Evaluation of Wound Morphology of Sclerotomy Sites of Sutureless Vitrectomy Using Spectralis Anterior Segment Optical Coherence Tomography

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Purpose: The aim of the study was to evaluate wound morphology in vivo in eyes undergoing sutureless vitrectomy.
Design: This was a prospective consecutive case series
Methods: Twenty eyes undergoing sutureless vitrectomy were evaluated using anterior segment optical coherence tomography on days 1, 15, and 30. Ten eyes each belonged to 23-gauge (group A) and 25-gauge (group B). Scans were taken on the incision sites. Group A cases were further divided into group A1 and A2 on the basis of the surgical time of less than 15 minutes' and more than 15 minutes' duration, respectively.
Results: On day 1, the mean outer and inner incision diameters in group A were 236.6 and 146 μm, and those for group B were 118.6 and 90 μm. A significant decrease ($P < 0.0001$) in both the port sizes was observed in both groups' follow-up. Group B showed significant decrease ($P < 0.0001$) in the port sizes on l follow-up as compared with group A. Group A1 had smaller incision size as compared with group A2 on the first postoperative day, although not statistically significant($P > 0.05$).
Conclusions: In both groups, the sclerotomy incisions showed good healing at 1-month duration. The 25-gauge sclerotomies showed better healing characteristics of wound morphology as compared with the 23-gauge sclerotomies.

Key Words: AS-OCT, incisions, small gauge, sutureless, vitrectomy

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Recent advances in the microsurgical techniques have led to increased adoption of sutureless vitrectomy using 23- and 25-gauge instrumentation. The 23-gauge sutureless pars plana vitrectomy, introduced by Eckardt[1] in 2005 has gained a significant support among the vitreoretinal surgeons. This has considerably transformed the outlook of patient management in the field of vitreous surgery. This procedure is becoming increasingly popular based on the several reported advantages over the traditional techniques such as reduced surgical trauma, improved postoperative comfort, faster visual recovery, shorter operating times, and reduced postoperative astigmatism.[2–4] However, there have been concerns regarding high incidence of postoperative complications such as hypotony and endophthalmitis, compared with conventional sutured 20-gauge system. These complications are due to compromised wound integrity associated with these sutureless surgeries.[5–7] Some surgeons[8,9] have proposed creation of oblique or biplanar incisions to prevent leakage through these sclerotomy sites, but the self-sealing characteristics of the sutureless ports still remain uncertain.

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Ultrasound biomicroscopy has been used to evaluate these incisions,[10–12] but the contact and immersion methodology may manipulate the wounds and increase the potential risk of endophthalmitis, limiting its application in imaging sclerotomy sites in the early postoperative period. Anterior segment optical coherence tomography (AS-OCT) is a noncontact, noninvasive imaging technique and has been developed to assess corneal and laser in situ keratomileusis flap thickness, tear film, anterior chamber depth, lens and intraocular lens status, trabeculectomy bleb morphology, angle anatomy, and profiles of clear corneal incisions. With the same principle, the scans can be passed on the sclerotomy sites to assess the wound architecture.

It is well known that the sclera heals with a fibrin plug within 6 to 12 hours,[13] so it is critical to assess if the incision is closed before wound healing occurs. Chen et al[14] had studied the incision architecture in sutureless sclerotomies in the immediate postoperative period. They had measured the incision length and angle of incision in 23- and 25-gauge sclerotomies and also looked into the architectural factors that may lead to postoperative wound leakage. Taban et al[15] evaluated 23-gauge sclerotomies with AS-OCT. They noted that oblique incisions provide adequate wound apposition as shown by OCT even on postoperative days 1 and 8. But details of sequential documentation of the same site in relation to healing of the sclerotomies has not been noted so far. The principal aim of our study was to evaluate the sequential morphology of sclerotomy ports in vivo in eyes undergoing 23- and 25-gauge transconjunctival sutureless vitrectomy (TSV) on 1, 15, and 30 days after surgery. We also looked at correlation of surgical time in relation to the size of sclerotomy ports.

MATERIALS AND METHODS

This was a prospective study composed of consecutive series of patients who

1. underwent primary 23- or 25-gauge TSV and
2. were willing to give written informed consent.

Patients excluded were those

1. with a history of prior scleral buckling or pars plana vitrectomy;
2. with presence of conjunctival or scleral scarring, any localized scleral thinning, and other coexisting ocular disorders (glaucoma, uveitis, etc);
3. whose ultrasound revealed retinal detachment in any eye with nonclear media; or
4. in whom silicone oil was used as an intraocular tamponade.

Detailed medical records and surgical and ocular parameters were recorded and reviewed prior to the surgery. Patients undergoing surgery with 23-gauge instrumentation were included in group A, whereas those undergoing surgery with 25-gauge instrumentation were included in group B. All surgeries in group B had surgical duration of less than 15 minutes. The

patients in group A were divided in group A1 and group A2 based on surgical duration of less than 15 minutes or more than 15 minutes, respectively. These vitrectomy times were less than those noted in one of our previous studies.[16] Constellation vitrectomy system (Alcon Laboratories Inc, Fort Worth, Tex) using 5000 cuts per minute has reduced overall vitrectomy times as compared with the Accurus system, which worked on the highest cut rate of 2500 per minute. The study was approved by the institutional review board and conducted in accordance with the tenets of the Declaration of Helsinki.

Surgical Procedure

All surgeries were performed by a single surgeon. All patients underwent 3-port pars plana vitrectomy with either 23- or 25-gauge instrumentation. At our center, we usually do macular surgeries with 25-gauge, and all the other indications with 23-gauge. Hence, in this study, the patients with macular hole and epiretinal membrane were selected for 25-gauge vitrectomy. These surgeries were performed under peribulbar anesthesia. The incisions were made with Edgeplus trocar cannula system, and surgeries were performed with Alcon Constellation Vision System (Alcon Laboratories Inc). All the incisions were created in a biplanar fashion with a 2-step approach—initially, the blade was inserted at a 30-degree angle, and then the entry was made perpendicular to the sclera. The incisions were made 3.5 to 4 mm posterior to limbus, depending on the phakic status of the patient. The infusion cannula was placed in the inferotemporal quadrant, whereas the 2 other cannulas were placed in the superotemporal and superonasal areas. The overlying conjunctiva was displaced before taking the incisions. We used the trocar fixation plate (pressure plate forceps) from ASICO (Westmont, Ill), in a multifunctional manner while making the incisions. The pressure plate forceps had incorporated calipers to measure distance from the limbus and serrations on the undersurface to allow good hold of the conjunctiva for misalignment over the proposed scleral entry. Fluid-air exchange was done in all cases at the end of vitrectomy. At the completion of surgery, the cannulas were plugged to prevent any egress of air during removal. We removed the cannulas by holding it with plain forceps and then massaging the wound area with a blunt-tipped applicator for 10 to 15 seconds to facilitate the stretched scleral fibers to regain their elastic memory.[17] This technique allows better sealing of the wound and prevents any inadvertent vitreous incarceration. The incisions were examined for any evidence of leakage after removal of the cannulas.

Optical Coherence Tomography

The sclerotomy wound imaging was made using Spectralis HRA+OCT (Heidelberg Engineering, Heidelberg, Germany) with infrared imaging and an anterior segment objective. All the anterior segment OCT scans were taken by a single examiner who was blinded to the groups under evaluation, thus eliminating observer bias. The Spectralis HRA+OCT allows us to easily take anterior segment or external images of the eyes by insertion of the anterior segment objective. By slightly pulling the camera back and changing the focus, the scleral ports can be viewed. The OCT device was used to scan across the incision site, so as to traverse the center of the incisions, showing them in profile. These scans were obtained at 1, 15, and 30 days after surgery and were evaluated for the lengths of external and internal entry wounds, presence of any wound gape, and any associated complications. The length of the incisions was measured using the analysis software provided with the Spectralis HRA+OCT (Fig. 1).

The *t* test was performed to analyze the reduction in inner and outer diameters.

RESULTS

A total of 20 patients (7 women and 13 men) undergoing vitrectomy were included in this study. The age range was 28 to 70 years with mean age of 50.21 years. All patients were of Indian origin. The most common indication for surgery was vitreous hemorrhage due to proliferative diabetic retinopathy (n = 8) followed by epiretinal membrane (n = 7) and macular hole (n = 3). Of 20 patients, 10 patients underwent vitrectomy with 23-gauge instrumentation, which were included in group A, whereas the remaining 10 patients underwent vitrectomy with 25-gauge instrumentation, and these were included in group B.

Gross and Slit-lamp examination

Gross examination at the end of surgery was done. None of the cases showed any evidence of wound leak (eg, obvious fluid or air/gas flow, continued conjunctival bleb formation), and none of the incisions required sutures.

Slit-lamp examination was done on the next day, which revealed subconjunctival hemorrhage, conjunctival chemosis, and injection over the incision site in all cases. The external or entry wounds were often visible under slit-lamp examination, but did not show signs of leakage in any patient.

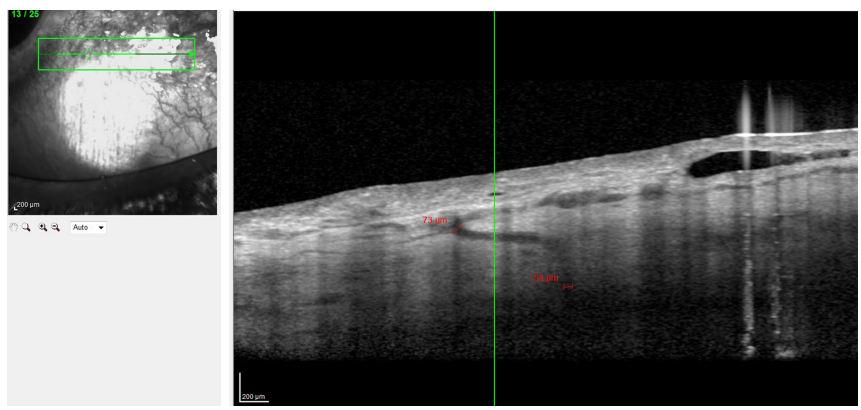

FIGURE 1. Measurement of length of the incisions using the analysis software provided with the Spectralis HRA+OCT.

TABLE 1. Surgical Duration and Diameter of Ports in Patients Undergoing TSV

Patient No.	Surgical Duration, min	Outer Diameter After Surgery, μm			Inner Diameter After Surgery, μm		
		Day 1	Day 15	Day 30	Day 1	Day 15	Day 30
Group A: 23-gauge vitrectomy							
1	21	274	134	74	197	64	34
2	16	246	122	68	131	55	22
3	12	178	97	61	116	42	17
4	13	222	114	51	134	61	16
5	16	168	92	57	114	54	24
6	17	247	128	61	140	61	19
7	11	258	137	54	168	48	18
8	13	214	128	72	143	52	24
9	19	254	131	68	151	47	22
10	17	265	103	54	162	36	14
Mean		232.6	118.6	62.0	145.6	52.0	21.0
Group B: 25-gauge vitrectomy							
1	13	142	71	27	124	58	18
2	16	127	62	24	92	51	11
3	11	94	57	22	72	44	14
4	11	116	54	19	94	39	11
5	10	84	62	26	62	41	12
6	11	136	64	25	84	38	9
7	13	148	59	19	107	37	10
8	12	122	69	21	74	41	9
9	11	116	67	18	105	35	9
10	10	101	50	20	86	31	10
Mean		118.6	61.5	22.1	90	41.5	11.3

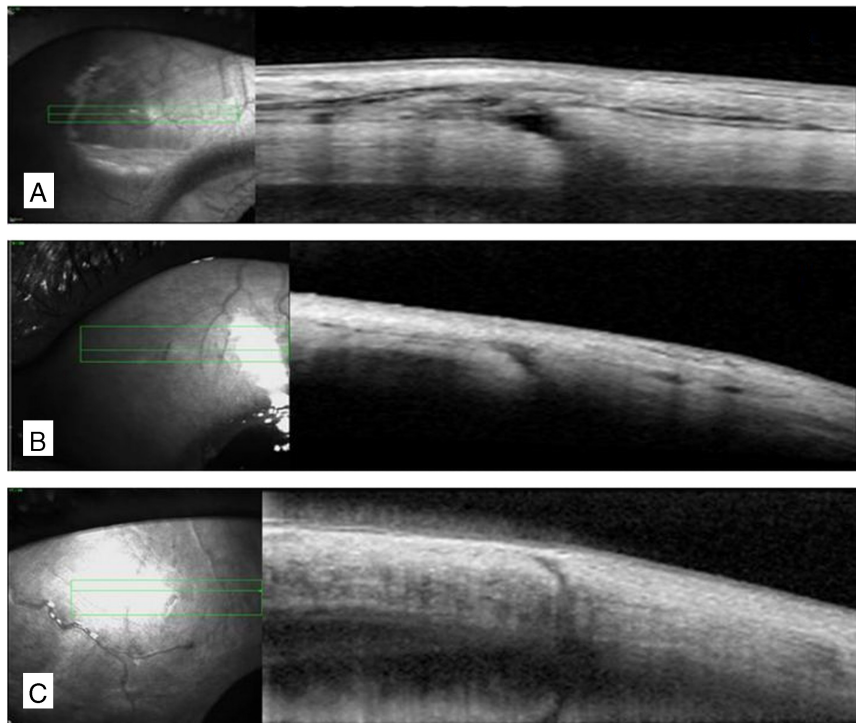

FIGURE 2. Ports of 23-gauge (group A). First day (A), 15th day (B), 30th day (C).

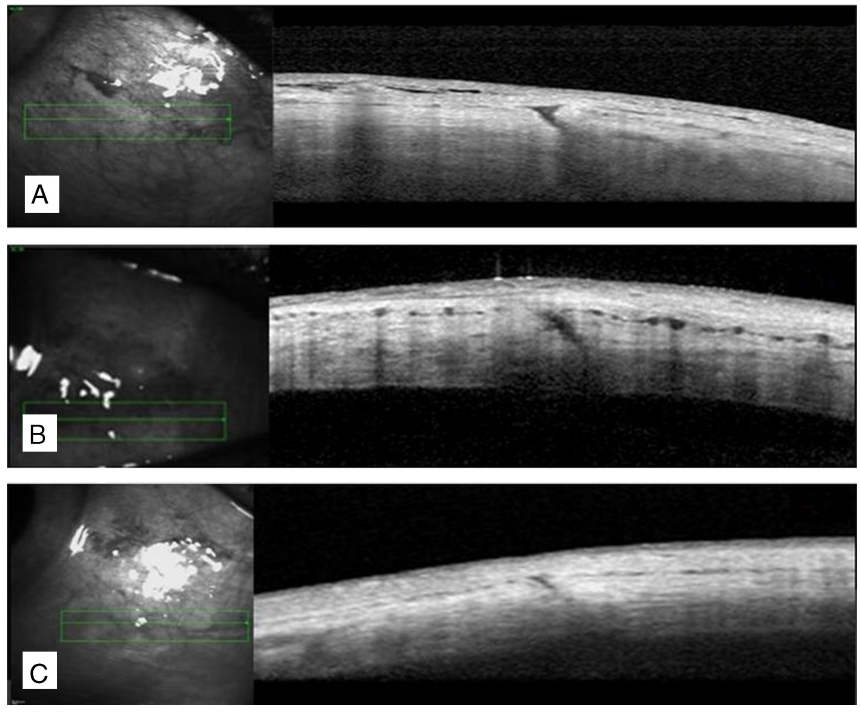

FIGURE 3. Ports of 25-gauge (group B). First day (A), 15th day (B), 30th day (C).

Anterior Segment Optical Coherence Tomography of the Sclerotomies

Table 1 presents a summary of surgical time and inner and outer diameters of the ports of the eyes undergoing vitrectomy (Figs. 2 and 3).

Statistically significant decrease in inner and outer diameters of the eye ports was observed at 15 and 30 days after surgery in both the groups ($P < 0.0001$, t test). The difference between group A and group B with respect to decrease in inner and outer diameters was also significant ($P < 0.0001$, t test), as group B showed more reduction in the diameter of the eye ports at days 15 and 30. Figure 4 presents the decrease in mean values of the outer and inner diameters for groups A and B.

Table 2 presents the inner and outer diameters of groups A1 and A2. Although statistically not significant ($P > 0.05$, Mann-Whitney U test), difference in the port sizes was observed between groups A1 and A2 on the first postoperative day. The average outer diameter in group A1 was 218 μm, and in group A2 it was 242.30 μm, whereas the average inner diameters were 140.30 and 149.80 μm respectively. This difference was noted only in the initial postoperative period, as on the 15th and 30th day, the average diameters between the 2 groups were almost the same.

Some other findings observed on AS-OCT were conjunctival ballooning (Fig. 5) in 4 patients operated on with 23-gauge and ciliochoroidal detachment (Fig. 6) in 1 patient. None of the

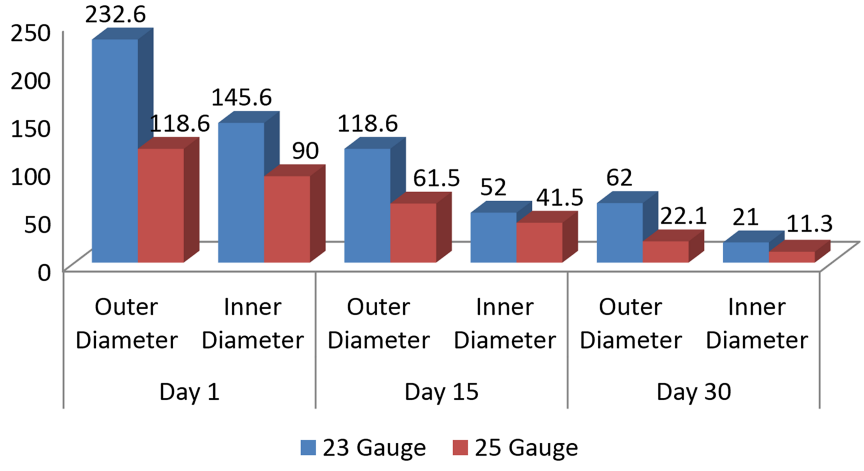

FIGURE 4. Dimension of the ports of eye groups A and B.

TABLE 2. Inner and Outer Diameters of Groups A1 and A2

	Outer Diameter After Surgery, μm			Inner Diameter After Surgery, μm		
	Day 1	Day 15	Day 30	Day 1	Day 15	Day 30
Group A1: 23-gauge vitrectomy (<15-min surgical duration)						
Mean	218.0	119.0	59.5	140.3	50.8	18.8
Group A2: 23-gauge vitrectomy (>15-min surgical duration)						
Mean	242.3	118.3	63.7	149.8	52.8	22.5

patients developed gross hypotony or endophthalmitis. None of the patients had vitreous incarceration.

DISCUSSION

Transconjunctival sutureless vitrectomy is gaining more popularity nowadays, and it plays an important role in the armamentarium of vitreoretinal surgeons. This technique has certain definite advantages over the conventional 20-gauge surgery, but there were reports regarding postoperative complications such as increased incidence of hypotony and endophthalmitis.

Kunimoto and Kaiser[18] had observed higher incidence of endophthalmitis in eyes undergoing 25-gauge vitrectomy (0.23%) as compared with 20-gauge vitrectomy (0.02%). This may be due to nonbeveling of the incisions in their series. Scott and associates[6] reported that 73% of their endophthalmitis cases were seen in patients in whom TSV was done with straight incisions.

Oblique or biplanar incisions have been proposed to help decrease or prevent the wound leakage at least in the immediate postoperative period, but there was little difference at any time point thereafter.[19] The internal lip of these incisions presses against the external lip because of intraocular pressure.

Taban et al[15] evaluated the wound closure in oblique 23-gauge sutureless sclerotomies of 14 eyes and proposed the creation of oblique incisions to prevent the complications of sutureless sclerotomies.

The outer diameter of 23-gauge cannula is 740 μm, whereas that of 25-gauge cannula is 530 μm. In this study, we have observed that the average outer diameter of 23-gauge sclerotomy sites was 232.60 μm, and average inner diameter was 107.44 μm. The corresponding readings for the 25-gauge sclerotomy sites were 118.60 and 90 μm. These findings suggest that the sclerotomy sites reduce to one third to one fourth on the first postoperative day. At the end of the first month, these wounds in 23- and 25-gauge almost healed with a small slit seen on AS-OCT.

The cases wherein the surgical duration was more than 15 minutes showed slightly larger outer and inner openings. This could be related to the tissue fatigue. The longer the surgical duration, the more the sclera becomes fatigued leading to less efficient self-sealing of the wound due to inflexibility and rigidity. Lin et al[19] also support the same finding. However, because our numbers were very small, this aspect needs to be looked at on much larger series to derive any conclusion.

The sclerotomy incisions take about a month to heal. The dimensions of the outer and inner opening of the sclerotomies depend on the gauge and surgical duration. The overall characteristics of wound healing related to the smaller 25-gauge ports were better compared with the larger 23-gauge ports. Anterior segment OCT using Spectralis is a fine tool to study sclerotomy ports in a noninvasive manner and could find many applications in the future to assess any new instrumentation or techniques related to incision making.

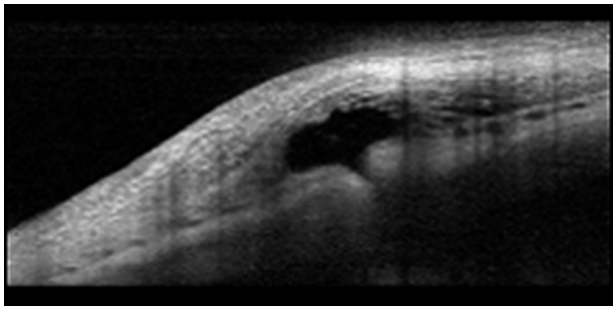

FIGURE 5. Conjunctival ballooning.

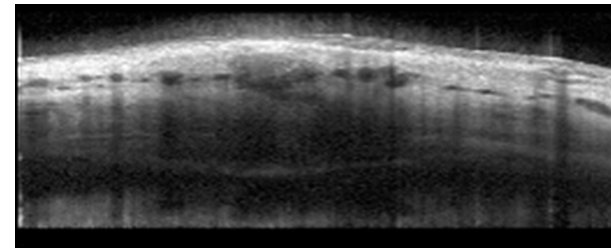

FIGURE 6. Ciliochoroidal detachment.

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"Whether you think you can, or you think you can't–you're right."
—***Henry Ford***