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Determinants of Vitreomacular Traction Width; Associations with Foveal Floor Width and Vitreoretinal Interface Changes

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Keywords:	Vitreomacular traction, Vitreoretinal interface, Foveal floor, Vitreoretinal, Macular Hole, Optical Coherence Tomography

Determinants of Vitreomacular Traction Width; Associations with Foveal Floor Width and Vitreoretinal Interface Changes

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ABSTRACT

Purpose: To investigate the relationship between vitreomacular traction (VMT) width, foveal floor width (FFW), and other anatomical characteristics between eyes of patients with VMT.

Methods: Retrospective observational study of unilateral and bilateral VMT cases from two specialist ophthalmic centres in the United Kingdom (UK) between 2016 and 2018. For unilateral VMT cases: VMT width in the affected eye and FFW in the non-affected fellow eye were measured. In bilateral VMT cases: VMT width in both eyes were measured. In all cases the presence of any associated inner or outer retinal, and vitreoretinal interface (VRI) changes, including epiretinal membrane were also documented.

Results: 88 patients fulfilled the study criteria: 57 having unilateral and 31 bilateral VMT. For unilateral VMT cases log (VMT) width was significantly correlated with FFW ($r=0.347$, $p=0.008$). Using stepwise linear regression FFW ($p=0.004$) and VRI changes ($p=0.03$) were both significantly associated with VMT width with a R^2 of 0.21. In bilateral VMT cases there was strong positive correlation between log (VMT) width ($r=0.88$, $p<0.001$), and the presence of any VRI ($r=0.90$, $p<0.001$) or outer retinal changes ($r=0.50$, $p<0.001$) between the two eyes.

Conclusion: These findings suggest that individual variations in foveal morphology as measured by the FFW, along with the presence of vitreoretinal interface changes, are associated with the extent of VMT width. VMT width, VRI and outer retinal changes were also highly correlated between eyes in bilateral VMT suggesting that individual patient factors, which may be genetic or acquired determine their presence and extent.

Keywords: Vitreomacular Traction, Vitreoretinal Interface, Foveal Floor, Vitreoretinal, Macular Hole, Optical Coherence Tomography.

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INTRODUCTION

Vitreomacular traction (VMT) has been defined as the occurrence of perifoveal vitreous cortex detachment from the retinal surface, with persistent macular attachment within a 3mm radius of the foveal centre. It is associated with distortion of the foveal surface and a variety of subsequent retinal changes (Steel et al. 2016) (Duker et al. 2013), which can include the formation of full thickness macular holes (FTMH) in some cases (Takahashi et al. 2012). Vitreomacular traction without FTMH has been classified into less than 1500µm, and greater than 1500µm in diameter, and described as focal VMT and VMT syndrome, respectively (Bottós et al. 2012).

VMT syndrome is typically associated with widespread intraretinal changes, whilst focal VMT can result in intra and outer retinal changes including macular hole formation (Johnson 2010) (Spaide et al. 2002). In focal VMT it has been observed that the width of VMT relates to angle of vitreous insertion and the degree and type of associated retinal changes (Theodossiadis et al. 2014). The degree of outer retinal disruption in macular holes is also thought to be related to the width of VMT and outer retinal dehiscence (Chung & Byeon 2017).

The width of vitreofoveal adhesion in focal VMT and FTMH would thus appear to be critical to outcome in these diseases (Witkin et al. 2010) but the aetiological reasons for variance in this important parameter are largely unknown.

Typically, most focal VMT has been observed as being around 400-500µm in size which are similar to the dimensions of the foveal floor. Foveal floor width is known to vary widely between individuals but with high inter eye concordance (Tick et al. 2011) (Dubis et al. 2012). We postulated that the width of VMT was related to the foveal floor dimensions and investigated this in cases of unilateral focal VMT. We also studied the correlation of the width of VMT in cases of bilateral disease, and other associated features of the VMT.

MATERIALS AND METHODS

This was a retrospective observational study of patients seen at two specialist ophthalmic centres in the United Kingdom (UK) between January 2016 and January 2018 with a diagnosis of either unilateral or bilateral focal VMT without FTMH.

Inclusion criteria in the unilateral cohort restricted cases to unilateral VMT with a normal fellow eye without VMT, that had not undergone previous treatment in either eye other than cataract surgery greater than 6 months prior to presentation. Patients with myopia greater than 6 dioptres, VMT in association with other macular pathology, and those with other eye macular pathology or inadequate imaging were excluded. The presence of vitreomacular adhesion (VMA) in the fellow eye, with vitreous attachment to the fovea and perifoveal separation, but without any changes in foveal contour or retinal morphology, was allowed.

Inclusion criteria in the bilateral cohort were patients with bilateral focal VMT who had not undergone any previous treatment. Patients with myopia greater than 6 dioptres, VMT in association with other macular pathology and those with inadequate imaging were excluded.

For each included dataset the participant age, gender, phakic status, and imaging modality were recorded.

All participants had undergone imaging using spectral domain optical coherence tomography (SD-OCT) on the Heidelberg Spectralis (Heidelberg, Germany) in one centre (Sunderland Eye Infirmary, Sunderland, UK) and with a Topcon 3D OCT (Topcon, Tokyo, Japan) in the second centre (Moorfield's Eye Hospital, London, UK) as part of their routine care.

Using the Heidelberg Spectralis, a central horizontal scanning protocol with 60-micron line spacing was used in the central 15 degrees. All scans used a 15 automatic real-time setting which enabled multisampling and noise reduction over 15 images. Using the Topcon, a macular volume scan was performed for each eye consisting of 256 horizontal B-scans, centred through the fovea.

Image measurements

On the SD-OCT scans, the VMT width in the affected eye(s) were measured as the maximum width of vitreomacular attachment on the OCT slice with the greatest dimensions as

previously described (figure 1). Any degree of inner retinal change was graded as present and defined as any separation of the inner retinal layers adjacent to the area of VMT. Similarly, any outer retinal change were classified as either present or absent and included the presence of a cotton ball sign, ellipsoid zone disruption, and/or any focal retinal pigment epithelium-retinal separation (Steel, et al. 2016). The presence of any associated vitreoretinal interface (VRI) change was also recorded, with either visible epiretinal membrane (ERM), or a thickened posterior hyaloid face at the area of vitreoretinal (VR) adhesion, being classed as present.

For unilateral cases; in the fellow non affected eye, the foveal floor width (FFW) was measured and defined as the widest distance between the two points at which the outer nuclear layer reached the inner retinal surface on the SD-OCT slice with the widest floor dimensions (figure 1). We also recorded the presence of vitreous attachment or VMA in the fellow eye.

[FIGURE 1]

Two observers performed the measurements with one performing the VMT width measurements and the other the fellow eye measurements in the unilateral dataset, and each performing opposite eye measurements and classification in the bilateral cases, in each case masked to the other’s findings. A third observer masked to results repeated the measurements in a subset of cases to ascertain agreement.

This research project adhered to the tenets of the Declaration of Helsinki. All data and scans were collected as part of routine care and fully anonymised, and as such under UK guidelines the investigation was categorised as service evaluation and did not require ethical approval.

Statistical analysis

Statistical analysis was performed using R (www.r-project.org). Participant demographic characteristics, and pre-operative and post-operative variables are presented as means, standard deviation and minimum and maximum values, or percentage (%) as appropriate. Associations between variables were carried out using chi-squared tests and correlations as appropriate. Linear regression using a stepwise approach was used for assessing the effect of

multiple variables for the outcome VMT width. Log transformation of VMT width was carried out to normalise the data. The repeatability of the FFW and VMT width measurements were tested using intra-class correlation (ICC).

RESULTS

During the study period there were 157 people seen with idiopathic VMT without myopia greater than 6 dioptres. There was missing fellow eye imaging in 14, previous or current FTMH in the fellow eye in 33, broad VMT in 9, and previous surgery in the fellow eye in 13. Of the remaining 88 cases, 57 were unilateral and 31 bilateral.

Unilateral VMT cases

Baseline data for the unilateral cases is shown in table 1.

[TABLE 1]

Log (VMT) width was significantly associated with FFW ($r=0.347$, $p=0.008$) (figure 2). The number of cases where VMT width was greater than FFW was 29/57 (51%). The mean absolute difference between the measures was 160 μm (standard deviation (SD) 146), ranging from 2 to 669 microns.

[FIGURE 2]

Age, gender, laterality and the presence of vitreofoveal adhesion were not associated with VMT width ($p=0.14$, 0.28 , 0.85 and 0.13 respectively). Increasing age was positively associated with the presence of outer retinal changes ($p=0.008$) but there were no other associations of either age or gender.

The presence of VRI change was associated, but not significantly with VMT width ($p=0.07$). The presence of outer and inner retinal changes were not associated with VMT width ($p=0.32$, and 0.62 respectively).

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Using stepwise linear regression FFW ($p=0.004$) and VRI change ($p=0.03$) was significantly associated with VMT width with a R^2 of 0.21, with FFW contributing 13%, and VRI change 7.5% of the association.

Bilateral VMT cases

Baseline data for the 31 bilateral cases in shown in table 2.

[TABLE 2]

There was strong positive correlation between log (VMT) width in the two eyes. ($r=0.88$, $p<0.001$) (figure 3).

[FIGURE 3]

There was an association between the two eyes for the presence of outer retinal changes ($r=0.50$) with 23 of the 31 having the same outer retinal change in both eyes ($p<0.001$). The association was less clear with inner retinal change, $r=0.34$, 21 out of 31 with the same grade ($p=0.12$).

There was a very strong association between the two eyes for the presence of VRI changes ($r=0.90$) with 30 of the 31 having the same VRI changes in both eyes ($p<0.001$).

The ICC for repeat measurements of foveal floor width was 0.84 ($F= 1.07$, $P=0.38$), and for VMT width 0.88 ($F =0.84$, $P=0.67$) indicating moderate-high repeatability, and with no systematic difference between observers.

DISCUSSION

There are wide inter-individual differences in foveal floor width and foveal morphology and it has been postulated before that these may affect an individual's predisposition towards developing retinal diseases and disease severity (Asefzadeh et al. 2007) (Kashani et al. 2010) (Kelty et al. 2008) (Wagner-Schuman et al. 2011). However, foveal morphology between fellow eyes in an individual are highly symmetrical and therefore inferences about one eye can be made using properties of the fellow eye (Wagner-Schuman et al. 2011) (Bradley et al. 1992) (El-Ashry et al. 2008) (Tick et al. 2011). We chose to measure FFW as a measure of the foveal floor. It is closely associated with foveal avascular zone (FAZ) diameter which has been shown to be significantly associated with foveal morphology (Chui et al. 2014) (Chui et al. 2012) (Dubis et al. 2012) (Tick et al. 2011).

We found a moderate but significant association of VMT width with FFW in the unilateral cases suggesting that foveal anatomy is an important factor in determining VMT width. The finding that VMT width was highly correlated between the eyes in bilateral cases also concurs with this. Kish et al reported that there are residual remnants of vitreous cortex present on otherwise normal post-mortem retinas concentrated at 500 and 1500-microns diameters from the foveal centre. This corresponds to the typical widths of VMT observed and to the width of the foveal floor, suggesting that even in normal eyes, this area has some heightened vitreoretinal adhesion mechanism. Laminin and fibronectin are thought to be important molecules in maintaining adhesion between the vitreous and the internal limiting membrane (ILM) but the individual determinants that result in VMT rather than spontaneous vitreous release as occurs in normal ageing are uncertain. The ILM is known to be very thin at the foveal centre and then gradually thickens reaching a maximum thickness at approximately 1000-1500 microns from the foveal centre. It has been noted that there is an electron dense zone of the parafoveal ILM on its vitreous side that is not present at the fovea, and also small electron dense blobs on the surface which may represents zones of higher VR adhesion, although they may simply represent areas of condensed vitreous remnants (Syrbe et al. 2018). These features may explain the mechanism for higher VR adhesion in the foveal floor and immediately adjacent areas of the ILM. It is interesting however that the width of VMT was actually less than the FFW in ~50% of the cases, suggesting that increased adhesion occurs

into the foveal floor area rather than just the parafovea. It is also thought that the presence of epiretinal membrane affects the strength and therefore width of VMT observed. We found a positive correlation between observable VRI changes and the width of VMT, confirming this hypothesis.

The width of VMT is important in its effects on the retina. Narrower widths of VMT are typically associated with higher angles of vitreous insertion and it has been noted that VMT with a higher vitreous insertion angle is associated with a greater risk of outer retinal changes compared to lower angles which are associated with more inner retinal changes. Spaide et al showed that a narrower vitreous attachment width is associated with a higher risk of FTMH formation in fellow eyes of FTMH (Spaide et al. 2002). It has also been observed that FTMH with higher vitreous insertion angles are associated with greater base dimensions and a lesser degree of visual recovery after surgery (Tsai et al. 2017). Furthermore, Chung and Byeon (Chung & Byeon 2017) hypothesised that there are two types of macular hole based on the zone of vitreofoveal adhesion, and the resultant degree of outer retinal tissue disruption, partly explaining differences in outcome. As we have observed half of the unilateral VMT cases measured less, and half more than the fellow eye FFW measurements and this may be important aetiologically in how much tissue disruption develops if macular hole formation occurs. Foveal floor width has also previously been found to be associated with FTMH size, and it could be hypothesised from our findings that a mismatch between VMT width and FFW could results in variable amounts of outer retinal disruption (Shin et al. 2015). Further prospective studies are needed in this regard.

It is interesting to note the high degree of inter-eye correlation we found in the bilateral VMT cases. This extended to both the VMT width as well as the VRI and outer retinal changes observed. This suggests that both anatomical and biological characteristics of an individual are highly important as to the extent and effect of the VMT, which are presumably related to genetic and possibly environmental factors. Interestingly gender and age were not systematically associated with width, interface or any retinal changes which might have been expected. Previous studies have shown males have significantly greater foveal and macular thickness compared to females on OCT (Adhi et al. 2012) (Gella et al. 2015) (Song et al. 2010)

(Wagner-Schuman et al. 2011) (Wong et al. 2005) and also shown to have larger deep and superficial foveal avascular zones on OCTA (Ghassemi et al. 2017). It may have been predicted that due to differing macular thickness between sexes there would be differences in FFW however interestingly others have also found no difference between male and females in foveal morphology despite the differences in thickness (Wagner-Schuman et al. 2011).

The investigation had a number of limitations. The populations studied were selected on the basis of having been seen at both centres with symptomatic VMT and may not be representative of other VMT populations. The patients were predominantly white Caucasian meaning that other ethnicities may have different findings. The imaging measurements were not automated and therefore prone to bias although the FFW and VMT widths were performed by separate investigators. The OCT imaging protocol used meant that we were unable to use *en face* viewing to measure the area of VMT attachment and report horizontal width of attachment only. It is known that vitreous attachment can be non-circular and therefore area of traction is likely to give a more complete assessment than width alone (Paul, et al. 2018). A further limitation of the OCT imaging acquisition was that different machines were used in the two centres which may have affected the accuracy of the results. Due to the observational nature of the study we were unable to investigate the subsequent course of the VMT, the probability of FTMH formation or how the morphological features which we measured impact on future visual prognosis.

In conclusion we found that there was a significant association between VMT width with FFW in the contralateral normal eye in unilateral focal VMT cases. We also found a high inter eye correlation in VMT width, as well as for the presence of VRI changes and outer retinal alterations in bilateral VMT. Our findings suggest that foveal morphology may be an important factor in determining VMT width. Future prospective studies are needed to investigate this further and the relationship with the sequelae of VMT, including macular hole formation and visual outcomes.

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For Peer Review

References

- Adhi, M, S Aziz, K Muhammad, and M Adhi. 2012. "Macular Thickness by Age and Gender in Healthy Eyes Using Spectral Domain Optical Coherence Tomography." *PLoS One* 7 (5): e37638.
- Asefzadeh, B, A A Cavallerano, and B M Fisch. 2007. "Racial Differences in Macular Thickness in Healthy Eyes." *Optom Vis Sci* 84 (10): 941-5.
- Bottós, J, J Elizalde, J F Arevalo, E B Rodrigues, and M Maia. 2012. "Vitreomacular Traction Syndrome." *J Ophthalmic Vis Res* 7 (2): 148-61.
- Bradley, A, R A Applegate, B S Zeffren, and W A Van Heuven. 1992. "Psychophysical measurement of the size and shape of the human foveal avascular zone." *Ophthalmic Physiol Opt* 12 (1): 18-23.
- Chui, T Y, D A VanNasdale, A E Elsner, and S A Burns. 2014. "The Association Between the Foveal Avascular Zone and Retinal Thickness." *Invest Ophthalmol Vis Sci* 55 (10): 6870-7.
- Chui, T Y, Z Zhong, H Song, and S A Burns. 2012. "Foveal Avascular Zone and Its Relationship to Foveal Pit Shape." *Optom Vis Sci* 89 (5): 602-10.
- Chung, H, and S H Byeon. 2017. "New Insights Into the Pathoanatomy of Macular Holes Based on Features of Optical Coherence Tomography." *Surv Ophthalmol* 62 (4): 506-21.
- Dubis, A M, B R Hansen, R F Cooper, J Beringer, A Dubra, and J Carroll. 2012. "Relationship between the Foveal Avascular Zone and Foveal Pit Morphology." *Invest Ophthalmol Vis Sci* 53 (3): 1628-36.
- Duker, J S, P K Kaiser, S Binder, and et al. 2013. "The International Vitreomacular Traction Study Group Classification of Vitreomacular Adhesion, Traction, and Macular Hole." *Ophthalmology* 120 (12): 2611-19.
- El-Ashry, M, V Hegde, P James, and S Pagliarini. 2008. "Analysis of Macular Thickness in British Population Using Optical Coherence Tomography (OCT): An Emphasis on Interocular Symmetry." *Curr Eye Res* 33 (8): 693-9.
- Gella, L, R Raman, and T Sharma. 2015. "Macular Thickness Measurements Using Copernicus Spectral Domain Optical Coherence Tomography." *Saudi J Ophthalmol* 29 (2): 121-5.
- Ghassemi, F, R Mirshahi, F Bazvand, K Fadakar, H Faghihi, and S Sabour. 2017. "The Quantitative Measurements of Vascular Density and Flow Areas of Macula Using Optical Coherence Tomography Angiography in Normal Volunteers." *Ophthalmic Surg Lasers Imaging Retina* 48 (6): 478-86.
- Johnson, M W. 2010. "Posterior Vitreous Detachment: Evolution and Complications of Its Early Stages." *Am J Ophthalmol* 149 (3): 371-82.
- Kashani, A H, I E Zimmer-Galler, S M Shah, L Dustin, D V Do, D Elliott, J A Haller, and Q D Nguyen. 2010. "Retinal Thickness Analysis by Race, Gender, and Age Using Stratus OCT." *Am J Ophthalmol* 149 (3): 496-502.

- Kelty, P J, J F Payne, R H Trivedi, J Kelty, E M Bowie, and B M Burger. 2008. "Macular Thickness Assessment in Healthy Eyes Based on Ethnicity Using Stratus OCT Optical Coherence Tomography." *Invest Ophthalmol Vis Sci* 49 (6): 2668-72.
- Kishi, S, C Demaria, and K Shimizu. 1986. "Vitreous Cortex Remnants at the Fovea After Spontaneous Vitreous Detachment." *Int Ophthalmol* 9 (4): 253-60.
- Paul, C, P Krug, H H Muller, and et al. 2018. "Comparison of the horizontal diameter to a modeled area of traction in eyes with vitreomacular traction: is the diameter close enough to the truth?" *Graefes Arch Clin Exp Ophthalmol* 256 (10): 1817-22.
- Shin, J Y, Y K Chu, and Y T Hong. 2015. "Determination of macular hole size in relation to individual variabilities of fovea morphology." *Eye* 29 (8): 1051-9.
- Song, W K, S C Lee, E S Lee, C Y Kim, and S S Kim. 2010. "Macular Thickness Variations With Sex, Age, and Axial Length in Healthy Subjects: A Spectral Domain-Optical Coherence Tomography Study." *Invest Ophthalmol Vis Sci* 51 (8): 3913-8.
- Spaide, R F, D Wong, Y Fisher, and M Goldbaum. 2002. "Correlation of Vitreous Attachment and Foveal Deformation in Early Macular Hole States." *Am J Ophthalmol* 133 (2): 226-9.
- Steel, D HW, L Downey, K Greiner, H Heimann, T L Jackson, Z Koshy, D AH Laidlaw, L Wickham, and Y Yang. 2016. "The Design and Validation of an Optical Coherence Tomography-Based Classification System for Focal Vitreomacular Traction." *Eye* 30 (2): 314-24.
- Syrbe, S, H Kuhrt, U Gärtner, G Habermann, P Wiedemann, A Bringmann, and A Reichenbach. 2018. "Müller Glial Cells of the Primate Foveola: An Electron Microscopical Study." *Exp Eye Res* 167: 110-117.
- Takahashi, A, A Yoshida, T Nagaoka, and et al. 2012. "Idiopathic Full-Thickness Macular Holes and the Vitreomacular Interface: A High-Resolution Spectral-Domain Optical Coherence Tomography Study." *Am J Ophthalmol* 154 (5): 881-92.
- Theodossiadis, G, P Petrou, M Eleftheriadou, A L Moustakas, I Datseris, and P Theodossiadis. 2014. "Focal vitreomacular traction: a prospective study of the evolution to macular hole: the mathematical approach." *Eye* 28 (12): 1452-60.
- Tick, S, F Rossant, I Ghorbel, A Gaudric, J Sahel, P Chaumet-Riffaud, and M Paques. 2011. "Foveal Shape and Structure in a Normal Population." *Invest Ophthalmol Vis Sci* 52 (8): 5105-10.
- Tsai, C Y, Y T Hsieh, T T Lai, and C M Yang. 2017. "Idiopathic Macular Holes and Direction of Vitreomacular Traction: Structural Changes and Surgical Outcomes." *Eye* 31 (12): 1689-96.
- Wagner-Schuman, M, A M Dubis, R N Nordgren, and et al. 2011. "Race- And Sex-Related Differences in Retinal Thickness and Foveal Pit Morphology." *Invest Ophthalmol Vis Sci* 52 (1): 625-34.
- Witkin, A J, M E Patron, L C Castro, E Reichel, A H Rogers, C R Bauman, and J S Duker. 2010. "Anatomic and Visual Outcomes of Vitrectomy for Vitreomacular Traction Syndrome." *Ophthalmic Surg Lasers Imaging* 41 (4): 425-31.
- Wong, A C, C W Chan, and S P Hui. 2005. "Relationship of Gender, Body Mass Index, and Axial Length With Central Retinal Thickness Using Optical Coherence Tomography." *Eye* 19 (3): 292-7.

Figure Legends

Figure 1: Measurement of vitreomacular traction (VMT) width (left) and foveal floor width (FFW) (right); the widest distance between the two points at which the outer nuclear layer reached the inner retinal surface on the SD-OCT slice with the widest floor dimensions.

Figure 2: Significant correlation between log (VMT width) and FFW in the contralateral eye in patients with unilateral VMT ($r=0.347$, $p=0.008$). FFW: foveal floor width, VMT: vitreomacular traction.

Figure 3: Significant correlation between log (VMT width) between the two eyes in patients with bilateral VMT ($r=0.88$, $p<0.001$). VMT: vitreomacular traction.

Tables

Table 1: Baseline characteristics of unilateral VMT cohort. (SD: standard deviation, VMT: vitreomacular traction, VRI: vitreoretinal interface)

Table 2: Baseline characteristics of bilateral VMT cohort. (SD: standard deviation, VMT: vitreomacular traction, VRI: vitreoretinal interface)

Figure 1: Measurement of vitreomacular traction (VMT) width (left) and foveal floor width (FFW) (right); the widest distance between the two points at which the outer nuclear layer reached the inner retinal surface on the SD-OCT slice with the widest floor dimensions.

338x127mm (200 x 200 DPI)

Figure 2: Significant correlation between log (VMT width) and FFW in the contralateral eye in patients with unilateral VMT ($r=0.347$, $p=0.008$). FFW: foveal floor width, VMT: vitreomacular traction.

Figure 3: Significant correlation between log (VMT width) between the two eyes in patients with bilateral VMT ($r=0.88$, $p<0.001$). VMT: vitreomacular traction.

194x171mm (200 x 200 DPI)

Variables	N=57
Age (years) mean	70.6
SD	9.3
Range	51-94
Gender	Female 44 (77%)
Affected eye mean VMT width (μm)	462
SD	221
Range	160-1276
Fellow eye foveal floor width (μm)	454
SD	139
Range	202 – 825
Presence of vitreous separation from fovea in fellow eye	Separation: 13 (23%) No separation: 27 (47%) Unknown separation: 17 (30%)
Inner retinal changes present	32 (56%)
Outer retinal changes present	31 (54%)
VRI change present	10 (18%)

Variables	N=31
Age (years) mean	73.4
SD	10.3
Range	49-87
Gender	Female 21 (68%)
Right eye	
VMT width (µm) mean	489
SD	228
Range	174-1435
Inner retinal changes present	22 (71%)
Outer retinal changes present	12 (39%)
VRI change present	5 (16%)
Left eye	
VMT width (µm) mean	505
SD	204
Range	154-1327
Inner retinal changes present	21 (68%)
Outer retinal changes present	8 (26%)
VRI change present	6 (19%)