Evaluation of vitreo-macular interface in diabetic macular edema with serous macular detachment (Spectral-domain OCT study)

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Abstract: Purpose: To evaluate the effect of vitreo macular interface changes on serous macular detachment in diabetic macular edema (whether spongy-like or cystoid). **Methods:** This study involved 281 eyes with diabetic macular edema and serous macular detachment. Complete ophthalmic examination, fundus fluorescein angiography (FFA) and optical coherence tomography (OCT) were done. Heidelberg Spectralis OCT was used to examine all eyes and scans were done on horizontal, vertical and twelve radial planes through the centre of the fovea. The height of serous macular detachment was measured with a caliper in all eyes & the state of vitreo macular interface was reported. ***Results:*** Of the 281 eyes with diabetic macular edema & serous macular detachment (SMD), spongy-like DME was reported in 213eyes (75.8%) and cystoid DME in 68 eyes (24.2%). With Spectralis OCT, serous macular detachment was shown as neuro-sensory retinal elevation over non-reflective cavity with minimal shadowing of the underlying structures. The height of serous macular detachment was measured with a caliper & the state of vitreo macular interface was reported. ***Conclusions :***Spectral domain optical coherence tomography plays a major role in the diagnosis of DME with SMD & provides detailed description of the associated vitreo macular interface changes. In our reported cases vitreo macular interface changes did not play a major role in the pathogenesis of SMD with DME as 68.33% with DME & SMD had no VM interface tractional changes. Further study on a larger number of cases is recommended to determine the role of vitreomacular interface changes in the development of SMD in eyes with DME.

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1. Introduction

Diabetic macular edema (DME) is a well documented, sight threatening complication of diabetes. It can cause structural retinal changes severe enough to make it the most common cause of visual loss in patients with diabetes **(Kim *et al.*, 2006 & *Massin et al., 2006).***

Previously described methods of assessing DME include contact and noncontact slit-lamp biomicroscopy, indirect funduscopy, fluorescein angiography, and fundus stereo photography **(Kim *et al.*, 2006).**

Today optical coherence tomography (OCT) has become a standard diagnostic technique for macular diseases. The currently increased resolution and improved image quality have enhanced its significance for macular diagnostics ***(Hassenstein & Meyer, 2009).***

OCT provides high-resolution cross sectional images of macular pathology *in vivo*. Owing to its noninvasive noncontact nature and use of near-infrared illumination of the fundus, it is well tolerated by patients **(Voo *et al.*, 2004).**

OCT also provides *in vivo* examination of the vitreous & gives good information about the vitreo retinal interface **(Dubey *et al.*, 2008).**

Spectral-domain OCT (SD-OCT) major advantages are the higher imaging speed and sensitivity, as well as the possibility of three-dimensional (3D) reconstruction of retina and the overlying vitreoretinal interface **(Koleva-Georgieva & Sivkova, 2009).**

On OCT, diffuse retinal thickening is usually defined as sponge-like swelling of the retina with a generalized, heterogeneous, mild hypo-reflectivity compared with normal retina. Cystoid macular edema was identified by the presence of intraretinal, round or oval cystoid areas of low reflectivity, which were typically separated by highly reflective septae. Serous retinal detachments were defined on OCT as a focal, arch-like elevation of neurosensory retina overlying a hypo- reflective, dome-shaped space ***(Baskin, 2010).***

The pathogenesis of SMD associated with DME is linked not only to an abnormality of the draining vascular system but also to impairment in the function of the RPE **(Turgut *et al.*, 2010).**

Diabetes indeed leads to early aging of the vitreous; migration of glial and epithelial cells has been found in the posterior hyaloid of diabetic patients and may contribute to an abnormal vitreomacular adherence. The role of the vitreomacular junction in the development of DME is still controversial **(Gaucher *et al.*, 2005)**

Posterior vitreous detachment (PVD) may induce several potentially serious pathologic events at the vitreoretinal interface **(Koleva-Georgieva & Sivkova, 2009).**

PVD is characterized by the separation of the vitreous from the posterior retina. The PVD process may be either complete or partial. Vitreo-macular traction (VMT) results from incomplete posterior vitreous detachment, with remaining adherence at the macula ***(Shechtman and Dunbar, 2009).***

We conducted this study to evaluate the vitreo-macular interface abnormalities in eyes with diabetic macular edema and serous macular detachment (DME&SMD) and to study if this has a role in SMD with DME.

2. Methods

This was a retrospective observational case series study where 281 eyes of diabetic patients were examined by OCT. Only patients with diabetic intra-retinal edema and serous macular detachment were included in the study.

Inclusion criteria included; (1) Absence of systemic hypertension and renal disease. (2) Eyes with clinical & angiographically confirmed diabetic macular edema. (3) SMD diagnosed with OCT. (4) Clarity of optical media to enable detailed fundus imaging. (5) Eyes with history of ocular trauma, previous intraocular surgery or laser treatment, previous intravitreal injections or vitreoretinal pathology other than diabetic retinopathy were excluded.

The Spectralis spectral domain OCT (Heidelberg Engineering, Heidelberg, Germany) was used, providing high-speed high-resolution spectral-OCT imaging & a vitreous viewing mode which is an option in the software allows better visualization of the vitreous and the vitreal-retinal interface. --%Spectral domain optical coherence tomography was used to detect type of DME, presence of SMD & to evaluate the vitreo-macular interface. Scans were done on horizontal multiple line scans, vertical multiple line scans and twelve radial line scans through the centre of the fovea & the vitreous viewing mode was used to evaluate the vitreo-macular relationships. The retinal thickness at the center of the fovea was measured on the OCT image directly using the built-in measurement function of the Spectralis OCT software. The height of the serous macular detachment was measured with a caliber on the scan.

Statistical analysis was performed using commercial software package (SPSS Inc., version 11.5; SPSS, Chicago, IL). Data were expressed in percentage, mean and standard deviation.

3. Results:

With Spectralis OCT, 281 eyes with DME & SMD were evaluated. The presence of SMD failed to be recognized by slit lamp biomicroscopy with a + 90 diopter noncontact lens or fundus fluorescein angiography (FFA) & was detected by means of Heidelberg Spectralis OCT only. All eyes had a detailed examination of the macular area with OCT for evaluation of the state of vitreomacular interface.

OCT findings included;

The sponge-like DME appeared as diffuse increase of the retinal thickness within the macular area with spongy appearance of the intermediate retinal layers with small rounded hypo-reflective spaces.

- Cystoid DME appeared as increase of the retinal thickness within the macular area with large rounded hypo-reflective spaces involving the central area of the scan.
- SMD appeared as neuro-sensory retinal elevation over non-reflective cavity with minimal shadowing of the underlying structures.
- No VM interface abnormalities; the posterior hyaloid could not be seen as the vitreous was totally still attached to the retina.
- Partial PVD with no traction; thin hypo-reflective line could be seen detached from the underlying retinal surface within the peripheral part of the macular scan but still attached centrally with no pulling effect on the surface.
- Partial PVD with VM traction; thin hypo-reflective line could be seen detached from the underlying retinal surface within the peripheral part of the macular scan but still attached centrally with pulling effect on the macular surface.
- Total PVD; thin hypo-reflective line could be seen totally detached from the underlying retinal surface within whole area of the macular scan.
- Taut posterior hyaloids; thin hyper-reflective line could be seen closely adherent to the underlying retinal surface within the central area of the scan,
- EMM; thin hyper-reflective line could be seen closely adherent to the underlying irregular retinal surface within the central area of the scan.

The DME with SMD reported on OCT examinations included;

The sponge-like in 213eyes (75.8%) with a mean central macular thickness of 504.34 ± 160.87µm.

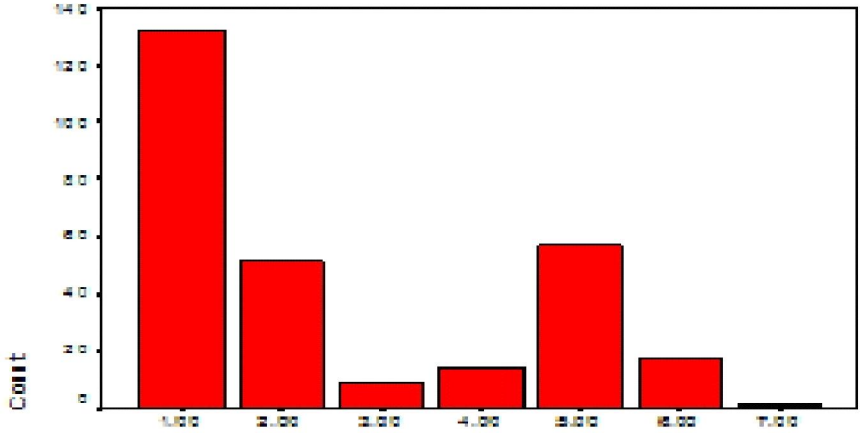
- The cystoid variant in 68 eyes (24.2%) with a mean central macular thickness of 540.31±167.46µm.

The SMD was confined to the foveal area with a mean height of 150.43±100.25 µm.

The vitreo-macular interface findings with SD-OCT were (Diagram 1);

No abnormalities in 132 eyes (46.98%).

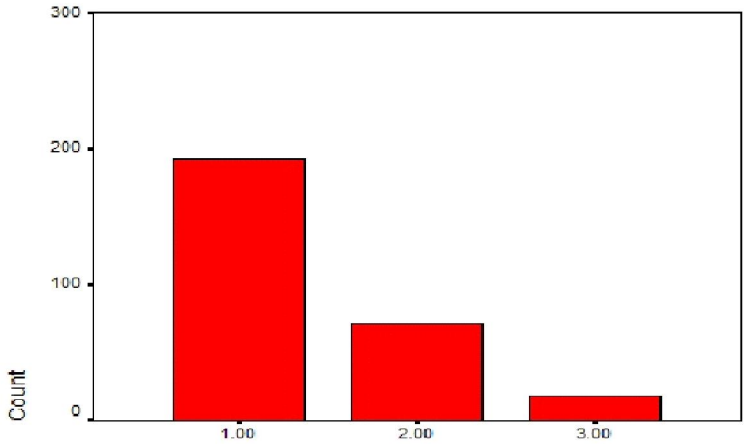
- Partial PVD with no VMT in 51 eyes (18.15%).
- Total PVD in 9 eyes (3.2%).
- Taut posterior hyaloids in 14 eyes (4.98%).
- Epimacular membrane (EMM) with tangential traction in 57 eyes (20.29%)
- Partial PVD with vitreo-macular traction (VMT) in 17 eyes (6.02%).
- EMM with anteroposterior (PA) traction in 1 eye (0.36%).



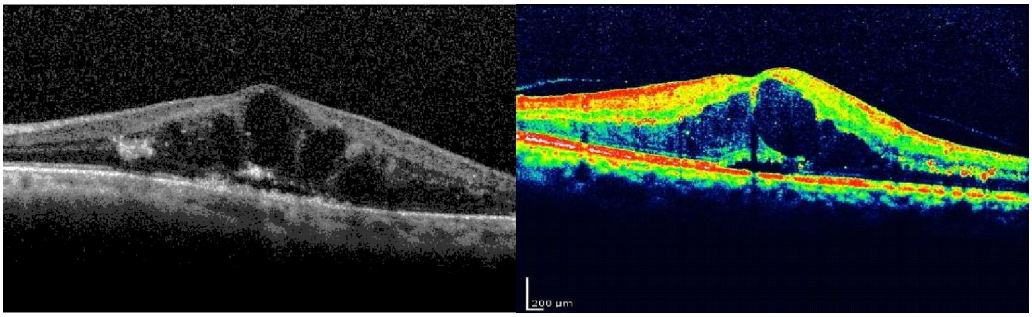
(Diagram.1) Number of eyes with vitreo macular interface findings according to their arrangements above

The vitreo-macular interface findings were categorized according to the presence or absence of traction & the direction of the exerted traction into the following (Diagram 2);

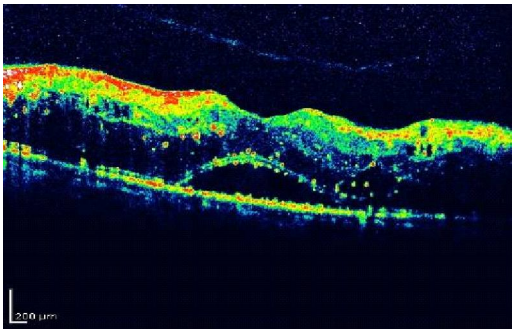
- ***Eyes with no traction (192 eyes of the 281 eyes, 68.33%);*** these included eyes with no vitreo-macular interface abnormalities, eyes with partial PVD with no traction & eyes with total PVD **(Fig. 1)**.
- ***Eyes with tangential traction (71 eyes of the 281 eyes, 25.27%);*** these included eyes with EMM or taut posterior hyaloids with tangential traction **(Fig. 2)**.
- ***Eyes with anteroposterior traction (18 eyes of the 281 eyes, 6.40%);*** these included eyes with partial PVD with vitreo-macular traction (VMT) & eyes with EMM with anteroposterior traction **(Fig. 3)**.



(Diagram. 2) Number of eyes in each VMI categories according to the presence or absence of traction according to their arrangement above

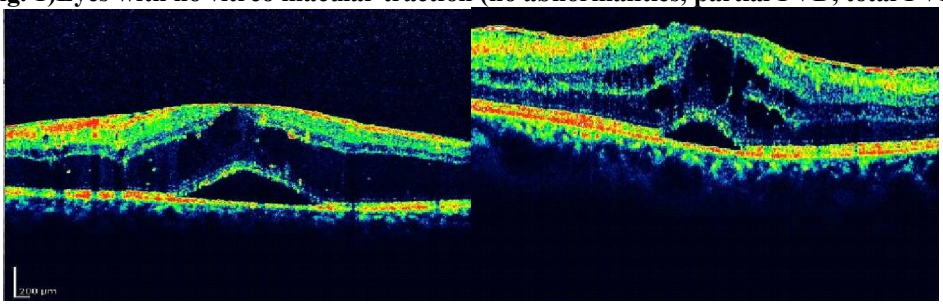


No VM interface abnormalities **Partial PVD without VMT**



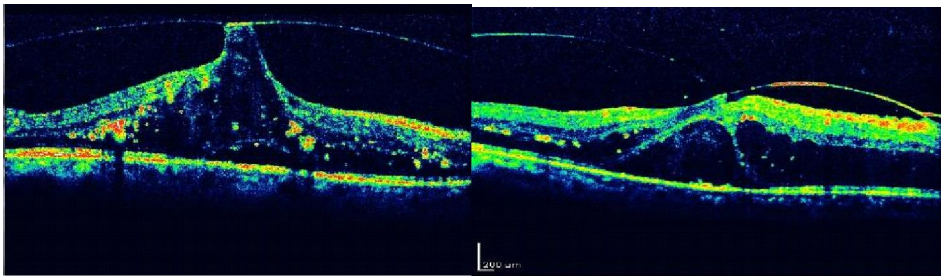
Total PVD

(Fig. 1)Eyes with no vitreo macular traction (no abnormalities, partial PVD, total PVD)



Taut posterior hyaloids **EMM with tangential traction**

(Fig. 2) Eyes with tangential traction (taut posterior hyaloids & EMM)



a ***b***

(Fig. 3) Eyes with VM anteroposterior traction (a. Partial PVD with VMT & b. EMM)

4.Discussion

Although the pathophysiology of DME is complex and multi-factorial, the vitreous had been suggested to play a pathogenic role in some eyes **(Johnson, 2005).** The role of the vitreous in the development of DME remains controversial. However, it is well established that DME may be exacerbated by the vitreomacular traction effects of partial vitreous detachment **(Johnson, 2009).**

Structural changes at the vitreoretinal interface promote migration and proliferation of vasogenic cells in the vitreous, consequent contraction can produce vitreous hemorrhage and macular edema **(Dubey et al., 2008).**

The interface between the retina and vitreous is well defined because of the difference in reflectivity of the relatively a cellular vitreous and the parallel-fiber orientation of the inner retina **(Voo et al., 2004).**

Evidence for a vitreous origin of development and exacerbation of diabetic macular edema arises from several clinical studies. The prevalence of posterior vitreous detachment (PVD) in patients with diabetic macular edema is significantly lower than in diabetic patients without macular edema, and vitreo-macular separation can cause spontaneous resolution of diabetic macular edema **(Gandorfer et al.,2005).**

Traction on macula can be induced from a partially detached posterior hyaloid or a contracting epiretinal membrane **(Koleva-Georgieva & Sivkova, 2009).**

Vitreoschisis and the presence of a thickened posterior cortical vitreous have been considered to play a key role in disease progression not only in terms of neovascularization but also in terms of diabetic macular edema, and removal of the cortical vitreous has been suggested as one treatment option for DME **(Gandorfer et al., 2005).**

In the current study, we evaluated the vitreo-macular interface findings in eyes with DME & SMD. The presence or absence of any tractional forces on the macular surface was recorded in addition to evaluation of the direction of tractional forces whether tangential or antro-posterior. According to the data obtained from the examined eyes, we found that eyes with no vitreo-macular traction account for 68.33% of the 281 eyes (these included eyes with no vitreo-macular interface abnormalities, eyes with partial PVD with no traction & eyes with total PVD), while eyes with tangential traction account for 25.27% (these included eyes with EMM or taut posterior hyaloids with tangential traction) and finally eyes with anteroposterior traction had a 6.40 %(these included eyes with partial PVD with VMT & eyes with EMM with anteroposterior traction). We excluded eyes with previous intravitral injections, laser or eye surgeries, ocular trauma to avoid any causes could participate in vitreal or VMI changes.

Koleva-Georgieva & Sivkova, 2009, assessed macular traction by evaluating the presence and strength of traction both from partially detached posterior hyaloid and epiretinal membranes in the 9 eyes with SMD in their series of 79 eyes with DME. They stated that macular traction was: absent in three eyes, questionable (without distortion of retinal contour from partial posterior vitreous detachment and/or epiretinal membrane) in three eyes, and definite (with distortion of retinal contour) in three eyes.

Ozdemir et al., 2005 studied serous macular detachment in diabetic cystoid macular oedema in 78 eyes. They excluded eyes with epiretinal membrane or vitreo-macular traction from their study. So, according to their series, VM traction could not be a driving force in the development of SMD.

Kaiser et al., 2001, analyzed nine eyes with DME and traction from a thickened, taut posterior hyaloid. In eight of these nine eyes they detected a shallow macular detachment by OCT & concluded that this macular detachment was due to posterior hyaloid traction.

In the current study, we found that 68.33% with DME and SMD had no VM interface tractional changes & so, in our examined eyes vitreo macular interface changes did not play a major role in the pathogenesis of SMD with DME in these eyes.

Conclusions

Spectral domain optical coherence tomography plays a major role in the diagnosis of DME with SMD & provides detailed description of the associated vitreo macular interface changes. In our reported data, vitreo macular interface changes did not play a major role in the pathogenesis of SMD with DME as 68.33% with DME & SMD had no VM interface tractional changes. Further study on a larger number of cases is recommended to determine the role of vitreomacular interface changes in the development of SMD in eyes with DME.

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