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Scleral curvature in a young adult population

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BACKGROUND

Previous studies measuring normative values were gathered and angles of corneal scleral toricity of normal and keratoconic eyes were performed using OCTs. Results of these studies:

- Measurements made from 15mm chord length or less were essentially symmetrical.¹
- Measurements made from 15mm chord length or further showed more asymmetry. Suggesting that scleral lenses larger than 15mm may require toric or quadrant-specific scleral designs.²
- The Pacific Scleral Lens Study demonstrated that variability of scleral angle at the 15mm chord vs. 20mm chord and they found the further away from the limbus the more asymmetry and variation present.³
- In both measurements from the 10-15mm chord and 15-20mm chord, the inferior quadrant is normally a “benchmark” with the temporal angle being steeper and the nasal being flatter. This seems to correlate with the extra-ocular muscle insertions.³
- Many studies have evaluated ocular parameters of Asians vs. Caucasians. Asians statistically have smaller palpebral fissures, smaller HVIDs, and their eyes are more prolate (steeper vertically/ flatter horizontally) than Caucasians.⁴
- The range of a mean radius of curvature of the cornea in a normal population tends to vary between 7.8 ± 0.25 mm (42.93D - 44.70D).⁵

PURPOSE

The purpose of the study was to evaluate scleral shape in a healthy young adult population. We hypothesized that there would be notable differences between genders, races, quadrants, and between eyes. The study was approved by our internal IRB.

METHODS

Thirty-seven third year students enrolled in the specialty contact lens laboratory volunteered to have their ocular surface evaluated by the sMap3D topographer. Of those only 33 had highly reliable scans that could be evaluated. One patient was excluded due to previous ocular surgery. Patient’s ethnic distribution was Caucasian (n=12), Indian (n=10), and Asian (n=10). There were 21 females and 11 males included. Average age was 25.6 ± 2.8 years.

Fluress™ was instilled in both eyes of each patient. Central, superior and inferior measurements were captured. The data was stitched by the system and analyzed at the 16mm chord. We then evaluated the reports for scleral curvature and scleral toricity. We compared for differences between gender, race, and right eye vs. left eye. (Figures 1 and 2)

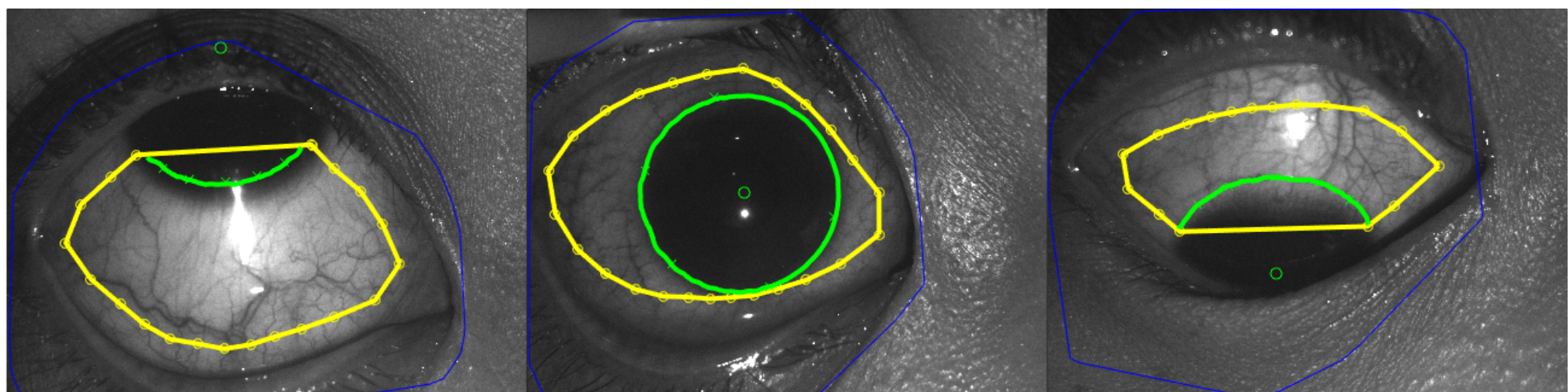
RESULTS

Right eyes had less toricity compared to left eyes by 0.09 D. (Figure 3) Right eyes had average scleral toricity at a 16mm chord of $1.57D \pm 0.98D$. For left eyes, the average toricity was $1.66D \pm 1.28$. There was a statistically significant difference between temporal curvature of OD vs. OS with a $p=0.02$, where OS had steeper curvature (Figure 4) When comparing races (Asian, Caucasian and Indian), there was a statistical trend showing a difference in the superior quadrant between Indians and Asians of the right eye with a $p=0.05$, where Indians were statistically steeper. (Figure 5) There were no other clinically significant points between races in any other quadrant. Comparing males vs. females, the superior quadrant of the right eye showed a statistical significance of $p=0.02$, with females being steeper than males. (Figure 6) All other quadrants between the genders were clinically insignificant. When comparing the total averages between quadrants for both right and left eyes the superior quadrant was the flattest followed by the nasal quadrant, in right eyes the inferior quadrant was the steepest, and in the left eyes the temporal quadrant was the steepest. The average base curve for our population was found to be 44.27D for the right eye and 44.07D for the left eye.

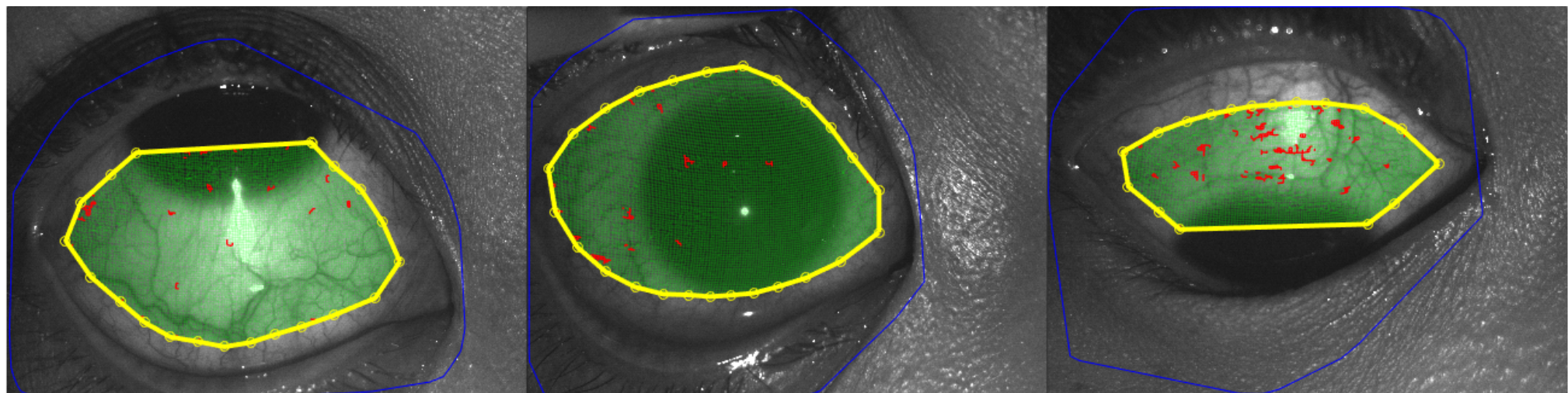
FIGURE 1 AND 2

The images were captured using Fluress™ in three fields of gaze then stitched together to create a three dimensional scleral shape.

Limbal and Scleral Identification



Fluorescein Coverage



Stitching Assessment



FIGURE 3

As in previous studies, we note toric asymmetry between the eyes.

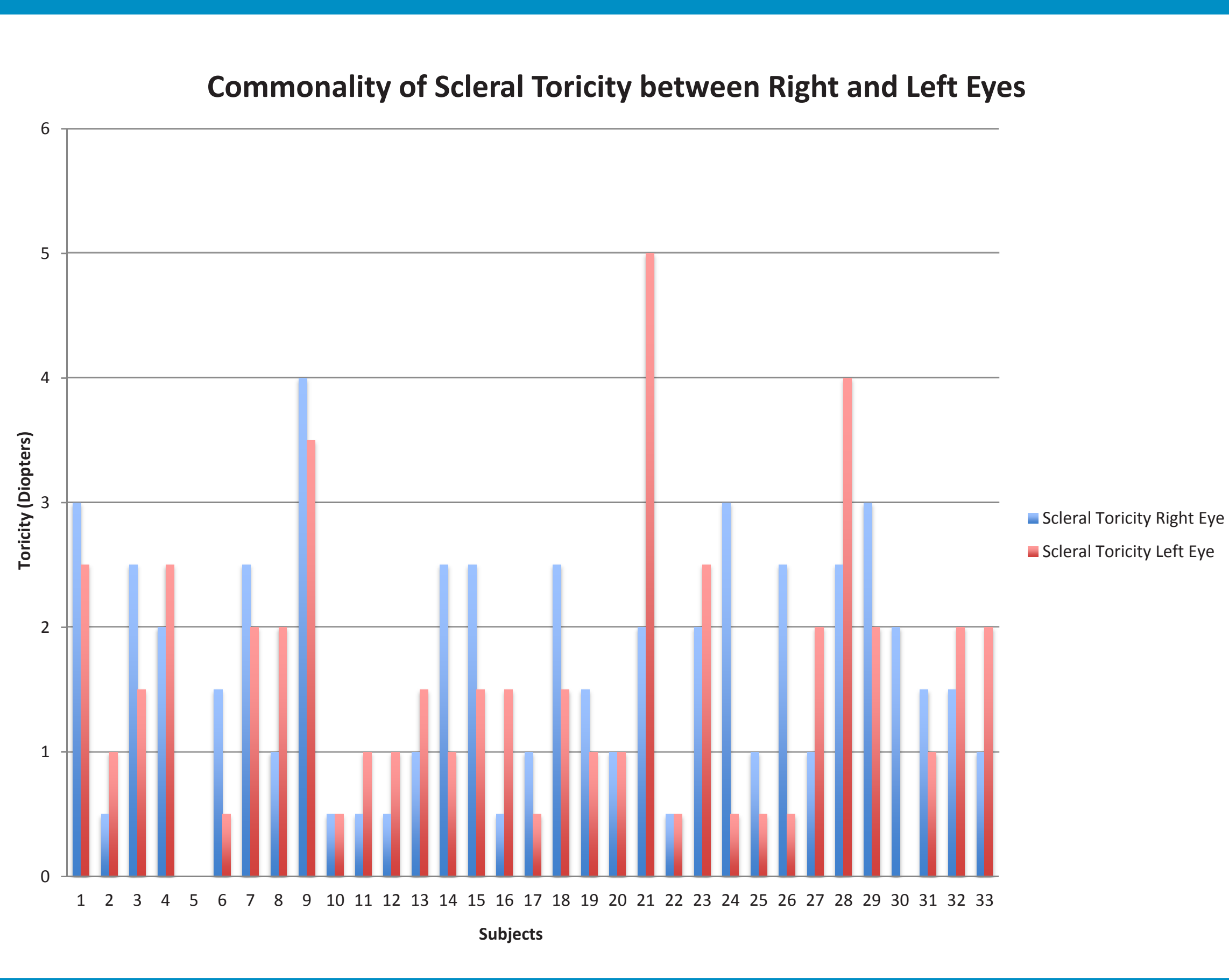
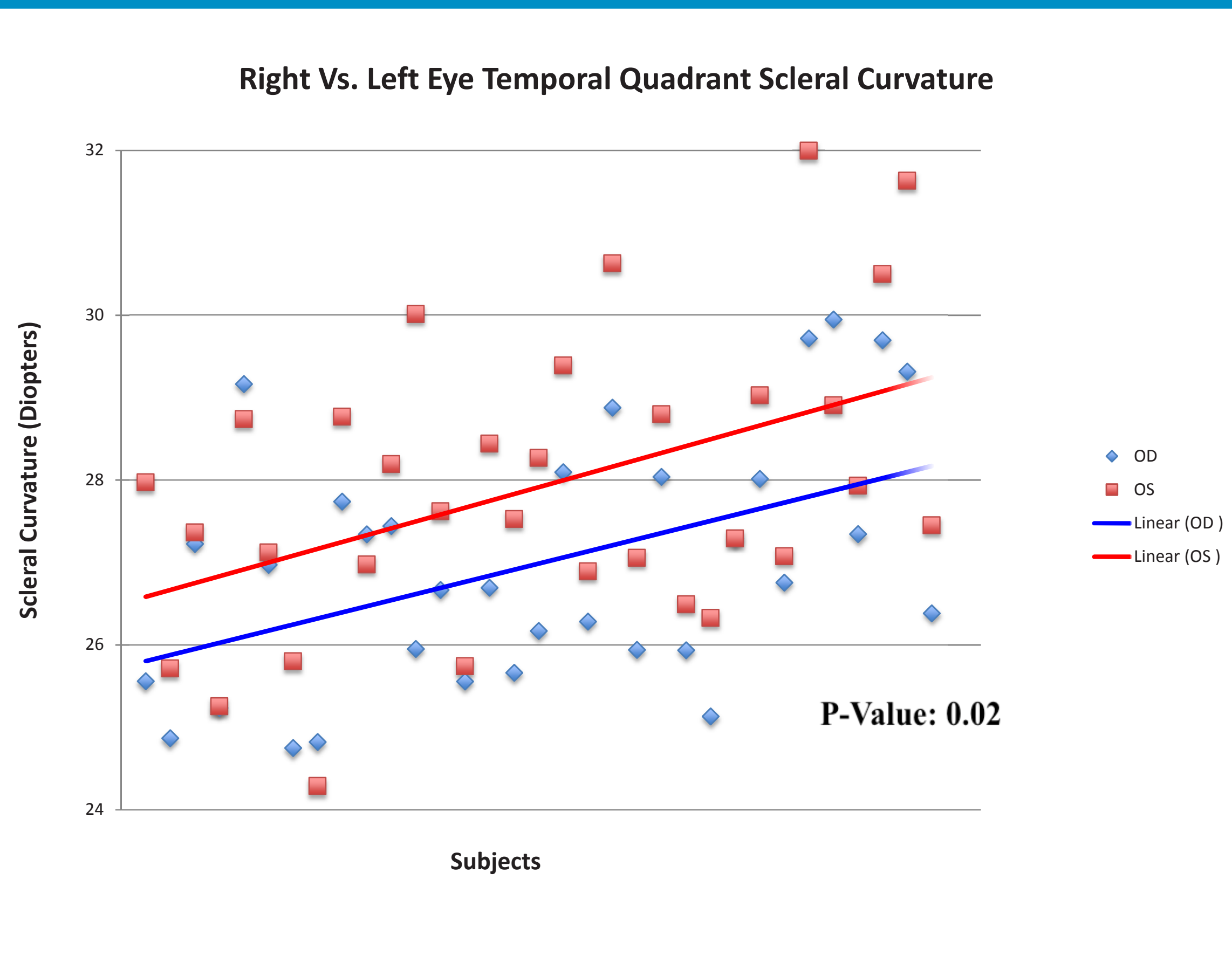


FIGURE 4

The temporal corneal curvature of the left eye was significantly steeper from that of the right eye.



DISCUSSION

Our findings support previous investigative studies. Specifically, the temporal scleral is steeper compared to the nasal sclera. It was previously noted that the inferior sclera was the bench-mark with having the temporal quadrant being steeper and the nasal quadrant being flatter in comparison; in our study this corresponds to the data of the left eye but for our right eye the inferior quadrant was actually the steepest followed by the temporal quadrants. Our analysis was only done at a 16mm chord so we cannot speak about chord diameter variability. However, our results do support the notion of asymmetry beyond 15mm.

FIGURE 5

We noted a statistical trend of steeper superior curvature in Indian vs. Asian populations ($p=0.05$). However, no difference was noted between Caucasians and Asians or Indians.

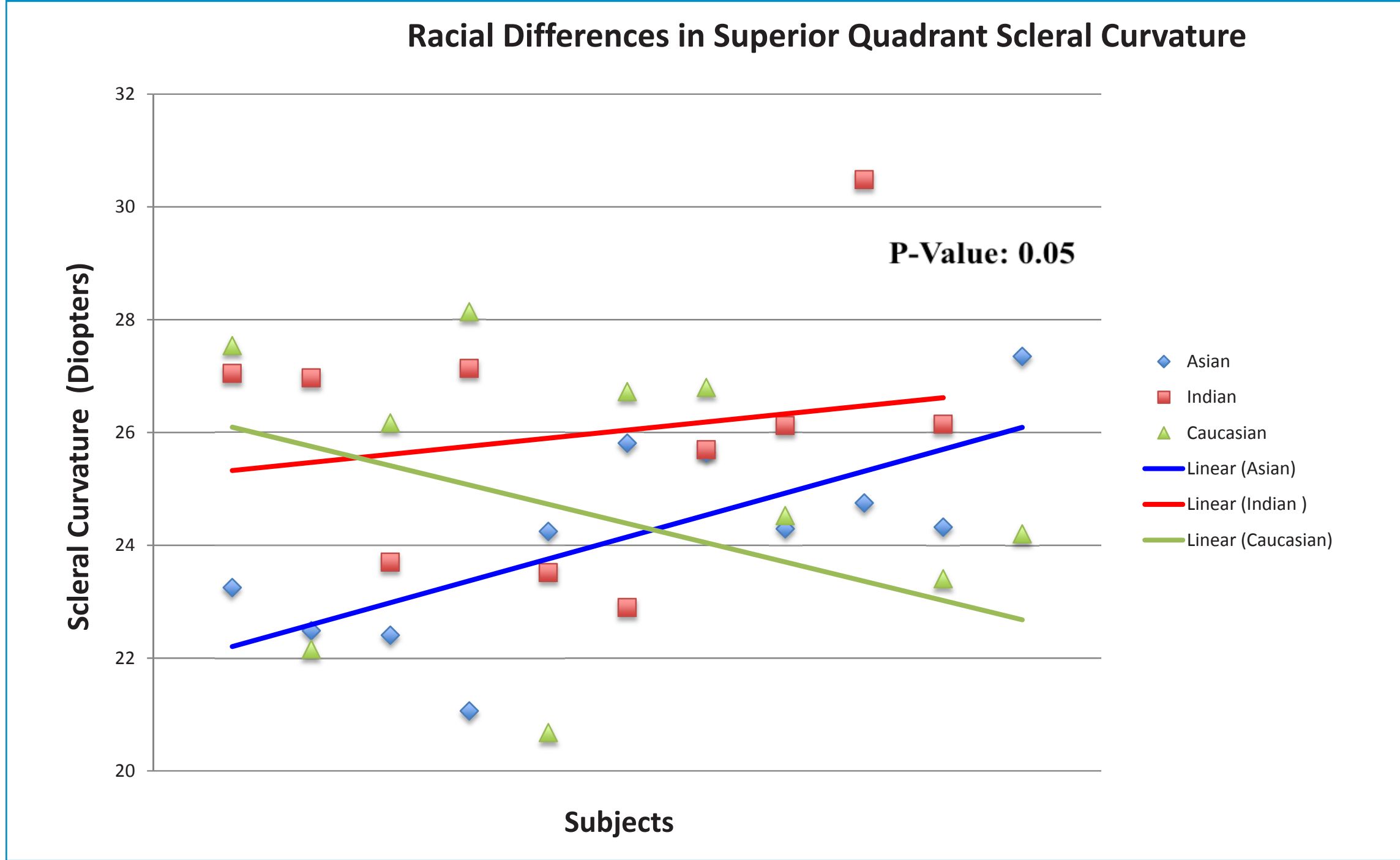
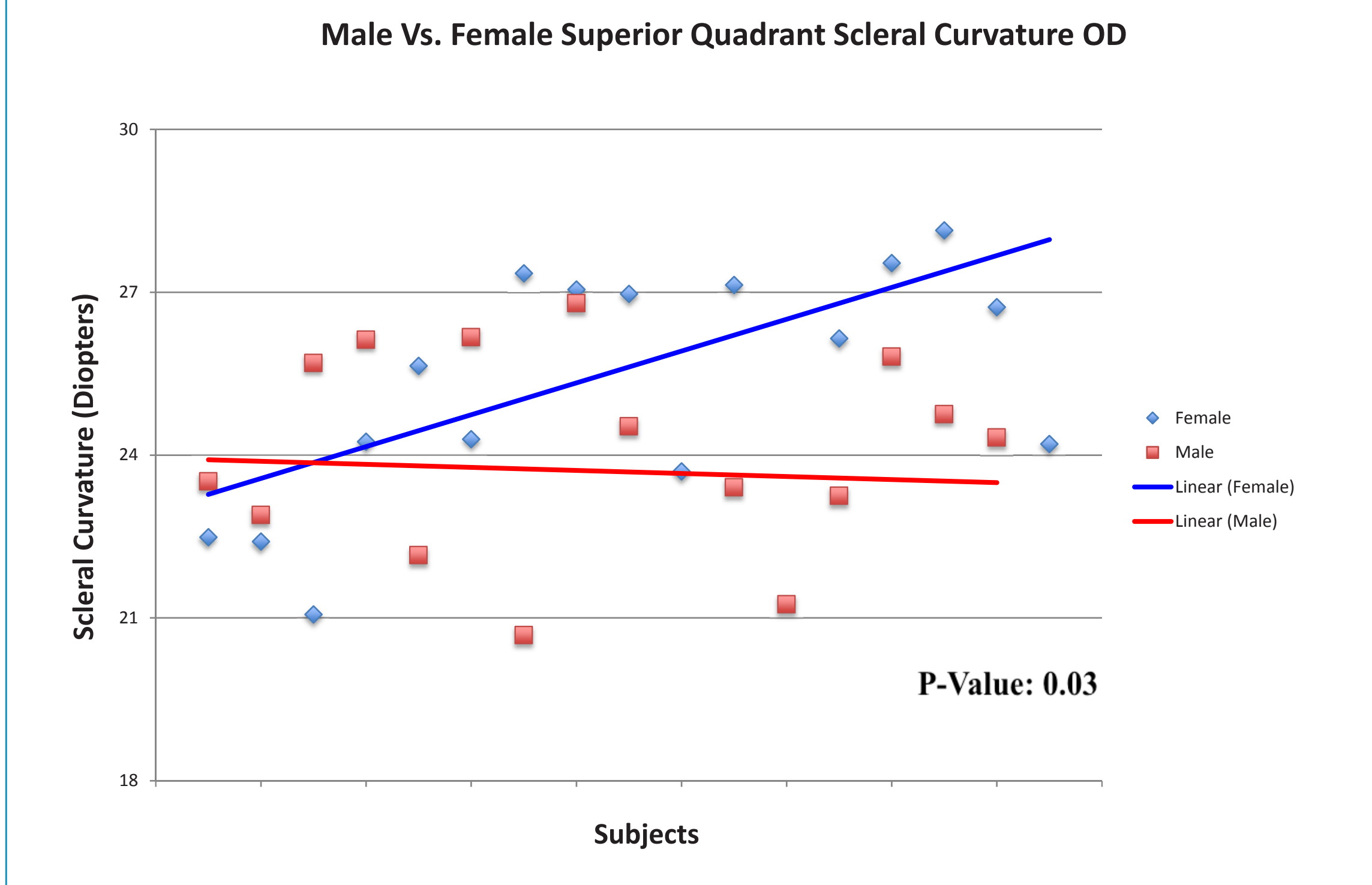


FIGURE 6

We found that women had steeper superior scleral curvature than men



We did find a statistically significant difference for the superior quadrant when comparing Indians and Asians; Asians are flatter in the superior quadrant. In previous studies most compared Asians to Caucasians; with significant findings of a more prolate shape in Asian eyes, our study saw no statistical significance when comparing Asians to Caucasians.

The range of a mean radius of curvature of the cornea in a normal population tends to vary between 7.8 ± 0.25 mm (42.93D - 44.70D); our subjects had an average of 44.27D in the right eye and 44.07D in the left, and thus the population used fits in the range of normal classified in previous research.

CONCLUSION

In conclusion, only temporal curvature between the right and left eyes, the superior quadrant of Asians compared to Indians, and the superior quadrant of men compared to women showed significant differences. Our results support previous studies suggesting differences in curvature/ elevation between the two eyes and the quadrants. Additionally, there are minor racial variances in scleral shape. These results support the recent development of lens designs that are eye specific and designed with these racial differences in mind.

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