SOLID STATE Lasik
SHARP SIGHT CENTRES

Dr Kamal B. Kapur
New Delhi
How a laser works

LASER – light amplification by stimulated emission of radiation

Contains the excitable atoms

Energy source to energize the atoms

Consists of mirrors that allow amplification of light to useful levels
Laser classified according to medium

- Gas: CO2, ArF (excimer), argon, HeNe

- Liquid: organic dye laser (rhodamine)

- Solid: Ruby, Nd-YAG, Ti: Sapphire, diode
Solid State Laser Source

- Diode-pumped Nd:YAG laser

- Energy efficient; does not require high voltage; requires lower maintenance
Laser ablation of corneal tissue

Window of ablation: 190 nm to 220 nm

Wavelength range wherein photo-ablation of corneal tissue can occur with a high degree of precision and minimal collateral and thermal damage.

Excimer (Gas): 193 nm    Nd:YAG - NLO (Solid): 213 nm
The CustomVis Pulzar Z1 Laser

• Solid state 213 nm laser

• 300 Hz, 0.6 mm gaussian flying spot (one of the smallest)
• Ultra fast, solid state scanning,
  • “crystalscan
  • 1,000 hz closed loop eye tracking
    • Limbus based
    • 1 ms latency

• Gaze tracking

• Topo and WF guided treatments (both)

• Optimized asphericity standard ablation software
• Convenient “planning software to laser link “ for customized treatment
Comparison between the 213 nm (solid state) and the 193 nm (excimer) laser
Histopathological characteristics

Comparison of corneal ablation between 213 nm (solid state) and 193 nm (excimer)

In vitro using porcine corneas
Comparison of histological characteristics

• Limited collateral damage to surrounding tissues seen in both 193 nm and 213 nm laser (Vetrugno et.al, 2001)

• Collagen lamellae remain well organized (after treatment) with both lasers (Gailitis et.al, 1991, Ren et.al 1990 jcrs)

• The amount of keratocyte apoptosis (precursor to haze) is similar between the 213 nm and the 193 nm laser.
Histological characteristics

- Cell migration and proliferation is less after corneal ablation with the 213 nm (solid state) as compared to the 193 nm (excimer) laser suggesting less inflammation.

Transmission through BSS and 0.9% NaCl

(Jain et al., 2004; unpublished data)

213nm has a significantly higher transmission through 0.9% NaCl and BSS than 193nm

Tissue hydration has less effect on the laser procedure with the 213 nm.
Advantages of 213nm Wavelength

• Clean & Smooth Ablated Surfaces
• Less BSS absorption than 193, hence less laser fired to achieve the same ablation depth
• Possibly Free from Hydration Monitoring (environmental /Surgeon fudge factor)
• less laser plumes (steam) -more accuracy
• Consistent laser energy (no gas pressure maintainance)
• 213 is Closer to absorption peak of corneal collagen than 193 (less collateral damage)
• Better pulse to pulse energy stability “Cooler” = requires less energy to perform required corneal ablation(less energy wasted vapourize water)

SEM of 213nm ablated surface
Morphological difference between standard laser and solid state.
Summary of comparison

- Corneas ablated with the 213 nm and 193 nm laser show similar histological characteristics.

- The main difference is transmission through BSS and 0.9% NaCl, 213 nm > 193 nm.

- Tissue hydration has less effect on the laser procedure with the 213 nm.

- 213 nm requires less energy to ablate corneal tissue.

- Studies on cytotoxicity, mutagenicity show non-conclusive findings.

- Overall benefits of the laser make it a superior choice.
PUPIL TRACKERS-Issues

Pupil centre may shift with the change in pupillary size
GAZE tracking-Advantages
• Ablation axis is adjusted on the laser computer screen.

• According to the limbal marking points to compensate for cyclotorsion.

Axis Registration
Only 5% of eyes changed more than 0.50D between 6 months and 12 months.
Case distribution according to Power in 487 eyes

- Total 487 cases
- From Dec 2007 till June 2008 operated at SHARP SIGHT CENTRES

Range of spherical equivalent diopter correction:
- <-4 Diopt.
- -4.25 to -7 D
- -7 to -10
- >-10 D
Speed of visual recovery

• The **best part about** this laser as it is a non dehydrating laser, is the speed of visual recovery *(the corneal bed is not dehydrated)*

• The patients **report** significant **visual improvement** within **10 minutes** with **68%** cases improving to **6/12** and above and improving rapidly over **2-3 hours** to reach nearly **98%** on first day post op.
Speed of visual recovery

<table>
<thead>
<tr>
<th>Time Period</th>
<th>6/12 or better</th>
<th>6/9 or better</th>
<th>6/6 or better</th>
<th>6/4 vision</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 minutes</td>
<td>68%</td>
<td>42%</td>
<td>0%</td>
<td>8%</td>
</tr>
<tr>
<td>1st day post op.</td>
<td>98%</td>
<td>82%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>1 week post op.</td>
<td>100%</td>
<td>92%</td>
<td>70%</td>
<td>0%</td>
</tr>
<tr>
<td>3rd week post op.</td>
<td>100%</td>
<td>96%</td>
<td>74%</td>
<td>74%</td>
</tr>
</tbody>
</table>

- 6/12 or better: Vision is clear at a distance of 12 meters.
- 6/9 or better: Vision is clear at a distance of 9 meters.
- 6/6 or better: Vision is clear at a distance of 6 meters.
- 6/4 vision: Vision is clear at a distance of 4 meters.
Visual quality is extremely good

- Post Op. visual quality is excellent with fantastic high order aberration control and excellent Retinal spot diagrams along with improvement in point spread function even in non customized lasik surgery (fig1.)

- No reported glare or haloes as may be seen with some excimer lasers

- Excellent modular transfer functions are noticed even in non customized lasik (fig 2.)

Giving immense satisfaction level to all our patients
WF Verification Display

Horizontal Point Profile

WF Exam #1 OD
Date / Time: 06-25-2008 / 16:15:23
Clinic: 
Physician: 
Operator: 
Points Accepted / Rejected: 228 / 28
Pupil / Scan Diameter: 5.80 / 5.10 mm
Fixation Target Position: -3.75 D

Auto Refraction

-8.87 D -1.50 D x 7°

Refration (Vertex Distance = 14.0 mm)
-8.73 D -1.08 D x 13° @ 3.00 mm
-8.86 D -1.61 D x 5° @ 4.50 mm
-8.88 D -1.75 D x 4° @ 5.10 mm

RMS @ 5.10 mm
Total: 8.109 μ
LO Total: 8.098 μ
Defocus: 8.049 μ
Astigmatism: 0.897 μ x 94°
HO Total: 0.423 μ
Coma: 0.172 μ x 10°
Spherical: 0.091 μ
Trefoil: 0.269 μ x 20°

Retinal Spot Diagram
Vertical Point Profile

Spacing: 10 min of arc
### WF Verification Display

#### Horizontal Point Profile

<table>
<thead>
<tr>
<th>Value</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1254</td>
<td></td>
</tr>
</tbody>
</table>

#### Vertical Point Profile

<table>
<thead>
<tr>
<th>Value</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>124</td>
<td></td>
</tr>
</tbody>
</table>

#### Retinal Spot Diagram

Spacing: 10 min of arc

#### Group: sharp sight centre

<table>
<thead>
<tr>
<th>Date / Time</th>
<th>06-27-2008 / 13:04:22</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinic</td>
<td></td>
</tr>
<tr>
<td>Physician</td>
<td></td>
</tr>
<tr>
<td>Operator</td>
<td></td>
</tr>
<tr>
<td>Points Accepted /Rejected</td>
<td>230 / 26</td>
</tr>
<tr>
<td>Pupil / Scan Diameter</td>
<td>4.81 / 4.00 mm</td>
</tr>
<tr>
<td>Fixation Target Position</td>
<td>-0.25 D</td>
</tr>
</tbody>
</table>

#### Auto Refraction

-0.75 D - 0.37 D x 15°

#### Refraction (Vertex Distance = 14.0 mm)

-0.50 D - 0.41 D x 14° @ 3.00 mm

-0.78 D - 0.41 D x 15° @ 4.00 mm

#### RMS @ 4.00 mm

- Total: 0.712 μ
- LO Total: 0.585 μ
- Defocus: 0.562 μ
- Astigmatism: 0.162 μ x 105°
- HO Total: 0.408 μ
- Coma: 0.358 μ x 119°
- Spherical: 0.095 μ
- Trefoil: 0.137 μ x 23°
1st day post operative
Notice- Improved point spread function
Excellent MTF values with improved Snellen acuity in dark too.
Visual acuity unaided

Unaided visual outcomes % at end of 3 weeks

- 6/4 vision
- 6/6 vision or better
- 6/9 or better

Power range -2 to -7 d
Predictability of MRSE @ 6 Months After Surgery

N = 53 Patients (87 Eyes)

71% ±0.25

88% ±0.50

100% ±1.00

Dr. Palikarlis

Number of patients followed up till 6 months
Practical stuff

- Small compact machine (less space)
- No restriction of surgery days
- No recurring cost of corrosive gases
- Less power consumption
- Less humidity and temp. dependent
- Hydration during procedure improves fixation
- Flaps sticks firm and faster
- Notice less flap edge haze
- PATIENTS HAPPY + DOCTOR HAPPY
Gas Filled Diode Tubes were replaced by Microchips
Just as Liquid Crystal Diode Screens (LCD) replaced gas filled TV monitors
Gas based Excimer laser will be replaced by SOLID STATE CRYSTAL BASED LASIK
No to Toxic Gases
No to Scary Noises
No to High Power Consumption
No to Hot Laser
No to Restricted Surgery Days
No to Bigger Flying Spot
No to Slow Eye Trackers
No to Longer Warm Up Time
No to Old Technology

NO TO EXCIMER LASER.....
Yes to Crystal Technology
Yes to Quiet Operation
Yes to Low Power Consumption
Yes to Cold Laser
Yes to Anytime Surgery
Yes to Smaller 0.6mm Spot
Yes to Fast (1KHz) Eye Tracker
Yes to Short Warm Up Time
Yes to The Future in Sight

YES TO SOLID STATE LASER
Conclusion

- Asphericity, centration and cyclotorsion optimization in standard CustomVis treatments prevented any significant induction of SA and coma and probably represents all the customization that is needed to achieve the desired quality of vision in myopic eyes.

- Customized ablation that aims for treatment of HOAs is probably necessary only where such aberrations are significantly increased i.e. in symptomatic irregular astigmatism.