Current Trends in Refractive Cataract Surgery

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Overview: younger patients being treated; patients expect high-quality vision; many variables influence outcome, including use of manual ultrasonography, surgical plan for arcuate incisions, calculation of astigmatism, method of capsulorhexis, and type of phacoemulsification (PE); newer technologies allow surgeon to minimize these variables

New technologies: biometry — manual A-scan rarely required due to availability of new technologies such as LENSTAR and IOLMaster; surgical planning — VERION system reduces errors with built-in formulas; femtosecond laser (FSL) — makes consistent corneal incisions with correct center and size and helps to disassemble nucleus; other developments — CENTURION system offers superior technology for PE; intraoperative aberrometry available; VERION — useful for centering toric lenses; system can track postoperative results, calculate surgically induced astigmatism, develop nomogram for controlling arcuate incisions, and plan locations of arcuate and primary incisions; surgical plan may be prepared in office and automatically transferred to LensSx laser, CENTURION system, or microscope; SoftFit new patient interface for use with LensSx laser that lowers docking pressure; surgical plan from VERION transferred to patient, so no need to mark cornea; system adjusts for cyclorotation caused by docking; before VERION available, surgeon had to manually manipulate each incision for capsulorhexis and pattern for nucleus

Femtosecond laser: standardizes corneal incisions, accurately calculates surgically induced astigmatism, makes precise arcuate cuts based on optical coherence tomographic measurement of corneal thickness, permits consistent capsulotomy, effective lens position, and refractive outcomes, and shortens PE time; length of tunnel adjustable and shorter than for manually created tunnel; arcuate cuts made with FSL have uniform depth with no ripple effect; surgeon may leave corneal incisions closed to control astigmatism and reduce sensation of foreign body; residual astigmatism may be revised in office for up to 1 yr after procedure

Effective lens position: if lens 0.5 mm posterior to intended position, 21-D lens provides only 20 D of correction; if lens 0.5 mm anterior to intended position, 21-D lens provides 22 D of correction; FSL minimizes variability in capsulorhexis; in early study with LenSx, capsulorhexis accounted for 71% of variance in outcomes

PE time: fragmentation with FSL reduces power and time required for PE; early study demonstrated 51% reduction in power, 43% reduction in time for PE, and less use of fluid inside eye; cube or matrix pattern frequently used for PE results in lower cumulative dissipated energy; laser creates fracture line and surgeon aspirates cubes; after treatment with FSL, dense cataracts behave like softer cataracts; surgery easier and refractive outcome better; in 5 to 10 yr, all cataracts likely to be treated with laser; CENTURION includes active fluidics that constantly monitor and maintain intraocular pressure (IOP), allowing procedure to be completed at lower IOP; with gravity-fed systems, most surgeons operate at IOP of 90 to 100 mm Hg; new technologies allow safer procedures

VERION: surgeon may vary how much astigmatism controlled with lens implant and how much with arcuate cut; system accommodates toric and multifocal lenses; surgeon may choose how to center lens; if multifocal lens centered on visual axis, placement of lens too nasal; instead, lens should be centered on preoperative, undilated pupil; aligning toric lenses no longer requires marking; for each degree of inaccuracy, ±3% of astigmatism correction lost; surgeon may use VERION without LenSx laser to create template for capsulorhexis; VERION useful for complicated cases such as patients who need Malyugin ring; active fluidics maintain stability of anterior chamber

Intraoperative aberrometry: takes real-time waveform images during surgery; surgeon may take aphakic image immediately after removing cataract and before removing lens to calculate lens power; surgeon may take phakic measurement just after implanting lens to check refraction; aberrometer useful for toric alignment; surgeon may identify residual refractive error after implantation; ORA aberrometer useful for patients who have had laser-assisted in situ keratomileusis (LASIK) or radial keratotomy, and for myopic or hyperopic patients; ORA pressure dependent, so reading changes if eye deviates from recommended pressure; too time consuming to use on every patient, but may be used when preoperative measurements not ideal; HOLOS new aberrometer that provides continuous data so surgeon does not have to stop to measure

ReSTOR toric lens: clinical trial completed but lens not yet available in United States; may allow more surgeons to feel comfortable implanting premium lenses

Light-adjustable lenses: allow surgeon to adjust refraction by 0.5 to 1.75 D in office after implantation; lenses not likely to receive approval from Food and Drug Administration for years

Educational Objectives

The goals of this program are to improve diagnosis and treatment of cataracts and pediatric esotropia. After hearing and assimilating this program, the clinician will be better able to:

1. Calculate the change in correction caused by suboptimal implantation of an intraocular lens.
2. Describe new and emerging technologies for cataract surgery.
3. Diagnose a child with esotropia.
4. Manage a child with amblyopia and esotropia who is likely to require surgical treatment.
5. Order appropriate neuroimaging for patients with esotropia.

Faculty Disclosure

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Pediatric esotropias: include infantile esotropia, Ciccia syndrome, accommodative esotropia, acquired nonaccommodative esotropias, and conditions accompanied by nystagmus; 99% of esotropias fall into 4 categories of infantile (congenital) esotropia, accommodative esotropia, Duane syndrome, or sensory esotropia

History: present illness — time of onset indicates whether condition congenital or acquired; laterality and presence of amblyopia give clues about etiology; pattern of esotropia (intertemporal vs constant) related to binocularity and fusional potential; if deviation constant for long time, probability of good binocularity lower; associated findings — may include developmental delay, nystagmus, or other neurologic findings; past medical history — examiner should assess history of prematurity, birth weight, gestational age, developmental milestones, cerebral palsy, hydrocephalus, and previous surgery; family history — strabismus, patching, glasses at early age, and eye muscle surgery relevant; family members at risk for same type or other types of strabismus

Visual acuity: numbers or pictures less accurate for assessment of visual acuity (VA) but may be used for younger children; to test crowding phenomena of amblyopia, patient should be presented with lines of optotypes; crowding (walking) bars prevent patient from reading chart in random order; in younger children who may not cooperate, ductions and versions may be done first, and then alignment (with cover test if patient cooperative, or using light reflex)

Fixation preference testing: used to assess VA in preverbal child; if VA equal, patient freely alternates fixation between eyes; if child does not alternate, examiner may occludefixing eye until crossed eye takes up fixation, then remove occluder; if patient maintains fixation with that eye, patient said to have maintained fixation, implying no amblyopia; if fixation not maintained, patient has central steady unmaintained fixation, and VA 20/40 or worse; if patient cannot fixate or follow with other eye, VA 20/400 or worse; if sensory nystagmus present, fixation unsteady and VA 20/200 or worse; goals of measuring VA to look for amblyopia, refractive errors such as combination of esotropia and anisometropia, and sensory esotropia (esotropia caused by visually significant lesion such as retinoblastoma or cataract)

Motility: versions refer to binocular eye movements; abnormal motility should be rechecked with good eye occluded; ductions refer to monocular eye movements; examiner should have patient move eye as far as possible; limited ductions confirmed with doll’s eye maneuvers; eye patch may be used to check ductions; placing child on spinning stool to induce vestibuloocular reflex demonstrates nystagmus; slow phase occurs in direction of spinning and fast phase in opposite direction; test rules out true duction deficit such as palsy of VI without performing magnetic resonance imaging (MRI); Duane retraction syndrome — if limited abduction observed, examiner should look for narrowing of palpebral fissure on adduction; retraction of globe on abduction indicates Duane syndrome, and no imaging or other investigation required; goal of checking duction to detect limited abduction, as from restricted medial rectus muscle; restricted medial rectus muscle of infantile esotropia and Duane syndrome both more common than palsy of VI

Alignment: quantifies esotropia: angle of deviation larger in congenital and smaller in accommodative esotropia; quantifying esotropia permits treatment planning (determination of how much muscle to recess) and allows surgeon to assess response to treatment and corrective lenses

Hirschberg test: corneal light reflex test; may use before performing alternate cover test; if alternate cover test not reliable, may do Krimsky test; patient has ≥30 prism diopeters (Δ) of deviation if corneal light reflex decentered temporally to border of pupil, 60Δ if decentered to midperipheral iris, and 90Δ if decentered to corneal limbus; test valid only if patient looks directly at light

Alternate cover test: requires patient to fixate on target; test performed at distance and near; examiner should move rapidly between eyes but linger briefly on each eye to give opposite eye time to refixate on target; when fixing eye occluded, crossed eye must shift temporally; placing prism in front of eye with apex pointing toward nose reduces distance that esotropic eye must move temporally to take up fixation; apex of prism should be pointed in direction of deviation (toward nose for esotropia); distant target helpful but not essential when screening for esotropia; valid testing requires each eye to have sufficient VA to see target and ability to move at least to midline

Other tests: if eye cannot move or child uncooperative, Krimsky test may be used; to perform test, put prism in front of deviated eye until corneal light reflex centered in each pupil; while child looking at distant target, examiner may attempt dry retinoscopy to screen for media opacities and refractive errors; problems of anterior segment can usually be seen using muscle light; dilation performed last

Cycloplegic refraction: accommodation can affect esotropia; children with +5 D of hyperopia may demonstrate 20/20 VA; proparacaine given first to speed absorption; next, phenylephrine used for dilatation; finally, 1% cyclopentolate used to paralyze ciliary muscle; examiner should wait 45 min to achieve maximum cycloplegia; atropine rarely required; dilated funduscopy examination mandatory because decreased vision may cause esotropia; lesions affecting central VA usually found in macula or optic disc

Infantile esotropia: usually not present at birth but evident by 6 mo of age; 50% of children have amblyopia and 50% have alternating strabismus at presentation; small esotropia <30Δ and present before 3 mo of age may spontaneously resolve, especially if intermittent; if deviation small and patient young, worthwhile to wait; in other cases, infantile esotropia requires surgery; children treated surgically before 12 mo of age more likely to have high-grade stereopsis; even with optimal surgical treatment, most patients do not have 20 seconds of arc; they do acquire some stereopsis but have monofixation syndrome; accurate measurements difficult to obtain in young children, and outcome of surgery more difficult to predict in small eyes; amblyopia — correcting amblyopia before surgery may facilitate fixation, but prolonged delays in surgery may worsen prognosis; reasonable to treat amblyopia before surgery if surgery not delayed past 12 mo of age and constant deviation treated within 8 wk; amblyopia refers to 2-line difference in VA between eyes not explained by organic cause; to reverse amblyopia requires 1 wk of full-time patching per year of life; therefore, 4 wk of full-time patching required in 4-yr-old child; half-time patching (4 hr/day) requires twice as long to achieve outcome; atropine eye drops may be used if compliance with patching problematic; final visual acuity same with drops or patching, but patching works faster

Accommodative esotropia: most common type of strabismus; usual onset at 2 to 3 yr of age, but may appear from 4 mo of age to 8 yr of age; esotropia usually ≥20Δ to 30Δ and intermittent, but becomes more constant with time; average refractive error ≤+4 D; hyperopia ≥+6 D usually results in bilateral amblyopia but not esotropia; treatment — includes prescription close to full cycloplegic refraction; glasses do not cure esotropia and may worsen crossing; over time, prescription may be reduced to achieve small esophoria of ≤+2 Δ; this prescription compatible with good depth perception and binocular fusion but helps patient develop larger divergence and fusional amplitudes; hyperopia increases until ≤8 yr of age, then decreases, requiring changes to prescription; 50% of children outgrow hyperopia, but those with ≥+4 D of hyperopia likely to need glasses; older patients may be treated with contact lenses or LASIK; prescription should be rechecked every 6 to 12 mo or if esotropia (in glasses) worsens; surgery — required if residual deviation >10Δ at distance, but
glasses still needed; surgery not done for accommodative deviation, because exotropia may result as accommodative amplitude decreases with age; if eyes straight at distance with full cycloplegic refraction but cross >10 D at near, child needs bifocals, but usually outgrows them as interpupillary distance increases; older children may use progressive lenses or bifocal contact lenses; brief course of cyclopentolate may incentivize younger children to wear glasses; stable patients followed every 6 mo or less often

Paretic esotropia: should be suspected when full abdution not present; however, contracture of medial rectus more common cause of limited abduction; eye with normal saccadic velocity does not have paresis

Duane syndrome: congenital and idiopathic; treatment required only if esotropia present in primary position; amblyopia rare; ipsilateral

Medial rectus recession sometimes effective; some patients need transposition of vertical rectus to lateral rectus muscle

Imaging: if Duane syndrome not present and patient has limited abduction and slowed saccadic velocity, neuroimaging required because 35% of such children have life-threatening intracranial lesion; general anesthesia often required to perform MRI in children; if palsy of VI present and no compensatory head position, amblyopia common

Sensory esotropia: children with poor vision in one or both eyes may develop exotropia or esotropia; treatment similar to that for congenital esotropia, except that reversible causes of decreased vision should be treated first; surgery performed only on bad eye

Acknowledgements

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- 5 minutes
- 10 minutes
- 60 minutes
- 35 minutes
- 10 minutes
1. The _______ system lowers docking pressure during cataract surgery.
   (A) VERION  (B) SoftFit  (C) CENTURION  (D) ORA

2. How much correction is provided by a 21-D lens that is implanted 0.5 mm posterior to the intended position?
   (A) 20 D  **
   (B) 21 D
   (C) 22 D
   (D) Cannot be determined from the information given

3. The _______ system features active fluidics that constantly monitor and maintain intraocular pressure.
   (A) LenSx  (B) CENTURION  **  (C) ORA  (D) SoftFit

4. Which of the following technologies is not yet approved by the Food and Drug Administration?
   (A) HOLOS aberrometer
   (B) ORA aberrometer  **
   (C) Light-adjustable lenses
   (D) VERION

5. Esotropia caused by a visually significant lesion such as retinoblastoma is called:
   (A) Paretic esotropia
   (B) Duane syndrome
   (C) Nonaccommodative esotropia
   (D) Sensory esotropia

6. When examining a child with esotropia, the ophthalmologist notices narrowing of the palpebral fissure and retraction of the globe on adduction. What is the diagnosis?
   (A) Infantile esotropia
   (B) Retinoblastoma
   (C) Duane syndrome
   (D) Paretic esotropia

7. To prevent poor stereopsis in children with infantile esotropia, surgery should be performed before:
   (A) 8 wk of age
   (B) 3 mo of age
   (C) 6 mo of age
   (D) 12 mo of age

8. When considering atropine drops vs patching for treatment of childhood amblyopia, which statement is correct?
   (A) Atropine is more efficacious and achieves a faster result
   (B) Patching is more efficacious and achieves a faster result
   (C) Both methods are equally efficacious, but atropine achieves a faster result
   (D) Both methods are equally efficacious, but patching achieves a faster result

9. Which of the following is the most common type of strabismus?
   (A) Accommodative esotropia  **
   (B) Congenital esotropia
   (C) Duane syndrome
   (D) Paretic esotropia

10. A child with esotropia is not thought to have Duane syndrome, but has limited abduction and slowed saccadic velocity. What is the next step?
    (A) Perform magnetic resonance imaging
    (B) Perform ipsilateral medial rectus recession
    (C) Prescribe corrective lenses
    (D) Observe

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