Clinical Ophthalmology

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ORIGINAL RESEARCH

A Comparison of Refractive Accuracy Between Conventional and Femtosecond Laser Cataract Surgery Techniques Using Modern IOL Formulas

This article was published in the following Dove Press journal:
Clinical Ophthalmology

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Purpose: To compare the refractive outcome prediction accuracy between conventional (CCS) and femtosecond laser assisted (FLACS) cataract surgery techniques using optimized lens constants for modern intraocular lens (IOL) formulas.

Patients and Methods: Our retrospective, comparative, interventional case series, compared data from 196 eyes undergoing CCS and 456 eyes undergoing FLACS with Acrysof IOL (Alcon laboratories, Inc) implantation. After optimizing IOL constants, the predicted refractive outcome was calculated for all formulas for each case. This was compared to the actual refractive outcome to provide the prediction error. The performance of CCS and FLACS was compared by the absolute prediction error and percentage of eyes within 0.25D, 0.5D and 1.0D of anticipated refractive outcome.

Results: There was no statistically significant difference in median absolute error between the CCS and LACS groups for the Kane (0.256, 0.236; p=0.389), SRK T (0.298, 0.302, p=0.910), Holladay (0.312, 0.275; p=0.090), Hoffer Q (0.314, 0.289; p=0.330), Haigis (0.309, 0.258; p=0.177), Barrett Universal 2(0.250, 0.250; p=0.866), Holladay 2 (0.250, 0.258; p=0.860) and Olsen (0.260, 0.255; p=0.570) formulas. Similarly, there was no consistent difference between the two techniques for percentage of patients within 0.25, 0.50 and 1.0D of predicted refractive outcome for each formula.

Conclusion: There was no difference in refractive outcome prediction accuracy between the CCS and FLACS techniques.

Keywords: femtosecond laser-assisted cataract surgery, refractive predictability, IOL formulas

Introduction

Recent generation of IOL formulas have significantly improved the refractive outcome prediction accuracy of modern cataract surgery. The ability of modern IOL formulas to achieve superior refractive outcomes over earlier third generation formulas[1–3] has been possible due to their accuracy at predicting the effective lens position. Recent large studies[4–7] comparing CCS and FLACS have demonstrated no clear differences in prediction of refractive accuracy using earlier IOL formulas. However, none of these studies undertook the recommended[8] IOL constant optimization to eliminate the source of bias inherent to IOL constants recommended by manufacturers.

We postulated that the improved precision of modern formulas, together with IOL constant optimization, may demonstrate that the superior capsulotomy

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submit your manuscript | www.dovepress.com
DovePress
http://doi.org/10.2147/OPTH.S296032

geometry and IOL position[9,10] advantages with FLACS translates into improved refractive outcomes.

In the present study, we investigated whether refractive outcome predictions were more accurate in FLACS when compared with CCS using optimized IOL constants for modern IOL formulas.

Patients and Methods

This retrospective, comparative, interventional comparative case series included all patients that had undergone CCS or FLACS surgery performed by a single surgeon (BC) between July 2015 and July 2019. Patients who had co- morbidities such as corneal scarring or previous ocular surgery were excluded. Other exclusion criteria were occurrence of intraoperative or postoperative complications or patients who had post-operative vision less than 6/12 (20/40) equivalent.

If both eyes from a single patient met the inclusion criteria, one eye was randomly chosen for inclusion in the analysis. The study was approved by the Royal Victorian Eye and Ear Hospital Human Research Ethics Committee. Individual patient consent was not required as no patient identifying data was stored and retrospective study design, in compliance with the local data privacy laws. The study was conducted in compliance with the Declaration of Helsinki.

Preoperative and Postoperative Examinations

Patients underwent a preoperative full visual acuity assessment, slit lamp anterior and posterior segment examination. Preoperative biometry was performed using the IOLMaster model 700 (Carl Zeiss Meditec AG).

Group Allocation

The population typically held private health insurance and each patient self-selected either technique based on their own preference, considering the increased out of pocket expense for the laser assisted technique.

Surgical Techniques

The same surgeon (BC) performed all surgeries in a private operating facility under topical anesthesia. Capsulotomies were centered on the pupil. After removal of the cataract, an Alcon SN60WF or Alcon T6 series (Alcon Laboratories, Fort Worth Texas) IOL was injected. The wound was enlarged only for higher powered IOLs, as per the manufacturer's recommendation. Postoperative management was identical for the two groups. Prednisolone acetate 1% (Prednefrin Forte, Allergan) and Chloramphenicol 0.5% (Chlorsig, Sigma Pharmaceuticals, Australia) were used four times per day for 4 weeks following surgery.

Conventional Technique

In this technique, clear corneal temporal 2.4mm wounds were used and the capsulotomy performed using forceps, followed by traditional phacoemulsification.

Femtosecond Laser Technique

The laser (LenSx platform, Alcon Surgical Inc) was used to perform the capsulotomy, lens fragmentation and wound construction. The pupil centered capsulotomy was used with the following parameters: 4.9mm diameter, with delta up 270 µm, delta down 330 µm, spot energy 6.50 µJ, spot separation 4µm and layer separation 4µm. Traditional phacoemulsification was then used to remove the nucleus.

Formulas to Predict Post-Operative Spherical Equivalent Outcome

Haigis,[11] Hoffer Q,[12,13] Holladay[14] and SRK/T[15] formulas were programmed into a previously validated[16] Excel spreadsheet (Microsoft, Redmond, Washington, USA) using the original publications and errata.

Data was entered into the respective third-party calculators for the other formulas: PhacoOptics program for the Olsen formula,[17] IOL Consultant software for the Holladay 2 formula,[18] and online calculators for the Barrett Universal 2.[19] The Kane formula was calculated by one of the authors (JK).

The constant for each formula was optimized to produce a mean prediction error of zero (or as close as possible) by performing multiple iterations of the data using varying constants. For the Haigis formula, results were included for single (a_0) and triple constant optimization.

For some formulas, a mean prediction error of zero could not be obtained due to limitations in how many decimal places could be entered for the constant into the calculator. In these cases the small residual mean error was removed by adjusting the refractive prediction error for each eye by an amount equal to the mean prediction error in that group as described in the JCRS editorial by Wang et al.[20]

Statistical Analysis

All statistical analysis was performed using Stata IC version 14 (College Station, TX, USA). Categorical variables were compared between surgical technique groups with Fisher's exact test. The distribution of continuous variables was assessed with the Shapiro–Wilk normality test and then the CCS and FLACS groups were compared using the two-sample *t*-test for normally-distributed variables and the Wilcoxon rank-sum test if the variable was not normally distributed.

Results

During the study period 352 CCS and 826 FLACS procedures were performed. After exclusions, 196 eyes (from 196 patients) were included in the CCS group and 456 eyes (from 456 patients) in the FLACS group. Details of the exclusions are show in Table 1.

Small, statistically significant differences were noted in the median for baseline demographics between the two groups (Table 2). The CCS group was older (75 v 73 years; p=0.008), had shorter axial length (23.33 v 23.66mm; p=0.028), anterior chamber depth (3.03 v 3.14mm; p=0.002), thicker lens (4.71 v 4.59mm; p=<0.001) and inferior post-operative corrected distance visual acuity (0.00 v 0.00; p = 0.005).

There was no statistically significant difference in gender proportions (37/40% Male) or toric IOL use (71% for both) between the CCS/FLACS groups. The groups displayed similar distributions of certain comorbidities (Table 3). Optimized constants are shown in Table 4.

There was no statistically significant difference in the median absolute error between the CCS and FLACS groups for any of the formulas (Table 5). There was also no difference in percentage of patients within 0.25, 0.50 and 1.00 D of predicted refraction for the CCS compared to the FLACS group (Table 6) for any of the formulas with the only exception the single constant optimized Haigis formula, where the percentage achieving within 1.0D of predicted was statistically higher in the FLACS group (98.5% v 95.9%; p=0.047).

Discussion

A femtosecond capsulotomy used in FLACS is considered geometrically superior to the manual capsulotomy in CCS. Studies have demonstrated it to have a more predictable diameter,[9,21–24] more circular,[9,21–25] less eccentric,[9,23,24] and less shrinkage post-operatively.[21,26] Consequently, the IOL position in FLACS demonstrates less tilt,[10] decentration,[10] greater overlap of the optic[9] and the post-operative IOL anterior-posterior position deviates less from predicted.[21]

Effective lens position has been shown to be the most important factor in refractive prediction accuracy.[27] We hypothesized, that the superior FLACS capsulotomy geometry when compared with CCS, might translate improved in refractive accuracy by improving the predictability of the effective lens position.

Clinical studies to date have typically used 3rd generation formulas and not consistently demonstrated a refractive benefit for FLACS. The FEMCAT,[4] FACT[5] and Roberts[28] randomized control trials, a prospective intraindividual trial,[29] the EUREQUO registry[30] and retrospective studies by Berk[6] and Chee,[7] have all used 3rd generation formulas and relatively large numbers have not demonstrated any refractive advantage. Ewe and colleagues,[31] in a prospective, non-randomized comparative study demonstrated an advantage for CCS over FLACS.

Only a few smaller studies, also using 3rd generation formulas, have identified a refractive advantage for FLACS. A prospective study of 132 eyes[32] published in 2012 reported the mean absolute error was less with

Table 1 Indications for Subject Exclusion from the Analysis

Exclusion Indication	CCS (352 Surgeries)		FLACS (826 Surgeries)	
	N Excluded	(Total Remaining)	N Excluded	(Total Remaining)
Co-morbidities	23	(329)	67	(759)
Intra operative complication	1	(328)	2	(757)
Missing post-operative subjective refraction	0	(328)	2	(755)
Post-operative VA worse than 6/12	6	(322)	19	(736)
Missing biometry (unable to measure AXL or K's)	0	(322)	2	(734)
Random exclusion of 1 eye where both eyes eligible	126	(196)	278	(456)
Final counts	196		456	

Table 2 Baseline Demographic and Clinical Characteristics

	CCS	FLACS	P value*
Age (y)			
Mean (95% CI)	74.0 (72.7,75.3)	72.4 (71.5, 73.2)	
Median (IQR)	75.0 (70.0, 80.0)	73.0 (67.0, 79.0)	0.008
Gender			
Male, n (%)	73 (37.2)	184 (40.4)	0.485
Pre op UDVA (logMAR)			
Mean (95% CI)	0.58 (0.53, 0.64)	0.60 (0.56, 0.64)	
Median (IQR)	0.60 (0.40, 0.80)	0.50 (0.30, 0.80)	0.840
Pre op CDVA (logMAR)			
Mean (95% CI)	0.20 (0.17, 0.22)	0.20 (0.18, 0.22)	
Median (IQR)	0.20 (0.10, 0.30)	0.20 (0.10, 0.30)	0.475
Axial length (mm)			
Mean (95% CI)	23.62 (23.45, 23.79)	23.79 (23.67,23.91)	
Median (IQR)	23.33 (22.84, 24.14)	23.66 (22.97, 24.50)	0.028#
Anterior chamber depth (mm)			
Mean (95% CI)	3.05 (3.00, 3.11)	3.15 (3.11, 3.18)	
Median (IQR)	3.03 (2.77, 3.29)	3.14 (2.88, 3.39)	0.002#
Lens thickness (mm)			
Mean (95% CI)	4.70 (4.64, 4.76)	4.59 (4.55, 4.63)	
Median (IQR)	4.71 (4.42, 4.99)	4.59 (4.29, 4.87)	<0.001#
Mean keratometry (D)			
Mean (95% CI)	43.92 (43.70, 44.14)	43.79 (43.65, 43.93)	
Median (IQR)	43.91 (42.81, 44.91)	43.75 (42.75, 44.89)	0.393
Corneal astigmatism (D)			
Mean (95% CI)	0.96 (0.86, 1.05)	0.89 (0.83, 0.96)	
Median (IQR)	0.81 (0.50, 1.28)	0.76 (0.43, 1.10)	0.091
Central corneal thickness (µm)			
Mean (95% CI)	548 (543, 553)	553 (549, 556)	
Median (IQR)	546 (527, 565)	553 (529, 574)	0.044#
Horizontal white to white (mm)			
Mean (95% CI)	11.92 (11.85, 11.98)	11.98 (11.94, 12.02)	
Median (IQR)	11.90 (11.65, 12.30)	12.00 (11.70, 12.30)	0.281
Pupil diameter (mm)			
Mean (95% CI)	3.83 (3.68, 3.97)	3.75 (3.67, 3.84)	
Median (IQR)	3.60 (3.10, 4.35)	3.60 (3.10, 4.20)	0.561
Post op UDVA (logMAR)			
Mean (95% CI)	0.28 (0.25, 0.32)	0.27 (0.24, 0.29)	
Median (IQR)	0.20 (0.10, 0.40)	0.20 (0.10, 0.40)	0.274
Post op refractive astigmatism (D)			
Mean (95% CI)	0.42 (0.36, 0.47)	0.39 (0.36, 0.42)	
Median (IQR)	0.50 (0.00, 0.50)	0.50 (0.00, 0.50)	0.475
Post op spherical equivalent (D)			
Mean (95% CI)	−0.91 (−1.03, −0.79)	−0.90 (−0.98, −0.83)	
Median (IQR)	−0.75 (−1.25, −0.38)	−0.75 (−1.25, −0.38)	0.682

(*Continued*)

Table 2 (Continued).

	CCS	FLACS	P value*
Post op CDVA (logMAR)			
Mean (95% CI)	0.02 (0.00, 0.03)	−0.01 (−0.02, 0.00)	
Median (IQR)	0.00 (−0.10, 0.10)	0.00 (−0.10, 0.00)	0.005#

Notes: *p value relates to the Wilcoxon Rank-Sum test for continuous variables and Fisher exact test for gender and IOL type. #Statistically significant difference between surgical technique groups.
Abbreviations: CI, confidence interval; IQR, interquartile range, UDVA, uncorrected distance visual acuity; CDVA, corrected distance visual acuity; D, dioptres.

Table 3 Comorbidity Counts

Comorbidity	CCS	FLACS	P value*
Amblyopia, n (%)	3 (1.5)	5 (1.1)	0.702
Fuchs endothelial dystrophy, n (%)	1 (0.5)	13 (2.9)	0.076
Past pterygium surgery, n (%)	2 (1.0)	6 (1.3)	1.000
Current prostaglandin drop use, n (%)	10 (5.1)	21 (4.6)	0.841
Glaucoma involving fixation, n (%)	2 (1.0)	2 (0.4)	0.588
Pseudoexfoliation syndrome, n (%)	2 (1.0)	12 (2.6)	0.249
Oral alpha agonist use, n (%)	2 (1.0)	9 (2.0)	0.519
Past vitrectomy, n (%)	0	5 (1.1)	0.329
Past retinal detachment, n (%)	0	3 (0.7)	0.558
Epiretinal membrane, n (%)	5 (2.6)	13 (2.9)	1.000
Age related maculopathy, n (%)	17 (8.7)	47 (10.3)	0.569
Diabetes, n (%)	16 (8.2)	34 (7.5)	0.750
Diabetic retinopathy, n (%)	3 (1.5)	1 (0.2)	0.084

Note: *p value relates to Fisher exact test for difference between surgical technique groups.

FLACS (0.5/0.38D, p=0.04). A prospective intraindividual study by Conrad-Hengerer[33] with one eye of 100 patients randomized to each technique published in 2015 demonstrated 71/92% (p<0.05) of eyes within 0.5 D of the intended outcome for CCS/FLACS. An accuracy of 92% of eyes achieving within 0.5D for FLACS

Table 4 Constants Used for the Different Formulas

Formula	Constant	SN60WF	SN6ATx
SRKT		118.72	118.91
Holladay 1		1.63	1.77
Hoffer Q		5.41	5.56
Haigis single optimisation	a0 a1 a2	−0.990 0.234 0.217	−0.828 0.234 0.217
Haigis triple optimisation	a0 a1 a2	−0.165 0.359 0.166	−0.590 0.408 0.184
Barrett Universal 2		118.71	118.96
Olsen	ACD const. C	4.43 0.340	4.56 0.368
Holladay 2		5.281	5.409
Kane		118.66	118.89

demonstrated in the Conrad-Hengerer study is relatively high and has not been replicated in other studies. For example, our study with modern biometry, optimized constants and strict case exclusion criteria demonstrated only 72/74% (SRK/T) and 79/81% (Haigis) from the CCS/FLACS groups were within 0.5D of the intended outcome. Other large studies[5,6,28,31,34] have typically reported 75% or less and no more than 83%, in either group, achieving within 0.5D of the intended outcome.

More recent relatively small studies, also using older 3rd formulas, have only demonstrated a benefit for FLACS on some outcome measures. A recent retrospective study with 50 cases in each group, reported a significantly greater percentage of eyes within 0.5D of the intended outcome (48/76%, p = 0.01) but no difference between groups for the mean absolute error. In this study, there was a mean prediction error difference between the groups (−0.42/-0.11) because they did not optimize their lens constants. This difference in mean prediction error likely explains the difference in mean absolute errors reported. A large retrospective comparative case series with 3144 eyes[34] demonstrated a statistically significant lower mean absolute error for FLACS compared with CCS (0.60 v 0.54D) however there was no difference in percentage of patients within 0.5D of intended.

None of these studies had used modern IOL formulas such as the Barrett Universal 2, Olsen or Kane formulas which have been reported to be more accurate than third generation

Table 5 Prediction and Absolute Errors for Each Formula

	Prediction Error	**Absolute Error**		
	All Eyes	**CCS**	**FLACS**	***p****
Kane				
Mean (95% CI)	0.000 (−0.029, 0.029)	0.312 (0.277, 0.347)	0.289 (0.268, 0.309)	
Median (IQR)	0.021 (−0.237, 0.246)	0.256 (0.135, 0.433)	0.236 (0.119, 0.410)	0.389
SRKT				
Mean (95% CI)	0.000 (−0.035, 0.035)	0.362 (0.322, 0.403)	0.363 (0.337, 0.389)	
Median (IQR)	0.007 (−0.293, 0.312)	0.298 (0.148, 0.514)	0.302 (0.150, 0.518)	0.910
Holladay 1				
Mean (95% CI)	0.000 (−0.033, 0.033)	0.368 (0.330, 0.406)	0.330 (0.307, 0.354)	
Median (IQR)	0.003 (−0.280, 0.290)	0.312 (0.165, 0.505)	0.275 (0.136, 0.460)	0.090
Hoffer Q				
Mean (95% CI)	0.000 (−0.034, 0.034)	0.373 (0.334, 0.413)	0.344 (0.321, 0.368)	
Median (IQR)	0.014 (−0.283,0.305)	0.314 (0.145, 0.555)	0.289 (0.140, 0.498)	0.330
Haigis				
Mean (95% CI)	0.000 (−0.031, 0.031)	0.344 (0.306, 0.382)	0.308 (0.286, 0.330)	
Median (IQR)	0.006 (−0.260,0.291)	0.309 (0.139, 0.467)	0.258 (0.122, 0.442)	0.177
Haigis Triple				
Mean (95% CI)	0.000 (−0.031, 0.031)	0.333 (0.295, 0.372)	0.304 (0.282, 0.326)	
Median (IQR)	0.011 (−0.259,0.273)	0.272 (0.128, 0.464)	0.262 (0.119, 0.417)	0.326
Barrett Univ.2				
Mean (95% CI)	0.000 (−0.030, 0.030)	0.314 (0.276, 0.352)	0.300 (0.278, 0.321)	
Median (IQR)	0.015 (−0.232,0.253)	0.250 (0.122, 0.435)	0.250 (0.110, 0.425)	0.866
Holladay 2				
Mean (95% CI)	0.000 (−0.029, 0.032)	0.316 (0.280, 0.352)	0.307 (0.285, 0.329)	
Median (IQR)	0.007 (−0.240,0.263)	0.250 (0.132, 0.430)	0.258 (0.132, 0.415)	0.860
Olsen				
Mean (95% CI)	−0.002 (−0.033, 0.028)	0.320 (0.284, 0.355)	0.303 (0.281, 0.324)	
Median (IQR)	−0.003 (−0.250,0.260)	0.260 (0.115, 0.440)	0.255 (0.130, 0.420)	0.570

Note: *p value relates to the Wilcoxon rank-sum test for difference between groups.
Abbreviations: CI, confidence interval; IQR, interquartile range.

Table 6 % of Eyes Within 0.25, 0.50 and 1.0D of Absolute Error

	CCS	FLACS	P *
Kane			
≤0.25 D (95% CI)	49.5% (42.5, 56.5)	54.0% (49.4, 58.5)	0.296
≤0.5 D (95% CI)	81.6% (76.2, 87.1)	84.4% (81.1, 87.8)	0.377
≤1.0 D (95% CI)	98.0% (96.0, 99.9)	99.1% (98.3, 100.0)	0.216
SRKT			
≤0.25 D (95% CI)	39.8% (32.9, 46.7)	41.0% (36.5, 45.5)	0.772
≤0.5 D (95% CI)	71.9% (65.7, 78.2)	73.9% (69.9, 77.9)	0.603
≤1.0 D (95% CI)	96.4% (93.8, 99.0)	96.5% (94.8, 98.2)	0.968
Holladay 1			
≤0.25 D (95% CI)	39.8% (32.9, 46.7)	43.2% (38.7, 47.8)	0.419
≤0.5 D (95% CI)	74.0% (67.8, 80.1)	79.0% (75.2, 82.7)	0.164
≤1.0 D (95% CI)	96.9% (94.5, 99.4)	98.0% (96.8, 99.3)	0.396
Hoffer Q			
≤0.25 D (95% CI)	43.4% (36.4, 50.3)	43.6% (39.1, 48.2)	0.949
≤0.5 D (95% CI)	68.9% (62.4, 75.4)	75.2% (71.3, 79.2)	0.093
≤1.0 D (95% CI)	97.5% (95.2, 99.7)	98.0% (96.8, 99.3)	0.641
Haigis			
≤0.25 D (95% CI)	42.4% (35.4, 49.3)	48.7% (44.1, 53.3)	0.137
≤0.5 D (95% CI)	79.1% (73.4, 84.8)	80.9% (77.3, 84.5)	0.588
≤1.0 D (95% CI)	95.9% (93.2, 98.7)	98.5% (97.3, 99.6)	0.047
Haigis Triple			
≤0.25 D (95% CI)	45.9 (38.9, 52.9)	48.0% (43.4, 52.6)	0.621
≤0.5 D (95% CI)	80.6% (75.1, 86.2)	81.4% (77.8, 84.9)	0.823
≤1.0 D (95% CI)	96.9% (94.5, 99.4)	98.5% (97.3, 99.6)	0.201
Barrett Univ. 2			
≤0.25 D (95% CI)	51.0% (44.0, 58.0)	51.5% (47.0, 56.1)	0.904
≤0.5 D (95% CI)	80.6% (75.1, 86.2)	82.0% (78.5, 85.5)	0.671
≤1.0 D (95% CI)	97.5% (95.2, 99.7)	98.3% (97.0, 99.5)	0.505
Holladay 2			
≤0.25 D (95% CI)	50.5% (43.5, 57.5)	49.8% (45.2, 54.4)	0.864
≤0.5 D (95% CI)	80.1% (74.5, 85.7)	82.5% (79.0, 86.0)	0.476
≤1.0 D (95% CI)	96.9% (94.5, 99.4)	98.7% (97.6, 99.7)	0.128
Olsen			
≤0.25 D (95% CI)	49.0% (42.0, 56.0)	49.6% (45.0, 54.2)	0.892
≤0.5 D (95% CI)	79.6% (74.0 85.2)	81.8% (78.3, 85.3)	0.509
≤1.0 D (95% CI)	98.0% (96.0, 99.9)	98.7% (97.6, 99.7)	0.490

Note: *p value relates to difference in proportions between groups.
Abbreviations: CI, confidence interval; D, dioptres.

formulas[1–3] to predict refractive accuracy. To the best of our knowledge, the only study using a later generation formula, was an intraindividual RCT of 110 paired eyes by Dzhaber[35] which used the Holladay 2 formula and did not demonstrate any difference. With this formula they reported similar values to other studies with 81/84% (p=0.17) of cases within 0.5D of the anticipated outcome. We hypothesized that when these modern formulas are used, there may be a refractive benefit for FLACS not evident with third generation formulas.

Ours is the first study that compared refractive prediction outcomes of FLACS and CCS using IOL constant optimization and included only one eye per patient as per the published recommendation.[8] The recommendation to perform IOL constant optimization allows a more reliable comparison between formulas, with any difference in absolute error likely to reflect a true difference in formula accuracy. However, despite optimizing IOL constants in our study, the refractive accuracy was very similar to large prospective FEMCAT[4] and FACT[5] trials which did not perform optimization. Results of our study reconfirms that although the capsulotomy performed by FLACS may appear much more central and circular as compared to CCS, it does not translate in to better ELP and achieving more accurate refractive outcomes.

FLACS cases have also been demonstrated to show less capsular bag[26] and capsulotomy shrinkage[21] at 1–3 months. It is also possible that these longer-term shrinkage forces are distributed relatively less symmetrically to the more irregular, less centered CCS capsulotomy and therefore more likely to induce long term IOL tilt, decentration and refractive change. This may be beneficial in the longer term for patients with multifocal and extended depth of focus lenses where lens tilt and decentration would degrade the visual outcome. A study using these lenses with longer term follow up would help address this question. A recent meta-analysis and commentary[36,37] reported a clinically but not statistically significant lower rate of posterior capsule rupture with LACS, which would also benefit refractive outcome since IOL position is less predictable in these cases.

Overall, our study did not find any refractive advantage for FLACS over CCS when using modern IOL formulas and optimized IOL constants during a short-term follow-up. This confirms that a refractive advantage should not be used in guiding a patient's decision to proceed with either technique.

A disadvantage of our study is the potential for bias associated with patient self-selection for the either procedure. FLACS incurs an increased patient out of pocket expense in Australia of $AUD850 (equivalent to $US550 or 500euros).

The strengths of this study include that the surgeries were performed by a single surgeon, consistent staff performed the follow up assessments and modern biometry (IOLMaster model 700) was used. In addition, few patients were lost to follow up, the series was relatively large, and a systematic approach taken to case exclusion.

Conclusion

Our study found no difference in refractive outcome prediction accuracy between the CCS and FLACS techniques using modern IOL formulas and optimized constants.

Acknowledgments

Sophie Rogers provided statistical support.

Disclosure

Jack X. Kane is the owner of the Kane formula. The authors report no other conflicts of interest in this work.

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