

# Higher-Order Aberrations after Femtosecond Laser-Assisted Cataract Surgery versus Phacoemulsification: A Systematic Review and Meta-analysis

Amena Thraya<sup>1</sup>, Kareem Sadek<sup>1</sup>, Sabrina Saladeen<sup>2</sup>, Brendan Tao<sup>3</sup>, Abdullah Al-Ani<sup>4</sup>, Clara Chan<sup>3</sup>

<sup>1</sup>Cumming School of Medicine, University of Calgary, <sup>2</sup>Temerty Faculty of Medicine, University of Toronto, <sup>3</sup>Department of Ophthalmology & Vision Sciences, University of Toronto, <sup>4</sup>Ophthalmology & Visual Sciences, Department of Surgery, University of Calgary

## INTRODUCTION

- Cataract remains a leading cause of vision impairment and blindness worldwide with cataract extraction and intraocular lens (IOL) implantation serving as one of the most commonly performed operations in ophthalmology (Pesudovs et al., 2021)
- Phacoemulsification is the current standard of care approach to removing cataracts involving several manual steps (Ty Ang et al., 2018)
- Femtosecond laser-assisted cataract surgery (FLACS) automates capsulotomy, lens fragmentation, and corneal incisions, theoretically improving IOL centration and reducing higher-order aberrations (HOAs) (Ty Ang et al., 2018)
- HOAs are complex optical imperfections that can manifest post-surgery, serving as additional clinical indicators of visual quality (Musat et al., 2026)
- Whether the advantages suggested by FLACS translate into measurable optical benefits remains unclear

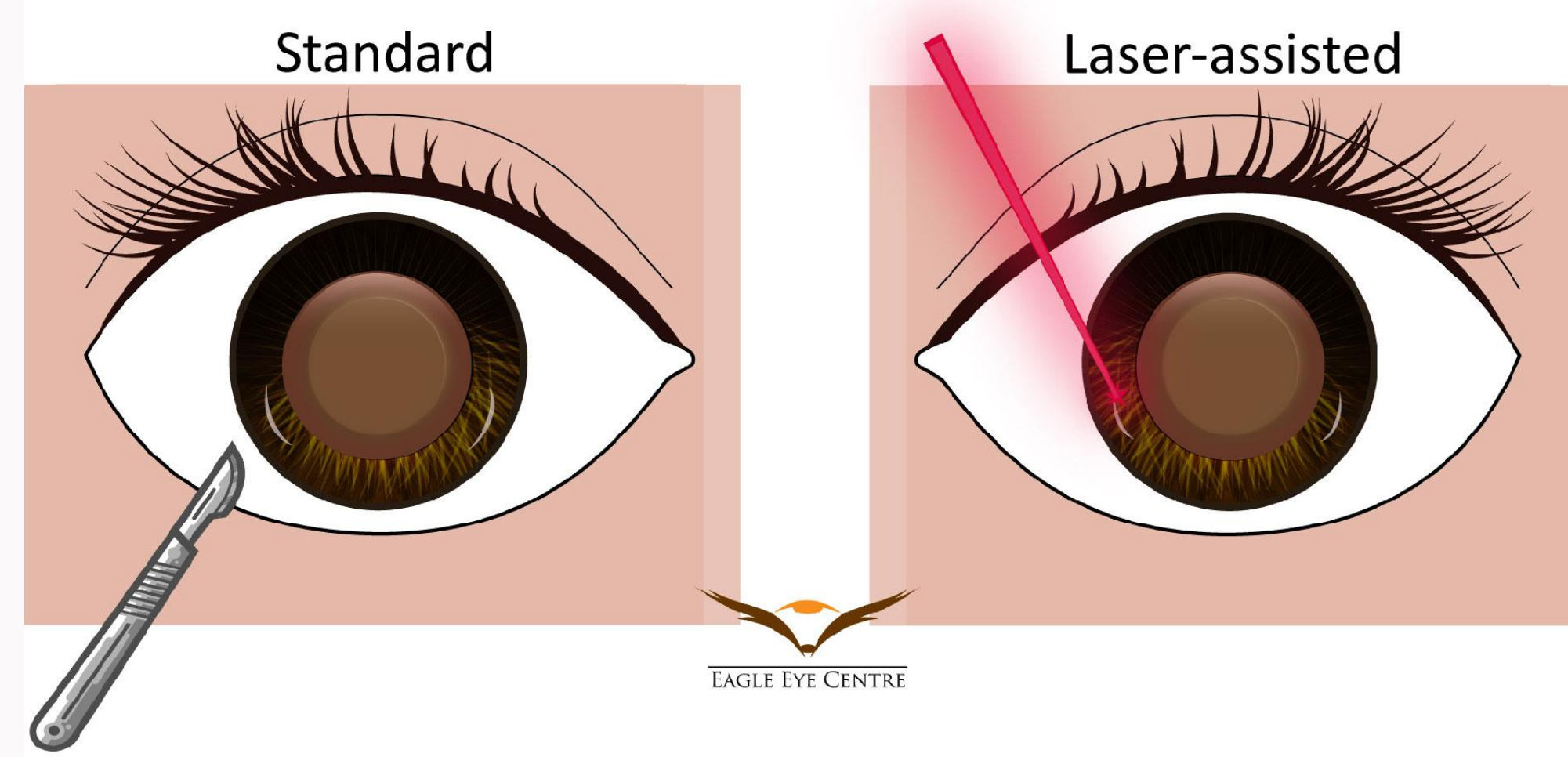


Figure 1: Cataract surgery performed by standard manual corneal incision (left) versus femtosecond laser assisted corneal incision (right). Image provided by Eagle Eye Centre.

## AIM

We aimed to address this critical question by conducting a systematic review and meta-analysis to **compare post-operative HOAs between FLACS and phacoemulsification** cataract surgeries.

## METHODS

- PRISMA 2020 guideline compliant and prospectively registered on PROSPERO (CRD420261319991)
- Databases searched: MEDLINE, Embase, ProQuest, Web of Science, CENTRAL, CINAHL, and Scopus
- Primary outcomes: postoperative corneal, internal, and total ocular HOAs, measured using wavefront aberrometry or corneal/topographic aberrometry
- Secondary outcomes: specific aberration components (coma, spherical, trefoil)

INCLUSION CRITERIA	EXCLUSION CRITERIA
<ul style="list-style-type: none"> <li>≥ 18 years</li> <li>cataract extraction with IOL implantation</li> <li>directly comparing FLACS with phacoemulsification</li> <li>randomized controlled trials and nonrandomized comparative studies</li> </ul>	<ul style="list-style-type: none"> <li>non-comparative, single-arm case series, case reports, reviews, editorials, letters without original comparative data, non-human studies</li> <li>ocular or corneal HOA outcomes could not be extracted or converted</li> <li>surgical or measurement introducing substantial clinical or methodological heterogeneity</li> </ul>

Table 1: Inclusion and exclusion criteria

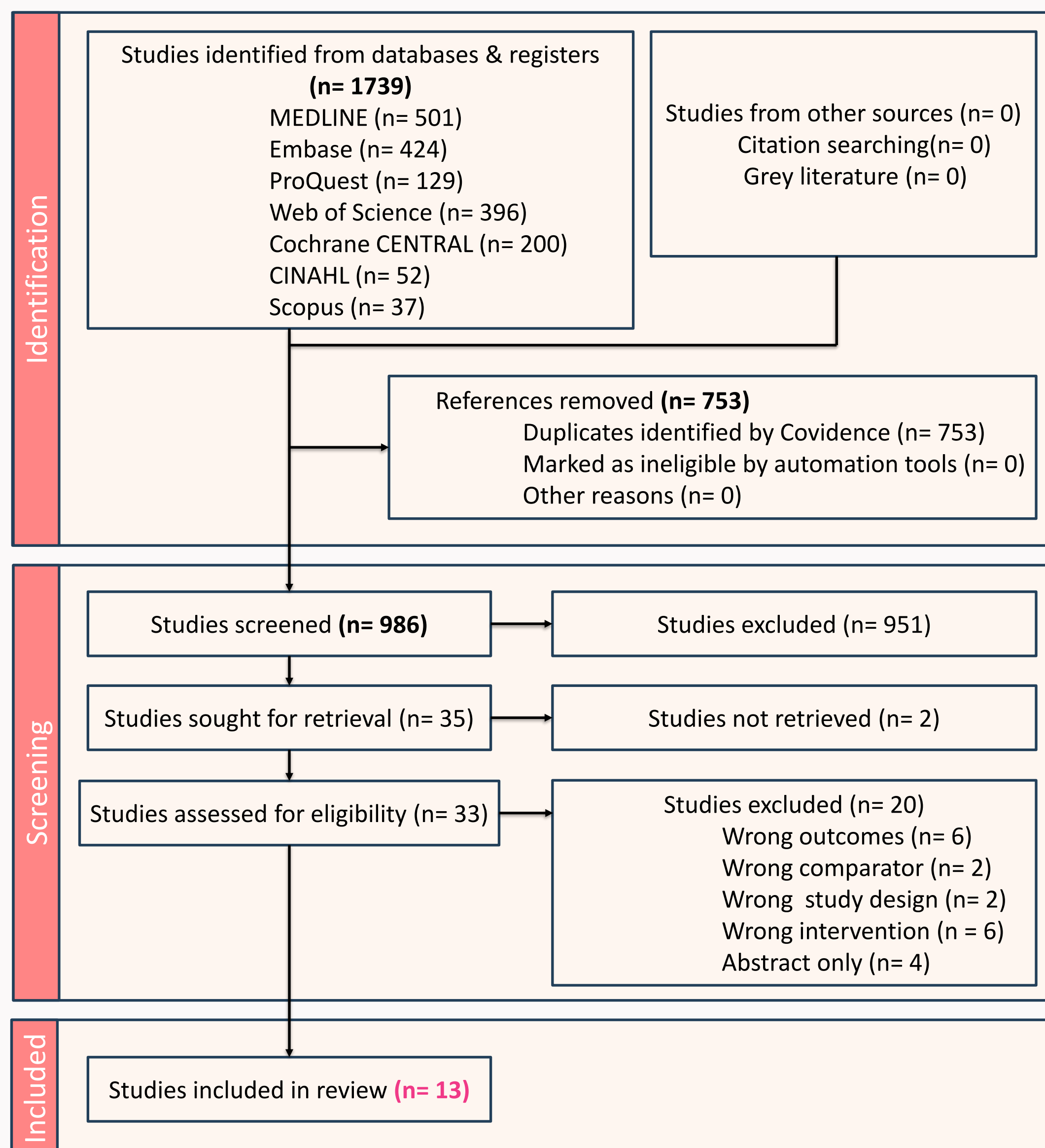


Figure 2: PRISMA flow diagram of the study selection process

## RESULTS

Study	Study Design	FLACS (eyes)	Phaco (eyes)	Follow-up (days)	IOL Type	FLACS Platform	Pupil Size for HOA Measurement
Mastropasqua 2014	Prospective randomized comparative	30	30	1, 7, 30, 180	AcrySof SN60WF (monofocal, Alcon)	LenSx (Alcon)	5.0 mm
Khoramnia 2015	Prospective clinical (toric IOL cohort with FLACS and standard subgroups)	12	Not reported as separate Phaco arm	2-4 months	T-flex 573T / 623T aspheric toric (Rayner)	LenSx (Alcon)	6 mm
Espallat 2016	Retrospective comparative	53	62	1 month, 1 year	AcrySof SN6ATx / SMD1TT (toric monofocal or multifocal, Alcon)	LenSx (Alcon)	5.0 mm
Pachtaev 2018	Prospective comparative (lens subluxation I-II)	35	54	Average 4 months (3-6 months)	MICL-2 (monofocal, Reper-NN, Russia)	LenSx (Alcon)	3 mm and 5 mm
Ernest 2019	Retrospective cohort	57	50	≥ 2 months postoperatively	TECNIS Symfony (EODF, J&J Vision) and AcrySof IQ ReSTOR +2.5 D (multifocal, Alcon)	LenSx (Alcon)	Mesopic, undilated (FLACS 4.74 ± 1.37 mm; Phaco 4.99 ± 1.24 mm)
Lee 2019	Retrospective comparative case series	23	26	1 month	TECNIS ZLB00 (diffractive multifocal, Abbott Medical Optics)	Catalys (Abbott Medical Optics)	6.0 mm
Shaheen 2020	Retrospective interventional comparative	50	50	6 months	Tecnis-1 (monofocal aspheric, hydrophobic acrylic, AMO)	Victus (Bausch & Lomb / Technolas) dilated in semi-dark room	5.0 mm scan
Pohlmann 2021	Retrospective single-center comparative	25	27	4 weeks	TECNIS ZCB00 (multifocal, Carl Zeiss), Hoya iSert 251 — randomly distributed aspheric monofocals	LenSx (Alcon)	5.0 mm scan
Zhong 2022	Retrospective cohort	105	116	≥ 1 year	TECNIS ZCB00 (monofocal, J&J Vision) and TECNIS Symfony ZXR00 (EODF, J&J Vision)	LenSx (Alcon)	3.0 mm and 5.0 mm (after dilation)
Chang 2023	Prospective consecutive cohort	35	57	1 month	TECNIS Symfony ZXR00 (EODF, J&J Vision)	LenSx (Alcon)	4.0 mm (mesopic)
Xu 2023	Prospective examiner-blinded cohort	131	130	1 week, 1 month, 3 months	TECNIS Symfony (EODF, J&J Vision)	LenSx (Alcon)	5.0 mm (after dilation with tropicamide 0.5%)
Qu 2024	Retrospective observational	70 (45 LASiG-FLACS) + 25 (H4iG-FLACS)	31	1 month, 6 months	AcrySof IQ PanOptix TFNT00 (diffractive trifocal, Alcon)	LenSx (Alcon)	4.0 mm
Onov 2025	Prospective randomized clinical trial	38	40	1 day, 12 days, 4 weeks, 6 weeks	KOWA 2.2R (monofocal aspheric)	FEMTO LDV Z8 (Ziemer)	Corneal HOAs (zone not explicitly stated)

Table 2: Study characteristics of all included studies

### FLACS is associated with significantly lower postoperative corneal HOAs

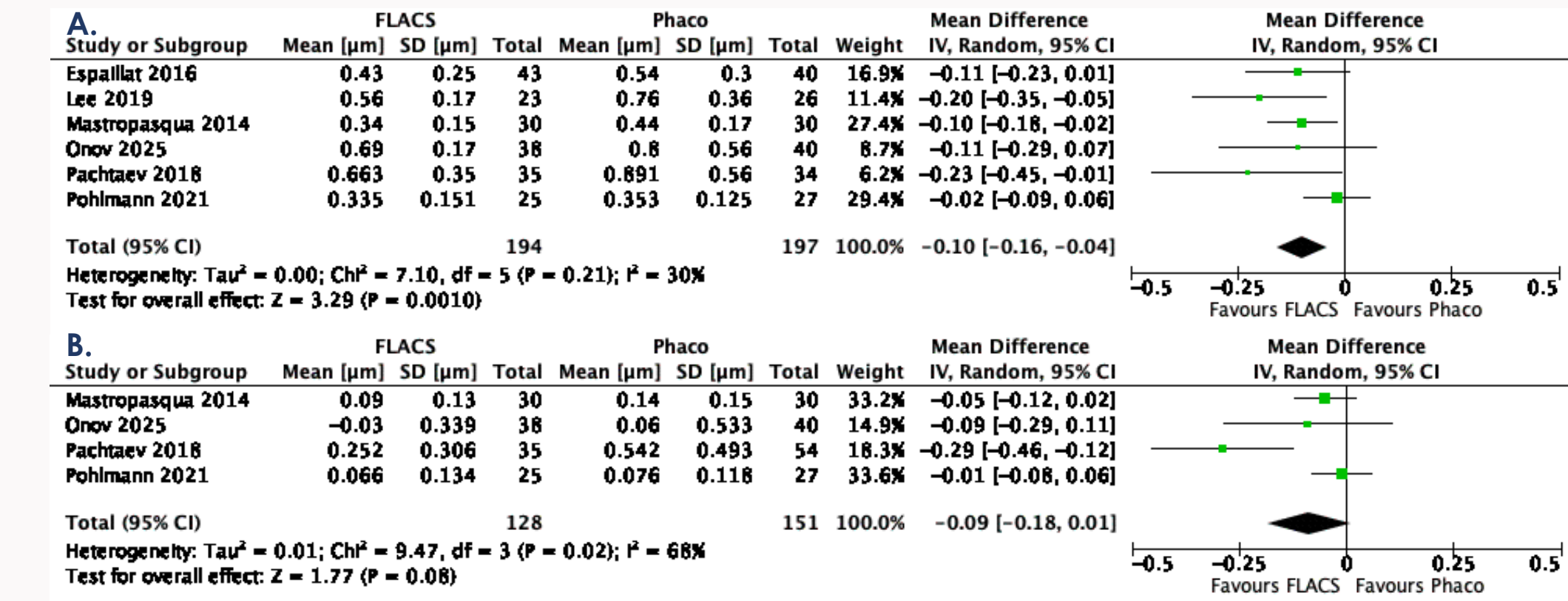


Figure 3: Forest plots of postoperative (A.) and surgically induced (B.) corneal HOAs in FLACS versus PHACO expressed as mean difference in um. Individual studies are represented by green squares with horizontal lines denoting their 95% confidence interval.

### FLACS is associated with significantly lower postoperative internal HOAs

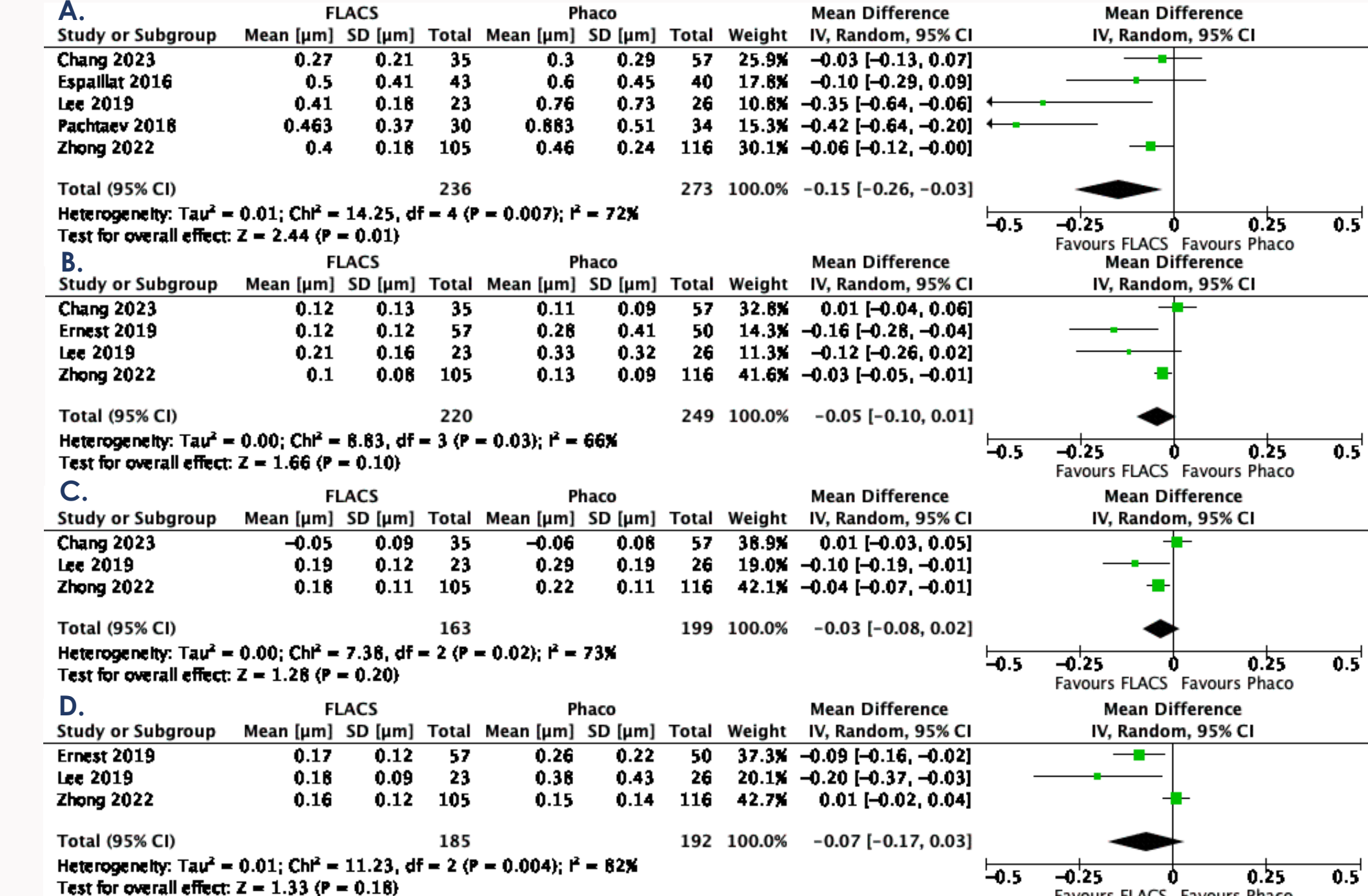


Figure 4: Forest plots of postoperative internal (A.), internal coma (B.), internal spherical (C.), and internal trefoil (D.) HOAs in FLACS versus PHACO expressed as mean difference in um. Individual studies are represented by green squares with horizontal lines denoting their 95% confidence interval.

## RESULTS/CONCLUSION

### FLACS is associated with significantly lower postoperative total (ocular) HOAs after sensitivity analysis

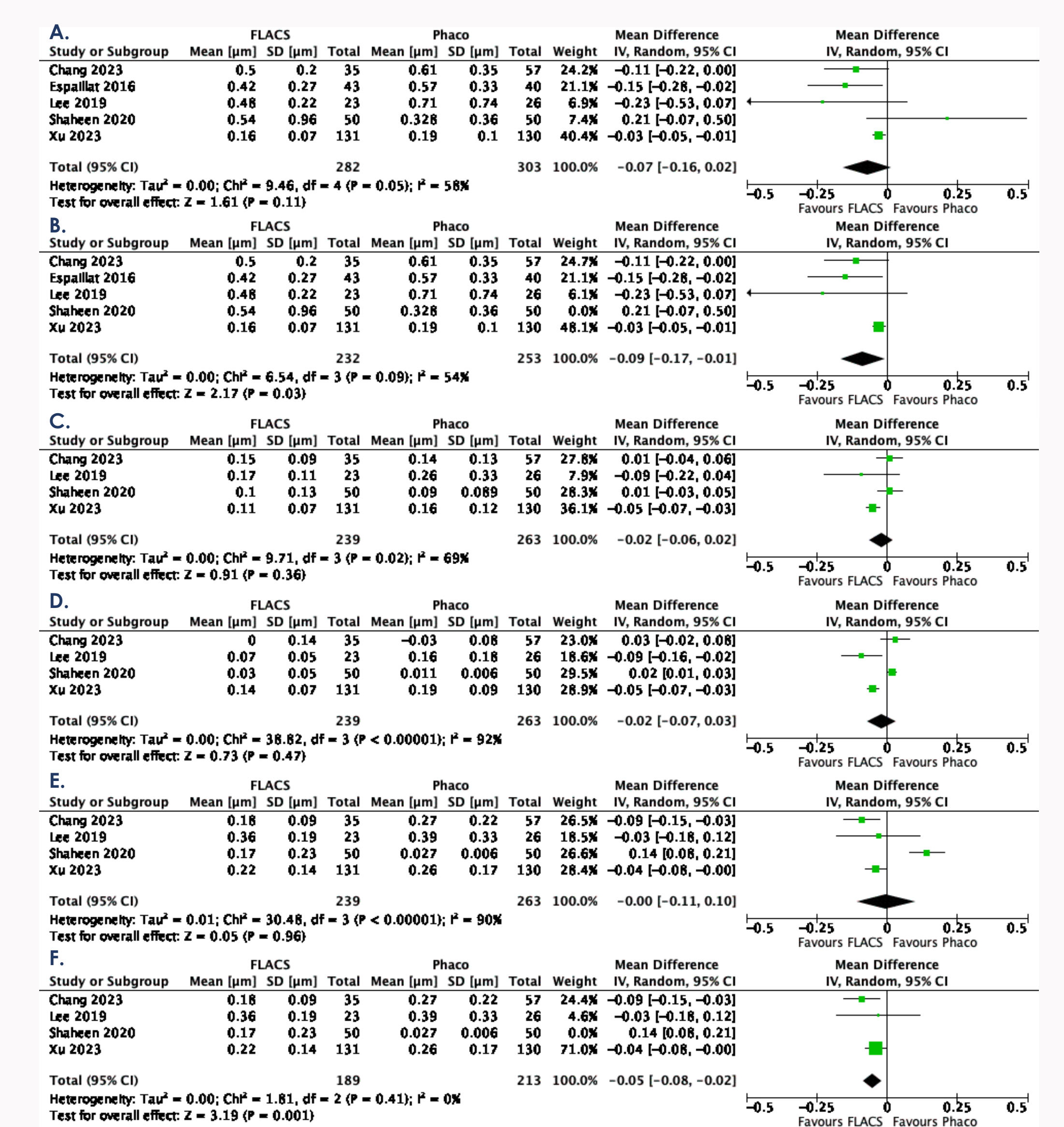


Figure 5: Forest plots of postoperative total ocular (A.), total ocular sensitivity (B.), ocular coma (C.), ocular spherical (D.), ocular trefoil (E.), and ocular trefoil sensitivity (F.) HOAs in FLACS versus PHACO expressed as mean difference in um. Individual studies are represented by green squares with horizontal lines denoting their 95% confidence interval.

### KEY POINTS:

- FLACS is associated with a **modest reduction in corneal and internal HOAs** compared to conventional phacoemulsification
- Despite these findings, they **do not consistently translate** into reduced total ocular aberrations
- Future studies limiting heterogeneity in approach are needed to better correlate FLACS with HOA reductions and **patient perceived quality of vision**

## ACKNOWLEDGEMENTS

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