



# Vertical Globe Position in Patients with Thyroid Eye Disease and Intraconal Tumors

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## ABSTRACT

Patients with phenotypically severe thyroid eye disease have been shown to be absent from work four to five times more frequently than asymptomatic or less severely affected patients due to the functional and aesthetic toll of the disease. [1] Our study compared pre- and post-operative measurements of globe position, interpupillary distance, proptosis, and exophthalmos between a normal control population and patients with thyroid eye disease or an intraconal tumor to determine if orbital surgery affects vertical globe position. 269 patients met our imaging criteria and were used in our linear regression and Pearson correlation analyses. Results demonstrated a significantly lower globe position in patients with thyroid eye disease compared to the control populace. Upon expanding the sample size and weighing the type of decompression surgery performed, we will determine if the trend of hypoglobus in thyroid eye disease and intraconal tumor patients is significant.

## PURPOSE

To determine if vertical globe displacement exists in patients with thyroid eye disease (TED) and intraconal tumors (ICT) relative to normal controls and evaluate whether surgery improves vertical globe position in patients with TED and ICT.

## BACKGROUND

Thyroid eye disease (TED) is characterized by a wide, variable array of disfiguring changes in the periocular area. Peri-orbital changes have significant effects on patient self-perception and lifestyle. [2, 3] Although axial proptosis and widened interpupillary distance (IPD) in TED patients have been described, changes in vertical position of the eye are not well-characterized. These changes may affect relative upper and lower eyelid positions, contributing to overall aesthetic disfigurement. This study seeks to determine the extent of vertical globe displacement in TED patients relative to non-TED and intraconal tumor (ICT) patients and determine the effect of surgery on vertical globe displacement in TED and ICT patients.

## METHODS

In this case-control study, we queried a patient clinical database for TED clinical diagnoses. Conditions that may modify orbital anatomy were excluded (i.e., neuromuscular disease and non-TED related orbital disease). Comparison groups were drawn from separate anonymized databases consisting of patients with (1) ptosis, (2) normal controls, and (3) ICT (**Table 1**). Vertical position and IPD were measured from photographs and exophthalmos was measured clinically. Primary outcomes were vertical globe position (measured from a line drawn between lateral canthi in each group relative to normal controls) (**Figure 1**) and vertical globe position change in TED and ICT patients who underwent orbital surgery. Secondary outcomes included the relationship between vertical globe position and both exophthalmos and IPD.

	TED	Controls	ICT
Number	171	61	37
Female (%)	137 (80.1)	41 (67.2)	22 (59.5)
Not East Asian (%)	150 (87.8)	48 (78.7)	28 (75.7)
Mean age (SD)	47.7 (14.1)	47.9 (17.5)	48.7 (17.6)
Mean vertical globe position mm (SD)	1.6 (1.4)	2.2 (1.1)	2.2 (1.0)
Mean IPD mm (SD)	62.5 (4.4)	59.6 (3.4)	62.2 (4.7)
Mean proptosis mm (SD) <sup>1</sup>	24.2 (3.3)	--	20.9 (4.5)

<sup>1</sup> Exophthalmometry was not performed on controls.

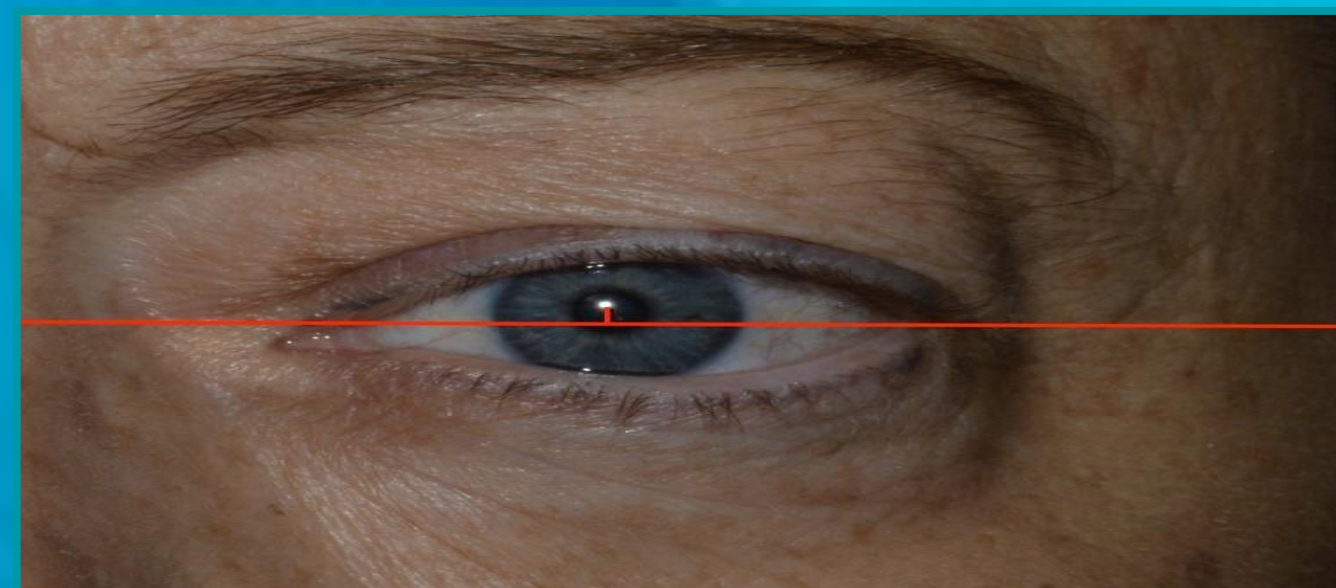
**Table 1.** Baseline demographic characteristics, vertical globe position, IPD, and proptosis measurements in patients with TED, ICT, and normal controls.

## RESULTS

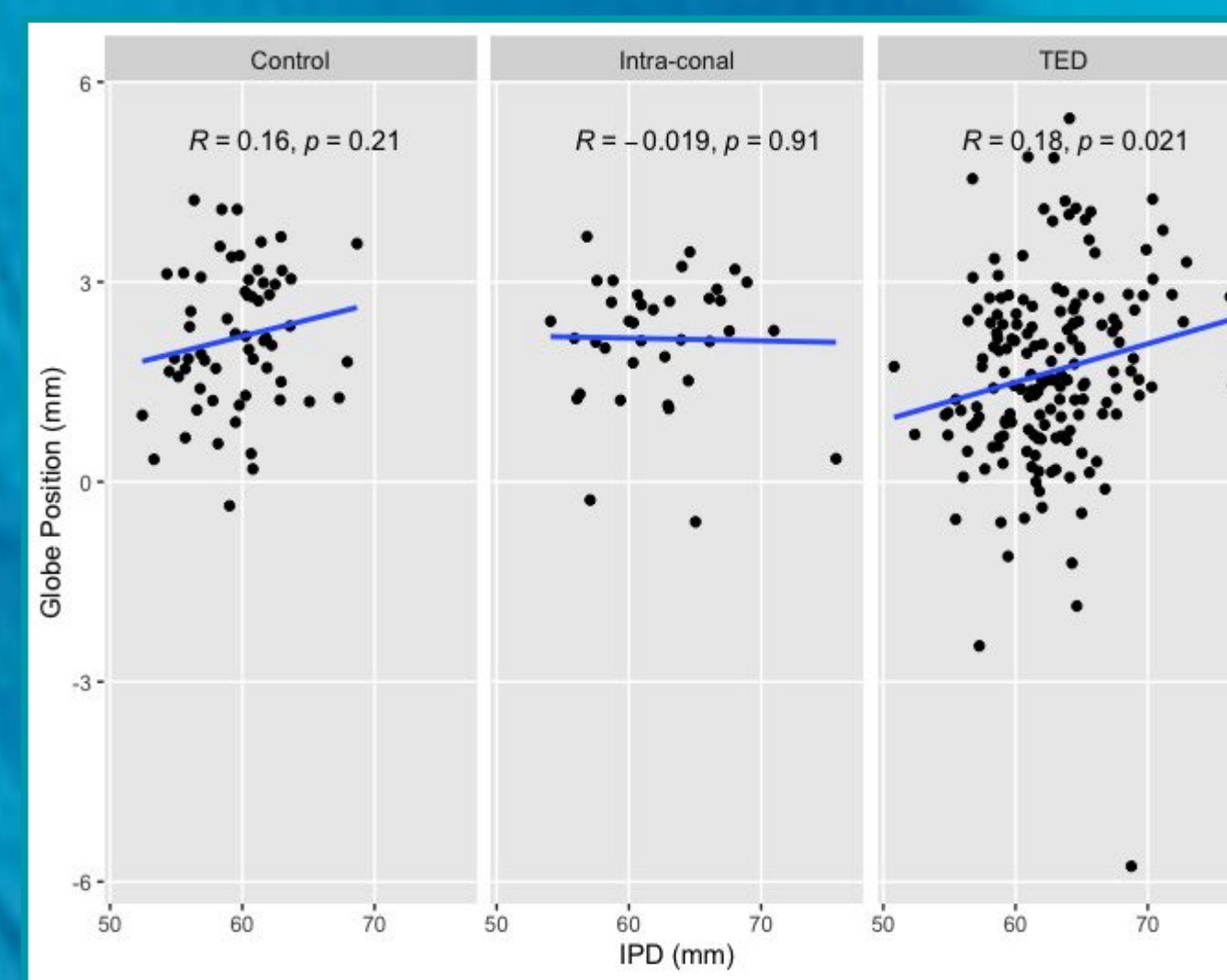
	Mean (SD) Vertical Globe Position	p-value <sup>2</sup>
<b>Overall</b>		
Controls (n=61)	2.2 (1.1)	Ref.
TED (n=141)	1.6 (1.4)	0.012
ICT (n=37)	2.2 (1.0)	0.899
<b>Non-East Asian</b>		
Controls (n=48)	2.2 (1.1)	Ref.
TED (n=124)	1.8 (1.3)	0.038
ICT (n=28)	2.2 (0.8)	0.872
<b>East Asian</b>		
Controls (n=13)	1.9 (0.8)	Ref.
TED (n=17)	0.7 (1.9)	0.084
ICT (n=9)	2.0 (0.8)	0.650

<sup>2</sup> Determined using linear regression models adjusted for age, sex, ethnicity.

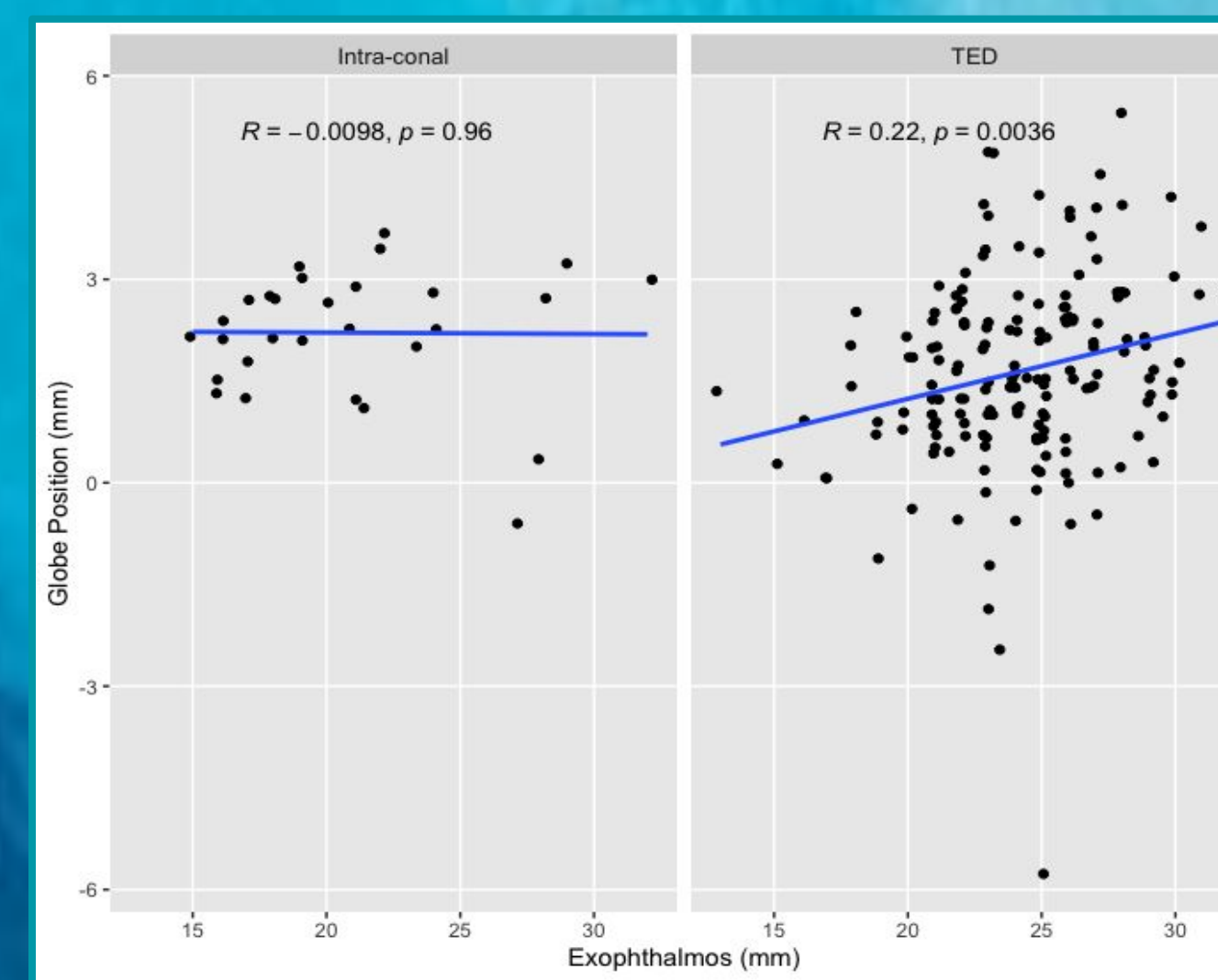
**Table 2.** Globe position in all individuals overall and among East Asians and non-East Asians.



**Figure 1.** Photograph demonstrating measurement technique used to determine vertical globe position. Patient pre- and post-operative photos were measured using the free image processing tool, ImageJ, provided by the National Institute of Health (NIH).



**Figure 2.** Globe position plotted against intra-pupillary distance (IPD) for TED, ICT, or normal control patients. Each point represents an individual eye, the text at the top of each plot represents the Pearson correlation coefficient and its associated p-value, the blue line represents a simple line of best fit through the points.



**Figure 3.** Globe position plotted against exophthalmos for TED and ICT patients. Each point represents an individual eye, the text at the top of each plot represents the Pearson correlation coefficient and its associated p-value, the blue line represents a simple line of best fit through the points.

	Mean (SD) preop globe position (mm)	Mean (SD) postop globe position (mm)	Mean (SD) change in globe position (mm)	P-value (paired t-test)
<b>TED</b>				
Overall (n=79 eyes)	1.64 (1.49)	1.40 (1.34)	-0.24 (1.87)	0.264
Non-East Asian (n=70)	1.76 (1.24)	1.32 (1.21)	-0.44 (1.14)	0.014
East Asian (n=9)	0.67 (2.68)	2.03 (2.11)	1.36 (4.41)	0.381
<b>ICT</b>				
Overall (n=36)	2.12 (0.96)	2.25 (0.97)	0.13 (1.09)	0.479
Non-East Asian (n=27)	2.15 (1.00)	2.31 (0.98)	0.16 (1.18)	0.490
East Asian (n=9)	2.02 (0.84)	2.06 (0.95)	0.04 (0.80)	0.881

**Table 3.** Mean pre- and post-operative vertical globe position in thyroid eye disease (TED) and intraconal tumor (ICT) patients overall and stratified by race.

## DISCUSSION

Vertical globe position in patients affected by TED was significantly lower compared to control participants. This pattern held true in the non-East Asian subgroup but did not reach predetermined statistical significance in the East Asian group. These differences remained significant after controlling for race, age, and sex (**Table 2**). Additionally, our results confirm previous reports in that patients affected by TED demonstrated wider interpupillary distance and greater axial proptosis. [1, 4] Pearson correlation revealed a significant positive correlation between vertical globe position and IPD for participants with TED, but not those with ICT or normal controls (**Figure 2**). TED patients exhibited a significant positive correlation between exophthalmos and vertical globe position, but this was not observed in participants with ICT (**Figure 3**).

115 individuals underwent orbital surgery and met inclusion criteria for the analysis on change in vertical globe position after surgery. 79 were TED patients with a mean age of 46.7 (SD 12.6), 55 (69.6%) of whom were female and 9 (11.4%) were East Asian. The remaining 36 were ICT patients with a mean age of 48.7 (SD 17.8), 21 (58.3%) of whom were female, and none were East Asian. Of these 36 individuals, 23 (63.9%) had hemangiomas, 9 (25%) had solitary fibrous tumors, and 4 (11.1%) had schwannomas.

The results of paired t-tests comparing pre- and post-operative vertical globe position in patients with TED and ICT are summarized in **Table 3**. Globe position for TED patients did not change significantly after decompression surgery. This held true for East Asian participants, but non-East Asian participants had a significantly lower globe position after decompression surgery (**Table 3**). Pre- and post-operative globe positions were not significantly different for ICT patients overall or when stratified by race.

Analysis of the coefficients examining the correlation between change in vertical globe position (i.e., post-operative position minus pre-operative position) and change in IPD and exophthalmos showed no significant correlations between change in vertical globe position and change in IPD in either the ICT or TED groups. Similarly, there was no significant relationship between change in vertical globe position and change in proptosis in the TED group; however, there did appear to be a significant negative relationship between change in vertical globe position and proptosis in the ICT group; i.e., as postoperative globe position increases proptosis becomes less severe.

Limitations of this study include measurement and sizing variability. We measured globe position after standardizing images using an average corneal diameter for men and women, thus may have lost accuracy in our measurements. However, this error should be normally distributed between the test populations, mitigating effects on the differences between the groups as demonstrated. Additionally, while weighing the type of decompression surgery may change the significance of our hypoglobus outcome, we did not test how changes in this axis affected the overall aesthetic outcome of the surgery as defined by patients. Further studies and calculations will be required to understand these dynamics and their implications for decompression surgery. We additionally require more samples to effectively stratify by decompression type in order to assess if surgical strategy may influence globe position or if simple reduction in exophthalmos is sufficient.

## CONCLUSION

TED and ICT patients experience hypoglobus; specifically in the non-East Asian TED group, decompression was significantly associated with increased hypoglobus, while the same was not true in the ICT population. There was no correlation between change in globe position and exophthalmos or IPD among TED patients that underwent surgery. There was, however, a significant negative relationship between change in vertical globe position and proptosis in the ICT group. Lower globe position among TED patients undergoing post-decompression surgery is a postoperative outcome for surgeons to discuss with patients.

## REFERENCES

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