



Comparison of vitreous loss rates between manual phacoemulsification and femtosecond laser–assisted cataract surgery

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PURPOSE: To compare the vitreous loss complication rate of manual phacoemulsification cataract surgery with that of femtosecond laser–assisted cataract surgery.

SETTING: Mercy Eye Specialists, Springfield, Missouri, USA.

DESIGN: Retrospective single-center case series.

METHODS: Cataract surgeries from 2010 to 2014 performed by 4 surgeons were audited for rates of vitreous loss. Vitreous loss data were statistically analyzed with and without exclusions.

RESULTS: Of the total 7155 cases from 2010 to 2014, 3784 were consecutively performed using manual phacoemulsification from 2010 to 2012 and 3371 were performed using femtosecond laser–assisted cataract surgery from 2013 to 2014. The rate of vitreous loss with exclusions was 1.17% in the manual phacoemulsification group and versus 0.65% femtosecond laser–assisted group; without exclusions, the rate was 1.40% versus 0.77%. In absolute terms, the rate decreased for every surgeon in the study. The chi-square test showed a statistically significant association between the date of surgery, and thus technique, and vitrectomy cases ($P < .05$). Odds ratio analysis with exclusions versus without exclusions indicated that surgeries performed from 2010 to 2012 using manual phacoemulsification were 1.6 times and 1.8 times, respectively, more likely to have vitreous loss than surgeries performed from 2013 to 2014 using the femtosecond laser–assisted cataract surgery technique.

CONCLUSIONS: Conversion from manual phacoemulsification to femtosecond laser–assisted cataract surgery resulted in a statistically significant decrease in vitreous loss. Because vitreous loss increases the risk for other serious complications of cataract surgery, this new finding has important implications for the safety of cataract surgery.

Financial Disclosure: Proprietary or commercial disclosures are listed after the references.

J Cataract Refract Surg 2016; 42:1003–1008 © 2016 ASCRS and ESCRS

Femtosecond laser–assisted cataract surgery is a new method of cataract removal that potentially offers advantages over manual phacoemulsification cataract surgery. It has been shown to improve the reproducibility of incisions, improve the accuracy of the anterior capsulotomy, decrease ultrasound energy use, and decrease cornea endothelial cell loss.^{1–6} However, further evidence regarding improved safety is needed. Vitreous loss is a complication that is associated with an increased risk for cystoid macula edema, retinal detachment, hemorrhage, glaucoma, wound complications, and endophthalmitis, which makes it

an excellent indicator to compare the safety of cataract surgery methods.^{7,8}

The practice from which this study's data was collected is unique because it represents multiple surgeons at a community-based ambulatory surgery center (ASC) in the United States that made a complete change from manual phacoemulsification to femtosecond laser–assisted cataract surgery. Since March 4, 2013, all cataract surgery has been performed with a femtosecond laser (Catalys, Abbott Medical Optics, Inc.). Two lasers were placed in separate operating rooms, and all patients, with the exception of patients

who could not be positioned under the laser for physical/positional reasons, have had femtosecond laser-assisted cataract surgery since that date. A hard stop-start date was chosen, and it involved all surgeries and all surgeons; therefore, a clear comparison of the vitreous loss rates between manual phacoemulsification and femtosecond laser-assisted cataract surgery could be performed. In addition, this community-based surgery center serves a stable health system population (Mercy Health System, Springfield, Missouri, USA), and patient demographics and comorbidities would also be expected to be similar in the 2 study groups.

PATIENTS AND METHODS

Operative summaries, self-reporting, and current procedural terminology coding were used to find cases with vitreous loss in the 2 study group timeframes. In addition, all cases that had a vitrectomy set opened were reviewed. This proved to be a reliable method because the vitrectomy set is an inventory item that is scanned into the record by the nursing staff and is independent of surgeon summary or coding.

In both groups, patients received the same preoperative topical drops, including an antibiotic, steroid, and nonsteroidal antiinflammatory drug (NSAID) medication, started 3 days before surgery. Patients continued their routine medications, including anticoagulants. Both groups received the same dilation regimen consisting of 2 drops each of phenylephrine 2.5% and tropicamide 1.0% (Mydracyl) 5 minutes apart. Both groups had topical anesthesia only. The manual phacoemulsification group had lidocaine gel, and the femtosecond laser-assisted group had preservative-free tetracaine, 1 drop administered 3 times 5 minutes apart. A peristaltic phacoemulsification system (Infinite, Alcon Surgical, Inc.) was used in the manual phacoemulsification group and a venturi-based system (Whitestar Signature, Abbott Medical Optics, Inc.) in the femtosecond laser-assisted group.

All surgeries, including the femtosecond laser assisted, were performed in the operating room. In this model, each femtosecond laser is located in an operating room. The patient is prepped and draped, and the laser procedure is performed under sterile conditions. Routinely, the laser portion is performed on the integrated bed first,

after which the bed is rotated away from the laser and placed under the operating microscope. When necessary, such as when placement of a pupil expansion device is required, surgery under the operating microscope was performed before the laser part of the procedure. To improve efficiency, 1 surgeon typically used 2 laser-equipped operating suites.

Each surgeon used the surgical technique of his or her choosing. All surgeons found they had to modify their manual phacoemulsification technique for the femtosecond laser-assisted group. This included using pneumodissection from the gas produced with the femtosecond-treated lens and included, in some cases, the rock-and-roll technique described by Nagy et al.⁹ Initially, standard spacing and energy settings of the femtosecond laser were used. Individual surgeons modified the settings going forward.

RESULTS

The patient demographic data were similar between patients in the manual phacoemulsification group (60.1% women) and patients in the femtosecond laser-assisted group (58.4% women). The mean age of the patients was 71.0 ± 9.5 years and 71.4 ± 8.8 years, respectively.

Table 1 and Figure 1 compare the vitreous loss rates between the manual phacoemulsification group and femtosecond laser-assisted case group. In absolute terms, the rate decreased for every surgeon in the study. Odds ratio analysis with exclusions versus without exclusions indicated that surgeries performed from 2010 to 2012 using manual phacoemulsification were 1.6 times versus 1.8 times more likely to have vitreous loss than surgeries performed from 2013 to 2014 using femtosecond laser-assisted cataract surgery.

The results used for statistical comparison were for only the 4 surgeons who were active during the time period of the study for both manual phacoemulsification and femtosecond laser-assisted cataract surgery (W.J.S., S.T., J.A.G., J.G.O.). A fifth surgeon (R.R.O.) joined the group after completion of residency and performed only femtosecond laser-assisted cataract surgery (Table 2). Those results will be reviewed as part of the discussion and were not used for statistical comparison. The chi-square test showed a statistically significant association between the date of surgery, and thus the technique, and vitrectomy cases with exclusions versus without exclusions ($P < .05$) (Table 2).

DISCUSSION

To our knowledge, our group is the first in which all of the surgeons, in exact coordination, stopped performing manual phacoemulsification and converted all cataract patients to femtosecond laser-assisted surgery without financial bias or ocular pathology exclusions. We are a community-based practice, and our

Submitted: January 23, 2016.

Final revision submitted: April 13, 2016.

Accepted: April 14, 2016.

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Presented at the annual meeting of the ASCRS Symposium on Cataract, IOL and Refractive Surgery, San Diego, California, USA, April 2015.

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Table 1. Comparison of vitreous loss rates between manual phacoemulsification and femtosecond laser-assisted case groups.

Parameter	Manual Phaco: 2010 to 2012	Femtosecond-Assisted Surgery: March 2013 to March 2014
With exclusions*		
Total cases, n	3775	3367
Vitreous loss cases, n (%)	44 (1.17) [†]	22 (0.65) [†]
Without exclusions*		
Total cases, n	3784	3371
Vitreous loss cases, n (%)	53 (1.40) [†]	26 (0.77) [†]

*Exclusions included preoperative planned vitrectomy, traumatic cataract, combination procedures, and cases requiring iris hooks or iris ring devices.
[†]P < .05

patient population shared similar demographics during the study period. Although there are many academic and government/military studies in the literature and information from a few individual surgeons, there is little information about the private-sector complication rates of ophthalmic ASCs in the United States.¹⁰⁻²⁵ A single-center study from Australia that compared femtosecond laser-assisted cataract surgery and manual phacoemulsification²⁶ found no significant difference in the rate of posterior capsule tears.

With few exceptions, all our patients had cataract surgery with femtosecond laser-assisted cataract surgery, including those with previous refractive radial keratotomy, vitrectomy, or trauma; Fuchs dystrophy; pterygia; glaucoma; intraoperative floppy-iris syndrome; posterior synechia; pseudoexfoliation; and partial cornea scarring. The only patients who received manual phacoemulsification were those who for physical reasons could not fit under the laser, on whom the laser interface did not fit, or who had

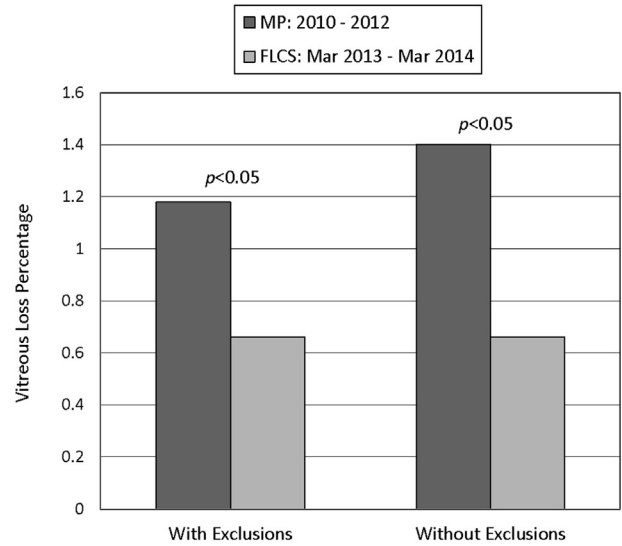


Figure 1. Comparison of vitreous loss rates between manual phacoemulsification (MP) and femtosecond laser-assisted cataract surgery (FLCS) groups with exclusions and without exclusions.

complete cornea opacification. In other words, the same indications were used for femtosecond laser-assisted cataract surgery that we had previously used for manual phacoemulsification, and 98% of cataract patients were able to have femtosecond laser-assisted cataract surgery during the second study period.

The vitreous loss rate decreased significantly whether the data were tested with or without exclusions. Most studies have exclusions, and we followed the examples of these studies for comparison purposes. Our vitreous loss rates for manual phacoemulsification were comparable with the rates in these studies^{10-22,A} (Table 3). We also compared the vitreous loss rates without exclusions, even though some patients were scheduled for a vitrectomy with the cataract surgery. We are a community-based practice and the only group in our region responsible for coverage of our level I trauma center (Mercy Hospital, Springfield, Missouri), which makes post-trauma cases a

Table 2. Vitreous loss rates for the individual surgeons.

Surgeon	Manual Phaco: 2010 to 2012			Femtosecond-Assisted Surgery: March 2013 to March 2014		
	Total Cases, n	Vitrectomy Cases, n	Vitreous Loss, %	Total Cases, n	Vitrectomy Cases, n	Vitreous Loss, %
1	1302	35	2.69	907	15	1.65
2	289	2	0.69	460	1	0.22
3*	0	0	NA	222	0	0.00
4	2059	3	0.15	1732	2	0.12
5	134	4	2.99	272	4	1.47

NA = not applicable

*Surgeon 3 was not included in the study's statistical analysis because there were no data before femtosecond-assisted surgery.

Table 3. Published rates of vitreous loss, 1999 to 2009 (adapted from Chang^A).

First Author	Published Year	Vitreous Loss Rate (%)	Study Size (N)
Desai ¹⁰	1999	4.40	18 454
Martin ¹¹	2000	1.30	3000
Lundstrom ¹²	2001	2.20	2731
Ionides ¹³	2001	2.90	1420
Gimbel ¹⁴	2001	0.20	18 470
Tan ¹⁵	2002	3.60	2538
Chan ¹⁶	2003	1.10	8230
Androudi ¹⁷	2004	4.00	5430
Hyams ¹⁸	2005	2.00	1364
Ang ¹⁹	2006	1.10	2727
Zaidi ²⁰	2007	1.10	1000
Mearza ²¹	2009	2.70	1614
Agarwal ²²	2009	1.60	6564

part of our surgery load. By looking at all cases that had a vitrectomy without exclusion, any subjective influence regarding case exclusion was eliminated and decreased the possibility that exclusions would result in a bias in favor of the femtosecond laser-assisted cataract surgery data.

Individual surgeon complication rate differences have to be considered. Regardless of whether the individual rate was at the high or low end of the range, all surgeons had a decrease in their individual rate. Experience has traditionally been thought of as an important influence on complication rates. Our most senior physician decreased his vitreous loss rate. It might have also contributed to extending his career. In the U.S., where the baby-boomer number of ophthalmologists is high, the adoption of femtosecond laser-assisted cataract surgery could allow physicians to practice longer and, possibly, with a lower complication rate. On the other end of the spectrum, 1 physician (R.R.O) joined our practice during the study. She performed only femtosecond laser-assisted cataract surgery during the study. In her 222 cases during the study period, which were her first cases in private practice after residency, the vitreous loss rate was 0% (zero). How many of us can say that we did our first 200 plus cases immediately after residency with no vitreous loss? Although this might be an example of an extremely gifted surgeon, it is possible that the adoption of femtosecond laser-assisted cataract surgery could decrease the vitreous loss rate of less experienced surgeons. In our group, the rate decreased for both low-volume surgeons and high-volume surgeons.

This report is not a thorough evaluation of all complications associated with femtosecond laser-assisted cataract surgery. Some reported complications, such

as pupil constriction after laser treatment, have not been a problem. This may be because the laser portion is performed in the operating room, where the time between laser application and the incision creation under the microscope is short. Also, we pretreat with NSAID drops, which has been shown to prevent increased prostaglandin levels.^{27,28} Other reported complications, such as subconjunctival hemorrhages, have been minimal and rarely of cosmetic significance, despite patients not discontinuing anticoagulant agents preoperatively. Although it takes time to adapt to the technique and take best advantage of the nuances of the femtosecond laser-treated lens, the learning curve was fairly flat, as evidenced by the lack of any cases of vitreous loss during the first month of conversion to femtosecond laser-assisted cataract surgery. A better understanding of the effect of the laser settings has led to improved outcomes, especially regarding the anterior capsulotomy. We reported these findings at the 2015 American Society of Cataract and Refractive Surgery (ASCRS) meeting.^B Additional findings, including anterior capsule tear data, were reported at the 2016 ASCRS meeting.^C

The conversion to femtosecond laser-assisted cataract surgery decreased the risk for vitreous loss for our patients. Our goal is to provide safe, effective surgery. There are those who argue that cataract surgery is highly successful and that phacoemulsification has contributed to this success. Statistically, the less frequently a complication occurs, the harder it is to show significant differences when comparing complication rates. That is why it is of particular significance that we report that femtosecond laser-assisted cataract surgery lowered the rate of vitreous loss and, therefore, improved the safety of cataract surgery for our patients.

WHAT WAS KNOWN

- Femtosecond laser-assisted cataract surgery improves the accuracy of the capsulotomy, decreases phacoemulsification energy requirements, and decreases corneal endothelial cell loss.

WHAT THIS PAPER ADDS

- Femtosecond laser-assisted cataract surgery might be safer than manual phacoemulsification cataract surgery.
- Most patients, even those with additional ocular pathology, can have femtosecond laser-assisted cataract surgery.
- Financial bias was removed from this study because all patients were offered femtosecond-laser assisted cataract surgery at no additional cost.

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FINANCIAL DISCLOSURE

Drs. Scott and Tauber are consultants to Abbott Medical Optics, Inc., Dr. Tauber is a consultant to Allergan, Inc., is principal investigator for the United States Department of Defense (grant W81XWH-10-2-0070), is on the Board of Directors of Mercy Health System Central Region, Mercy Research Institute, Springfield, Missouri, USA, and owns stock in Ocugenics L.L.C. and Calhoun Vision. Dr. Ohly does research for Glaukos Corp.



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