Getting Up to Date with LASIK

Gary S. Schwartz, MD, MHA
Associated Eye Care
Stillwater, MN
Adjunct Associate Professor
University of Minnesota

Disclosure

- I am not a paid consultant to any drug or device company.

LASIK

- Use one instrument to make a flap.
- Use a second instrument to change the shape of the cornea.

Modern advancements

- Better flaps
- Better ablations
- Better nomogram adjustment
- All should lead to better visual acuity, better quality of vision, and happier patients.

What we’re “curing”

- Myopia
- Hyperopia
- Regular astigmatism
- Irregular astigmatism

Changing the corneal surface

- Myopia – flatten it
- Hyperopia – steepen it
- Regular astigmatism – steepen and flatten accordingly
- Irregular astigmatism – smooth out the irregularities
Excimer laser

- Photochemical reaction
  - Not photothermal or photodisruptive
- Breaks carbon-carbon bonds without generating heat.
- Solid tissue turns into vapor in a reaction that is called “ablation”.
  - The tissue is “ablated” away

Excimer laser on human hair

Excimer Laser Ablation

- Myopia – remove more tissue centrally

Myopic Ablation

Excimer Laser Ablation

- Hyperopia – remove more tissue peripherally

Hyperopic Ablation
Excimer Laser Ablation

- Astigmatism
  - Torus = sphere + cylinder
  - Flatten steep axis
  - Steepen flat axis

Astigmatic Ablation

Pre-op

Post-op

PRK vs. LASIK

Corneal Anatomy

Surface Ablation (PRK)

- Advantages over LASIK
  - Very safe to perform
  - Minimal risk of long term problems
    - Ectasia, dry eye
- Disadvantages compared to LASIK
  - Discomfort for 2-3 days
  - Vision may take weeks to months to stabilize

LASIK

- Advantages over PRK
  - Fast visual recovery
  - Probably better for higher refractive errors
  - Less risk of scarring or haze
- Disadvantages compared to PRK
  - Higher risk during and after surgery
  - More chronic discomfort, dry eye problems
Where has the progress come?

- Flaps – safety
  - More predictable diameter
  - More predictable depth

- Ablations – improved quality of vision
  - Less night-time vision problems
  - Customization

- Nomogram adjustment – improved results

Mechanical Microkeratomes

- Initially, flaps were created by metal blade instruments called microkeratomes

Problems with microkeratomes

- Small risk of operator error that could result in large problems.
- Not overly precise
  - Set the blade for 160 microns, and flaps could range from 120-200 microns thick.
  - Patients with occult ABMD could end up with sloughing of epithelium
Femtosecond laser flaps

- Femtosecond laser works by creating a series of contiguous bubbles a specific depth below the surface of the cornea.
  - Eventually bought by AMO
  - Now 4 lasers approved by FDA 2001-2010
    - AMO, Technolas, Ziemer, Alcon
Excimer laser ablation

Improvements

- Laser delivery
- Trackers
- Autocentration
- Managing torsion

Delivering Laser Energy

- Broad beam
- Flying spot
- Scanning slit

Flying Spot

Flying spot technology

- All modern lasers use flying spot technology.
- Some use combination of spots of different sizes.
Trackers

- Tracker will “see” where the eye is over 1000 times per second.
- If the eye moves a little, the laser will move with it.
- If the eye moves a lot, the laser will shut off.

Autocentration and Iris Registration

- Modern lasers will identify the center of the pupil, and center the treatment on it.
  - Surgeon can adjust center of treatment to account for angle-kappa, etc.
  - By identifying iris structures, the laser can adjust for cyclotorsion.

Ready for the next stage

- Flying Spot
- Trackers
- Autocentration
- Iris registration

Customized Ablations
**Customized ablation**

- Like buying custom made clothes.
- Off-the-rack clothes fit us all OK, but having someone make you clothes from your actual measurements should fit you better.
- The more data points used, the better the fit.

**Customized (wavefront) ablation**

- Treats concept that not all astigmatism is regular.

**Conventional LASIK**

- Wavefront
  - Tries to get entire optical image as regular as possible.
- Topo-link
  - Tries to get the corneal surface as spherical as possible.

**Wavefront**

- AMO VISX S4
- TECHNOLAS 217Z

**Emmetrope – parallel light going in**
Most people aren’t exactly “regular”
Treating this with conventional LASIK

Breaking down “irregular astigmatism” into “higher order aberrations”

Wavefront aberrations

Conventional LASIK only treats second order aberrations
Myopia, hyperopia, astigmatism

Wavefront aberrations

The biggest aberrations treated by wavefront technology are myopia, hyperopia, astigmatism, coma, and spherical aberration
Advantages to Wavefront

- Treats total lower- and higher-order aberrations without worrying about which parts of the eye are responsible.
- Holds potential that it can fix corneal problems from pathology or prior surgery.
- Refraction is automatically incorporated in the treatment.

Disadvantages of Wavefront

- Fails to consider how aberrations from lens will change over time.
- Only gathers data from inside the pupil.
- Has not proven that it can reduce high levels of higher-order aberrations significantly.

Topo-link

- Treats based off two separate classes of data:
  - Refraction
  - Topography
- The goal is a smooth corneal surface without small areas of steepness or flatness.
Advantages to Topo-Link

- Since most irregularities affecting vision lie on the corneal surface, it may make sense to focus on treating these.
- Treats a part of the eye that is stable and consistent through the lifetime.
- Can treat large diameters.

Disadvantages of Topo-link

- No good nomograms to handle cases where patient’s total astigmatism doesn’t line up with corneal astigmatism.
- Not yet approved for hyperopia or mixed astigmatism.
- Not good for enhancements at this time.

Nomogram adjustment

- Lasers come with standard nomograms to treat refractive errors.
- Changing nomograms is a slow proposition for the laser companies.
- Many surgeons “tweak” their own nomograms.
- Some do it based on data, others on instinct.
Nomogram adjustment

- Everyone using a particular laser
  - Just fine-tune a laser’s nomogram for everyone
- A single surgeon using a particular laser
  - Surgeon specific
  - Hydration, length of time flap is up
  - Site specific
  - Temperature, humidity

- Computerized data-collection systems have been developed to try to standardize nomograms.
- Most are small, specific for a single laser.
- Most allow surgeons to compare themselves to others.

IBRA

- Created by Swiss company, Zubisoft
- All FDA-approved excimer lasers.
  - Also premium IOL’s
- Reference database
- Personal nomogram adjustment
- $1000-$1200 a year depending on package

- Easy input
  - Online interface
- Good output
  - Gives immediate nomogram adjustment from day 1 of use.
  - Can get data in table form, chart form
  - Statistical analysis.

Summary

- Better flaps
- Better ablations
- Better nomogram adjustment

- All lead to better visual acuity, better quality of vision, and happier patients.