Singapore National Eye Centre

SingHealth

Scheimpflug Corneal Topographer and Combined Placido Disc and Anterior Segment OCT Measurements of Corneal Topography Before and After LASIK

Audrey YC Pang, Jodhbir S Mehta

The authors have no financial interests to disclose.

INTRODUCTION

- Laser in situ keratomileusis (LASIK) is the most widely performed refractive procedure. Accurate measurements of corneal topography and pachymetry are essential in pre-operative assessment to achieve successful treatment outcomes and to avoid and reduce the risk of keratectasia. They are also important in the diagnosis and monitoring of cornea ectasia, keratoconus or cornea degeneration
- Traditional Placido-disc topographers are limited to evaluation of the anterior corneal surface. The Orbscan slit-scanning device (Bausch & Lomb, Rochester, New York) was the first technology that allowed measurement of the posterior surface. The current system is a hybrid system consisting of slit scanning and Placido imaging technology.
- The Pentacam (Oculus, Inc., Lynnwood, WA), which is based on Scheimpflug imaging to provide a three-dimensional scan of the anterior segment structures, was the second technology to enable measurement of the posterior cornea surface. Its use in measurement of corneal shape, power and pachymetry has been studied and compared with the Orbscan in post-operative eyes, and those with keratoconus.
- More recently, the Visante Omni (Carl Zeiss Meditec, Jena, Germany) which uses high speed anterior segment optical coherence tomography (OCT) combined with a Placido-disc topographer (Atlas topographer) has been introduced as another device that can measure both the anterior and posterior corneal topography accurately.
- There are no reports comparing the Pentacam and Visante Omni systems, the aim of this study was to compare the measurements of cornea topography and pachymetry before and after LASIK using two different technologies—Scheimpflug imaging using Pentacam and combined Placido imaging and OCT imaging using Visante Omni.

Singapore National Eye Centre
SingHealth

METHODS

- This prospective study evaluated 25 patients who had bilateral LASIK, between August 2011 and June 2012, at the Singapore National Eye Centre.

- Exclusion criteria consisted of a history of eye disease or ocular abnormalities that would normally exclude the patient from undergoing LASIK. Both eyes of 25 patients were measured using the Pentacam (Oculus, Inc., Lynnwood, WA) and Visante Omni (Carl Zeiss Meditec, Jena, Germany) before and after LASIK.

- The images from both machines were obtained on the same day pre and post-operatively. The corneal topography for the best fit ellipsoid on both instruments were measured and the variables for the anterior cornea curvature (ACC), posterior cornea curvature (PCC), anterior cornea elevation (ACE), posterior cornea elevation (PCE) and the pachymetry of the thinnest point in the 8mm diameter zone were recorded.

- Paired t tests were used to analyze the inter-device differences for each variable. The mean difference (MD), standard deviation (SD), and the 95% limits of agreement (LoA) (MD ± 1.96SD) were calculated. Bland-Altman plots were used to assess the agreement between the individual measurements from each device .

RESULTS (1)

- 50 eyes from 25 patients were analyzed in this study Most of the patients were of Chinese race (72%), followed by the Malay (16%) and Indian (4%) race, which is reflective of the general population in Singapore.
- The mean age was 27.6 ± 5.8 (range: 20-39 years). The mean pre-operative refractive error spherical equivalent) was -5.25 ±2.45D (range : -10.75 to -1.63) in the left eyes and -5.50 ± 2.38D (range: -10.63 to -2.13) in the right eyes. Most of the eyes (84-92%) had a moderate to high degrees of myopia (moderate myopia is defined as <-6.00D).
- The paired t tests in the pre-operative eyes showed that all parameters measured showed that there was no statistical difference between the values for PCE in the left eyes, and ACE in the right eyes, using the Pentacam and the Visante Omni. The other values showed a statistical difference ($p<0.05$) but the mean paired differences (MD) were small.
- All the mean values measured by the Visante Omni were larger, except for the pachymetry where the Visante Omni readings were thinner (MD -10.08um ± 8.24 for in the left eyes and -11.56um ± 6.53 in the right eyes).
- The paired t tests in the post-operative eyes showed no statistical difference for the values of ACC and flat PCC between the two devices. The other values showed a statistical difference ($p<0.05$) but the mean differences were small.

RESULTS (2)

- The pre and post-operative measurements in the left eyes are shown in Table 1 and 2 respectively. The pre-operative mean difference (MD) for the flat ACC was 0.40D (±0.31), the steep ACC was 0.52D (±0.48), the flat PCC was 0.12D (± 0.14) , the steep PCC was 0.27D (± 0.15), the ACE was 0.68µm (±1.22), the PCE was 1.16µm (±3.65) and pachymetry was -10.08µm (± 8.24) . The width of limits for the 95%LoA ranged from 0.53 to 1.88D for ACC and PCC, 4.76µm to 14.3µm for ACE and PCE, and 32.30µm for pachymetry. 92% - 100 % of the cases fell within the 95% LoA.
- The post-operative MD for the flat ACC was -0.18D (±1.02), the steep ACC was -0.31D (±1.48), the flat PCC was 0.00D (±0.15) , the steep PCC was 0.17D (±0.13), the ACE was 1.96µm (± 4.26), the PCE was 2.52µm (± 2.50) and pachymetry was -6.12µm (±9.28) . The width of limits for the 95%LoA ranged from 0.50 to 5.80D for ACC and PCC, 9.81µm to 16.69µm for ACE and PCE, and 36.36µm for pachymetry. 92% - 96 % of the cases fell within the 95% LoA.
- 100% of the pre-operative pachymetry measurements for both eyes lie within the 95%LoA.
- The Bland Altman plots show that a strong between-instrument agreement in all 7 variables measured pre- and post-operatively. (Figures 1-4)
- The pre- and post-operative measurements and Bland-Altman plots in the right eyes showed similar results to the left eyes.

Pre-op for left eye	Mean paired difference	(SD)	95% limits of agreement			% of cases with 95% limits of agreement	95% CI for lower limit of agreement			95% CI for upper limit of agreement		
			Lower	Upper	Width of limits	(n = 25)	Lower	Upper	Width of CI	Lower	Upper	Width of CI
Visante anterior elevation (Pre-op) - Pentacam anterior elevation (Pre-op)	0.68	(1.22)	-1.70	3.06	4.76	96.0%	-2.57	-0.83	1.74	2.19	3.93	1.74
Visante flat anterior curvature (Pre-op) - Pentacam flat anterior curvature (Pre-op)	0.40	(0.31)	-0.21	1.02	1.23	96.0%	-0.44	0.01	0.45	0.80	1.24	0.45
Visante steep anterior curvature (Pre-op) - Pentacam steep anterior curvature (Pre-op)	0.52	(0.48)	-0.42	1.46	1.88	96.0%	-0.76	-0.07	0.69	1.12	1.81	0.69
Visante posterior elevation (Pre-op) - Pentacam posterior elevation (Pre-op)	1.16	(3.65)	-5.99	8.31	14.30	92.0%	-8.60	-3.38	5.22	5.70	10.92	5.22
Visante flat posterior curvature (Pre-op) - Pentacam flat posterior curvature (Pre-op)	0.12	(0.14)	-0.14	0.39	0.53	92.0%	-0.24	-0.05	0.19	0.29	0.49	0.19
Visante steep posterior curvature (Pre-op) - Pentacam steep posterior curvature (Pre-op)	0.27	(0.15)	-0.02	0.56	0.58	96.0%	-0.13	0.08	0.21	0.45	0.67	0.21
Visante pachymetry (Pre-op) - Pentacam pachymetry (Pre-op)	-10.08	(8.24)	-26.23	6.07	32.30	100.0%	-32.12	-20.34	11.79	0.18	11.96	11.79

Table 1. Statistical analysis of between-instrument measurements for the left eyes pre-operatively.

Singapore National Eye Centre
SingHealth

Post-op for left eye	Mean paired difference	(SD)	95% limits of agreement			% of cases with 95% limits of agreement	95% CI for lower limit of agreement			95% CI for upper limit of agreement		
			Lower	Upper	Width of limits	(n = 25)	Lower	Upper	Width of CI	Lower	Upper	Width of CI
Visante anterior elevation (Pre-op) - Pentacam anterior elevation (Pre-op)	-1.96	(4.26)	-10.30	6.38	16.69	96.0%	-13.35	-7.26	6.09	3.34	9.43	6.09
Visante flat anterior curvature (Pre-op) - Pentacam flat anterior curvature (Pre-op)	-0.18	(1.02)	-2.18	1.83	4.01	96.0%	-2.91	-1.45	1.46	1.10	2.56	1.46
Visante steep anterior curvature (Pre-op) - Pentacam steep anterior curvature (Pre-op)	-0.31	(1.48)	-3.21	2.59	5.80	92.0%	-4.27	-2.15	2.11	1.53	3.64	2.11
Visante posterior elevation (Pre-op) - Pentacam posterior elevation (Pre-op)	2.52	(2.50)	-2.38	7.42	9.81	96.0%	-4.17	-0.59	3.58	5.63	9.21	3.58
Visante flat posterior curvature (Pre-op) - Pentacam flat posterior curvature (Pre-op)	0.00	(0.15)	-0.30	0.29	0.58	96.0%	-0.40	-0.19	0.21	0.18	0.39	0.21
Visante steep posterior curvature (Pre-op) - Pentacam steep posterior curvature (Pre-op)	0.17	(0.13)	-0.08	0.42	0.50	96.0%	-0.17	0.01	0.18	0.33	0.51	0.18
Visante pachymetry (Pre-op) - Pentacam pachymetry (Pre-op)	-6.12	(9.28)	-24.30	12.06	36.36	92.0%	-30.93	-17.67	13.26	5.43	18.69	13.26

Table 2. Statistical analysis of between-instrument measurements for the left eyes post-operatively.

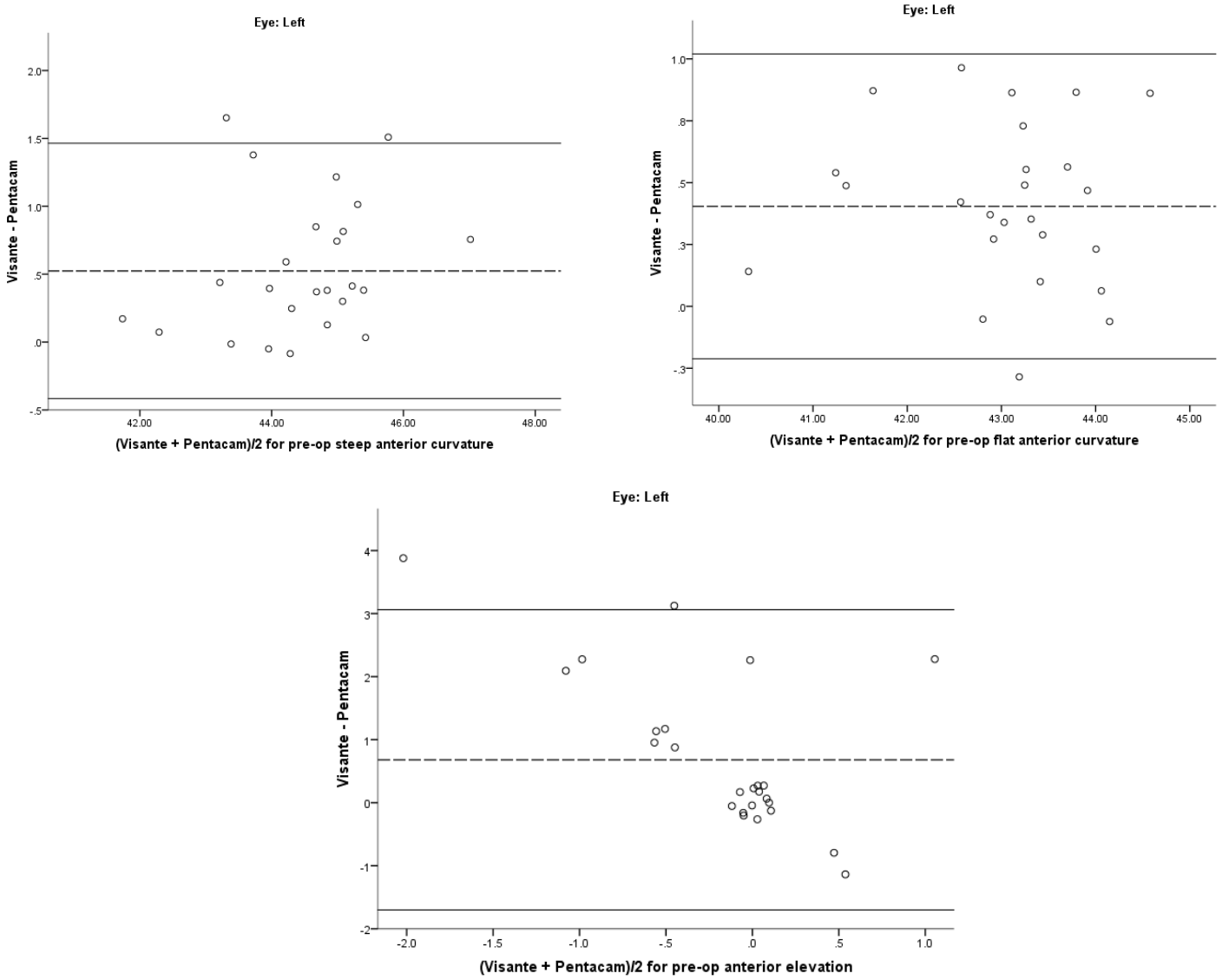


Fig 1. Bland Altman plots for between-instrument pre-operative anterior cornea measurements in the left eyes .

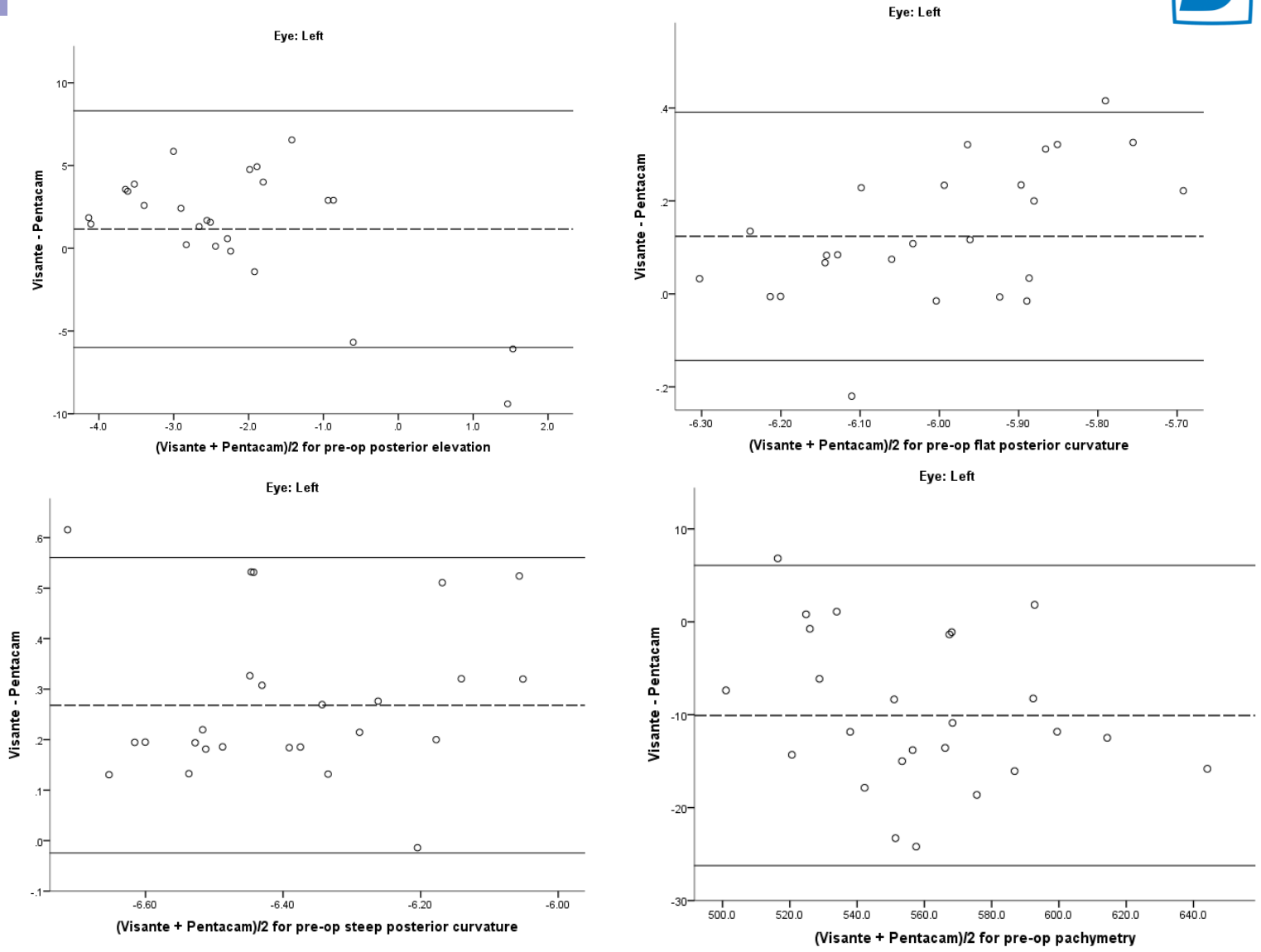
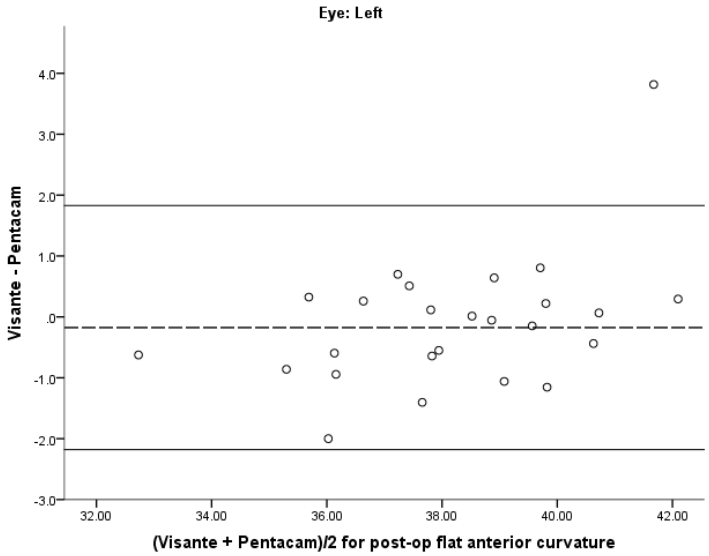
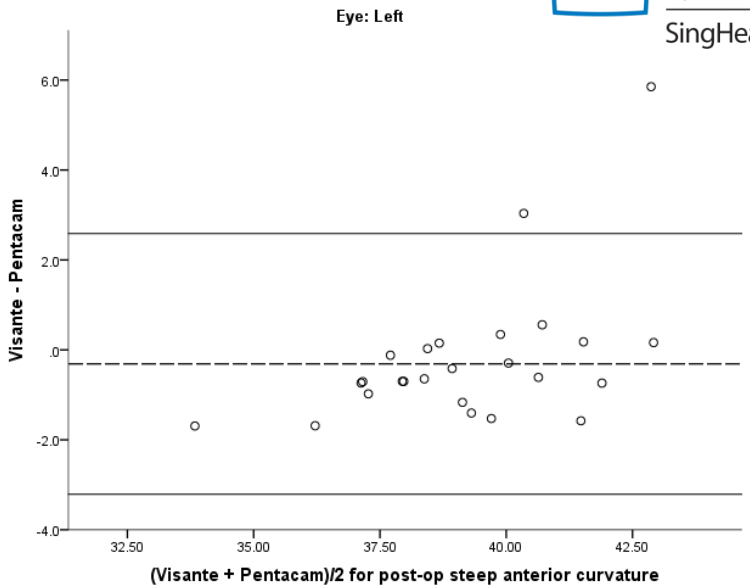


Fig 2. Bland Altman plots for between-instrument pre-operative posterior cornea measurements and pachymetry in the left eyes.





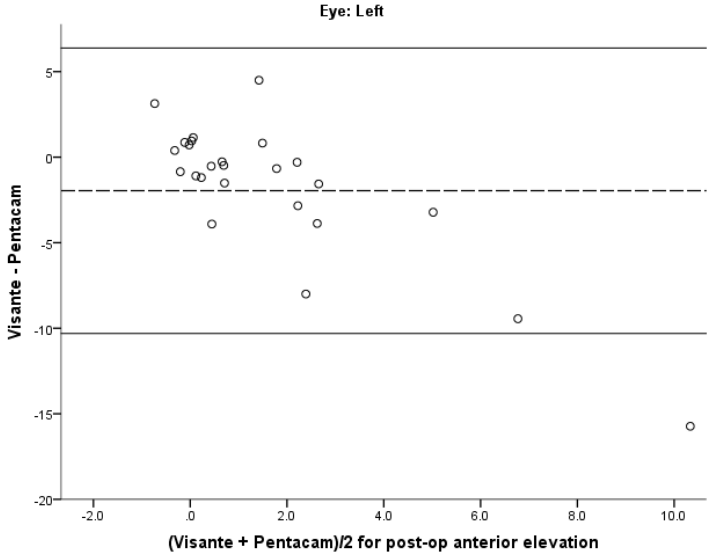


Fig 3. Bland Altman plots for between-instrument post-operative anterior cornea measurements in the left eyes.

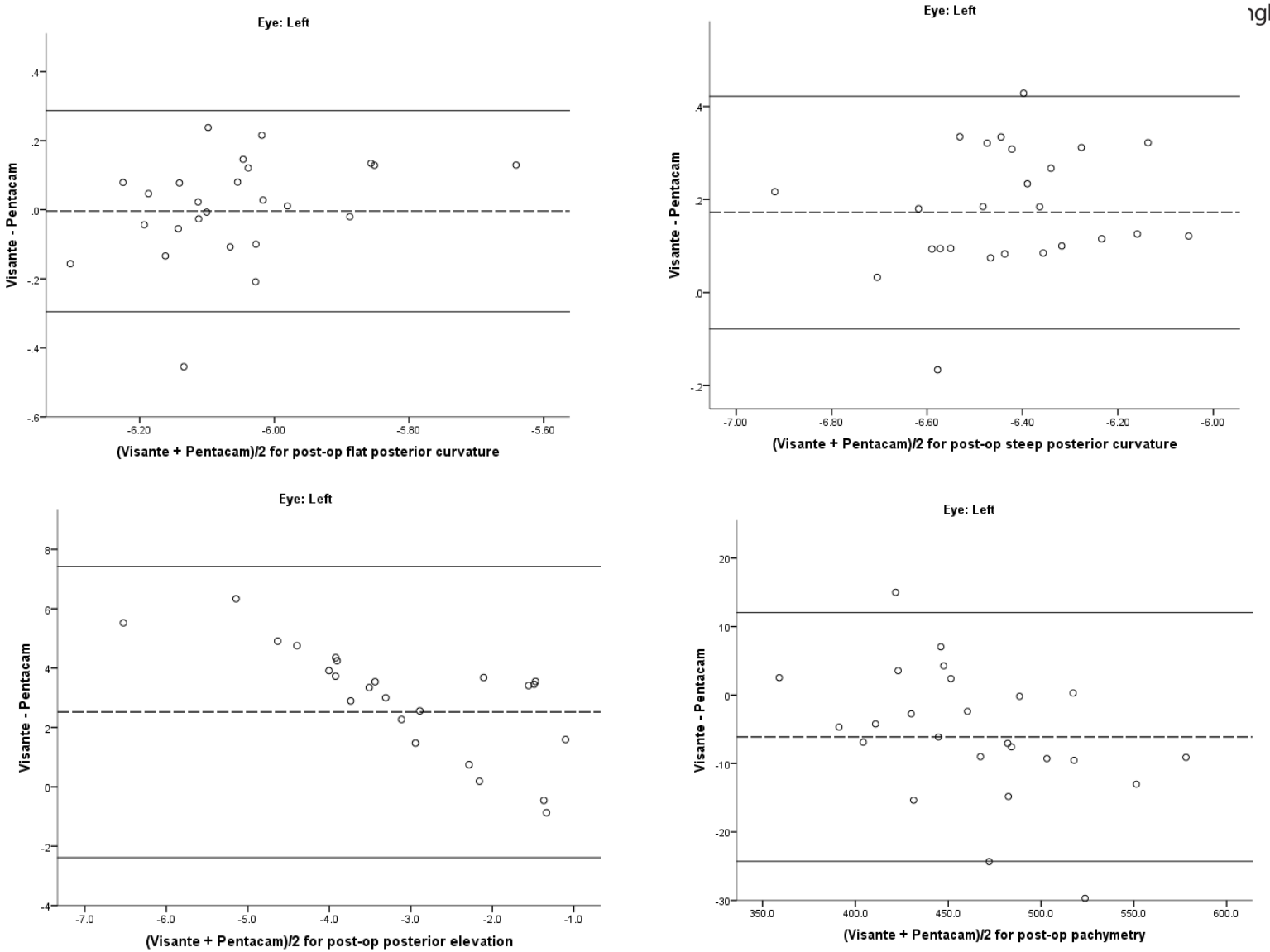


Fig 4. Bland Altman plots for between-instrument post-operative posterior cornea measurements and pachymetry in the left eyes .

CONCLUSION

- In this study, we found that although there are small differences between the measurements for anterior and posterior cornea curvature, cornea elevation and pachymetry acquired by the Pentacam and Visante Omni, and the two devices were in good agreement with each other.
- Both the Pentacam and Visante Omni provide detailed and useful information about the anterior and posterior cornea surfaces, elevation and pachymetry, despite using different mechanisms to acquire the data. From this data, it appears that the Visante Omni may under-measure pachymetry of the thinnest point compared to the Pentacam, and over-measures the other values, but these values are clinically insignificant. More studies in larger populations will be needed to elucidate the reason for the differences. In this study, both devices seem to perform equally well in pre- and post-LASIK cornea measurements, and we found a high degree of accuracy between the two systems.