DIATHERMY OF LEAKING SCLEROTOMIES AFTER 23-GAUGE TRANSCONJUNCTIVAL PARS PLANA VITRECTOMY

A PROSPECTIVE STUDY

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Purpose: To evaluate the efficacy of bipolar diathermy in ensuring closure of leaking sclerotomies after complete 23-gauge transconjunctival sutureless vitrectomy.

Methods: In this prospective, interventional case series, in 136 eyes of 136 patients with at least one leaking sclerotomy at the end of a complete 23-gauge transconjunctival sutureless vitrectomy, external bipolar wet-field diathermy was applied to leaking sclerotomies, including the conjunctiva and sclera. Intraoperative wound closure, and postoperatively, at 6 hours, 1 day and 3 days, sclerotomies leakage, intraocular pressure, hypotony, and hypotony-related complications were evaluated.

Results: Intraoperative closure was achieved in 231 of 238 leaking sclerotomies (97%) that received diathermy. One of these with postoperative leakage needed suture. Compared with baseline (14.4 ± 2.8 mmHg), mean intraocular pressure was lower at 6 hours (13.2 ± 3.8 mmHg, Tukey–Kramer $P < 0.001$) and not different at 24 hours or 72 hours. Hypotony (intraocular pressure <5 mmHg) was observed in 6 eyes (4.5%) at 6 hours, in 2 (1.5%) at 24 hours, and in none at 3 days. Logistic regression analysis showed that, 6 hours postoperatively, hypotony was related to younger age (≤50 years) at surgery ($P = 0.031$). No hypotony-related complications were recorded.

Conclusion: Bipolar wet-field diathermy of sutureless sclerotomies is an effective method for ensuring a leaking sclerotomies closure.

RETINA 0:1–7, 2012

Recent advances in small-gauge transconjunctival sutureless vitrectomy (TSV) have now changed patient management.[1–3] This technique is gradually becoming more and more used by most surgeons on the basis of advantages compared with traditional techniques, such as reduced surgical trauma, postoperative comfort, faster visual recovery, shorter operating times, and reduced postoperative astigmatism.[1,3–5]

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However, the method has some potential drawbacks, such as a higher incidence of wound leaks, with ensuing incomplete filling with tamponading agents, earlier disappearance and subconjunctival migration of tamponading agents, hypotony, choroidal detachment, retinal detachment, vitreous incarceration, and endophthalmitis.[6–13] Even with recent advances in incision techniques, such as oblique incisions, biplanar cannula insertions, and slit-shaped scleral tunnel incisions, it may be difficult to ensure perfect self-sealing of every entry site, especially in particular cases, such as eyes with myopia or thin sclera, reoperation on a vitrectomized eye, multiple exchanges of instruments, young patients, and extensive vitreous base dissection.[2,3,12–15] Furthermore, subclinical leakage occurs even after successful self-sealing on the

operating table, and delayed hypotony may develop the next day and last for several days thereafter.[16]

In cases of leaking sclerotomies, many have reported placing a single transconjunctival and transcleral absorbable suture. The data from the 2010 Practice and Trends survey of the American Society of Retina Specialists supported these numbers: 91.3% of the members of the American Society of Retina Specialist who perform 23-gauge surgery suture at least one sclerotomy (https://www.retinaspecialists.org/services/pat_survey/. Accessed: March 19, 2011).

Sutures sometimes can be difficult to place because of chemosis or bleeding, and suturing may lead to some undesirable effects, such as astigmatism and a foreign body sensation.[17] To limit these complications, some of us recently described a new technique for the closure of the sclerotomy using bipolar diathermy applied to the wound, including the conjunctiva and sclera, after small-gauge TSV.[17]

The aim of the present study was to evaluate the efficacy of bipolar diathermy in ensuring wound closure of leaking sclerotomies after complete 23-gauge TSV and the incidence of postoperative complications.

Patients and Methods

Subjects

This prospective, uncontrolled, interventional study included a consecutive series of patients who underwent 23-gauge TSV surgery between January 2009 and July 2010 at the Department of Ophthalmology of the University of Bari. The study, following the tenets of the Declaration of Helsinki, was approved by the Institutional Review Board of Azienda ospedaliero-universitaria consorziale "Policlinico di Bari", Bari, Italy. All patients provided informed consent after the aim of the study and the possible risks had been fully explained.

We included all eyes treated by complete 23-gauge TSV that had at least one leaking sclerotomy at the end of the surgery after the removal of cannulas. We excluded eyes that had preoperative choroidal hemorrhage or detachment, previous glaucoma surgery, penetrating injury, or scleromalacia.

Informed consent was obtained from all patients before undergoing 23-gauge vitrectomy explaining that in case of leaking sclerotomy at the end of the procedure, diathermy would have been performed to close the entry site. In case of persistent leakage, a regular suture would have been positioned.

Surgical Technique

All patients underwent 3-port, 23-gauge TSV under general or local anesthesia, depending on patient preference. All operations were performed at one hospital by the same surgeon (F.B.) with the Constellation Vision System (Alcon Laboratories, Inc, Fort Worth, TX) using the Edgeplus trocar system (Alcon Laboratories, Inc), a slit-shaped blade, or with Pentasys (Fritz Ruck GmbH, Eschweiler, Germany) using MidLabs trocars (Medical Instrument Development Laboratories, Inc, San Leandro, CA), a conventional solid shaft-type trocar–cannula system. Wide-angle fundus visualization was achieved by using the binocular indirect ophthalmomicroscope noncontact wide-field imaging system (BIOM, Oculus, Munich, Germany).

After thorough disinfection of the periocular skin with 5% povidone–iodine and instillation of povidone–iodine into the inferior fornix, in all phakic patients clear cornea lens surgery with intraocular lens implantation was performed by using a standard phacoemulsification technique to allow complete removal of vitreous base.

The conjunctiva and the Tenon capsule were anteriorly displaced away from the intended sclerotomy site with forceps to purposefully misalign the conjunctival and scleral incisions. A trocar was inserted at an angle of approximately 30° parallel to the limbus. Once it was past the trocar sleeve, the angle was changed to be perpendicular to the surface and the cannula was inserted into the eye, making a biplanar entry. The cannula was held in place with forceps and the trocar was removed. A complete vitrectomy was carried out, including vitreous base shaving with external scleral depression, with triamcinolone as the visualizing agent.[18]

After the vitrectomy was completed, on the basis of the surgical indication, patients underwent complete gas–fluid exchange or partial air–fluid exchange (20%–30% fill at the end of the procedure); the percentage of air was chosen because it is enough to help the sealing of the sclerotomy internally, for the different surface tension of air relative to fluid, with minimal discomfort for the patient postoperatively.

In cases that required internal tamponade, intravitreal gas (SF6 20%–24%), Densiron-68, or silicone oil (Acri.Sil-ol 1000, 1,000 cps; Acri.Tec, Hennigsdorf, Germany) was injected. At the end of the procedure, the cannulas were removed by slowly pulling them out one by one, after the angled entry path over the light pipe. The light pipe was then slowly removed and each sclerotomy site was then gently pressed with a cotton swab and carefully inspected for leakage, indicated by air or gas escape or the formation of a subconjunctival bleb. The infusion pressure was maintained at 10 mmHg to 20 mmHg during cannula removal.

When any degree of leakage was detected, diathermy was applied on the sclerotomy site with curved jewelers bipolar forceps (Alcon Laboratories, Inc) after

the sclerotomy had been cleared with a cotton swab. The bipolar diathermy was applied on the conjunctiva overlying the sclerotomy and was continued until the site developed a whitish appearance. If the sclerotomy site was found to be leaking after this procedure it was sutured with a single 9-0 vicryl stitch. The eye was dressed with a standard nonpressure ocular bandage. Topical antibiotics and steroids were prescribed for 1 month and oral antibiotics for 5 days postoperatively.

Examination

Intraoperatively, we recorded the number of leaking sclerotomies requiring suturing that persisted after diathermy. Wound leak was defined as on-table sclerotomy leakage that did not self-seal after three 20-second sessions of pressure to the incision with a cotton tip applicator, requiring subsequent sutures to close the wound leak.

Patients were examined 6 hours, 24 hours, and 3 days after surgery with anterior segment slit-lamp examination to search for the possible presence of subconjunctival blebs and had Seidel testing using 2% fluorescein on the wounds and intraocular pressure (IOP) measured by Goldmann applanation tonometry (the mean IOP of 3 successive measurements was taken). We defined "hypotony" as an IOP of 5 mmHg or less. At each visit, the presence of clinical signs of hypotony (Descemet folds, choroidal folds, and retinal folds) and hypotony-related complications (ciliochoroidal detachment, suprachoroidal detachment, collapsed eye, and endophthalmitis) were evaluated and recorded.

In all patients treated after 10 April 2010, the closure of sclerotomies was evaluated by using Visante optical coherence tomography model 1000 (Carl Zeiss Meditec, Dublin, CA) 24 hours, 7 days, and 1 month after TSV. This examination was added in the study protocol after the start of the study through an amendment, when the instrument was available at our clinic. The Enhanced Anterior Segment Single model was selected. The beam was carefully aligned to scan across the pars plana region traversing the center of the incisions and rotated parallel to the limbus to follow the paths of the incisions. Two-dimensional images were captured when the whole tract was displayed in a cross-sectional profile. The anatomical features of the sclerotomy and any presence of conjunctival bleb, local ciliochoroidal detachment, or vitreous incarceration were noted.

In all eyes tamponaded with silicone oil, the oil was removed 3 months after surgery, and at this time, we evaluated the mobility of the conjunctiva in relation to sites of sclerotomy with a cotton tip applicator. A shift of the conjunctiva parallel with the limbus of <2 mm was considered as an indicator of conjunctival scar.

Data Analysis

Descriptive statistics of leaking sclerotomies before and after diathermy were compiled. The mean IOPs before and after treatment were compared by analysis of variance; if significant, multiple comparisons were performed with the Tukey–Kramer test. Logistic regression analysis was used to evaluate the relationship of any variables (age, sex, surgical indication, lens status, previous vitrectomy, axial length, combined cataract extraction, tamponading agent used, vitrectomy platform, and trocars used) with both postoperative hypotony and leaking sclerotomies requiring suturing after diathermy. P values <0.05 were considered statistically significant. Statistical analyses used SPSS for Windows, version 16.0 (SPSS, Inc, Chicago, IL) to assess the relationship.

Results

Of the 392 eyes that underwent complete 23-gauge TSV, 136 eyes of 136 patients had at least one leaking sclerotomy and were included in the study (Figure 1). The baseline demographic, clinical, and surgical characteristics of the enrolled patients are reported in Table 1.

Overall, 238 of 408 sclerotomies (58%), with a mean ± SD of 1.8 ± 0.8 per eye, were leaking at the end of TSV and received diathermy. In 4 eyes, persistent intraoperative leakage was seen after diathermy (7 of 238 sclerotomies, 3%), and a suture was placed at the end of surgery: 2 eyes had 1 sutured sclerotomy, 1 had 2 sutured sclerotomies, and 1 had 3 sutured sclerotomies.

In 132 eyes (231 of the 238 sclerotomies treated by diathermy, 97%), diathermy was effective and sutures were not required; these eyes were included in the postoperative analysis. At 6 hours, 1 sclerotomy (1 of 231, 0.43%) had a positive Seidel test and needed suturing; it was excluded from further analysis. Logistic regression analysis demonstrated no correlation between the variables analyzed and the failure of intraoperative and postoperative diathermy that required suturing of the sclerotomy.

Compared with baseline (14.4 ± 2.8 mmHg), mean intraocular pressure was lower (13.2 ± 3.8 mmHg, Tukey–Kramer, $P < 0.001$). In particular, a significant IOP reduction was detected (Tukey–Kramer, $P < 0.01$ vs. baseline) in eyes tamponaded with gas or air, whereas no difference was recorded in eyes tamponaded with silicone oil or densiron (Table 2). Corneal Descemet folds were seen in 11 eyes (8.3%) and choroidal folds in 3 eyes (2.3%); no eyes had postoperative ciliochoroidal detachment or suprachoroidal

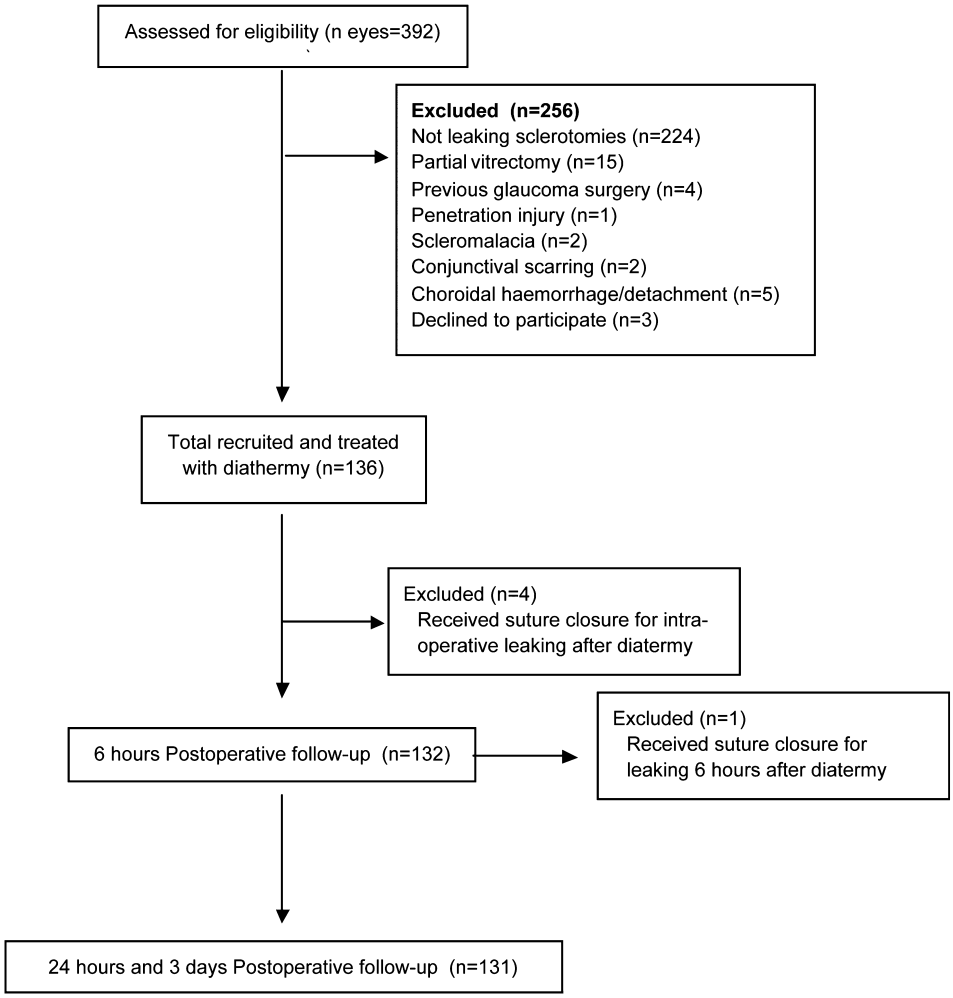

Fig. 1. Flow diagram of participants through each stage.

detachment, and no cases of collapsed eye or endophthalmitis were recorded.

At examinations performed at 24 hours and at 3 days, none of the sclerotomies had a positive Seidel test or conjunctival blebs; mean IOP in the whole group, and also in air/gas tamponaded eyes, was not different from baseline (Table 2). Corneal Descemet folds and choroidal folds had disappeared spontaneously.

The incidence of hypotony was 4.5% (6 of 132 eyes) at 6 hours, 1.5% (2 of 131 eyes) at 24 hours, and none (0 of 131 eyes) at 3 days after TSV. Logistic regression analysis showed that 6 hours postoperatively, hypotony was related to age (younger than 50 years) at the time of operation ($P = 0.031$). At 24 hours, no factor was related to postoperative hypotony.

The optical coherence tomography examination was performed in 32 eyes with 60 leaking sclerotomies treated by diathermy. The site of the sclerotomy was undetectable in all cases at 24 hours owing to a hyperreflective conjunctival cap shadowing the incision, without significant chemosis (Figure 2). The hyperreflective conjunctival mound persisted in 51 (85%) of the examined sclerotomies at 1 week; in the 9 remaining sclerotomies, the optical coherence tomography showed good apposition and alignment of the scleral tract, with minimal internal gaping and without ciliochoroidal detachment. At 1 month, the conjunctival cap had disappeared in all sclerotomies, and the inner and outer lips of the wound were found well aligned and apposed without conjunctival bleb, vitreous incarceration, or local ciliochoroidal detachment. In all 29 eyes with silicone oil tamponaded, this was removed after 3 months; in all eyes, the conjunctiva overlying the sclerotomies was freely mobile, shifting over the sclera >2 mm.

Discussion

The aim of this study was to evaluate the efficacy of a new technique, bipolar diathermy, in closing leaking

Table 1. Demographic, Clinical, and Surgical Characteristics of Eyes Treated With Diathermy

	Study Group (n = 136)
Age, mean ± SD, years	62.3 ± 13.0
Gender, n (%)	
Male	78 (57)
Female	58 (43)
Axial length >26 mm, n (%)	39 (29)
History of previous vitrectomy, n (%)	45 (33)
Preoperative lens status, n (%)	
Phakic	82 (60)
Pseudophakic	50 (37)
Aphakic	4 (3)
Surgical indication, n (%)	
Rhegmatogenous retinal detachment	37 (27)
Tractional retinal detachment	27 (20)
Proliferative vitreoretinopathy	9 (7)
Macular hole	10 (7)
Vitreous hemorrhage/opacity	26 (19)
Epiretinal membrane	16 (12)
Macular edema	7 (5)
Retained lens fragments	4 (3)
Tamponade materials, n (%)	
Gas	29 (21)
Air	68 (50)
Silicone oil	29 (21)
Densiron	10 (7)
Combined cataract extraction, n (%)	82 (60)
Vitrectomy platform/trocar, n (%)	
Constellation/slit-shaped blade	89 (65)
Pentasis/solid shaft type	47 (35)

sclerotomies after 23-gauge complete TSV. We found intraoperative closure in 97% of the cases, irrespective of surgical indication, lens status, trocar type, or tamponading agent.

The main drawback of an unsutured wound is that it might leak postoperatively, causing hypotony and related complications.[6–13,19–22] Risk factors for a leaking sclerotomy during 23-gauge TSV are myopia, thin sclera, history of previous vitrectomy, a young age at operation, vitreous base dissection, the use of intravitreal triamcinolone, multiple exchanges of instruments, pseudophakia, combined phacoemulsification and vitrectomy procedures, and absence of tamponade.[3,12–15,23]

The incidence of leaking sclerotomy requiring intraoperative suture placement in 23-gauge TSV ranges between 0% and 38.0%[6,12,19,20,22,24–28]; this variability is probably related to different inclusion criteria, such as surgical indications, vitreous base dissection, tamponading agents, and reoperations.

A leaking sclerotomy is usually treated by suture placement. This is usually a simple maneuver, but it can lead to some undesirable effects, such as astigmatism and foreign body sensation, and sometimes it could be difficult to place because of chemosis or bleeding.[29]

Alternative techniques, such as tissue glues[30–32] and polyethylene glycol–based hydrogel bandaging,[33] have been proposed but are not currently used. Releasable suture placement has been described,[34] although it requires release at the slit lamp on the first postoperative day, which can be difficult to perform when scleral or conjunctival bleeding occurs. Furthermore, during suture release, the monofilament lying on the ocular surface passes through the internal portion of the eye, possibly leading to infection. Delayed postoperative hypotony can also occur.[17]

In this study we used bipolar diathermy of the wound, including the conjunctiva and sclera. The technique resulted highly effective (97% closure) also in cases at high risk of leakage and avoided, in most of the cases, the need of a suture; it is very easy and fast to perform, does not add costs, and does not induce complications. Furthermore, in case of failure of diathermy, it is always possible to suture the leaking sclerotomy.

A major concern with sutureless vitrectomy is the possibility of postoperative hypotony. In our study, IOP slightly decreased (mean difference 1.7 mmHg) at 6 hours in eyes that had received air or gas tamponaded but was not different from baseline at 1 day and 3 days. This could be related to subclinical loss of air or gas, as previously reported.[12]

After 23-gauge TSV, the reported incidence of hypotony is 6.5% to 11.3% in the early postoperative period,[12,25] and 0% to 10% at 1 day,[12–14,19–22,24,25,28,35–38] with a resolution within 1 week. We found hypotony in 4.5% of the treated eyes at 6 hours, in 1.5% at day 1, and

Table 2. Intraocular Pressures Values Before and After 23-Gauge Vitrectomy of Eyes Treated With Diathermy

	Overall		Silicone Oil/Densiron Group		Gas/Air Group	
Preoperative	n = 132	14.4 ± 2.8	n = 37	14.0 ± 3.2	n = 95	14.5 ± 2.7
6 hours	n = 132	13.2 ± 3.8	n = 37	14.2 ± 4.5	n = 95	12.8 ± 3.4
24 hours	n = 131	13.8 ± 3.5	n = 37	14.8 ± 3.1	n = 94	13.4 ± 3.6
3 days	n = 131	15.1 ± 3.6	n = 37	14.4 ± 3.3	n = 94	15.4 ± 3.7
P (ANOVA)		<0.001		0.753		<0.001
P (Tukey–Kramer)		<0.01*		—		<0.01*

Data are expressed as mean IOP (mmHg) ± SD.
*6 hours versus preoperative.
ANOVA, analysis of variance.

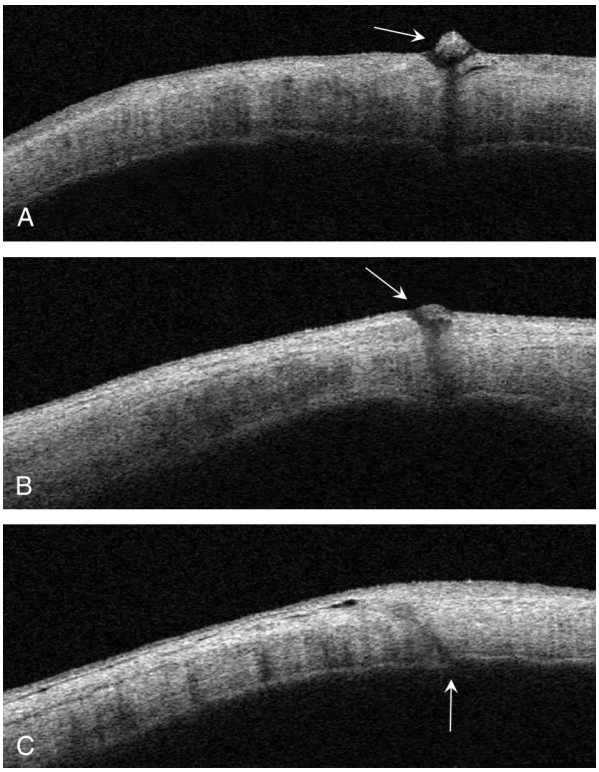

Fig. 2. Images obtained with the Visante anterior segment optical coherence tomography after diathermy showing morphological features of sclerotomies. **A.** At day 1 postoperatively, a hyperreflective cap is visible (arrow), which shadows the underlying sclera. **B.** At 1 week, the hyperreflective conjunctival cap persisted (arrow) reduced in size. **C.** At 1 month, the conjunctival cap disappeared, and the inner and outer lips of the wound are well aligned with barely visible internal wound gaping at the sclerotomy site (arrow).

in no eye at 3 days; the only factor associated with the occurrence of hypotony at 6 hours was the age younger than 50 years. Our overall rate is low, also considering that all eyes included had a high risk of hypotony, because all had at least one leaking sclerotomy and had received a vitrectomy with complete vitreous base dissection.

Several factors, such as the axial length, type of trocar, bevel, and tamponading agent used, have been reported to affect the closure of the sclerotomy.[12,14,39,40] In particular, the type of trocar entry blade may influence sclerotomy closure: a microvitreoretinal blade shaft design that creates a flat, linear, self-sealing incision seems to be more stable despite surgical manipulation than a beveled solid shaft.[14] Our technique was effective, regardless of the axial length, type of trocar, bevel, or tamponading agent used.

Regarding the mechanism of closure, the optical coherence tomography findings of Visante showed, in the immediate postoperative period and for several days, a hyperreflective area shadowing the scleral incision, and at 1 month, the inner and outer lips of the wound were well aligned without vitreous incarceration, indirect signs of leakage, or other reason for closure of the sclerotomies. From these findings we speculate that the mechanism of closure after bipolar diathermy may be the formation of a conjunctival plug, sealing the outer opening of the sclerotomy, more than scleral shrinkage. This hypothesis of a predominant effect on the conjunctiva rather than to the sclera is supported by the results in eyes with high myopia, in which diathermy was effective with no evidence of charring of the sclera, and by our experience of failure of closure when the diathermy was applied on bare sclera (B.F., unpublished data, 2011).

In all eyes tamponaded with silicone oil, when this was removed, the conjunctiva over the sclerotomies had no signs of fibrosis shortly after surgery; this result is especially important in cases of reoperation or future filtering surgery. At the time of silicone oil removal, the conjunctiva was freely mobile over the underlying sclera, in contrast to what occurs when a transconjunctival and transcleral suture is passed, when the conjunctiva fuses with the underlying sclera.

Another major concern about sutureless surgery is the possible occurrence of endophthalmitis. Although our study did not aim and was not powered to evaluate the risk of postoperative endophthalmitis, and a large prospective clinical trial is needed to explore this issue, we found no cases of endophthalmitis in our series. Theoretically, the closure of sclerotomies during the critical immediate postoperative period prevents leakage of intraocular fluid, thus reducing the entry of ocular surface fluid into the incisions and possibly the incidence of postoperative endophthalmitis.

There are some limitations to the study: first, the lack of a untreated control group, which does not allow us to determine the natural course of some of these leaky sclerotomies; second, a short follow-up period; and third, we did not report on other possible risk factors that may have influenced the postoperative failure of diathermy, like postoperative face position in non-liquid-filled eyes because its incidence was too low to evaluate.

In conclusion, diathermy after 23-gauge TSV has shown favorable results in sealing leaking sclerotomies, with a primary success rate of 97%. The availability of a safe technique that effectively closes sclerotomies in nearly all treated eyes may further favor the recommendation of 23-gauge TSV, thus extending the spectrum of its application to all vitreous diseases, particularly in cases in which wound leakage is expected.

Key words: bipolar diathermy, leaking sclerotomy, sutureless vitrectomy.

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