Full-Field 3-D Optical Coherence Tomography Imaging and Treatment Decision in Diffuse Diabetic Macular Edema

I read with great interest the article by Liu et al. on the comparison of time-domain (TD) and spectral-domain (SD) optical coherence tomography (OCT) on the treatment decision-making in the management of diabetic macular edema (DME) by repeat anti-VEGF medications. The authors find that SD-OCT does not appear to change the ultimate treatment decision or increase the level of certainty of the retina specialist relative to TD-OCT in most cases of DME. They add that further studies are needed to identify specific clinical factors that may be associated with a different treatment decision.

We described previously the subject on extrafoveal vitreous traction associated with the diffuse type of DME; that is, DDMF.3,5 That diagnosis (Figs. A–D; Supplementary Video S1) could be made plainly by the aid of full-field 3-D SD-OCT images (Topcon 1000; Topcon Corporation, Tokyo, Japan).5 Sole extrafoveal vitreous traction (without accompanying vitreofoveal traction) associated with DDMF, either at the macula or its vicinity and/or at the optic nerve head (ONH), was detected in 34.5% of DME eyes (20/58), and additional extrafoveal traction membranes were detected in conjunction with vitreofoveal traction ones.3 Such diagnoses improved our treatment decision-making and outcome.

The OCT scan line would detect vitreous traction or adherence site(s) at the fovea (i.e., vitreofoveal) or at an extrafoveal site, either vitreoretinal or vitreopapillary, only if the tissues adhere at the interface site that the scan line crosses. However, as for the automatic central 6-radial lines OCT program, the distance between two adjacent scan lines at a location just 2 mm, for example, from the fovea is >1 mm, or >1000 μ(2π × radius/12 = 2 × 3.14 × 2 mm/12; the circumference equation), and >500 μ as close as 1 mm from the center. Therefore, any extrafoveal traction site located within the wide non-scanned areas using this program would be overlooked, although it often is macular (extrafoveal) and so close (1–3 mm) to the macular center. However, in the current study, scanning by the TD-OCT (Stratus OCT; Carl Zeiss Meditec, Jena, Germany) involved only the 6-radial lines, and the 6-mm vertical and horizontal cross-hairs programs. Furthermore, areas other than this central 6 × 6 mm, including the vitreopapillary site, also were not examined.

In contrast, using TD-OCT 2000, we detected extrafoveal traction membranes, either vitreoretinal or vitreopapillary, in 10.8% (20/186) of DME eyes. That was possible by undertaking a thorough (and timely) search at the skipped areas for such membranes by the aid of the manual “Line group” program.2 If an extrafoveal traction membrane was relatively tangential to the macula (in contrast to a more vertically-oriented one), but the 6-radial scan lines did not cross its contact site(s), a premacular taut posterior hyaloid. The OCT detection of premacular posterior hyaloid membranes, either taut or thinner, was reported later by others,6 but none reported on a search for extrafoveal site of contact of these premacular membranes.

As for the SD-OCT scanning, DME eyes were scanned in the current study by either Cirrus HD-OCT or Spectralis SD-OCT (Heidelberg Engineering GmbH, Heidelberg, Germany).1 In each, scanning was performed by the separate parallel lines, but only local macular cubes (A scans/B scan, 6 × 6 mm), and vertical and horizontal high resolution line scans (A scans/B scan) were obtained. Again, scanning was undertaken only centrally.1 In contrast, we earlier presented relatively high prevalence of extrafoveal traction membranes associated with the DDMF.3 That was achievable by means of the 3-D SD-OCT technique that scans the field continuously, point by point, rather than by separate lines. Furthermore, our scanning protocol includes a thorough search for extrafoveal traction sites in different areas throughout the area centralis (Fig. C), including the ONH.3 The 3-D SD-OCT software provides a running B-scan and full-field 3-D figures, and movies throughout the whole examined fields (Figs. C, D; Supplementary Video S1). By “zooming out” the high-resolution minute vitreoretinal interface details, the full-field 3-D figures and video clips enabled viewing of the whole field under evaluation. These figures and movies provided an important guidance on improved treatment-decision in DDMF.

Based on several hundred DDMF eyes (since 2003), we found that the most common extrafoveal vitreous traction sites associated with the DDMF, which often are multifocal, were at the macula located up to 3 mm from the fovea, at the papillomacular bundle zone adjacent to the ONH, and/or at the ONH. The association of extrafoveal vitreous traction and vitreofoveal traction with DDMF, exceeding 50% of DME eyes,3 (and of Evi membrane, a unified posterior hyaloid-epiretinal membrane complex) coincides with the well-accepted reports as regards to the significance of the vitreous body on the pathogenesis of DDMF.

From the clinical aspect, using the (full-field) 3-D SD-OCT, we reported recently on the mid-term outcome of grid laser photocoagulation (GLP) in center-involved DDMF.4 Excluded from the study were eyes with extrafoveal and vitreofoveal traction. The GLP was found efficacious (77.8%, 14/18) in DME eyes without central epiretinal membrane or macular capillary dropout ≥ 2 DD after 15.9 ± 7.4 months of follow-up. Outcome was substantially better than that reported previously for DDMF.8,9 Furthermore, we may observe another clinical aspect in that extrafoveal traction issue: In the case presented in Figure D and Supplementary Video S1, for example, with three extrafoveal traction sites associated with the DDMF, it is conceivable that PPV should be considered. On the other hand, observing only the central B-scan (Fig. B) could be misleading, and GLP and/or repeated intravitreal medications then could, probably erroneously, be ensued. The GPL would not be expected to improve that DDMF, but intravitreal anti-VEGF medication may be able to partially and temporarily affect the juxtanuclear complexes of the macular capillaries, thus reducing capillary leakage and edema. However, that effect probably would be doomed to a need for further injections as long as the traction is present. In that regard, a recent European Vitreoretinal Society (EVRS) multicenter study (n = 870, 60 centers) reports on high superiority of PPV over intravitreal medications in DDMF (available in the public domain at http://www.evrs.eu/2012-evrs-congress-dresden/).

In conclusion, 3-D SD-OCT that scans the field in a continuous fashion and, thus, offers full-field 3-D SD-OCT images was found to be an important contribution for decision-making in DDMF treatment.

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FIGURE. (A) Diffuse DME in a patient with proliferative diabetic retinopathy. The cross sign is manually marked at the fovea. (B) The central B-scan of the 3-D SD-OCT presents DDME; the foveal site (vertical line) is depicted automatically from the manual sign in (A). Short premacular posterior hyaloid membrane is evident (arrow), while the fovea is free from traction. (C) A search for the contact of the premacular membrane with the retina or ONH is made. The B-scan SD-OCT presents two adjacent, relatively thin extrafoveal vitreous traction sites at approximately 2.5 mm superior to the fovea, associated with the DDME. Another vitreous traction site is located 3 mm inferior to the fovea (presented in Supplementary Video S1). (D) Full-field 3-D presentation of the vitreomacular association. The superior (left side) and inferior extrafoveal traction membranes look thick (more than those detected by the B-scan) and are connected by a taut posterior hyaloid (arrow). Diffuse macular edema is evident (arrowhead). The fovea (vertical line, depicted from the manual sign in [A]) is free from traction (see also Supplementary Video S1).