20]</td>
<td>2011</td>
<td>106</td>
<td>12</td>
<td>8.4 ± 3.6</td>
<td>31</td>
<td>17</td>
<td>1.4 ± 0.8</td>
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<tr>
<td>Arriola-Villalobos et al. [21]</td>
<td>2012</td>
<td>19</td>
<td>54</td>
<td>3.16 ± 3.9</td>
<td>16.3</td>
<td>16.3 ± 4.2</td>
<td>0.47 ± 0.96</td>
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<tr>
<td>Craven et al. [22]</td>
<td>2012</td>
<td>240</td>
<td>24</td>
<td>—</td>
<td>8.4</td>
<td>17.1 ± 2.9</td>
<td>2.0 ± 1.4</td>
</tr>
</tbody>
</table>

iStent + Phaco

<table>
<thead>
<tr>
<th>Author (year)</th>
<th>Treatment</th>
<th>Number of eyes</th>
<th>Follow-up (months)</th>
<th>Number (%)</th>
<th>Change from baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Craven et al. [2012] [15]</td>
<td>PE+1 iStent</td>
<td>117</td>
<td>24</td>
<td>19 (16.2%)</td>
<td>8.1% Decrease, 81.3% Decrease</td>
</tr>
<tr>
<td>Samuelson et al. [2011] [14]</td>
<td>PE+1 iStent</td>
<td>117</td>
<td>12</td>
<td>17 (14.5%)</td>
<td>8.0% Decrease, 86.7% Decrease</td>
</tr>
<tr>
<td>Fea [2010] [16]</td>
<td>PE+1 iStent</td>
<td>12</td>
<td>15</td>
<td>0</td>
<td>17.3% Decrease, 90.0% Decrease</td>
</tr>
<tr>
<td>Fernández-Barrientos et al. [2010] [17]</td>
<td>PE+2 iStent</td>
<td>17</td>
<td>12</td>
<td>0</td>
<td>27.3% Decrease, 100% Decrease</td>
</tr>
<tr>
<td>Craven et al. [2009] [18]</td>
<td>PE+1 iStent</td>
<td>48</td>
<td>12</td>
<td>6 (12.5%)</td>
<td>20.3% Decrease, 75.0% Decrease</td>
</tr>
</tbody>
</table>

IOP, intraocular pressure; meds, glaucoma medications; PE, phacoemulsification.
iStent + Phaco

- Randomised controlled multi-center trial
- iStent + phaco vs phaco alone
- 240 eyes, OAG, 12 months follow-up
- Decrease in IOP similar
  - 1.5 ± 3.0 (8%) vs 1.0 ± 3.3 (5.4%)
- Need for post op IOP medications lesser in iStent group
  - 15% vs 35% (p=.001)
- Adverse events
  - IOP spike 12%
  - Stent obstruction 7%
  - Stent malposition 6%

Samuelson et al. Ophthalmology 2011

More iStents = Lower IOP

- Case series
- 2 or 3 iStents implanted at end of phacoemulsification
- 53 eyes, OAG, 12 months follow-up
- Post-op IOP less than pre-op IOP (p<.001)
- Mean IOP at 1 year 14.3 mmHg
- Target IOP achieved in 77% post-op vs 43% pre-op
- Medications reduced from 2.7 to 0.7 (p<.001)
- 74% needed fewer medications
- 3 stent group needed significantly less medication


Hydrus Schlemm’s Canal Scaffold

- Intracanalicular scaffold
- Nitinol material: flexible, biocompatible
- Scalloped, open design
- Spans 3 clock hours to target multiple collector channels
- Inserted through TM
- Increase TM outflow facility by 74% in donor eyes
  - Compared to 34% with two trabecular micro-bypasses
- IOP reduction
  - Prospective uncontrolled series
  - 44 eyes, phaco + hydrus, 3 months follow-up
  - 28% reduction (21.4 ± 4.8 to 15.4 ± 4.4)
- Complications
  - Blood reflux (15%)
  - Iritis (4%)

1 Hays CL et al. Invest Ophthalmol Vis Sci 2014
2 Tetz et al. ESCRS 2011

Hydrus in POAG

- Multicenter trial
- 40 pts, POAG, 6 months follow-up

<table>
<thead>
<tr>
<th>IOP</th>
<th>Medications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-op</td>
<td>21.6 ± 4.4</td>
</tr>
<tr>
<td>Post-op</td>
<td>16.9 ± 3.8</td>
</tr>
</tbody>
</table>

- 58% reduced medication usage by > 1 med
- 4 had PAS near device inlet
- No hypotony, endophthalmitis

Lorenz et al. AGS 2012
Hydrus + Phaco

- Multicenter trial
- 29 pts, POAG and PXG, 6 months follow-up

<table>
<thead>
<tr>
<th>IOP</th>
<th>Medications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-op</td>
<td>21.1 ± 5.3</td>
</tr>
<tr>
<td>Post-op</td>
<td>15.9 ± 3.5</td>
</tr>
</tbody>
</table>

Pfeiffer et al. AGS 2012

Trabectome

- Excise and cauterize strip of TM and inner wall of Schlemm’s canal
- Create direct pathway for aqueous to collector channels
- Using high frequency electrocautery
- Lower IOP by enhancing trabecular outflow without external filtration
- Modest results
  - Reduce IOP by about 5 mmHg
  - IOP <15 mmHg seldom reached
- Safe with minimal complications
  - Blood reflux considered normal
- No adverse effect on subsequent trabeculectomy

2 Jeal SY et al. J Glaucoma 2012


Trabectome Results

<table>
<thead>
<tr>
<th>Table 3: Trabectome studies results.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Author</td>
</tr>
<tr>
<td>------------------------</td>
</tr>
<tr>
<td>Trabectome alone</td>
</tr>
<tr>
<td>Minckler et al. [2]</td>
</tr>
<tr>
<td>Minckler et al. [3]</td>
</tr>
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<td>Mosaed et al. [5]</td>
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<td>Trabectome/Phaco</td>
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<td>Francis et al. [6]</td>
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<td>Francis [7]</td>
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<tr>
<td>Vold [4]</td>
</tr>
<tr>
<td>Mosaed et al. [5]</td>
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<td>Francis et al. [8]</td>
</tr>
<tr>
<td>Maea et al. [9]</td>
</tr>
</tbody>
</table>

Brandao L et al. J Ophthalmo. 2013
**Trabectome + Phaco**

**Table 3. Studies of combined phacoemulsification and trabeculectomy**

<table>
<thead>
<tr>
<th>Author (year)</th>
<th>Treatment</th>
<th>Number of eyes</th>
<th>Follow-up (months)</th>
<th>Number (%) lost to follow-up</th>
<th>Change from baseline</th>
<th>Mean IOP (%)</th>
<th>Mean Meds (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Francis (2010) [21]</td>
<td>PE-Trabectome</td>
<td>114</td>
<td>24</td>
<td>47 (41%)</td>
<td>31.1% Decrease</td>
<td>22.1 ± 5.5</td>
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<tr>
<td></td>
<td>PE</td>
<td>145</td>
<td></td>
<td>104 (71.7%)</td>
<td>11.7% Decrease</td>
<td>15.3 ± 4.6</td>
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<td>Mosad et al. (2010) [22]</td>
<td>PE-Trabectome</td>
<td>290</td>
<td>12</td>
<td>24 (8%)</td>
<td>22.8% Decrease</td>
<td>23.0 ± 10.7</td>
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</tr>
<tr>
<td></td>
<td>PE</td>
<td>189</td>
<td></td>
<td>120 (64%)</td>
<td>33.3% Decrease</td>
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<tr>
<td>Francis and Winsky (2011) [20]</td>
<td>PE-Trabectome</td>
<td>158</td>
<td>24</td>
<td>106 (67%)</td>
<td>22.2% Decrease</td>
<td>15.4 ± 3.1</td>
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<tr>
<td>Ahuja et al. (2013) [23*]</td>
<td>PE-Trabectome</td>
<td>232</td>
<td>24</td>
<td>166 (72%)</td>
<td>31.9% Decrease</td>
<td>11.0 ± 5.7</td>
<td></td>
</tr>
</tbody>
</table>

IOP, intraocular pressure; meds, glaucoma medications; PE, phacoemulsification; NR, not reported.

**Phaco-trabectome vs Phacotrabeculectomy**

- 89 phaco-trabectome vs 23 phacotrabeculectomy
- 1 year follow-up

<table>
<thead>
<tr>
<th></th>
<th>Phaco-trabectome</th>
<th>Phacotrabeculectomy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-op IOP</td>
<td>22.1 ± 5.5</td>
<td>23.0 ± 10.7</td>
</tr>
<tr>
<td>Post-op IOP</td>
<td>15.4 ± 3.1</td>
<td>11.0 ± 5.7</td>
</tr>
<tr>
<td>Decrease</td>
<td>6.7 (27%)</td>
<td>12 (44%)</td>
</tr>
</tbody>
</table>

- Post-op complications
  - Early IOP spike in phaco-trabectome
  - More frequent and severe in phacotrabeculectomy

**Trabectome for OAG**

- Retrospective, single-center (Mayo), case series
- 246 cases
  - 88 trabectome, 158 phaco-trabectome
  - 24 months follow-up

<table>
<thead>
<tr>
<th></th>
<th>Pre-op</th>
<th>Post-op</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean IOP</td>
<td>21.6 ± 8.6</td>
<td>15.3 ± 4.6</td>
<td>-29% P&lt;.001</td>
</tr>
<tr>
<td>Number of medications</td>
<td>3.1 ± 1.1</td>
<td>1.9 ± 1.3</td>
<td>-38% P&lt;.001</td>
</tr>
</tbody>
</table>

**Excimer Laser Trabeculotomy (ELT)**

- Creates small holes in TM and inner wall of Schlemm’s canal
- Provide direct pathway for aqueous into collector channels
- Xenon-chloride pulsed excimer laser connected to quartz fiber-optic probe
- 8-10 laser punctures over 90° through ab interno approach
ELT Results

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Number of eyes</th>
<th>Follow up (months)</th>
<th>IOP reduction (mmHg)</th>
<th>IOP reduction (%)</th>
<th>Postop. IOP (mmHg)</th>
<th>Reduction in meds</th>
</tr>
</thead>
<tbody>
<tr>
<td>ELT only</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Babighian et al. [10]</td>
<td>2006</td>
<td>21</td>
<td>24</td>
<td>7.8 ± 0.07</td>
<td>31.8</td>
<td>16.9 ± 2.1</td>
<td>0.71 ± 0.8</td>
</tr>
<tr>
<td>Babighian et al. [11]</td>
<td>2010</td>
<td>15</td>
<td>24</td>
<td>7.4</td>
<td>29.6</td>
<td>19.1 ± 1.8</td>
<td>0.73 ± 0.8</td>
</tr>
<tr>
<td>ELT/Phaco</td>
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<td></td>
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</tr>
<tr>
<td>Wilmsmeyer et al. [12]</td>
<td>2006</td>
<td>60</td>
<td>12</td>
<td>10.7 ± 1.7</td>
<td>47</td>
<td>12.8 ± 1.5</td>
<td>1.8 ± 0.9</td>
</tr>
<tr>
<td>Töteberg-Harms et al. [13]</td>
<td>2011</td>
<td>24</td>
<td>12</td>
<td>8.9 ± 5.2</td>
<td>34.7</td>
<td>16.5 ± 4.9</td>
<td>0.79 ± 0.6</td>
</tr>
</tbody>
</table>

1 Babighian S et al. Eye 2010
2 Töteberg-Harms M et al. Ophthalmologe 2011

ELT

- ELT vs 180°SLT<sup>1</sup>
  - Prospective randomised clinical trial
  - 30 pts, POAG, 24 months follow-up
  - No significant difference in complete/ qualified success

- Phaco + ELT<sup>2</sup>
  - Case series
  - 28 eyes, OAG, 1 year follow-up
  - IOP reduction: 25.3 ± 2.9 to 16.5 ± 5.0 (P<.001)
  - Medications: 2.3 ± 1.3 to 1.5 ± 1.4 (P=.017)

CyPass Suprachoroidal Microstent

- Polyamide material
- Size of a grain of rice
- Ab interno insertion into suprachoroidal space
- Drain aqueous into suprachoroidal space
CyPass alone for OAG

- Multi-center clinical trial
- 225 eyes, OAG, 12 months follow-up

<table>
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<tr>
<td>Pre-op</td>
<td>22.6 ± 5.7</td>
<td>2.4 ± 1.3</td>
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<tr>
<td>Post-op</td>
<td>18.9 ± 8.1</td>
<td>1.4 ± 1.4</td>
</tr>
</tbody>
</table>

- No post-op adverse events

CyPass + Phaco

- Multi-center clinical trial
- 184 eyes, OAG, 6 months follow-up
- Mean pre-op IOP 21.1 ± 5.9
- Mean pre-op meds 2.1 ± 1.1
- Pre-op uncontrolled IOP (n=57)
  - 37% reduction in IOP, meds reduced by >50%
- Pre-op well-controlled IOP (n=41)
  - IOP unchanged, meds reduced by 71%
- Complications
  - Transient early hypotony (13.8%)
  - Transient IOP rise (10.5%)

<table>
<thead>
<tr>
<th>Sample size</th>
<th>Pre-op IOP</th>
<th>Post-op IOP</th>
<th>Follow-up</th>
<th>Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>81</td>
<td>22.9</td>
<td>16.2</td>
<td>6 months</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Shallow AC, Transient hyphaema</td>
</tr>
<tr>
<td>2</td>
<td>121</td>
<td>25.6</td>
<td>15.5</td>
<td>6 months</td>
</tr>
<tr>
<td></td>
<td>(34 with IOP analysis)</td>
<td></td>
<td></td>
<td>Transient hyphaema, Persistent inflammation, BRVO, Macula edema</td>
</tr>
</tbody>
</table>
Drain Aqueous into Subconjunctival Space

AqueSys

- Porcine collagen tube
- 6 mm long
- 225um external diameter with internal lumen
- Ab interno surgical approach
- Tube implanted into pigmented trabecular meshwork with one end in anterior chamber and the other in the subconjunctival space
- Aqueous drained directly from AC into subconjunctival space

AqueSys Data

- None available on PubMed
ECP

- Pulsed, continuous–wave diode laser
- Delivered with fiber optic cable
- Fiber optic cable houses the laser probe and endoscopic camera
- Laser applied to ciliary processes
- Under direct endoscopic visualization

ECP + Phaco

MIGS Results

- MIGS better than phaco alone in reducing IOP
- No RCTs, mostly case series
- IOP reduction inferior to trabeculectomy
- Small number of subjects
- Short duration of follow-up
- Lack of publications

**Table 1.** Studies of combined phacoemulsification and endoscopic cyclophotocoagulation

<table>
<thead>
<tr>
<th>Author (year)</th>
<th>Treatment</th>
<th>Number of eyes</th>
<th>Follow-up (months)</th>
<th>Number (%)</th>
<th>Change from baseline</th>
<th>Mean IOP (%)</th>
<th>Mean Meds (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Mean (%)</td>
<td>Mean (%)</td>
</tr>
<tr>
<td>Clement et al. [4]</td>
<td>PE-ECP</td>
<td>63</td>
<td>12</td>
<td>NR</td>
<td>23.9 Decrease</td>
<td>45.8 Decrease</td>
<td></td>
</tr>
<tr>
<td>Lindfield et al. [5]</td>
<td>PE-ECP</td>
<td>58</td>
<td>24</td>
<td>17 (29%)</td>
<td>33.0 Decrease</td>
<td>5.1 Increase</td>
<td></td>
</tr>
<tr>
<td>Lima et al. [6]</td>
<td>PE-ECP</td>
<td>368</td>
<td>35.2 (Mean)</td>
<td>NR</td>
<td>46.7 Decrease</td>
<td>74.3 Decrease</td>
<td></td>
</tr>
<tr>
<td>Kahook et al. [7]</td>
<td>PE-ECP (1 site)</td>
<td>15</td>
<td>6</td>
<td>8 (53%)</td>
<td>32.2 Decrease</td>
<td>21.9 Decrease</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PE-ECP (2 sites)</td>
<td>25</td>
<td></td>
<td>12 (48%)</td>
<td>45.9 Decrease</td>
<td>79.7 Decrease</td>
<td></td>
</tr>
<tr>
<td>Berke [9]</td>
<td>PE-ECP</td>
<td>626</td>
<td>38.4 (Mean)</td>
<td>NR</td>
<td>17.6 Decrease</td>
<td>57.5 Decrease</td>
<td></td>
</tr>
<tr>
<td>Gayton et al. [10]</td>
<td>PE-ECP</td>
<td>29</td>
<td>23.5 (Mean)</td>
<td>12 (21%)</td>
<td>28.8 Decrease</td>
<td>34.4 Decrease</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PE-trab</td>
<td>29</td>
<td>27.2 (Mean)</td>
<td></td>
<td>31.9 Decrease</td>
<td>29.2 Decrease</td>
<td></td>
</tr>
<tr>
<td>Uram [8]</td>
<td>PE-ECP</td>
<td>10</td>
<td>19.2 (Mean)</td>
<td>0 (&lt;1 year)</td>
<td>23.9 Decrease</td>
<td>45.8 Decrease</td>
<td></td>
</tr>
</tbody>
</table>

ECP, endoscopic cyclophotocoagulation; IOP, intraocular pressure; meds, glaucoma medications; NR, not reported; PE, phacoemulsification; trab, trabeculectomy.
Efficacy

- Minimally Effective Glaucoma Surgery?
- Not suitable for patients with low target IOP

Should We Adopt MIGS?

- Depends on outcome of trials
  - Safety
  - Efficacy
  - Long term results
- Ease of performing surgery
- Cost of procedure, implant & consumables

Surgical Options

Phacoemulsification alone or with
1. Filtration surgery – trabeculectomy/ MMC
2. Goniosynechiolysis
3. Endoscopic cyclophotocoagulation
4. Minimally Invasive Glaucoma Surgery (MIGS)
   a. Aquesys
   b. Hydrus
   c. iStent
   d. Trabectome

Phaco Plus Glaucoma Surgery – How To Do It

Daniel SU
Consultant
Glaucoma Service
Singapore National Eye Centre
Phaco Alone in PACG – Potential problems

- Very shallow anterior chamber
- Iris prolapse
- Bulky lens
- Zonular weakness
- Posterior synechiae especially after acute attack

Solutions

- Long corneal tunnel
- Break posterior synechiae before starting capsulorrhexis
- Release viscoelastic before hydrodissection
- Increase bottle height during phaco
- Gentle nuclear manipulation
- May require capsular tension ring

Phaco/ IOL/ Trab/ MMC

- Surgical videos
- Dissect conjunctival flap and scleral flap
- Place MMC sponges under conjunctival flap
- Perform phaco
- Perform sclerostomy and iridectomy
- Closure of scleral and conjunctival flaps
**Goniosynechiolysis in PACG**

- Surgical video
- Complete phaco/IOL, inflate AC with viscoelastic
- Visualise PAS & angle structures with gonio lens
- Insert spatula into AC to reach iris
- Gently break PAS with spatula
- Additional corneal incisions to reach all quadrants

- Avoid excessive downward pressure with gonio lens – view obscured by corneal striae
- Greater post-op inflammation
- Intensive post-op steroids
- Beware bleeding in patients on anti-platelet medications or anti-coagulation

**Open Angle Glaucoma**

- Phaco/IOL plus
  - Increase aq outflow
  - Trab/MMC
  - Aquesys
  - Hydrus
  - iStent
  - Trabectome

- Reduce aq inflow
  - ECP

**Endoscopic cyclophotocoagulation**

- Complete phaco, inflate sulcus with viscoelastic (not the AC!!)
- Insert probe with camera oriented correctly
- Continuous laser mode
- Advance probe towards ciliary processes till they whiten and shrink, then withdraw
- Pay attention to endoscope view & microscope view
Aquesys

- Surgical video
- Complete phaco/ IOL, inflate AC with viscoelastic
- Visualise angle structures with gonio lens
- Insert implanting needle into AC
- Enter PTM, aiming to exit sclera 2-3mm behind limbus
- Deploy implant

Hydrus

- Surgical video
- Complete phaco/IOL, inflate AC with viscoelastic
- Visualise angle structures with gonio lens
- Implant inserted into target zone

iStent

- Surgical video
- Complete phaco/ IOL, inflate AC with viscoelastic
- Visualise angle structures with gonio lens
- Embed implant through TM
- May need 2 or more implants spaced far apart

Trabectome

- Surgical video
- Complete phaco/ IOL, inflate AC with viscoelastic
- Visualise angle structures with gonio lens
- Insert probe into AC
- Embed sharp tip into PTM & commence cutting in anti-clockwise direction
- Disengage TM, turn in opposite direction, repeat
Complications of Glaucoma Surgery
What to expect and how to manage them

Jocelyn CHUA
Consultant
Glaucoma Service
Singapore National Eye Centre

Complications: When can these occur?

• Intraoperative
• Early postoperative
• Late postoperative

Type and severity of complications depends on the type of glaucoma surgery performed as well as disease severity

Filtration surgery
1. Trabeculectomy with antimetabolites
2. Aqueous shunt

Cyclophotocoagulation
1. Endoscopic
2. Trans scleral

Filtration surgery
1. Ab-interno trabeculotomy with Trabectome
2. Trabecular bypass I-stent
3. Goniosynechiolysis
4. AqueSys
5. Hydrus

Type and severity of complications depends on the type of glaucoma surgery performed as well as disease severity
Intraoperative complications

- Conjunctival button hole – Gentle handling of conjunctiva
- Subconjunctival hemorrhage - Gentle subconjunctival dissection; preop cessation of antiplatelets / anticoagulants
- Torn scleral flap – Avoid creating a thin flap
- Suprachoroidal bleed – Avoid intraoperative hypotony; myopes, nanophthalmics, hypertensives, Sturge weber eyes at risk
- Hyphema – Avoid incision of iris root during iridectomy
- Retained anti-metabolite sponge – need to account for number of sponges (medicolegal)

Management of intraoperative complications

- Conjunctival button hole – 8/0 vicryl closure
- Torn scleral flap – Suture torn edges if minor tear; otherwise consider another site or tutopatch flap
- Suprachoroidal bleed – Immediate wound closure, reform AC (Healon GV)
- Hyphema – AC washout with BSS/adrenaline; air bubble

Early postoperative complications

- Wipe-out visual loss – high risk in very advanced glaucoma
- Acute endophthalmitis
- Hypotony / Shallow anterior chamber / choroidals
- Overfiltration – Avoid having loose flap sutures
- Bleb wound leak – Meticulous conjunctival closure; Avoid MMC treatment to wound edge
- Underfiltration – Avoid having tight flap sutures; iridectomy performed
- Malignant glaucoma
- Hyphema – Avoid damage to iris root
- Corneal epitheliopathy – Ensure good irrigation of MMC

Management of early postoperative complications

- Hypotony / Shallow anterior chamber / choroidals
  – Reduce topical steroid, topical atropine 1%
  – Overfiltration: Flex contact lens, torpedo patch, AC reformation with Healon GV, resuture of scleral flap
  – Bleb wound leak: bandage contact lens, resuture of conjunctiva
- Underfiltration – Bleb massage / adjust suture tension, early suturelysis, glaucoma medications
Management of early postoperative complications

- Malignant glaucoma (depends on phakic status)
  - Topical atropine 1%
  - Yag anterior hyaloid, vitrectomy
- Hyphema
  - Conservative management; AC washout if persistent non clearing hyphema and/or associated with very high IOP
- Corneal epitheliopathy
  - Due to MMC, dry eyes, dellen effect
  - Copious lubrication
  - Preservative free steroids and antibiotics

Late postoperative complications

- Blebitis / Endophthalmitis
- Overfiltration
- Hypotony / Shallow anterior chamber / choroidals
- Corneal epitheliopathy
- Underfiltration
  - Cataract
  - Bleb wound leak (Trabeculectomy only)
  - MMC-related cystic bleb (Trabeculectomy only)

Management of late postoperative complications

- Overfiltration
  - Autologous blood injection, compression sutures, bleb revision
- Underfiltration due to bleb fibrosis
  - Bleb needling with 5-FU
- Cataract - phacoemulsification
- Bleb wound leak (Trabeculectomy only)
  - bleb revision
- MMC-related cystic bleb (Trabeculectomy only)
  - bleb revision

Late postoperative complications (Post aqueous shunt)

- Tube obstruction – minimize risk of hyphema, vitreous in AC, bevel tube end
- Tube exposure – secure tube to minimize micro-movement; risk independent of patch material
- Tube malposition – avoid proximity to cornea
- Endothelial cell loss with corneal decompensation
Management of late postoperative complications (Post aqueous shunt)

- Tube obstruction
  - Yag blood/vitreous
- Tube exposure / malposition
  - Tube revision
- Corneal decompensation
  - Corneal transplant with tube revision

Filtration surgery
1. Trabeculectomy with antimetabolites
2. Aqueous shunt

Non-penetrating / minimally invasive surgery
1. Ab-interno trabeculotomy with Trabectome
2. Trabecular bypass I-stent
3. Goniosynechiolysis
4. AqueSys
5. Hydrus

Type and severity of complications depends on the type of glaucoma surgery performed as well as disease severity

Advantages
- Conjunctival sparing
- No need to fashion scleral flap
- Risk of suprachoroidal bleed similar to that of phacoemulsification alone
- No MMC treatment
- Shorter surgical time
- Glaucoma procedure performed using the same clear corneal incision
- Easier postoperative management

Pre-requisite for success
- Correct identification of angle structures – posterior trabecular meshwork
- Able to use goniolens well
- Familiarity with instruments / implants
- Patient selection / glaucoma severity

Intraoperative complications

- Hyphema / Reflux bleed
- Damage to contiguous ocular structures

Early postoperative complications

- Underfiltration with raised IOP – Topical glaucoma meds
- Hyphema – often treated conservatively
- Dislodged implant – may need removal of implant

Late postoperative complications

- Underfiltration with raised IOP – Topical glaucoma meds

I-Stent: Success of IOP control

- At 6 mths – 66% medication free
- At 1 year – 30% final IOP reduction; 75% medication free
- At 15 / 24 months – 67% medication free; medication use not statistically significant
- After 3 years – 16% final IOP reduction; 42% medication free
- Subjects: Mild-moderate primary open angle glaucoma / ocular hypertension

Trabectome: Success of IOP control

- At 6 mths – 30% final IOP reduction
- At 24 months – 14% failure rate with 12% occurring within 2 weeks after surgery
- At 30 months – 40% mean IOP reduction; 16% failure rate

References:

### Intraoperative complications

- **Trans-scleral**
  - Scleral / conjunctival burn

- **Endoscopic**
  - Laser damage to intraocular structures

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**Type and severity of complications depends on the type of glaucoma surgery performed as well as disease severity**

### Early postoperative complications

- **Raised IOP** – Topical glaucoma meds
- Increased AC inflammation – increase topical steroid
- Hypotony
- Posterior vitreous detachment / retinal detachment
- Cystoid macular edema

### Late postoperative complications

- **Raised IOP** – Topical glaucoma meds
  - At 12 months – Overall success of 55%
- Phthisis bulbi / vision loss

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