

Influence of Vitreous Traction on AMD

Anomalous posterior vitreous detachment is associated with dry AMD, and vitreomacular attachment with wet AMD.

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The stimuli for choroidal neovascularization (CNV) in age-related macular degeneration (AMD) are not completely defined. However, it has been confirmed that the vitreous plays a role in the pathogenesis of exudative AMD. We have been interested in the relationship between traction from the posterior vitreous and the development of AMD, and we have performed a number of studies exploring that relationship.

Three comparative studies were performed to evaluate the relationship of the posterior vitreous to the macula in AMD. The first evaluated vitreomacular adhesion (VMA) and posterior vitreous detachment (PVD) in eyes with exudative AMD, nonexudative AMD, and age-matched controls.¹ A second study, designed to eliminate potential influences of genetics and environment, compared VMA and PVD in patients with wet AMD in one eye and dry AMD in the fellow eye.² The first two studies were done in collaboration with Jerry Sebag, MD, of the VMR Institute, and Lawrence Yannuzzi, MD, of Vitreous-Retina-Macula Consultants of New York. A third study examined differences in these conditions between active and end-stage AMD.²

In the first study, in a total of 163 eyes, ultrasound revealed a significantly lower percentage of complete PVD in eyes with exudative AMD (17 of 50; 34%), in comparison with eyes with nonexudative AMD (41 of 57; 71.9%) and control eyes (34 of 56; 60.7%). Optical coherence tomography (OCT) showed persistent central VMA surrounded by a detached posterior vitreous cortex in more eyes with exudative AMD (18 of 50; 36%) than in nonexudative AMD (4 of 57; 7%) and control eyes (6 of 56; 10%).

In the second study, in patients with wet AMD in one eye and dry AMD in the other (Figure 1), similar results were seen. Again, VMA was significantly higher in eyes with wet AMD compared with dry AMD, and complete PVD was higher in eyes with dry AMD than wet AMD.

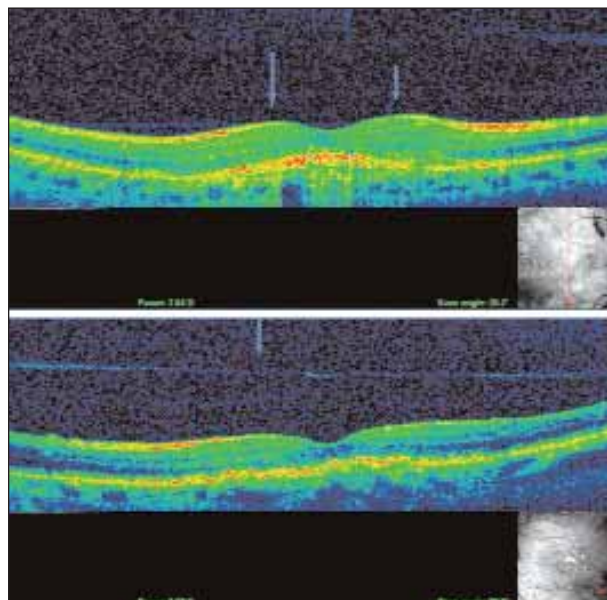


Figure 1. Two eyes of the same patient: (top) Left eye has attached posterior hyaloid and a full PVD; (bottom) right eye has dry drusen and detached posterior hyaloid.

In the third study, examining advanced disease, the difference did not continue to be significant because of an increased incidence of PVD and decreased incidence of VMA in eyes with disciform scars.

Taken together, our conclusion from these studies was that PVD was highly associated with dry AMD, as confirmed by ultrasound, and that a high percentage of eyes with wet AMD have vitreomacular adhesions, with OCT providing useful information about the relationship of vitreous and retina. Genetic and environmental factors did not influence these observations, and the differences did not persist into end-stage disease.

3-D OCT STUDY

Others have suggested that persistent attachment of the posterior vitreous cortex to the macula may be a risk factor for the development of exudative AMD due to chronic low-grade inflammation induced by vitreoretinal traction,³ due to macular exposure to cytokines or free radicals in the vitreous gel,⁴ and/or due to interference with oxygenation and nutrition of the macula from the vitreous.⁵

In light of our own studies and these observations, we formed the hypothesis that vitreomacular traction might play a role in the development of neovascularization, and we sought to examine this hypothesis using high-definition 3-D imaging technologies.

This most recent study was designed to examine tractional forces in the development of exudative AMD. We wanted to determine whether spectral domain high-definition OCT, with its higher resolution, faster scan acquisition, and raster scanning capability, could contribute additional information about the localization and direction of vitreomacular traction.

We examined a consecutive series of patients, who presented with different types and stages of exudative AMD and vitreoretinal adhesions, using a 3-D display system that allowed enhanced visualization of subtle structures of the vitreoretinal interface.⁶ Eyes were imaged with the macular cube 512x128 program of the Cirrus HD OCT (Carl Zeiss Meditec, Jena, Germany) and with the high speed mode of the Spectralis OCT (Heidelberg Engineering, Heidelberg, Germany), oversampled twice, and with a single high-resolution line placed through the center of the lesion. Visualization was further improved by ray-traced 3-D reconstruction using a custom-made subprogram in the Cinema 4D XL 11.0 software program (Maxon Computer, Friedrichsdorf, Germany). A pseudo-segmentation algorithm was implemented using noise-reduction filtering and a stepped color gradient. Finally, the ray-traced shading was backed directly into the texture, resulting in real-time visualization using OpenGL.

Using this system, 25 eyes of 20 patients, mean age 76.6 years, were examined. Most of the patients (62%) were under treatment with vascular endothelial growth factor (VEGF)-inhibiting therapy; 38% were treatment-naïve.

Vitreomacular adhesions surrounded by shallow detachment of the posterior hyaloid were localized in the fovea in 52.4% and were juxtafoveal in 47.6% of eyes. In 93% of the juxtafoveal lesions, a retinal angiomatous proliferation (RAP) was present.

The area of the adhesion in each eye corresponded with localization of a "hot spot" shown in that eye's indocyanine green angiography, even if the lesion extended under the foveal avascular zone. Overall, the area of

adhesion corresponded in 100% of eyes with the localization of the CNV.

In 72% of eyes, traction of the posterior hyaloid on the retina was visible, and the traction forces were directed toward the CNV, which could be visualized in the 3-D images. Tight adhesion and traction could also be detected on the temporal margins of the optic disc. Adhesions and traction forces were visible with both OCT machines.

CONCLUSIONS

Using 3-D spectral domain OCT technology from two manufacturers with this image-enhancement system, we were able to gain further insights into the precise location of VMAs, the direction of traction, and the forces of the vitreous, as well as the development of CNV. Visualization of the tractions and 3-D post-processing were possible in real time regardless of the spectral domain OCT hardware used.

Further studies will be required to confirm interesting aspects of the current study, such as the high incidence of RAP lesions associated with vitreoretinal traction, traction on the margin of the optic disc, and persistence of adhesions during anti-VEGF therapy. Subsidiary pharmacologic vitreolysis or sutureless, non-vitreotomizing posterior-hyaloid-lifting surgery might be potential avenues to improve the treatment of exudative AMD. ■

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