2 Current Outcomes with Cataract Surgery: Can We Do Better?

David F. Chang

As modern small incision cataract surgery is one of the most successful operations in all of medicine, how much we can hope to further improve results? Adopting a more expensive and time-consuming way to perform the procedure cannot be justified without providing significant benefits to the patient. To contemplate the question of where a new technology might add value, this chapter assesses our current outcomes of cataract surgery from two vantage points—safety and refractive outcomes.

Potential for Improving Safety

Femtosecond (FS) laser cataract technology automates several delicate and critical steps of the cataract procedure. These include the primary and side-port corneal incisions, astigmatic keratotomy, the continuous circular capsulotomy, and nuclear fragmentation and softening. When compared to manual performance of these same functions, we would expect that a FS laser should offer greater precision and reproducibility. As only a handful of peer-reviewed outcome studies are available at this time (Summer, 2011), we are left to ponder what the laser technology's potential impact on safety and complications will be?

D.F. Chang, M.D. (✉)
762 Altos Oaks Drive, Suite 1,
Los Altos, CA, 94024, USA
e-mail: dceye@earthlink.net

Clear Corneal Incisions

A more precise and reproducible incision would improve wound integrity. The possible correlation of an increasing postsurgical endophthalmitis rate since 1992 with increasing utilization of clear corneal incisions was highlighted by Taban and coauthors in 2005 [1]. This observation raised the controversial question of whether clear corneal incisions increased the endophthalmitis risk relative to scleral pocket incisions, because of a higher incidence of subclinical wound leak. Lacking any randomized prospective comparative trials, retrospective studies have provided the only data addressing this question [2, 3]. One compelling study was Wallin and coauthors' 2005 cohort study of 27 consecutive cases of endophthalmitis occurring at a single institution (Utah) [4]. They determined that several factors significantly increased the statistical risk of endophthalmitis at their institution. Failure to use any antibiotic on the same day as surgery increased the endophthalmitis risk five-fold, while zonular or posterior capsular rupture increased the endophthalmitis risk 17-fold. However, the single most dangerous factor was an incision leak, which led to a 44-fold increase in endophthalmitis.

Based on the available evidence, many would agree that clear corneal incisions are less forgiving than scleral pocket incisions with respect to poor wound construction both during and after surgery, and that the risk rises with increasingly wider incisions [5]. Along with astigmatism

R.R. Krueger et al. (eds.), *Textbook of Refractive Laser Assisted Cataract Surgery (ReLACS)*,
DOI 10.1007/978-1-4614-1010-2_2, © Springer Science+Business Media, LLC 2013

Table 2.1 Incidence of anterior capsule tears [11–14]

Study	Date	AC tear (%)	*N*
Muhtaseb	2004	2.8	1,000
Marques	2006	0.8	2,646
Unal	2006	5.0	296
Olali	2007	5.6	358

control, improved incision integrity is one advantage cited by proponents of micro-incisional cataract surgery. Regardless of size, precise and proper wound construction is certainly important for optimizing wound integrity. Newer accommodating IOL technologies will challenge us with the requirement for larger cataract incisions [6]. Sutures and tissue adhesives will allow us to safely increase the size of our clear corneal incisions, and the FS laser may prove to be advantageous in this regard as well.

Continuous Curvilinear Capsulotomy

Long acknowledged by many as the single most important step of our phaco procedure, the capsulorhexis offers many benefits. By allowing us to trap and encapsulate the optic and both haptics, IOL centration is virtually assured [7, 8]. An overlapping capsulorhexis enables the capsular bag to envelope the optic with a shrink wrap effect, by which a sharp posterior optic edge will kink the posterior capsule [9, 10]. This mechanical lens epithelial cell barrier reduces the incidence of secondary membrane formation. One of the most important benefits of a capsulorhexis, however, is that of safety. Like an elastic waistband, the capsulorhexis can stretch without tearing during the multitude of maneuvers to which the capsular bag is subjected during cataract surgery. In contrast, a single radial tear significantly increases the risk of wraparound extension into the posterior capsule [11].

Table 2.1 shows data on the incidence of anterior capsule tears reported from four contemporary studies [11–14]. The lowest published rate of anterior capsular tears comes from Bob Osher's personal series of more than 2,600 consecutive eyes, which was 0.8% [11]. The incidence of tears occurring during the capsulorhexis step was 0.5%. Of note was the fact that 48% of his anterior capsular tears eventually extended into the posterior capsule and 19% of cases with a torn capsulorhexis required an anterior vitrectomy. This study suggests that the rate of anterior capsular tear is reasonably low in the hands of an expert surgeon, but that if it occurs, the risk of significant complications is very high in even the most experienced hands.

At the other end of the spectrum is the resident experience reported by Unal and coauthors [13]. The capsulorhexis is consistently cited by residents as one of the most difficult steps to master [15]. The rate of torn capsulorhexis in the Unal series was 5% and of irregular capsulorhexis was 9%. The overall rate of posterior capsule rupture and vitreous loss was 6.4% [13].

Table 2.2 Published vitreous loss rates—1999–2009 (0.2–4.4%) [16–28]

Author	Published	% Vitreous loss	Study size
Desai	1999	4.4	18,454
Martin	2000	1.3	3,000
Lundstrom	2001	2.2	2,731
Ionides	2001	2.9	1,420
Gimbel	2001	0.2	18,470
Tan	2002	3.6	2,538
Chan	2003	1.1	8,230
Androudi	2004	4.0	543
Hyams	2005	2.0	1,364
Ang	2006	1.1	2,727
Zaidi	2007	1.1	1,000
Mearza	2009	2.7	1,614
Agrawal	2009	1.6	6,564

Posterior Capsule Rupture and Vitreous Loss

Table 2.2 and Fig. 2.1 list 13 studies of vitreous loss rates in non-resident series published during the decade between 1999 and 2009 [16–28]. Excluding Howard Gimbel's exceptionally low rate of 0.2% [20], the vitreous loss rates

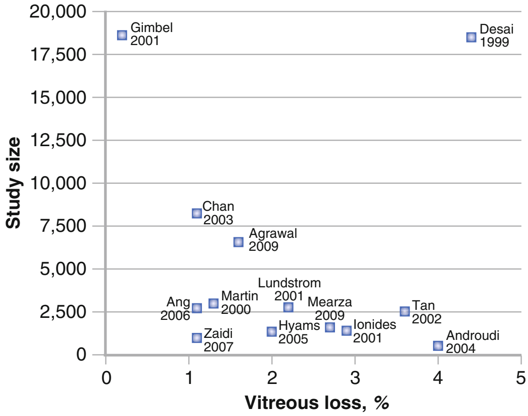

Fig. 2.1 Studies of vitreous loss rates in non-resident series published during the decade between 1999 and 2009 [16–28]

Table 2.3 Published vitreous loss rates residents—2002–2010 (1.3–6.1%) [15, 29–35]

Author	Published	% Vitreous loss	Study size
Blomquist	2002	4.5	1,400
Dooley	2006	4	100
Bhagat	2007	5.4	755
Pot	2008	1.3	982
Rutar	2009	3.1	320
Lee	2009	4.9	226
Carricondo	2010	6.1	261
Blomquist	2010	3.2	1,833

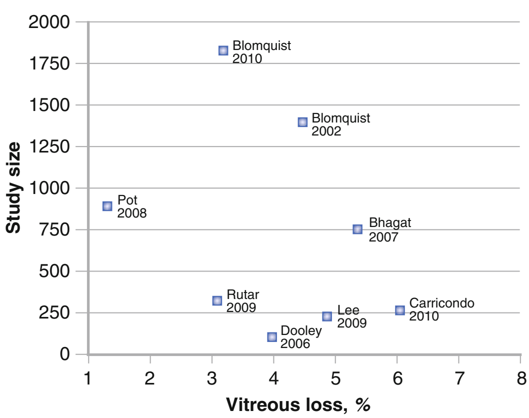

Fig. 2.2 Studies of vitreous loss rates among residency programs that were published from 2002 to 2010 [15, 29–35]

consistently range from 1 to 4%. Table 2.3 and Fig. 2.2 list eight studies of vitreous loss rates among residency programs that were published from 2002 to 2010 [15, 29–35]. With the exception of one study, these rates consistently ranged from 3 to 6%. The best current published data on vitreous loss rates come from two recent studies of large patient populations. Narendran and coauthors' 2009 report on the Cataract National Dataset audit of 55,567 operations from the United Kingdom (UK) reported a 1.9% rate of vitreous loss [36]. Greenberg and coauthors' 2010 published study of cataract surgery in 45,082 US Veterans Administration Hospital cataract surgeries had a vitreous loss rate of 3.5% [37].

Ultrasound Power/Endothelial Cell Loss

A number of studies have shown a reduction in ultrasound energy when employing a phaco chop method compared to divide and conquer [38–41]. The correlation of phaco chop with reduced endothelial cell loss is less consistent in the literature [39, 42, 43]. Part of the variability of the results from these studies undoubtedly relates to the varying density of the nuclei encountered. For example, Park and coauthors compared phaco chop to stop-and-chop in a bilateral eye study involving 51 patients [44]. There was no statistical difference in mean effective phaco time (EPT) for moderately dense nuclei; however, with dense nuclei, there was a statistically significant reduction in mean EPT with chopping ($P<0.01$). The specific comparison of stop and chop to pre-chopping may be more relevant in assessing the FS laser's potential benefit. Pereira and coauthors found that pre-chopping significantly reduced effective phaco time and phaco power in a small prospective trial of 50 eyes [45].

Despite these reported advantages to chopping, the 2010 Leaming survey of ASCRS members reported that only 32% of respondents were performing phaco chop, compared to 62% who were performing divide-and-conquer. The fact

Table 2.4 Hitting emmetropia [54–59]

Author	N	Biometry	% Within 0.50 D	% Within 1.00 D
Landers (2009)	55	IOLMaster	75	93
		Immersion U/S	49	85
Kim (2009)	30	Contact U/S	70	93
Lim (2009)	100	Contact U/S	45	83
Gale (2009)	–	IOLMaster	–	80–87
Eleftheriadis (2003)	100	IOLMaster	–	96
Murphy (2002)	1,676	Contact U/S	45	72
Mean			57	87

that the phaco chop technique is generally more difficult to learn may be an important factor underlying these statistics. Reducing ultrasound time by pre-chopping and softening the nucleus is an important potential benefit of FS laser cataract surgery. The denser the nucleus, the greater the ultrasound reduction should be, and the more likely a clinically significant difference in endothelial cell loss would be found.

Potential for Improving Refractive Outcomes

Spherical Equivalent Accuracy

Many factors must be successfully managed to achieve pseudophakic emmetropia. A major advance has been in the more accurate determination of axial length with non-contact, partial coherence interferometry [47–49]. Two variable IOL power calculation formulae have been successfully used for decades [50–52]. More advanced formulae, such as those developed by Haigis and Holladay, incorporate additional variables in an effort to better predict the effective lens position [53]. Table 2.4 summarizes six published studies that analyze refractive accuracy [49, 54–58]. Some of these series employed contact A-scan biometry, while others employed partial coherence interferometry. Even in the study with the best results, 25% of eyes fail to refract to within 0.5 D of the intended spherical equivalent target postoperatively.

The one important variable that cannot be measured in advance is the final axial resting position of the IOL optic—the so called, effective lens position (ELP). Calculating a surgeon's personalized A-constant is an effort to optimize the ELP prediction based on variables in individual surgical techniques. In addition to capsular bag fixation of the IOL, the primary surgical variable that affects ELP is the diameter and shape of the capsulorhexis [59–61]. The generally accepted surgical objective is a round capsulorhexis that overlaps the optic edge for all 360° of its circumference. This means that as the capsular bag shrinks and contracts postoperatively, the capsular forces are uniformly and symmetrically balanced in all three dimensions. A larger diameter capsulorhexis that is all or partially "off" the optic edge should permit the optic to move slightly anterior to the position of one constrained by a completely overlapping anterior capsular rim.

Accommodating IOL designs may impose additional requirements for capsulorhexis diameter and shape. The ELP of a hinged optic, such as with the Crystalens, would be expected to vary with the capsulorhexis diameter. If one assumes a preferred diameter of 5.0 mm, a smaller diameter capsulorhexis will contract more and may displace the optic more posteriorly. In contrast, a larger diameter capsulorhexis should allow the optic to shift more anteriorly. Studies will be needed to determine whether a FS laser capsulotomy is able to improve refractive outcomes on the basis of greater ELP predictability. Finally, there is one special complication that is unique to premium refractive IOLs—that of a patient receiving a well-positioned monofocal IOL, but not the toric, multifocal, or accommodating IOL that they strongly preferred. For example, with the synchrony dual optic accommodating IOL, the

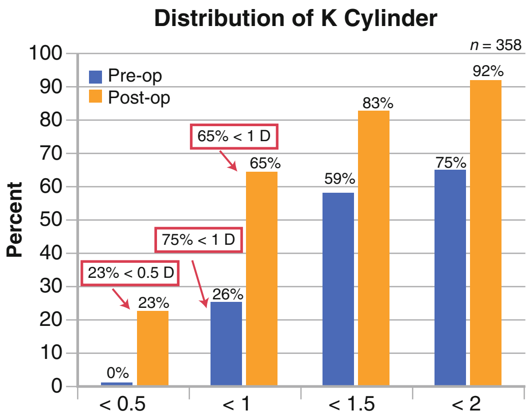

Fig. 2.3 Gills LRI data. $n=358$, Mean pre-op cyl 1.59 D (mild-moderate astigmatism) [68]

anterior optic shifts forward with accommodative effort [6]. If the capsulorhexis does not completely overlap the anterior optic edge, the 5.0 mm diameter anterior optic may partially dislocate out of the bag and into the ciliary sulcus. A capsulorhexis that is too large or eccentric in shape is therefore a contraindication to implanting the synchrony accommodating IOL. A torn capsulorhexis is also a contraindication to using the Crystalens, in my opinion, because of the significant potential for subluxation. A radial capsulorhexis tear also increases the potential for single and three-piece IOL decentration, and may be problematic for a multifocal or toric IOL where proper optical alignment is more critical. Although they might attain excellent corrected visual acuity with an intracapsular monofocal IOL, these aforementioned patients are often emotionally distraught at having permanently lost the opportunity to receive the premium refractive IOL that they had selected preoperatively.

Astigmatism Management

The number of cataract surgical patients with preoperative corneal astigmatism has been determined from several studies. A published study of more than 23,000 eyes found that 8% of patients had at least 2.0 D of corneal astigmatism preoperatively [62]. The percent of eyes with at least 1.0 and 0.5 D of preoperative corneal astigmatism were 36 and 74% respectively. This correlated well with a study of more than 4,500 eyes in which 35% of eyes had at least 1.0 D, and 22% had at least 1.5 D of preoperative corneal astigmatism [63].

Incisional astigmatic keratotomy (AK) is a popular method of simultaneously reducing preoperative corneal astigmatism at the time of cataract surgery [64]. There is a relative dearth of published studies on the efficacy of this method in conjunction with phaco. Carvalho and coauthors found a statistically significant reduction in mean topographic astigmatism from 1.93 ± 0.58 D preoperatively to 1.02 ± 0.60 D postoperatively using limbal relaxing incisions in 25 eyes [65]. Mingo-Botín and coauthors compared toric IOLs to incisional astigmatic keratotomy in 40 eyes undergoing cataract surgery who were randomized to either technique of astigmatism reduction [66]. The mean reduction in keratometric astigmatism was 0.58 D (30% of the preoperative corneal astigmatism) in the 20 eyes receiving AK, and there was with a statistically significant reduction in mean pre-op refractive astigmatism (pre-op -2.17 ± 1.02; post-op -1.32 ± 0.60; $p=0.001$). However, the residual refractive astigmatism was ≤ 1.0 D in only 8/20 eyes (40%) receiving AK, compared to 18/20 eyes (90%) receiving a toric IOL. Poll and coauthors achieved a mean 0.46 D of postoperative astigmatism with astigmatic keratotomy in 115 eyes undergoing cataract surgery, which was comparable to toric IOL results in their series [67].

The largest reported series of eyes undergoing astigmatic keratotomy combined with phaco is from Gills, and is shown in Fig. 2.3 [68]. He analyzed 358 eyes with mild to moderate preoperative astigmatism, of which 74% had more than 1.0 D of astigmatism. The mean preoperative astigmatism of 1.59 D was reduced to a mean of 0.99 D postoperatively. Sixty-five percent of these treated eyes had <1 D of keratometric cylinder postoperatively and only 23% had <0.5 D of astigmatism postoperatively.

In the 2010 Leaming survey, 67% of respondents most often use a toric IOL and 18% of respondents most often use astigmatic keratotomy to treat pre-existing astigmatism in their cataract patients [46]. Astigmatic keratotomy will always be plagued by an unavoidable variable—that of the individual tissue response to the corneal relaxing incision. Nevertheless, it stands to reason that AK results will be more accurate if the depth, curvature, length, diameter and axial orientation of the incisions (upon which the nomograms are developed and based) are made as reproducibly consistent as possible. It will be of great interest to see if FS laser astigmatic keratotomy will fulfill this potential.

Key Points

1. The most recent published cataract surgical studies estimate the rate of vitreous loss to be 2–4%.
2. Thirty-five percent of cataract patients have at least 1 D of corneal astigmatism.

References

1. Taban M, Behrens A, Newcomb RL, et al. Acute endophthalmitis following cataract surgery: a systematic review of the literature. Arch Ophthalmol. 2005; 123:613–20.
2. Cooper BA, Holekamp NM, Bohigian G, Thompson PA. Case–control study of endophthalmitis after cataract surgery comparing scleral tunnel and clear corneal wounds. Am J Ophthalmol. 2003; 136: 300–5.
3. Lertsumitkul S, Myers PC, O'Rourke MT, Chandra J. Endophthalmitis in the western Sydney region: a case–control study. Clin Exp Ophthalmol. 2001;29: 400–5.
4. Wallin T, Parker J, Jin Y, et al. Cohort study of 27 cases of endophthalmitis at a single institution. J Cataract Refract Surg. 2005;31:735–41.
5. Nichamin LD, Chang DF, Johnson SH, et al. American Society of Cataract and Refractive Surgery Cataract Clinical Committee. ASCRS White Paper: what is the association between clear corneal cataract incisions and postoperative endophthalmitis? J Cataract Refract Surg. 2006;32:1556–9.
6. Bohórquez V, Alarcon R. Long-term reading performance in patients with bilateral dual-optic accommodating intraocular lenses. J Cataract Refract Surg. 2010;36:1880–6.
7. Colvard DM, Dunn SA. Intraocular lens centration with continuous tear capsulotomy. J Cataract Refract Surg. 1990;16:312–4.
8. Ram J, Apple DJ, Peng Q, et al. Update on fixation of rigid and foldable posterior chamber intraocular lenses. Part I: Elimination of fixation-induced decentration to achieve precise optical correction and visual rehabilitation. Ophthalmology. 1999;106: 883–90.
9. Ram J, Pandey SK, Apple DJ, et al. Effect of in-the-bag intraocular lens fixation on the prevention of posterior capsule opacification. J Cataract Refract Surg. 2001;27:367–70.
10. Nishi O, Nishi K, Wickstrom K. Preventing lens epithelial cell migration using intraocular lenses with sharp rectangular edges. J Cataract Refract Surg. 2000;26:1543–9.
11. Marques FF, Marques DM, Osher RH, Osher JM. Fate of anterior capsule tears during cataract surgery. J Cataract Refract Surg. 2006;32:1638–42.
12. Muhtaseb M, Kalhoro A, Ionides A. A system for preoperative stratification of cataract patients according to risk of intraoperative complications. Br J Ophthalmol. 2004;88:1242–6.
13. Unal M, Yücel I, Sarici A, et al. Phacoemulsification with topical anesthesia: resident experience. J Cataract Refract Surg. 2006;32:1361–5.
14. Olali CA, Ahmed S, Gupta M. Surgical outcome following breach rhexis. Eur J Ophthalmol. 2007;17:565–70.
15. Dooley IJ, O'Brien PD. Subjective difficulty of each stage of phacoemulsification cataract surgery performed by basic surgical trainees. J Cataract Refract Surg. 2006;32(4):604–8.
16. Desai P, Minassian DC, Reidy A. National cataract surgery survey1997–98: a report of the results of the clinical outcomes. Br J Ophthalmol. 1999;83:1336–40.
17. Martin KR, Burton RL. The phacoemulsification learning curve: per-operative complications in the first 3000 cases of an experienced surgeon. Eye. 2000;14 (Pt 2):190–5.
18. Lundstrom M, Barry P, Leite E, et al. 1998 European Cataract Outcome Study: report from the European Cataract Outcome Study Group. J Cataract Refract Surg. 2001;27:1176–84.
19. Ionides A, Minassian D, Tuft S. Visual outcome following posterior capsule rupture during cataract surgery. Br J Ophthalmol. 2001;85:222–4.
20. Gimbel HV, Sun R, Ferensowicz M, et al. Intraoperative management of posterior capsule tears in phacoemulsification and intraocular lens implantation. Ophthalmology. 2001;108:2186–9 [discussion 2190–2].
21. Tan JHY, Karwatowski WSS. Phacoemulsification cataract surgery and unplanned anterior vitrectomy: is it bad news? Eye. 2002;16:117–20.
22. Chan FM, Mathur R, Ku JJK, et al. Short-term outcomes in eyes with posterior capsule rupture during cataract surgery. J Cataract Refract Surg. 2003;29:537–41.
23. Androudi S, Brazitikos PD, Papadopoulos NT, et al. Posterior capsule rupture and vitreous loss during phacoemulsification with or without the use of an anterior chamber maintainer. J Cataract Refract Surg. 2004;30:449–52.
24. Hyams M, Mathalone N, Herskovitz M, et al. Intraoperative complications of phacoemulsification in eyes with and without pseudoexfoliation. J Cataract Refract Surg. 2005;31:1002–5.

25. Ang GS, Whyte IF. Effect and outcomes of posterior capsule rupture in a district general hospital setting. J Cataract Refract Surg. 2006;32:623–7.
26. Zaidi FH, Corbett M, Burton BJL, Bloom PA. Raising the benchmark for the 21st century—the 1000 cataract operations audit and survey: outcomes, consultant-supervised training and sourcing NHS choice. Br J Ophthalmol. 2007;91:731–6.
27. Mearza AA, Ramanathan S, Bidgood P, Horgan S. Visual outcome in cataract surgery complicated by vitreous loss in a district general hospital. Int Ophthalmol. 2009;29:157–60.
28. Agrawal V, Upadhyay J, Indian Cataract Risk Stratification Study Group. Validation of scoring system for preoperative stratification of intra-operative risks of complications during cataract surgery: Indian multicentric study. Indian J Ophthalmol. 2009;57: 213–5.
29. Blomquist PH, Rugwani RM. Visual outcomes after vitreous loss during cataract surgery performed by residents. J Cataract Refract Surg. 2002;28:847–52.
30. Bhagat N, Nissirios N, Potdevin L, Chung J, Lama P, Zarbin MA, Fechtner R, Guo S, Chu D, Langer P. Complications in resident performed phacoemulsification cataract surgery at New Jersey Medical School. Br J Ophthalmol. 2007;91:1315–7.
31. Pot MC, Stilma JS. Low complication rate with cataract operations carried out by registrars in ophthalmology. Ned Tijdschr Geneeskd. 2008;8(152):563–8.
32. Rutar T, Porco TC, Naseri A. Risk factors for intraoperative complications in resident-performed phacoemul-sification surgery. Ophthalmology. 2009; 116:431–6.
33. Lee J-S, Hou C-H, Yang M-L, Kuo JZ-C, Lin K-K. A different approach to assess resident phacoemulsification learning curve: analysis of both completion and complication rates. Eye. 2009;23:683–7.
34. Carricondo PC, Fortes AC, Mourao Pde C, Hajnal M, Jose NK. Senior resident phacoemulsification learning curve (corrected from cure). Arq Bras Oftalmol. 2010;73:66–9.
35. Blomquist PH, Sargent JW, Winslow HH. Validation of Najjar-Awwad cataract surgery risk score for resident phacoemulsification surgery. J Cataract Refract Surg. 2010;36:1753–7.
36. Narendran N, Jaycock P, Johnston RL, et al. The Cataract National Dataset electronic multicentre audit of 55,567 operations: risk stratification for posterior capsule rupture and vitreous loss. Eye (Lond). 2009;23 (1):31–7.
37. Greenberg PB, Tseng VL, Wu WC, et al. Prevalence and predictors of ocular complications associated with cataract surgery in United States Veterans. Ophthalmology 2010 [Epub ahead of print].
38. DeBry P, Olson RJ, Crandall AS. Comparison of energy required for phaco-chop and divide and conquer phacoemulsification. J Cataract Refract Surg. 1998;24:689–92.
39. Pirazzoli G, D'Eliseo D, Ziosi M, Acciarri R. Effects of phacoemulsification time on the corneal endothelium using phacofracture and phaco chop techniques. J Cataract Refract Surg. 1996;22:967–9.
40. Ram J, Wesendahl TA, Auffarth GU, Apple DJ. Evaluation of in situ fracture versus phaco chop techniques. J Cataract Refract Surg. 1998;24:1464–8.
41. Wong T, Hingorani M, Lee V. Phacoemulsification time and power requirements in phaco chop and divide and conquer nucleofractis techniques. J Cataract Refract Surg. 2000;26:1374–8.
42. Vajpayee RB, Kumar A, Dada T, Titiyal JS, Sharma N, Dada VK. Phaco-chop versus stop-and-chop nucleotomy for phacoemulsification. J Cataract Refract Surg. 2000;26(11):1638–41.
43. Storr-Paulsen A, Norregaard JC, Ahmed S, Storr-Paulsen T, Pedersen TH. Endothelial cell damage after cataract surgery: divide-and-conquer versus phaco-chop technique. J Cataract Refract Surg. 2008; 34:996–1000.
44. Park JH, Lee SM, Kwon JW, et al. Ultrasound energy in phacoemulsification: a comparative analysis of phaco-chop and stop-and-chop techniques according to the degree of nuclear density. Ophthalmic Surg Lasers Imaging. 2010;41:236–41.
45. Pereira AC, Porfirio F, Freitas LL, Belfort R. Ultrasound energy and endothelial cell loss with stop-and-chop and nuclear preslice phacoemulsification. J Cataract Refract Surg. 2006;32:1661–6.
46. 2010 Leaming Survey. Accessed at http://www.analeyz.com/AnaleyzASCRS2010.htm
47. Haigis W, Lege B, Miller N, Schneider B. Comparison of immersion ultrasound biometry and partial coherence interferometry for intraocular lens calculation according to Haigis. Graefes Arch Clin Exp Ophthalmol. 2000;238:765–73.
48. Packer M, Fine IH, Hoffman RS, et al. Immersion A-scan compared with partial coherence interferometry: outcomes analysis. J Cataract Refract Surg. 2002; 28:239–42.
49. Landers J, Goggin M. Comparison of refractive outcomes using immersion ultrasound biometry and IOLMaster biometry. Clin Exp Ophthalmol. 2009;37: 566–9.
50. Retzlaff JA, Sanders DR, Kraff MC. Development of the SRK/T intraocular lens implant power calculation formula. J Cataract Refract Surg. 1990;16:333–40.
51. Hoffer KJ. The Hoffer Q formula: a comparison of theoretic and regression formulas. J Cataract Refract Surg. 1993;19:700–12 [Erratum: J Cataract Refract Surg 1994;20:677].
52. Olsen T, Corydon L, Gimbel H. Intraocular lens power calculation with an improved anterior chamber depth prediction algorithm. J Cataract Refract Surg. 1995; 21:313–9.
53. Hoffer KJ. Clinical results using the Holladay 2 intraocular lens power formula. J Cataract Refract Surg. 2000;26:1233–7.
54. Kim SW, Kim EK, Cho BJ, et al. Use of the pentacam true net corneal power for intraocular lens calculation in eyes after refractive corneal surgery. J Refract Surg. 2009;25(3):285–9.
55. Lim LH, Lee SY, Ang CL. Factors affecting the predictability of SRK II in patients with normal

axial length undergoing phacoemulsification surgery. Singapore Med J. 2009;50(2):120–5.
56. Gale RP, Saldana M, Johnston RL, et al. Benchmark standards for refractive outcomes after NHS cataract surgery. Eye. 2009;23(1):149–52.
57. Eleftheriadis H. IOLMaster biometry: refractive results of 100 consecutive cases. Br J Ophthalmol. 2003;87(8):960–3.
58. Murphy C, Tufy SJ, Minassian DC. Refractive error and visual outcome after cataract extraction. J Cataract Refract Surg. 2002;28:62–6.
59. Cekic O, Batman C. The relationship between capsulorhexis size and anterior chamber depth relation. Ophthalmic Surg Lasers. 1999;30:185–90.
60. Norby S. Sources of error in intraocular lens power calculation. J Cataract Refract Surg. 2008;34:368–76.
61. Hill WE. Intraocular lens power calculations: are we stuck in the past? Clin Exp Ophthalmol. 2009; 37:761–2.
62. Hoffmann PC, Hutz WW. Analysis of biometry and prevalence data for corneal astigmatism in 23,239 eyes. J Cataract Refract Surg. 2010;36:1479–85.
63. Ferrer-Blasco T, Montés-Micó R, Peixoto-de-Matos SC, González-Méijome JM, Cerviño A. Prevalence of corneal astigmatism before cataract surgery. J Cataract Refract Surg. 2009;35:70–5.
64. Amesbury EC, Miller KM. Correction of astigmatism at the time of cataract surgery. Curr Opin Ophthalmol. 2009;20:19–24.
65. Carvalho MJ, Suzuki SH, Freitas LL, Branco BC, Shor P, Höffling-Lima AL. Limbal relaxing incisions to correct corneal astigmatism during phacoe-mulsification. J Refract Surg. 2007;23:499–504.
66. Mingo-Botín D, Muñoz-Negrete FJ, Won Kim HR, Morcillo-Laiz R, Rebolleda G, Oblanca N. Comparison of toric intraocular lenses and peripheral corneal relaxing incisions to treat astigmatism during cataract surgery. J Cataract Refract Surg. 2010;36: 1700–8.
67. Poll JT, Wang L, Koch DD, Weikert MP. Correction of astigmatism during cataract surgery: toric intraocular lens compared to peripheral corneal relaxing incisions. J Refract Surg. 2011;27:165–71.
68. Gills JP, Wallace RB, Fine IH, et al. Chapter 7: Reducing pre-existing astigmatism with limbal relaxing incisions. In: Henderson BA, Gills JP, editors. A complete surgical guide for correcting astigmatism. 2nd ed. Thorofare, NJ: Slack; 2011.

Springer

http://www.springer.com/978-1-4614-1009-6

Textbook of Refractive Laser Assisted Cataract Surgery (ReLACS)

Krueger, R.R.; Talamo, J.H.; Lindstrom, R.L. (Eds.)

2013, XIX, 289 p., Hardcover

ISBN: 978-1-4614-1009-6