

The Utility of Measuring Spherical Aberration in Cataract Surgery

Authors: Beyas Basu¹, Kirrily Hoole², Wendy Nicholson³, Yiming Xu⁴, Dr Vinod Gopalan⁵, Dr Madeleine Adams⁶



INSIGHT EYE SURGERY

^{1,5}School of Medicine & Dentistry, Griffith University, Southport,
²Insight Eye Surgery, BApp Sc (Optom) Hons Grad Cert (OcTher) QUT,
³Insight Eye Surgery, BApp Sc (Optom) Grad Cert (OcTher),
⁴Insight Eye Surgery, BVisSci MOptom,
⁶Director of Insight Eye Surgery, MB ChB BSc (Hons) PhD FRANZCO



Background

Spherical aberration (SA) is used to extend depth of field in presbyopia-correcting intraocular lens (IOL) designs. This study assessed the utility of preoperative SA measurements in tailoring post-operative outcomes. Corneal and total eye SA were compared among patients who had undergone cataract surgery with different IOL designs. This comparison allows the SA presumed to be induced by each IOL to be calculated.

Methods

This retrospective cohort study included 309 eyes that had undergone IOL implantation (Table 1). The IOL designs included: three monofocal (Bausch + Lomb enVista MX60, Alcon Clareon Monofocal CNA0T0-6, RayOne Toric RAO610T), one enhanced monofocal (RayOne EMV RAO200E/RAO210T), three extended depth-of-focus (Alcon Clareon Vivivity CNWET0-6, TECNIS PureSee DET100-600, Bausch + Lomb LuxSmart) and one trifocal (Alcon Clareon PanOptix Trifocal CCWTT0-6) (Table 2). Corneal aberrations were measured using the Sirius Scheimpflug-Placido Tomographer at 3.0mm and 6.0mm optical zones. Total eye SA was measured using a pyramidal-based aberrometer (Osiris) at a 3.0mm optical zone.

Table 1: Patient demographics

Parameter	Median (IQR)
Age (years)	71 (66 to 78)
Photopic pupil size (mm)	3.47 (3.17 to 3.94)
Axial length (mm)	23.65 (23.07 to 24.45)
Spherical equivalent (D)	-0.19 (-0.46 to -0.07)
IOL power (D)	21.50 (19.00 to 22.50)
Posterior Capsular Opacification	93
Post-operative Monocular UDVA	6/6 (6/6 to 6/7.5)
Post-operative Monocular UAVA	N6 (N5 to N8)
Post-operative Binocular UDVA	6/6 (6/6 to 6/6)
Post-operative Binocular UAVA	N6 (N5 to N7)

Table 2: IOL characteristics

IOL	Manufacturer	Type	Material; Diameter; Shape	Power range (D)	Aberration profile	Sample size
enVista MX60T	Bausch + Lomb	Monofocal	Acrylic; 6mm; biconvex	0 to +34.0	Neutral	81
Clareon Monofocal CNA0T0-6	Alcon	Monofocal	Acrylic; 6mm; biconvex	+6.0 to +30.0	Negative	31
RayOne Toric RAO610T	Rayner	Monofocal	Acrylic; 6mm; biconvex	+8.0 to +30.0	Neutral	5
RayOne EMV RAO200E, RAO210T	Rayner	Enhanced Monofocal	Acrylic; 6mm; biconvex	+10.0 to +30.0	Positive	40
Clareon Vivivity CNWET0-6	Alcon	EDoF	Acrylic; 6mm; biconvex	+10.0 to +30.0	Negative	124
TECNIS PureSee DET100-600	Johnson & Johnson	EDoF	Acrylic; 6mm; biconvex	+5.0 to +34.0	Neutral	22
LuxSmart	Bausch + Lomb	EDoF	Acrylic; 6mm; biconvex	+6.0 to +34.0	Negative	3
Clareon PanOptix Trifocal CCWTT0	Alcon	Trifocal	Acrylic; 6mm; biconvex	+6.0 to +34.0	Negative	3

Results

Regardless of their intended aberration profile, most IOL types induced all three SA changes, including negative, positive, and no change in SA. LuxSmart and PanOptix consistently induced negative Z4(4,0) changes (Figure 1a); PanOptix consistently induced positive Z6(6,0) changes (Figure 1b) but they represented a small sample size.

The change in median total eye Z4(4,0) induced by Clareon (p < 0.001), Vivivity (p = 0.041) and LuxSmart (p = 0.004) were statistically significant (Figure 2a). Vivivity induced a statistically significant change in median total eye Z6(6,0) (p < 0.001) (Figure 2b). The median values suggest a trend in SA change (Figure 2), but the wide distribution of SA inductions (Figure 1) indicate that the trends are not directionally consistent.

There were no statistically significant differences between preoperative and postoperative corneal higher-order aberrations, indicating that surgically induced corneal aberrations were unlikely.

Figure 1: Presumed total eye SA induced by each IOL (a) Z4(4,0) (b) Z6(6,0)

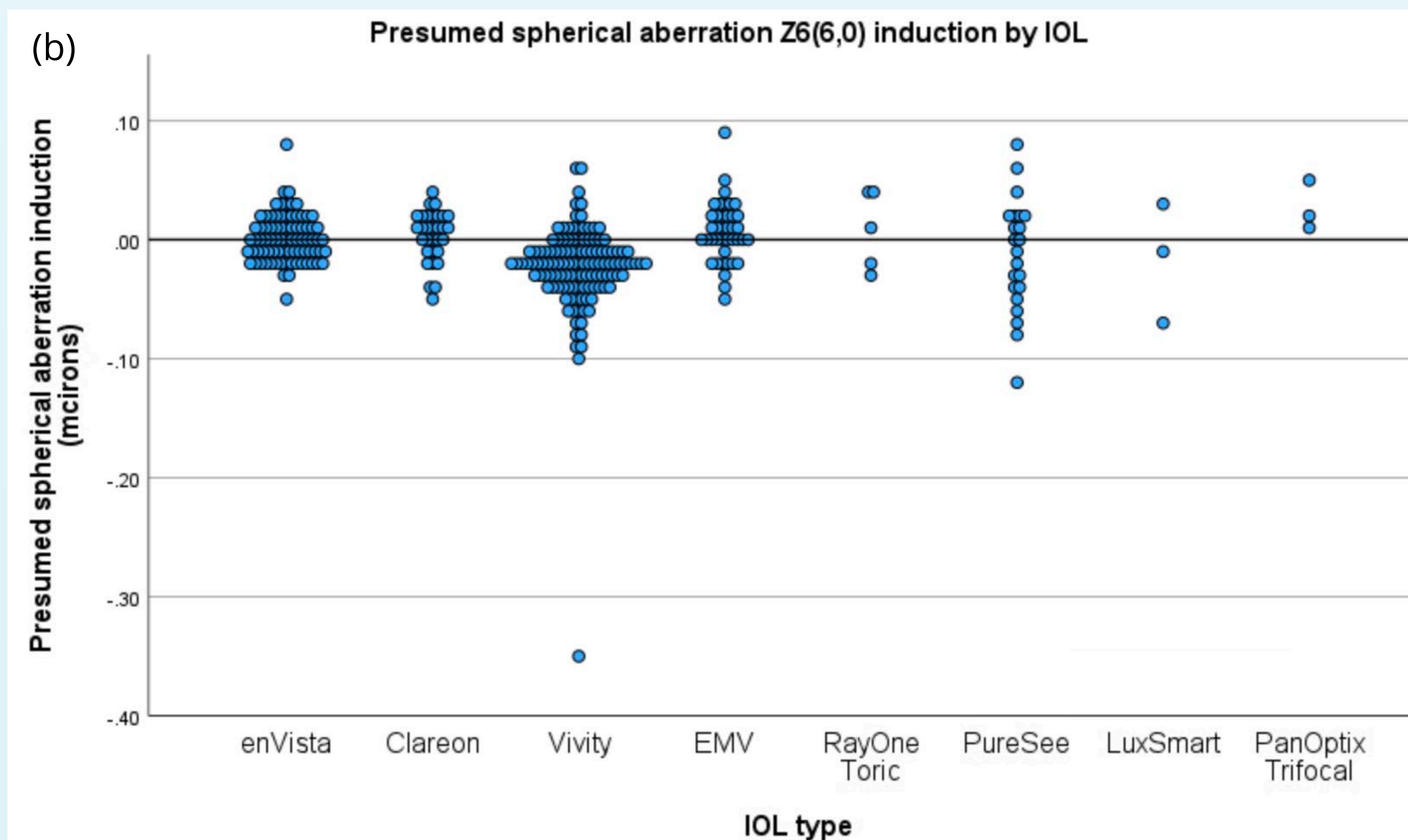
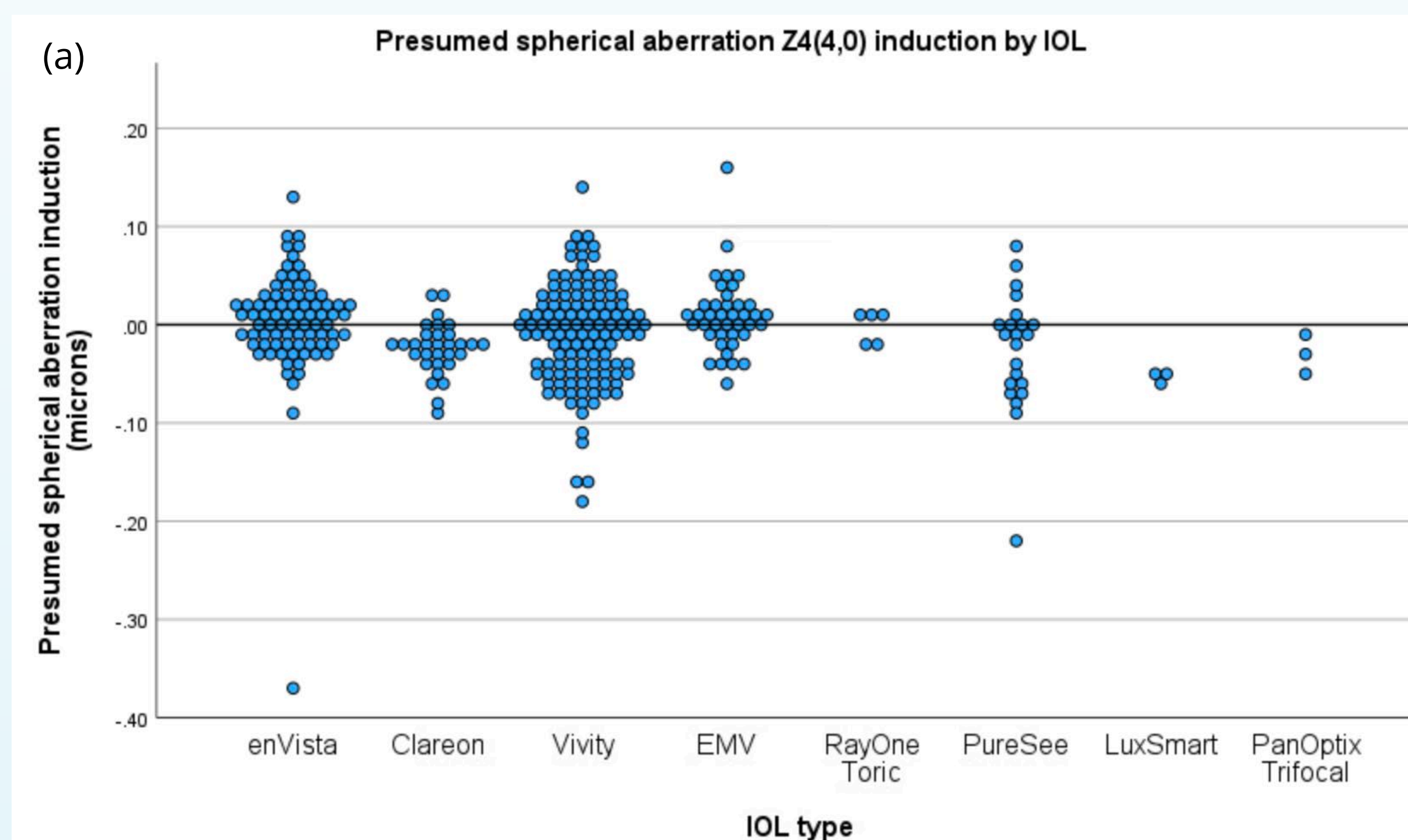
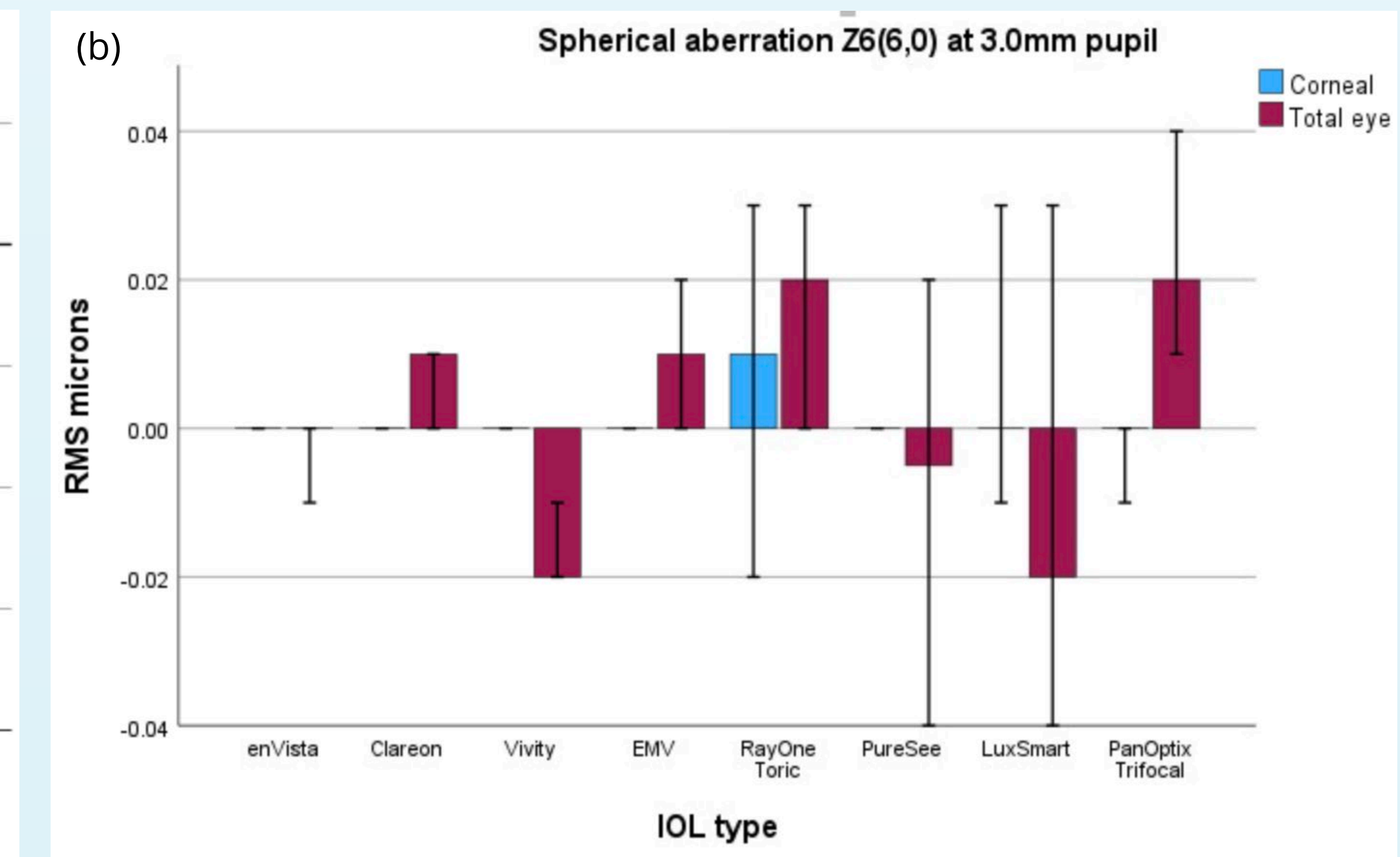
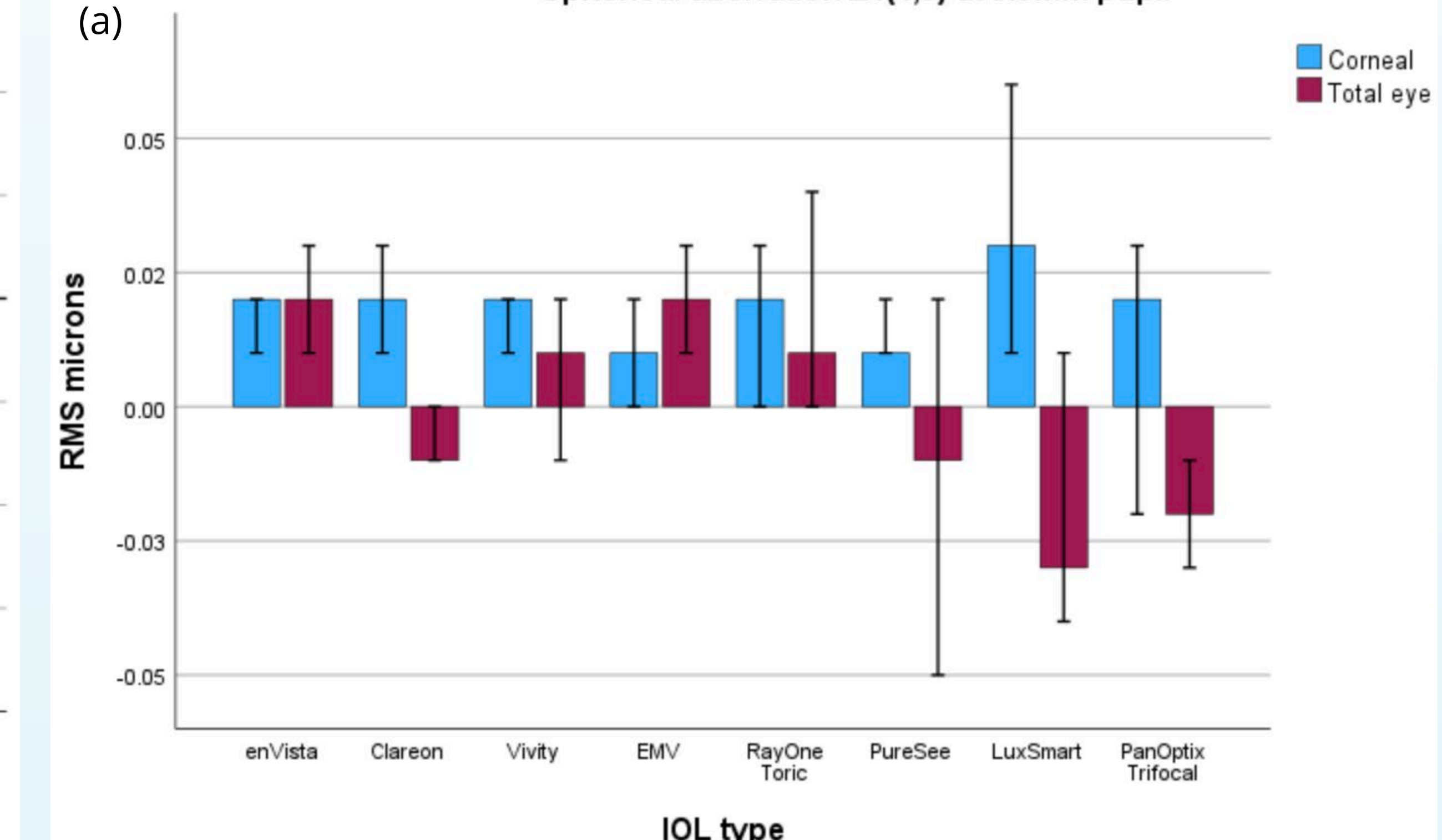


Figure 2: Median corneal and total eye SA comparison (a) Z4(4,0) (b) Z6(6,0)



Conclusion

This study indicated that the SA induced by most IOLs was inconsistent in direction. Tailoring IOL selection based on pre-operative corneal SA may not be practicable as the effect of the induction is not clinically predictable.

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