The Literature

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OUTCOMES OF FEMTOSECOND LASER CATARACT SURGERY WITH A DIFFRACTIVE MULTIFOCAL INTRAOCULAR LENS

Lawless M, Bali SJ, Hodge C, et al[1]

ABSTRACT SUMMARY

Lawless et al analyzed the visual and refractive outcomes in the first 61 consecutive eyes undergoing laser cataract surgery (LCS group) with implantation of a diffractive multifocal IOL (AcrySof IQ Restor IOL +3.0 D; Alcon Laboratories, Inc.) between May and July 2011. The control group included a retrospective consecutive cohort of 29 eyes that underwent manual phacoemulsification cataract surgery (MCS group) with implantation of the same IOL between December 2010 and April 2011. The investigators collected visual and refractive parameters preoperatively and 1 and 3 months postoperatively.

The study found the mean spherical equivalent and visual acuity of the two groups to be comparable. The mean postoperative spherical equivalent refraction was -0.01 ±0.35 D and -0.06 ±0.30 D in the LCS and MCS groups, respectively (P = .492). The mean absolute refractive prediction error was 0.26 ±0.25 D for the LCS group and 0.23 ±0.16 D for the MCS group (P = .489). The mean arithmetic refractive prediction error was 0.06 ±0.44 D and -0.02 ±0.30 D for the LCS and MCS groups, respectively (P = .388). The investigators did not observe a significant difference in the mean postoperative uncorrected distance visual acuity or uncorrected near visual acuity between the groups, and none of the eyes in either group had surgical complications or lost corrected distance visual acuity during the follow-up period.

DISCUSSION

As expectations for outcomes in cataract surgery have shifted from the restoration of sight to spectacle independence, reducing postoperative refractive errors has become cataract surgeons' goal.[2] Many claims have been made about the importance of phaco time, capsular circularity and centricity, and phaco energy, yet these parameters are only proxies for what our patients (and we surgeons) ultimately care about.[3-6]

Lawless et al evaluated patients' refractive outcomes and found the mean spherical equivalent visual acuity and refraction between eyes that underwent LCS and MCS to be comparable. Similarly, Filkorn et al found no significant difference in mean refractive spherical equivalent (-0.50 ±1.06 D for LCS vs -0.58 ±1.28 D for MCS) or corrected distance visual acuity between the two cataract procedures.[7] They did, however, find that 41.6% of eyes that underwent LCS (n = 77) were within 0.25 D of the target refraction versus 28.1% of eyes in the conventional group (n = 57). These numbers suggest that, for every eight patients treated with laser cataract surgery, one would fall within 0.25 D rather than 0.50 D of the target. This difference nearly disappeared for eyes within 0.50 D of the target refraction. Mihaltz et al did not report statistically significant differences in uncorrected or corrected distance acuity between LCS and MCS.[8] The laser group had less vertical tilt of the IOL and intraocular vertical coma, but no significant differences were observed in 10 other parameters of higher-order aberrations. Additionally, no Bonferroni correction was made for analyzing multiple parameters and identifying two for which there were differences.

> "Perhaps with time and larger cohorts, laser cataract surgery may prove to be statistically significantly advantageous compared with conventional phacoemulsification."

It is important to note that the surgeons who performed LCS in these small cohorts were new to the procedure and therefore at a disadvantage. This suggests that, perhaps with time and larger cohorts, LCS may prove to be statistically significantly advantageous compared with conventional phacoemulsification. Surgeons can likely achieve refractive precision, a fast recovery for patients, and excellent visual outcomes with existing technology simply by (1) performing precise biometry and multiple assessments of keratometry, (2) using an optical zone marker (or heads-up display) to guide the capsulorhexis' creation, (3) centering the capsulorhexis and IOL on the undilated pupillary center or visual axis, (4) conducting thorough cortical cleanup and polishing of the posterior

and anterior capsules' undersurfaces, and (5) employing viscoelastic to optimally protect the cornea (soft-shell technique and/or viscoelastic injection immediately after hydrodissection for maximal endothelial protection).

CORNEAL ENDOTHELIAL CELL LOSS AND CORNEAL THICKNESS IN CONVENTIONAL COMPARED WITH FEMTOSECOND LASER-ASSISTED CATARACT SURGERY: THREE-MONTH FOLLOW-UP

Conrad-Hengerer I, Al Juburi M, Schultz T, et al[9]

ABSTRACT SUMMARY

Conrad-Hengerer et al quantified changes in endothelial cell counts and corneal thickness measurements in patients undergoing standard phacoemulsification compared with laser cataract surgery in this prospective, randomized, intraindividual cohort study. One eye of each patient underwent standard phacoemulsification (control group), and the other eye underwent laser cataract surgery (LCS; study group). An IOL was implanted in both eyes. The investigators used pulsed ultrasound energy for phacoemulsification, and they performed noncontact endothelial cell microscopy and corneal pachymetry preoperatively and 1 day, 3 to 4 days, 7 to 10 days, 50 to 60 days, and 90 to 100 days postoperatively.

According to the study, the femtosecond laser did not add to the endothelial damage caused by cataract surgery. The mean endothelial cell loss was 7.9% ±7.8% (standard deviation) 1 week postoperatively and 8.1% ±8.1% 3 months postoperatively in the study group and 12.1% ±7.3% and 13.7% ±8.4%, respectively, in the control group. The mean relative change in corneal thickness from the preoperative values was -0.0% ±1.9% on day 1, 2.8% ±1.8% at 1 week, and 3.3% ±1.7% at 3 months in the study group versus -0.9% ±2.3%, 2.4% ±1.5%, and 3.2% ±1.4%, respectively, in the control group. Based on these results, the investigators concluded that the laser's use might be beneficial in eyes with low preoperative endothelial cell values (eg, corneal guttata).

DISCUSSION

Over the past 10 years, technical and technological improvements have reduced ultrasound time and energy during phacoemulsification.[10-15] The use of the femtosecond laser during cataract surgery offers the potential advantage of reducing the amount of ultrasound energy delivered during the procedure. The study by Conrad-Hengerer et al is the first to compare endothelial cell loss and corneal thickening after LCS versus phacoemulsification. In the study, eyes that underwent LCS had lost significantly fewer endothelial cells 3 months postoperatively, and no ultrasound energy was used for 64% of eyes.

Previous studies have shown that effective phaco time was reduced by 70% in eyes treated with the Catalys Precision Laser System (OptiMedica Corporation) compared with eyes treated with phacoemulsification.[16] Takacs et al reported central corneal thickness to be lower in eyes treated with the LenSx Laser (Alcon Laboratories, Inc.; 580 ±42 µm) compared with eyes in the conventional group (607 ±91 µm) on the first postoperative day. There was no significant difference, however, 1 week or 1 month postoperatively.[17]

These studies indicate that there is less corneal trauma with LCS than with phacoemulsification. It should be noted that all eyes in the conventional phaco groups in these studies underwent grooving with the phaco handpiece instead of modern techniques such as chopping, carousel, or prechopping. The 13.7% rate of endothelial cell loss in the phaco group reported by Conrad-Hengerer et al seems abnormally high compared with data found in the literature, which report an average cell loss of 3.2% to 11.6% using modern techniques.[13,14,18-21] Studies that compare modern methods of mechanical nuclear fragmentation with that of laser technology are needed to elucidate the merit of a change in practice as well as its cost.

COST-EFFECTIVENESS OF FEMTOSECOND LASER-ASSISTED CATARACT SURGERY VERSUS PHACOEMULSIFICATION CATARACT SURGERY

Abell RG, Vote BJ[22]

ABSTRACT SUMMARY

In this retrospective study, Abell and Vote performed a comparative cost-effectiveness analysis of laser cataract surgery (LCS) and conventional phacoemulsification cataract surgery (PCS) using computer-based econometric modeling. The investigators created a hypothetical cohort of patients undergoing cataract surgery in the better-seeing eye based on a review of the current literature and their direct experience with LCS. They obtained the complication rates of cataract surgery from a review of the current literature to complete the cohort of patients and outcomes. These data were incorporated with time trade-off utility values converted from visual acuity outcomes.

Based on the simulated complication rates of PCS and LCS and assuming an improvement in visual acuity of 5% in uncomplicated cases of LCS, the cost-

effectiveness (dollars spent per quality-adjusted life-years [QALY]) gained from LCS was not beneficial at $92,862 Australian dollars (AUD). The total QALY gain for LCS over PCS was 0.06 units. Multivariate sensitivity analyses revealed that LCS would need to significantly improve visual outcomes and complication rates over PCS and decrease the cost to patients to improve cost-effectiveness. Modeling a best-case scenario of LCS with excellent visual outcomes (100%), a significant reduction in complications (0%), and a significantly lower cost to patients ($300) resulted in an incremental cost-effectiveness ratio of $20,000 (AUD).

Based on these results, the investigators concluded that LCS, irrespective of the potential improvements in visual acuity outcomes and complication rates, is not currently cost-effective for patients compared with cost-effectiveness benchmarks and other medical interventions, including PCS. A significant reduction in the cost to patients (via reduced consumable/click cost) would increase the likelihood of LCS' being considered cost-effective.

DISCUSSION

Data on the cost-effectiveness of LCS with regard to clinically pertinent endpoints relative to phacoemulsification remain sparse. In this study, researchers used a decision tree model to analyze cost utility and estimate the incremental cost-effectiveness ratio of LCS versus phacoemulsification.[22] The authors argue that, even with a 5% increase in BCVA and reduced complication rates, laser technology for cataract surgery is not cost-effective. This claim is striking, considering that the authors were conservative in their estimate of the cost of LCS and generous in their estimates of improvement in surgical outcomes.

The World Health Organization defines an intervention as cost-effective if its total direct costs are less than three times the gross domestic product per capita to avert one lost QALY.[23] In reality, cost-effectiveness benchmarks vary by country. The cost of $92,861 (AUD)/QALY is within Australia's general threshold of $110,000 (AUD)/QALY,[24] yet it is well above Australia's Department of Health and Aging cost-effectiveness threshold of $60,000 (AUD)/QALY.[25] For comparison, the cost of conventional phacoemulsification is $4,378 (AUD)/QALY.[22]

Considering the high cost of health care in the United States and declining financial margins for error in practice, ophthalmologists should approach LCS with prudence and carefully decide whether fiscally mortgaging balance sheets to corporate interests truly serves patients' interests, as phacoemulsification is already one of the most cost-effective techniques in the world. ■

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