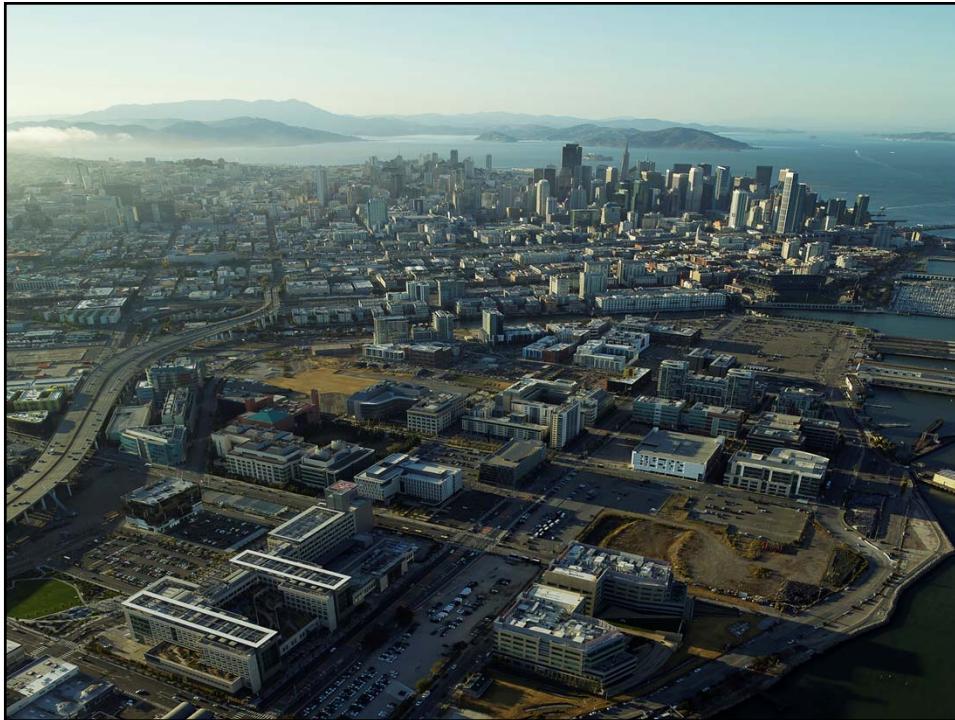


Femtosecond Laser Cataract Surgery

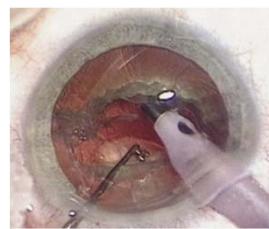
Stephen D. McLeod, MD

Theresa M. and Wayne M. Caygill, MD Distinguished Chair
Professor and Chair, Department of Ophthalmology
Francis I. Proctor Foundation
University of California San Francisco

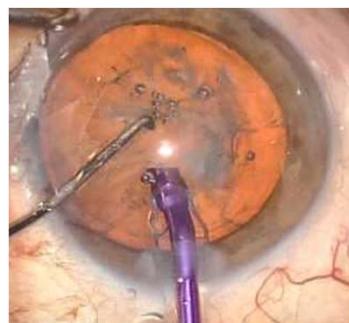


Femtosecond Lasers in Cataract Surgery

- High bar set by standard phacoemulsification
- Swedish National Cataract Register, 2002-2009
 - Capsule complications: of 602,553 procedures, 12,574; 2% overall
 - Rate as of 2006: 1.6%
- Royal College of Ophthalmologist' National Ophthalmology Database Study 2006-2010
 - Capsule complications in 1.95 percent of cases
 - BSCVA of 20/20 in 50% of cases without co-morbidity
- European Registry of Quality Outcomes for Cataract and Refractive Surgery
 - 368,256 cataract extractions
 - BSCVA of 20/40 in 94% of cases, 20/20 in 60% of cases



Phaco vs Femto



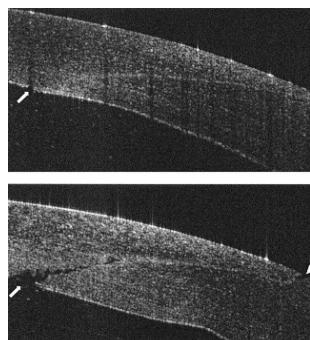
- Phacoemulsification
 - Highly evolved technology
 - Relatively fast
 - Excellent outcomes

Femtocataract Applications



- Creation of corneal entry wounds
- Creation of arcuate incisions
- Creation of capsulorhexis
- Nuclear pre-phaco segmentation

Corneal Wounds



- Relationship between corneal wound incontinence and endophthalmitis risk
- Wound architecture considered important
- Can be standardized with femtosecond laser

Corneal Wounds

ORIGINAL ARTICLE SUPPLEMENTAL DATA

Comparison of Surgically Induced Astigmatism and Morphologic Features Resulting From Femtosecond Laser and Manual Clear Corneal Incisions for Cataract Surgery

Tiago B. Ferreira, MD, FEBOS-CR; Filomena J. Ribeiro, MD, PhD, FEBO; João Pinheiro, MD; Paulo Ribeiro, PhD; João G. O'Neill, MD, PhD

Journal of Refractive Surgery. 2018;34(5):322-329 <https://doi.org/10.3928/1081597X-20180301-01>

Posted May 9, 2018

Any significance for induced astigmatism or vision?

- 600 eyes
 - 300 femto, 300 manual
- No significant difference
 - SIA
 - Flattening effect
 - Torque
- Slightly better wound dimension reproducibility by OCT

Corneal Wounds

Randomized prospective evaluation of the wound integrity of primary clear corneal incisions made with a femtosecond laser versus a manual keratome

Eric Donnenfeld, MD, Eric Rosenberg, DO, Henry Bousan, BA, Zac Davis, BA, Alanna Nattiv, DO

J Cataract Refract Surg 2018; 44:329-335 © 2018 ASCRS and ESCRS

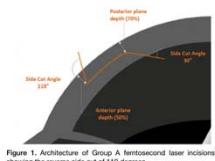


Figure 1. Architecture of Group A femtosecond laser incisions showing the reverse side cut of 110 degrees.

Wound stability or integrity?

- Donnenfeld et al, JCRS March 2018
- 110 reverse cut vs 70 forward cut vs metal
- 15 eyes in each group

Corneal Wounds

- "Higher would leak pressure in reverse side cut"
- POD 1 Seidel test with pressure
 - None in 110 reverse
 - 53% in 70 forward
 - 87% in metal

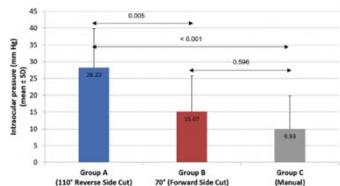
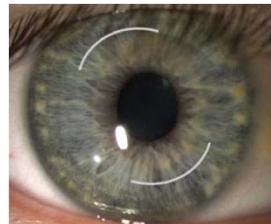


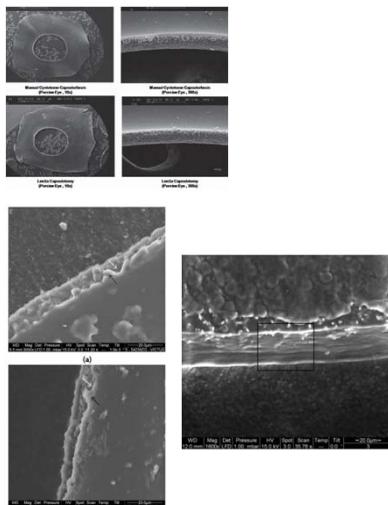
Figure 2. The mean IOP at which wounds leaked in response to a balanced salt solution irrigation (at the conclusion of surgery). (IOP = intraocular pressure).

Creation of Arcuate Incisions

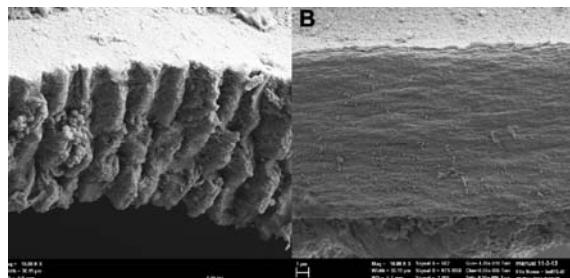


- Corneal arcuate incisions can be readily performed with femtosecond laser
- With standard blade, frequently performed at limbus as well as cornea
- No evidence of greater effectiveness or predictability of femtosecond arcuates

Creation of Capsulorhexis



- Femtosecond can place perfectly sized and located capsulorhexis
- Can be important in lens optic centration and PCO rates
- Nagy et al, JRS 2009;25:1053-60
- Serrao et al, J Ophthalmol 2014;ID 520713



- Abell et al (Ophthalmology 2014;121:17-24)
 - 1626 patients undergoing FLACS or PCS
 - 3 femto platforms studied for incidence of anterior capsule tears
 - Tissue submitted for EM
 - 1.87% of AC tears in FLACS group, compared to 0.12% in PCS group
 - Edge irregularity in FLACS group not seen in PCS group

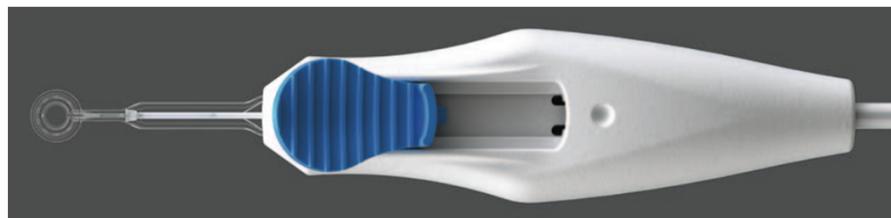
Table 2. Between-group comparison of Intraoperative complications.

Complication	Number (%)		
	Laser Assisted (n = 1852)	Phacoemulsification (n = 2228)	P Value
Incomplete capsulotomy	21 (1.13)	NA	NA
Anterior capsulotomy tag	30 (1.62)	1 (0.004)	.0001
Anterior capsule tear	34 (1.84)	5 (0.22)	.0001
Posterior capsule tear	8 (0.43)	4 (0.18)	NS
Corneal haze	12 (0.65)	1 (0.04)	.0009
Unstable pupil	30 (1.65)	14 (0.65)	.003
Iris hooks/Malyugin ring	5 (0.27)	1 (0.04)	NS

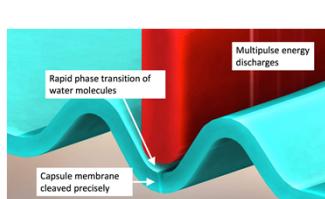
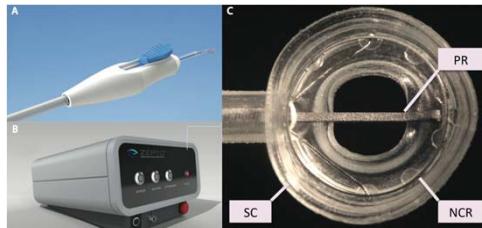
NA = not applicable; NS = not significant

- Abell et al (JCRS 2015;41:47-52)
 - 1852 FLACS vs 2228 PCS
 - 1.84% of AC tears in FLACS group, 0.22% in PCS group
 - 8 PC rents in FLACS group, 4 PC rents in PCS group, NS

Zepto



Zepto Capsulotomy



Zepto Clinical Data

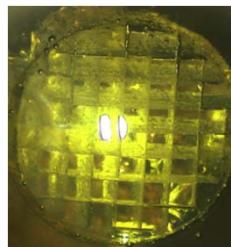
Comparison of Manual vs. Femtosecond vs. "Precision Pulse Capsulotomy"



- Paired comparisons
 - 8 femto vs. 8 zepto
 - 8 manual vs. 8 zepto
 - 8 femto vs. 8 manual
- Zepto tear strength greater than both femto and manual
 - Zepto vs femto: x3
 - Zepto vs manual: x4
 - femto = manual

Ophthalmology 2016;123:265-74

Nuclear Fragmentation



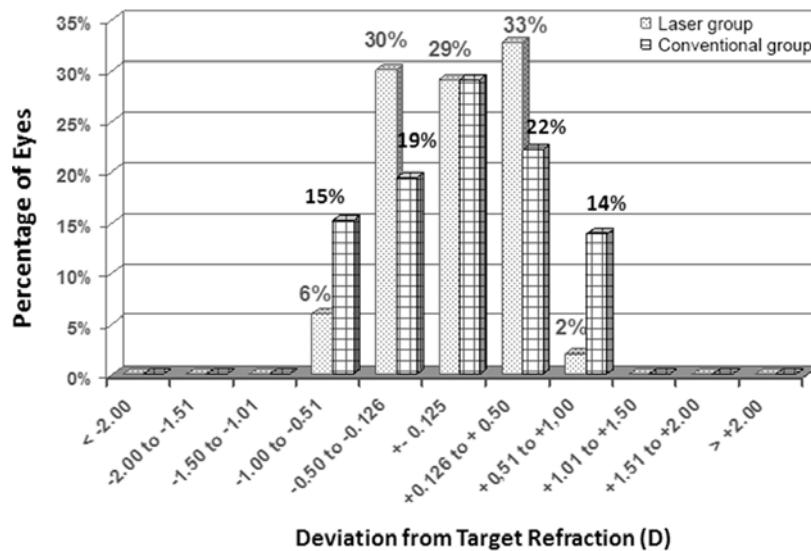
- Studies have generally shown a decrease in phacoemulsification power and time using the femtosecond laser compared to standard phaco
- none have taken into account the *cumulative* energy delivered by femtosecond PLUS phaco
- Endothelial cell count or central corneal thickness significantly related to operating time and fluid flow

Intraoperative Complications

- Anterior capsule issues
 - Tags
 - Incomplete circle
 - Anterior capsule rent
 - Extension to posterior capsule, dropped lens
- Acute capsular block syndrome
 - Dropped lens
- Miosis
- Transient ocular hypertension
- Retained subincisional cortex
 - Can increase cornea edema due to prolonged I/A time
 - Addressed with bimanual approach

Visual Outcomes

- Most studies have failed to show a difference in visual outcome measures in comparing FLACS to PCS.
- Conrad-Hengerer et al randomized 200 eyes to FLACS vs PCS.
 - Unmasked post-operative evaluations?
 - Metal keratomes used for all corneal incisions
 - 92% of eyes in FLACS group were within 0.5D of target at 6 months compared to 71% in conventional group
 - Not considered “clinically significant” by authors
 - Lower laser flare AC cell in FLAC group until day 3



Meta-analysis of FLACS vs SUPS

Cochrane Review, Day et al

- 16 RCTs from Germany, Hungary, Italy, India, China, Brazil
- 1638 eyes of 1245 adults
- Primary outcome:
 - Intraoperative complications, primarily anterior and posterior capsule tears
- Secondary outcomes:
 - UCVA and BSCVA
 - Refractive outcomes
 - Quality of vision
 - Postop complications
 - Cost effectiveness

Meta-analysis of FLACS vs SUPS

Cochrane Review, Day et al

- “overall, studies were at an unclear or high risk of bias”
- In both groups (10 studies, 1075 eyes), the number of anterior and posterior capsule tears was low:
 - femto: 2 anterior tears
 - phaco: 2 anterior, 1 posterior tear
- “inconclusive” difference in CME and elevated IOP rates
- Small FLACS advantage for 6 month BSCVA (1.5 letters), not considered clinically significant
- No quality of life data
- Inadequate data from these studies to assess cost

Meta-analysis of FLACS vs SUPS

Cochrane Review, Day et al

- “the evidence from the 16 randomized controlled trials (RCTs) included in this review could not determine the equivalence or superiority of laser-assisted cataract surgery compared to standard manual phacoemulsification for our chosen outcomes due to the low to very low certainty of the evidence available from these studies”

Meta-analysis of FLACS vs SUPS



Efficacy and Safety of Femtosecond Laser-Assisted Cataract Surgery Compared with Manual Cataract Surgery

A Meta-Analysis of 14 567 Eyes

Marko Popovic, MD¹ | Xavier Campeau-Möller, MD,^{2,3} Matthew B. Schleske, MD,^{2,3}
Iqbal K. Ahmed, MD, FRCSC^{2,3}

- Similar meta-analysis
 - 15 RCTs
 - 22 Observational cohorts
 - 14,567 eyes
- No difference for refractive and visual outcomes
- FLACS favored for:
 - Phaco time
 - Post-op pachymetry
 - Preservation of endothelial cell count

Retrospective FLACS vs SUPS



Visual and Refractive Outcomes in Manual versus Femtosecond Laser-Assisted Cataract Surgery

A Single-Center Retrospective Cohort Analysis of 1838 Eyes

Thomas A. Beck, MD,¹ Matthew B. Schlesinger, MD,² Xavier Campos-Miller, MD,^{3,4} Austin M. Penina, BMSc,⁵ Iqbal Re K. Ahmed, MD,^{3,6}

- Retrospective analysis of 1838 eyes
 - 883 manual
 - 955 FLACS
- Absolute error in refractive target
- Proportions 20/20 or better and 20/25 or better

No difference in refractive or visual outcomes

Table 4. Complications and Additional Postoperative Refractive Procedures

	MCS (N = 883)	FLACS (N = 955)
Intraoperative		
Posterior capsule tear	4 (0.45)	9 (0.94)
Anterior capsule tear that ran posteriorly	0 (0)	4 (0.42)
Intraoperative decision to change IOLs or leave eye aphakic	2 (0.23)	5 (0.52)
Primary corneal incision requiring suture	0 (0)	15 (1.57)
Day 1 postoperative		
Mild corneal edema (1–2+)	555 (62.9)	580 (60.7)
Marked corneal edema (3–4+)	37 (4.2)	56 (5.86)
Cystoid macular edema	2 (0.23)	2 (0.21)
Week 3 postoperative		
Mild corneal edema (1–2+)	5 (0.57)	8 (0.84)
Marked corneal edema (3–4+)	0 (0)	2 (0.21)
Cystoid macular edema	2 (0.23)	2 (0.21)
Additional postoperative refractive procedures		
Posterior capsule opacification requiring laser treatment	7 (0.79)	12 (1.26)
LASIK or PRK	2 (0.23)	5 (0.52)
Limbal relaxing incisions	8 (0.91)	17 (1.78)

FLACS = femtosecond laser-assisted cataract surgery; IOL = intraocular lens; MCS = manual cataract surgery; PRK = photorefractive keratectomy. Data are no. (%) of eyes.

Special Circumstances



Fuchs Endothelial Dystrophy

- Bascom Palmer 2018, Zhu et al
 - Retrospective review of 207 eyes (64 femto, 143 conventional)
 - 3 months minimum follow up, mean 30
 - No difference in corneal decompensation rates

Special Circumstances

Dense Nuclei



- LOCS III or greater
- Reduced phaco energy with FLACS pre-chop

ARTICLE
Femtosecond laser-assisted compared with standard cataract surgery for removal of advanced cataracts

Kathryn M. Hatch, MD, Tim Schulz, MD, Jonathan H. Talamo, MD, H. Burkhard Dick, MD, PhD

J Cataract Refract Surg 2015; 41:1833–1838 © 2015 ASCRS and ESCRS

Case selection: Limitations



- Small pupil
- Corneal opacity
- Orbital anatomy
- Patient cooperation
- Intumescent white cataract

Cost and Cost Effectiveness

- Requires
 - Additional instrumentation
 - Additional disposable supplies
 - Additional time
- Cost effective benefit
 - Increased safety?
 - Increased visual performance?
 - QALY methodology attempts to fix dollar value to safety and vision
 - Abell and Vote, Ophthalmology 2014:
 - Simulate complication rate and improved visual outcome of “5%”
 - ***Current models do not support cost effectiveness***

Abell and Vote: Cost-effectiveness of Femtosecond Laser-Assisted Cataract Surgery vs Phacoemulsification Cataract Surgery. Ophthalmology 2014;121:10-16

