Clinical Study

In Vivo Comparison of 23- and 25-Gauge Sutureless Vitrectomy Incision Architecture Using Spectral Domain Optical Coherence Tomography

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Received 19 November 2012; Accepted 30 January 2013

Academic Editor: David A. Wilkie

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Purpose. To investigate the in vivo incision architecture using spectral domain optical coherence tomography (SD-OCT) in 23-gauge and 25-gauge transconjunctival sutureless pars plana vitrectomy (TSPPV). Methods. A prospective observational study of 22 eyes of 22 patients that underwent three-port 25-gauge (10 eyes) or 23-gauge (12 eyes) TSPPV was performed. The three sclerotomies sites in each eye were analyzed by Corneal Adapter Model (CAM) RTVue SD-OCT (Optovue Inc., Fremont, CA, USA) with wound cross-section images (longitudinal and transversal) on days 1, 7, and 30 postoperatively. Transversal and longitudinal length, location, angle between the conjunctival surface tangent and the incision plane, and architecture deformations were evaluated. Results. All patients (22 eyes) completed the study and surgeries lasted less than 60 minutes. All wounds were obliquely performed, 23-gauge mean angle was $23 \pm 5^\circ$, and 25-gauge angle was $21 \pm 4^\circ$. Twenty-three-gauge sclerotomy transversal mean length was $1122 \pm 242 \mu m$ and 25-gauge transversal sclerotomy mean length was $977 \pm 174 \mu m$; 23-gauge longitudinal mean length was $363 \pm 42 \mu m$ and 25-gauge longitudinal sclerotomy mean length was $234 \pm 19 \mu m$; 23-gauge open wound thickness mean was $61 \pm 28 \mu m$ and 25-gauge open wound thickness mean was $22 \pm 6 \mu m$. All results were statistically significant ($P < 0.05$). No vitreous incarceration or silicone oil residue was observed in incision sites with both gauges. Conclusions. The 23-gauge and 25-gauge architectural wound constructions were well visualized using CAM SD-OCT. Statistical differences between the two gauges were observed throughout the study period.

1. Introduction

Transconjunctival sutureless pars plana vitrectomy (TSPPV) has considerably transformed the outlook of patient management in the field of retina and vitreous surgery since when described in 2002 [1, 2]. At first, the cannulas were introduced straight through the sclera at the sclerotomy sites in a perpendicular fashion. However, with this technique questions have been raised regarding to the true self-sealing characteristics of some of these TSPPV, with reports of increased hypotony and endophthalmitis rates associated [3–9]. The creation of the beveled opposed to a straight sclerotomy incision to prevent leakage through these sutureless wounds was a greater advantage for the procedure [10–14]. But the limitations of the instruments, fluidics, extensive flexibility of the instruments, and poor illumination caused by a small lumen 0.5 mm caliber reduced the use of 25-gauge TSPPV, even with advantages over the traditional techniques.
such as reduced surgical trauma, improved postoperative comfort, faster visual recovery, shorter operating times, and reduced postoperative astigmatism [2, 15, 16]. This procedure became increasingly most commonly used when 23-gauge TSPPV was introduced to overcome the limitations of 25-gauge describe above [17–20].

However, there still exists debate of the self-sealing characteristics of TSPPV with respect to the best wound architecture construction. Recently, ultrasound biomicroscopy (UBM) [21] and time-domain optical coherence tomography (OCT) [22–24] have been used to evaluate wound architecture in vivo. The aim of this study was, therefore, to use the high-resolution anterior segment (AS) spectral domain OCT (SD-OCT) to investigate the wound architecture of both 23-gauge and 25-gauge TSPPV in order to gain further insight into the sclerotomy wound construction.

3. Results

Average patient age at time of surgery was 65.1 years ± 15.1 (range 36–83 years). Ten patients were men. Thirty 25-gauge sclerotomies of ten eyes and thirty-six 23-gauge sclerotomies of 12 eyes were analyzed. Indications for surgery were epiretinal membrane (4), rhegmatogenous retinal detachment (RD) (4), tractional RD (8), and macular hole (6). Combined phacoemulsification and IOL implantation through clear corneal incision were performed in 2 eyes with RD. All cataract incisions were performed after the infusion trocar was placed. 10–0 nylon suture was used at the corneal incision to prevent anterior chamber collapse during the cannula insertion. There was no failure in cannula insertion due to hypotony or anterior chamber collapse. In two patients with RD a silicone intraocular injection after vitrectomy (one for each gauge) was necessary. All patients with RD underwent TSPPV without scleral buckle.

No intraoperative suture placement was necessary and no patient had hypotony on the first postoperative day. The IOP was normal in all postoperative visits (range: 12 to 22 mmHg).

All three incisions of each eye were evaluated using SD-OCT to define incision on postoperative days 1, 7, and 30. Transversal and longitudinal length, location, angle formed between the conjunctival surface tangent and the incision plane were taken; besides, information about location and architecture deformations was collected (Figure 1). SAS V9.1 programming language (SAS Institute Inc., Cary, NC, USA) was used for statistical analyses. Accepted level of significance for all tests was a P value of less than 0.05.

Figure 1: Images of the 25-gauge sclerotomies on postoperative. A cross line scan parameters of transverse and longitudinal measurements illustrated with a diagrams.
Figure 2: Spectral domain OCT images (RTVue with a corneal adaptor module-CAM from Optovue Inc., Fremont, CA) at the postoperative period of 23-gauge sutureless pars plana vitrectomy. (A) Longitudinal (upper) and transversal (bottom) length measurement at the sclerotomy incision, on postoperative day 1. (B) Longitudinal (upper) and transversal (bottom) length measurement at the sclerotomy incision, on postoperative day 7. (C) Longitudinal (upper) and transversal (bottom) length measurement at the sclerotomy incision, on postoperative day 30.

Figure 3: Spectral domain OCT images (Optovue with Cornea Camera) at the postoperative period of 25-gauge sutureless pars plana vitrectomy. (A) Longitudinal (upper) and transversal (bottom) length measurement at the sclerotomy incision, on postoperative day 1. (B) Longitudinal (upper) and transversal (bottom) length measurement at the sclerotomy incision, on postoperative day 7. (C) Longitudinal (upper) and transversal (bottom) length measurement at the sclerotomy incision, on postoperative day 30.

to 42) with 23-gauge, and 234 ± 19 μm (range: 265 to 19) with 25-gauge. Mean open wound thickness was 61 ± 28 μm (range: 543 to 42) with 23-gauge and 22 ± 6 μm (range: 48 to 6) with 25-gauge. All results were statistically significant (P < 0.05).

No vitreous incarceration or silicone oil residue was observed in incision sites with both gauges (Figures 2 and 3), and no architectural structure difference was observed comparing macular to RD cases. Tables 1 and 2 describe transversal and longitudinal results for all gauges.

4. Discussion

Chen first described sutureless self-sealing sclerotomies in 1996 [25]. After that, other authors have described their experience and technique modification [1, 2, 17, 26]. Twenty-three and 25-gauge tunnel incision cannulas require no suture because of a reduced diameter, 0.5 mm [1] and 0.72 mm [17], respectively, placed obliquely to the scleral surface. The longitudinal length of the sclerotomy was around 50% of the lumen diameter of the gauges. On postoperative days 1 and 30, the incision length showed low variance, suggesting that the scleral fibers were partially cut and partially dissected without damage, suggesting no variation during those days (Table 1).

Imaging exams, such as UBM [21] and AS-OCT, serve as a tool to produce clear cross-sectional images of the pars plana, including vitreous base. These regions are difficult to examine adequately using lenses and/or slit lamp, and it may be useful to locate the sclerotomy site [27]. Boker and Spitznas reported the use of UBM to examine the sclerotomy site after PPV [28]. In a series of 20 eyes of 19 patients, the entry sites were
Table 1: Transversal length of sclerotomy incisions after transconjunctival sutureless pars plana vitrectomy performed with 23-gauge and 25-gauge measured with SD-OCT at the postoperative followup.

<table>
<thead>
<tr>
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<th>23-gauge (microns)</th>
<th>25-gauge (microns)</th>
<th>P value</th>
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<tbody>
<tr>
<td></td>
<td>Average ± SD</td>
<td>Average ± SD</td>
<td></td>
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<tr>
<td>Postoperative day 1</td>
<td>1117 ± 247</td>
<td>977 ± 205</td>
<td>0.03</td>
</tr>
<tr>
<td>Postoperative day 7</td>
<td>1120 ± 234</td>
<td>944 ± 144</td>
<td>0.04</td>
</tr>
<tr>
<td>Postoperative day 30</td>
<td>1129 ± 254</td>
<td>944 ± 144</td>
<td>0.003</td>
</tr>
<tr>
<td>Total</td>
<td>1122 ± 242</td>
<td>974 ± 174</td>
<td>0.04</td>
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Table 2: Longitudinal length of sclerotomy incisions after transconjunctival sutureless pars plana vitrectomy performed with 23-gauge and 25-gauge measured with SD-OCT at the postoperative followup.

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<th>25-gauge (microns)</th>
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<tbody>
<tr>
<td></td>
<td>Average ± SD</td>
<td>Average ± SD</td>
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<tr>
<td>Postoperative day 1</td>
<td>375 ± 39</td>
<td>236 ± 18</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Postoperative day 7</td>
<td>357 ± 37</td>
<td>233 ± 23</td>
<td>&lt;0.001</td>
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<tr>
<td>Postoperative day 30</td>
<td>355 ± 49</td>
<td>233 ± 23</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Total</td>
<td>363 ± 42</td>
<td>234 ± 19</td>
<td>&lt;0.001</td>
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identified by UBM, and the authors concluded that UBM was useful in determining possible sources of complications after vitrectomy and could give further insight into the interactions between pars plana sclerotomy and anterior fibrovascular proliferation [29]. The major shortcoming of UBM is that the direct pressure of the open immersion cup on the incisions could alter the observed architecture and increase the potential risk of endophthalmitis, especially in the early postoperative period [22]. The risk of compression with the UBM exam can possibly be reduced using the ClearScan bag/balloon available.

Some authors demonstrated the importance of the oblique incisions in vitro studies where angled incisions were superior at histopathology and in AS-OCT [14, 23, 30], Taban et al. using time domain AS-OCT imaging demonstrated that 23-gauge sutureless vitrectomy performed using oblique (angled) incisions provided adequate wound closure evident even on postoperative day one [23].

Anterior segment OCT is a noncontact and noninvasive imaging exam and considered for serial examination. Time domain AS-OCT is well suited to examine sutureless vitrectomy incisions in the immediate postoperative period, with adequate penetration depth and low resolution [22]. SD-OCT images obtained not only clearly showed the profile of the incisions with a high resolution that allowed accurate measurement of parameters such as incision length and angle, but also identified the fine architectural features identified by the authors as wound opening thickness. SD-OCT has a limitation related to depth.

In the present study, we were able to identify the three sclerotomy sites with SD-OCT using the corneal camera. All wounds were obliquely built with a safety angle of entrance, longitudinal diameter was close to 50% of the cannula lumen, and transversal wound length (distance between the external and internal scleral limits) was around 1 mm. There was an adequate wound closure with a hyporeflective signal corresponding to an open wound thick scar. All results were statistically significant showing difference between the wound architecture comparing sutureless vitrectomy with 23-gauge and 25-gauge.

Conflict of Interests

The authors declare no conflict of interests.

References


