Trans Epithelial Surface Ablation
A personal reflection over a collective experience

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SCHWIND USERS LECTURE, BOOTH C13
ESCRS CONGRESS
LONDON 2014
The efficacy and safety of my first 300 eyes treated with the SCHWIND ARMARIS

14th International SCHWIND User Meeting
17-20 January 2013

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Birmingham
United Kingdom
City of Birmingham
World Famous Brands: ‘a city of a thousand trades’
Introduction

Trans-PRK should appear to offer:

- One-step treatment
- Non-Touch technique
- Fast epithelial healing
- Quicker recovery
The Mechanism

- Central epithelial thickness 55 µm*
- Peripheral epithelial thickness at 8 mm diameter 65 µm* (Reinstein DZ et al. J Refract Surg. 2008 Jun;24(6):571-81)
- One profile (epithelium removal + refraction)
- Epithelium removal part is refractive neutral, thus no extra refraction is induced
- Calculation based on two different ablation values per pulse; higher for epithelium
The Advantages

- Simultaneous ablation of the epithelium and the stroma to **shorten the overall treatment time**
- **Minimise corneal dehydration**
- Epithelial tissue removal can be **optimised to avoid** myopic-like corrections (−0.75 D).
- Superimposing a defined epithelial thickness profile with a refractive **aspheric ablation profile**.
- The diameter of epithelial removal can be calculated to match the ablation zone thus **decreasing the wound surface area**
- Less instrumentation (**less infection**)
The Disadvantages

- We will cover this at the end
What is known?

- **Clinch et al. (1998)**
  - Summit; mechanical removal optimal results
- **Kanitkar et al. (2000)**
  - Visx S3; no difference in healing time, less pain in alcohol assisted
- **Lee et al. (2005)**
  - Visx S3; No differences in pain/haze/UCVA
  - Trans-PRK yielded overcorrection
- **Ghadhfan et al. (2007)**
  - NIDEK EC5000; Trans-PRK yielded better outcomes
- **Buzzonetti et al. (2009)**
  - NIDEK CXIII: PTK mode to be safe and effective
What is known?

<table>
<thead>
<tr>
<th></th>
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<tr>
<td>No. of eyes</td>
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<td>30</td>
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<td>-0.21 ± 0.61</td>
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<td>-0.04 ± 0.02</td>
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<td></td>
</tr>
<tr>
<td>UDVA</td>
<td>0.67</td>
<td>0.97</td>
<td>0.8</td>
<td>0.8</td>
</tr>
</tbody>
</table>
Let’s just revisit principles of PTK

- This is equal depth ablation at all positions
- So why does it induce hyperopic shift?
FLAT DEPTH PTK PRINCIPLES

- This is equal depth ablation at all positions
- So why does it induce hyperopic shift?
  - i) Central epithelium is thinner by 10µm and ablation will be 10µm deeper simulating -0.75 myopia, i.e., inducing a +0.75D hyperopic shift.
FLAT DEPTH PTK PRINCIPLES

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  - i) Central epithelium is thinner by 10µm and ablation will be 10µm deeper simulating -0.75 myopia, i.e., inducing a +0.75D hyperopic shift.
  - ii) Reduce axial length inducing minimal hyperopic of <0.25D per 100µm of tissue ablation.
This is equal depth ablation at all positions.

So why does it induce hyperopic shift?

- i) Central epithelium is thinner by 10µm and ablation will be 10µm deeper simulating -0.75 myopia, i.e., inducing a +0.75D hyperopic shift.

- ii) Reduce axial length inducing minimal hyperopia of <0.25D per 100µm of tissue ablation.

- iii) Peripheral loss of laser energy (~40%) results in less ablation thus enlarging the gap between central and peripheral stromal ablation.
FLAT DEPTH PTK PRINCIPLES

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- So why does it induce hyperopic shift?
  - i) Central epithelium is thinner by 10µm and ablation will be 10µm deeper simulating -0.75 myopia, i.e., Inducing a +0.75D hyperopic shift.
  - ii) Reduce axial length inducing minimal hyperopia of <0.25D per 100µm of tissue ablation.
  - iii) Peripheral loss of laser energy (~40%) results in less ablation thus enlarging the gap between central and peripheral stromal ablation
- **Summation of i), ii), iii) gives +1.50D HYPEROPIC SHIFT**
The perceived advantages

- Simultaneous ablation *shorten the overall treatment time*
- Minimise corneal dehydration
- Refractive *aspheric ablation profile*
- Decreasing the wound surface area
- Less instrumentation (*less infection*)
..but! think beforehand

- **Flatter cornea nasally**
  - epithelial thickness unequally distributed
  - Inducing toricity

- **The thinnest point could be anywhere**
  - Between entrance pupil centre and the corneal apex

- **Large angle kappa**
  - The discrepancy between ablation centre and the minimal epithelial thickness lead to asymmetrical stromal ablation

- **Risk of misalignment** higher in inferior steepening, retreatments, keratoconus
  - Should we treat on the visual axis?
Published studies using this specific model of TransPRK on regular normal untreated non-pathologic corneas have **shown NO refractive differences** between laser transepithelial and mechanical or alcohol assisted epithelial removal.
Techniques in preparing cornea

- Aslanides, 2012
  - Iodine
  - Tetracaine 0.5%
  - Drape & speculum
  - Full wet Merocel sponge
  - 3 slow ‘painting movements’ on epithelium
  - MMC for 30sec if ablation >75µm

- Fadlallah, 2011
  - 5mg Valium
  - 1 drop oflocacin & proparacaine 3 times 5 minutes apart
  - Draped & suction speculum
My Experience: Technique

- At medical review
  - Warn patient not to rub eyes whilst waiting
  - Inform staff
  - No further drops

- At time of surgery
  - 1 drop poxymetacaine 0.5%
  - Tegaderm UL
  - Speculum avoiding corneal contact
  - Exclude debris
  - ‘Step on it’
Choice of topical LA

- Proxymetacaine 0.5% induces (Birchall et al. BJO 2001):
  - Less pain
  - Less reflex wetting

- Amethocaine 0.5% in SEM study (Boljka et al. BJO 1994):
  - Deposits on microvilli
  - Loss of microvilli
  - Increased desquamation
My early experience with 20 patients (mean age 26.2 (22-41))

<table>
<thead>
<tr>
<th></th>
<th>No. Of eyes</th>
<th>Mean sphere</th>
<th>Mean Cyl</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-op</td>
<td>40</td>
<td>-3.59 (-2.0 to -5.25)</td>
<td>-0.40 (0 to -1.25)</td>
</tr>
<tr>
<td>TARGET</td>
<td>41% AIMING FOR EMMETROPIA</td>
<td>59% AIMING FOR +0.25DS</td>
<td></td>
</tr>
<tr>
<td>OZ SIZE</td>
<td>Mean was 6.82mm (6.3-7.6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>At 1 month</td>
<td>34 (3 patient DNA)</td>
<td>+0.12 (0 to +0.50)</td>
<td>-0.36 (0 to -1.25)</td>
</tr>
<tr>
<td>At 3-6 months</td>
<td>32 (4 patient DNA)</td>
<td>-0.12 (+0.50 to -0.50)</td>
<td>-0.23 (0 to -0.50)</td>
</tr>
<tr>
<td>&gt;6/12</td>
<td>100%</td>
<td>75%; 6.25% patients had ‘trace haze’</td>
<td></td>
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</table>
# My Experience: Case Study

<table>
<thead>
<tr>
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<th>RE</th>
<th>LE</th>
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<tbody>
<tr>
<td>Pre-op</td>
<td>-3.25/ -0.50 axis 175</td>
<td>-3.50/ -0.25 axis 13</td>
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<tr>
<td>Scotopic pupil</td>
<td>8.59</td>
<td>7.69</td>
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<tr>
<td>AIM</td>
<td>+0.25</td>
<td>+0.25</td>
</tr>
<tr>
<td>0Z(mm)</td>
<td>7.50</td>
<td>7.50</td>
</tr>
<tr>
<td>TZ(mm)</td>
<td>1.56</td>
<td>1.51</td>
</tr>
<tr>
<td>TAZ(mm)</td>
<td>9.06</td>
<td>9.01</td>
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<tr>
<td>Pulse count</td>
<td>24347</td>
<td>23279</td>
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<tr>
<td>AD(µm)</td>
<td>137</td>
<td>133</td>
</tr>
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</table>
And another image
Significant Corneal Haze
My Experience: Case Study

<table>
<thead>
<tr>
<th></th>
<th>UCV A</th>
<th>R sphere</th>
<th>R cyl</th>
<th>R axis</th>
<th>BCVA</th>
<th>Haze</th>
<th>UCVA</th>
<th>L sphere</th>
<th>L cyl</th>
<th>L axis</th>
<th>BCVA</th>
<th>Haze</th>
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<tr>
<td>preop</td>
<td>-3.25</td>
<td>-0.50</td>
<td>175</td>
<td>1.0</td>
<td></td>
<td></td>
<td>-3.50</td>
<td>-0.25</td>
<td>13</td>
<td>1.0</td>
<td></td>
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<tr>
<td>3 day</td>
<td>0.63</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.63</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2 wks</td>
<td>0.63</td>
<td>-0.25</td>
<td>-0.25</td>
<td>175</td>
<td>1.0</td>
<td>0.63</td>
<td>-0.50</td>
<td>-0.75</td>
<td>180</td>
<td>1.0</td>
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<tr>
<td>2 mth</td>
<td>0.79</td>
<td>0</td>
<td>-0.25</td>
<td>40</td>
<td>1.0</td>
<td>0.79</td>
<td>0</td>
<td>-0.25</td>
<td>165</td>
<td>1.0</td>
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<tr>
<td>3 mth</td>
<td>0.50</td>
<td>-0.25</td>
<td>-0.50</td>
<td>120</td>
<td>0.79</td>
<td>&lt;1.0</td>
<td>0.50</td>
<td>-0.50</td>
<td>-0.25</td>
<td>20</td>
<td>0.79</td>
<td>&lt;1.0</td>
</tr>
<tr>
<td>4 mth</td>
<td>0.25</td>
<td>-0.75</td>
<td>-0.50</td>
<td>90</td>
<td>0.40</td>
<td>2.0</td>
<td>0.16</td>
<td>-1.25</td>
<td>-0.50</td>
<td>155</td>
<td>0.32</td>
<td>2.0</td>
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<tr>
<td>5 mth</td>
<td>0.16</td>
<td>-2.75</td>
<td>-1.00</td>
<td>20</td>
<td>0.80</td>
<td>2.0</td>
<td>0.20</td>
<td>-2.50</td>
<td>0</td>
<td>0</td>
<td>0.80</td>
<td>2.0</td>
</tr>
<tr>
<td>6 mth</td>
<td>0.16</td>
<td>-1.50</td>
<td>0</td>
<td>0</td>
<td>0.80</td>
<td>1-2</td>
<td>0.20</td>
<td>-2.00</td>
<td>0</td>
<td>0</td>
<td>1.0</td>
<td>1-2</td>
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Now let's have a look at the collective results

- 546 eyes from Database
- 5 surgeons
- 5 Schwind Amaris 750
- Were they all included?
Were they all included?

NO
What happened?

- 147 were excluded
- Incomplete data
- Persistent DNA
- Monovision aim
- Laser setting adjustment >10%
- MMC used
Who made it?

399 eyes included

- Complete data
  - 1 & 3 months
- All myopic treatments
- Mean age 30 (18-53)
- FEMALE 54.9%
- MALE 44.1%
What was the pre-operative prescription?

- **MSE:** \(-3.88 \text{D} \pm 1.47\)  
  \((-1.25 \text{ to } -8.00)\)
- **Mean Sphere:** \(-3.58 \text{D} \pm 1.44\)  
  \((-0.50 \text{ to } -7.75)\)
- **Mean Cylinder:** \(-0.60 \text{D} \pm 0.53\)  
  \((0 \text{ to } -3.50)\)
Efficacy: SEQ Refractive Accuracy

Refractive outcome - Percentage within Attempted

89% +/- 0.5D
99% +/- 1.0D
Efficacy: Uncorrected Snellen VA

99% > 6/12
70% > 6/6
Efficacy: Uncorrected Cumulative Snellen VA

PreOP BCVA vs. postOP UCVA - Percentage

- 20/10 or better
- 20/12.5 or better
- 20/16 or better
- 20/20 or better
- 20/25 or better
- 20/32 or better
- 20/40 or better
- 20/63 or worse

- 1 m (399)
- 3 m (399)
- preSCVA (399)
Safety: change in Snellen lines of BCVA

Change in BCVA - Percentage 'SAFETY'

- 1% lost >2 lines of BCVA
Predictability: SEQ

Scatter: Attempted vs. Achieved SEQ 'PREDICTABILITY'   399 eyes

\[ y = 0.95x \]

\[ R^2 = 0.88 \]

overcorrected

undercorrected
Predictability: Change in Astigmatism

\[ y = 1.01x \]

\[ R^2 = 0.47 \]

- \textbf{overcorrected}
- \textbf{undercorrected}
Stability: of SEQ over 3 months

Achieved Correction SEQ over Time 'STABILITY'
-0.17
-0.20
-3.88
n=399 n=399 n=399
-6.00
-5.00
-4.00
-3.00
-2.00
-1.00
0.00
1.00
pre op 1 m 3 m
OPTIMAX

Graph showing the stability of SEQ over 3 months with achieved correction values and data points.
Other aspects at 3 months

- **MEAN OZ 6.91**
- **MEAN TZ 8.24**

**Sphere**
- $-0.05 \pm 0.33$  
  (+1.25 to -1.00)

**Cyl**
- $-0.25 \pm 0.25$  
  (0 to -1.75)

**What about corneal haze?**
Other aspects at 3 months

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**Sphere**
- $-0.05 \pm 0.33$  
  (+1.25 to -1.00)

**Cyl**
- $-0.25 \pm 0.25$  
  (0 to -1.75)

**HAZE**
- 0 to 0.5: 91%
- 1: 7%
- 1.5: 1.5%
- 2.0: 0.5%
## What can we add?

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<td>+</td>
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<td><strong>UCVA</strong></td>
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<td>0.97</td>
<td>0.8</td>
<td>0.8</td>
<td>1.01</td>
</tr>
<tr>
<td><strong>Haze (0-0.5)</strong></td>
<td>90%</td>
<td>91%</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td><strong>Haze (1-1.5)</strong></td>
<td>8%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td><strong>Haze (2)</strong></td>
<td>2%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td><strong>Loss of 2 or more lines</strong></td>
<td>5%</td>
<td>-</td>
<td>-</td>
<td>1%</td>
<td></td>
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The disadvantages

- **For high myopes**
  - Thermal effects
  - Large OZ needed if large pupils +/- high astigmatism
  - Less precise as longer surgical time

- **Low myopes**
  - Ensure wider OZ (7.00mm) to ablate epithelium fully

- **It all depends on EPITHELIUM that we cannot measure**
  - Thicker: small OZ and less AD
  - Wasted tissue if epithelium profile is thinner
  - A decentred epithelial thinnest point could induce coma and astigmatism up to 0.75D
  - Laser treatment on the corneal vertex or EP may not match thinnest profile, thus treat on VISUAL AXIS
Schwind ‘rule of thumb’ recommendation from Mosquera et al. (BJO, 2013) for MYOPIA

- **Below −1.00 D**: TransPRK not be used
- **−1.00 D and −2.00 D**, OZ of 7.3 mm
- **−2.00 D and −3.00 D**, OZ of 6.8 mm
- **Above −3.00 D**: OZ of at least 6.3 mm
Schwind ‘rule of thumb’ recommendation from Mosquera (BJO, 2013) for HYPEROPIA

- < +1.50D, no TransPRK

- +1.50 D to +3.00 D, OZ of 7.2 mm

- > +3.00 D an OZ of at least 6.7 mm.
My Experience: Exclusion criteria

- **Refractive**
  - $\leq -1.50$DS & SEQ $-8.00$D or more.

- **Optical**
  - Poor oily tear film/poor wetting

- **Clinical**
  - Previous corneal surgery
  - Previous Keratitis or current epithelial disease
  - Dense scars within intended OZ
  - Inferior steepening on scans
  - Basement Membrane dystrophy
My biggest concerns

- The appearance of \textit{uneven epithelial surface} following topical LA
  - Optimal way to prepare and reduce mechanical trauma
  - Should I convert to LASEK/PRK?
  - Negate benefit of corneal wavefront

- \textit{Large pupil} sizes

- \textit{Smallest OZ} possible
  - Particularly in higher myopes

- \textit{Energy profile} of the ablation

- How \textit{chilled} should the irrigation be
Is there room for improvement?

- Well yes, I think so
- Sir James Watt improved the steam engine
  - Rotary motion (1781)
  - Double-acting engine (1782)
  - Centrifugal governor for automatic control of the engine’s speed (1786)
Thank you!

- ‘I’m here, I’m here, what are you waiting for!'