Recent Advances in Cataract Surgery: Light Adjustable Lens

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Vision Basics

The cornea and the lens work together to focus images in the eye.
Near and Farsightedness

The Nearsighted Eye - the cornea and lens are too curved and/or the eye is too long.
The Farsighted Eye - the cornea and lens are too flat and/or the eye is too short.
Astigmatism

- “out of roundness” of the eye
  Usually from the cornea
  Blurs vision at both far and near
Accommodation

The automatic adjustment of the eye for seeing at different distances effected chiefly through changes in the position and convexity of the crystalline lens.
Normal Accommodation

When looking at near objects, the lens continues to change shape & move forward to focus image.

Near Vision

Near images focus on retina

Lens changes shape & position

Near vision is clear
Distance vision out of focus
The Aging Eye

The aging lens loses its ability to change shape. Reading glasses or bifocals are required. Loss of Accommodation is called **PRESBYOPIA**.
Cataracts

Cataract disrupts transmission of light through lens. Images may be blurred, dark & distorted.
Changes of a Healthy Human Crystalline Lens with Time

6 months
8 years
12 years
15 years
47 years
60 years
70 years
82 years
90 years

*photos courtesy of J. Marshall
Cataract Surgery

- Most common surgery done in US
- Very successful with greater than 95% enjoying an improvement in vision
- The cataractous lens is removed leaving behind an empty “bag” of lens capsule
- The human lens is replaced with an artificial lens (intraocular lens)
- Advancements in incision size, irrigation fluid, time, lenses, safety, laser
Cataract Surgery

- Phacoemulsification
  Surgical procedure to remove a cataract using sound waves to disintegrate the lens which is then removed by suction.
  2-3 mm incision
  80% less irrigation
Intraocular Lens Implantation

- Injectable through small incision
Recent Advancements

- IMPROVED FRONT TO BACK PROCESS
  Pre-operative measurements, planning, surgery, and outcomes
- HOW the surgery is performed
  Femtosecond Laser assisted cataract surgery
  Dropless
- LENS IMPLANT types
  Astigmatism correction, Multifocal, Accommodating Lens
  Light Adjustable Lens
Pre-operative measurements

- Biometry

  Measurements of the length and front curvature of the eye
  Formulas to calculate PREDICTIVE lens implant power
Femtosecond Laser for Cataract

- History
  Developed in 2005
  First US case in 2010
  Greater than 100,000 performed worldwide
  LensX, Catalys, Victus, Ziemer
Intraocular Lenses

- Sir Harold Ridley
  November 29, 1949
  PMMA

- Widespread use in 1970s

- Small incision
  Silicone and acrylic
Differentiating IOLs

IOLs come in different sizes, shapes & materials. Each has unique characteristics & capabilities

Single Power Lenses (Monofocal and Toric)
- Corrects only distance vision
- Toric lens corrects astigmatism
- Does not accommodate in eye
- Glasses required for near work

Multifocal/Diffractive Lenses (+/- Toric)
- Multiple, fixed focal points
- Does not accommodate
- Must find appropriate focal point
- Extensive neurological adaptation

Accommodative Lens (+/- Toric)
- Single focal point
- (Mostly) full range of distance, intermediate & near vision
- Uses eye’s natural focusing mechanism
- Rapid visual recovery
Outcomes data

- Modern cataract surgery has become complicated
  - Planning
  - Intraoperative issues
  - Post-operative outcomes
Outcomes with cataract surgery

- Until recently, ALL cataract surgery is a predictive model
  - Incredible variation between humans makes it impossible to predict every outcome with certainty
  - No option to “try it on” or adjust easily after surgery unless willing to have additional surgery (LASIK or lens exchange)
Light Adjustable Lens

- Developed in Europe for over a decade
- FDA approved in US in 2017
- 92% 20/25 or better without glasses
  - 92% within 0.5D of target (LASIK success)
  - Twice as likely to be 20/20 without glasses than control after 6 months
  - No other lens greater than 80% in an FDA study
- Silicone lens with UV sensitive macromers
- Long term studies show stability > 7 years
Light Adjustable Lens process

- Standard surgery performed with LAL
- UV protecting glasses all waking hours until 24 hours after final “lock-in” treatment
Light Adjustable Lens process

- First treatment 17 days after surgery
Light Adjustable Lens process

- Additional treatments every 3-4 days
- Can adjust lens 3 times
Light Adjustable Lens process

A. Adjustment Beam
- Light from the RxSight LDD is directed by the surgeon to the Light Adjustable Lens

B. Photopolymerization
- Macromers in the path of the light are photopolymerized

C. Diffusion and Power Change
- Unpolymerized macromers move into the exposed area, causing precise shape and power change

D. Lock-In Beam
- The entire lens is exposed to light to polymerize all the remaining macromers

E. Final Result
- The outcome is a precise change in the lens power to match the patient's individual prescription
Light Adjustable Lens limitations

- Must have good eye dilation (> 7mm) to treat entire lens
- UV absorbing medications
  - Hydrochlorothiazide, tetracyclines
- Must wear special UV protecting goggles for entire treatment period (4-5 weeks)
Case study 1 - refractive surprise

- 76 year old patient wants to be glasses independent

Surgery performed using laser and implanting multifocal lens in both eyes

After surgery both eyes had slight far sightedness and astigmatism

“Weak” 20/25 vision and unable to read comfortably and consistently without glasses

Halos around lights at night

Options?
Case study 2 - change your mind

- 67 year old patient wants to be glasses independent at distance
  Surgery performed using Light Adjustable Lens in both eyes
  After surgery both eyes had slight far sightedness and significant astigmatism
  First treatment resulted in 20/20 distance vision in each eye
  Patient returned and was unhappy with intermediate and near vision
  - Trial contact in non dominant eye successful
  - Treatment to make much better for intermediate and near vision before finalizing
Case study 3 - treating result

- 74 year old patient wants to be glasses independent at distance and would like to have better near vision but is unsure about mono vision
  - Surgery performed using Light Adjustable Lens in both eyes
  - After surgery both eyes had significant unpredictable far sightedness and astigmatism - REFRACTIVE SURPRISE!
  - Would have been a poor outcome with all other approaches

First treatment resulted in 20/20 distance vision in each eye
- Returned 3 days later with trial contact over non-dominant eye to improve intermediate and near vision
  - Liked! No way to know without trial after surgery
- Second treatment improved near vision significantly in non-dominant eye (also incorporated negative spherical aberration (EDF))
Light Adjustable Lens

- Major advantage is the ability to correct ANY refractive error (hyperopia, myopia, astigmatism) AFTER surgery
- Major advantage is ability to adjust MORE THAN ONCE
- Major advantage is ability to EXPERIENCE outcome and then decide desired outcome
- Other technologies (i.e., multifocal lens) can result in great outcomes but predictions can NEVER be as consistently accurate as treating the outcome
  - Especially after previous refractive surgery (LASIK, PRK, RK)
- Takes the complexity OUT of the operating room and moves it into the clinic
Criticisms of Light Adjustable Lens

- “My surgical results are good enough”
- “It’s still just a monofocal lens”
  - Accuracy and superior optical performance
  - Negative spherical aberration incorporated
  - Results in extended depth of focus
- “Just do LASIK after surgery”
  - Contrast sensitivity loss and dry eyes
- “It takes too much time”
Predicting vs Treating the Outcome

- “Off the rack” suit/dress
- Tailor fit
## Comparing Lens Options

<table>
<thead>
<tr>
<th>Pros</th>
<th>Light Adjustable lens</th>
<th>Multifocal lens</th>
<th>Accommodative lens</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuracy</td>
<td>Very little dysphotopsias</td>
<td>Good distance, near</td>
<td>Good distance, near</td>
</tr>
<tr>
<td>Cons</td>
<td>Intolerance to monovision</td>
<td>Halos, dysphotopsias, Refractive error</td>
<td>Unpredictable result, focusing Refractive error</td>
</tr>
</tbody>
</table>
What Matters Most in Outcomes?

- Computer/phone usage very high
- Don’t underestimate the importance of intermediate vision!
- Light Adjustable Lens allows trial before finalizing result
Cataract Surgery Protocol 2021

- **GOOD** - standard surgery
  - Glasses for best vision (near and often distance)

- **BETTER** - Laser plus standard lens
  - Good distance vision - glasses for reading
  - Limited astigmatism treatment
  - Unavoidable risk of spherical error

- **BEST 1** - Laser plus multifocal/accommodating lens
  - Unavoidable risk of spherical error

- **BEST 2** - Light Adjustable Lens
  - Distance vision with readers or mono vision (1 near, 1 far)
  - Superior if previous refractive surgery (LASIK, PRK, RK)
  - “Try it on” before decision
  - Treat according to experience, NOT prediction
Conclusion

- Rapid evolution
  - Light Adjustable Lens
- Customized personal treatment
  - Make realistic goals and expectations to determine which approach is best
  - No single approach is best for everyone

- Talk with your surgeon.
Thank you!

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