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TRANSCONJUNCTIVAL 23 GAUGE VITREO-RETINAL SURGERY

23-gauge transconjunctival vitrectomy is based on the concept of 25-gauge transconjunctival sutureless vitrectomy. It was developed to improve on the reported shortcomings of 25-gauge vitrectomy versus conventional 20-gauge vitrectomy, such as the high flexibility of the instruments, the occasional early postoperative ocular hypotony, and the poor efficiency of the instruments. The main problem encountered during the development of 23-gauge vitrectomy was that while its stability and functionality were improved over those of 25-gauge instruments, leakage from the sclerotomies also increased. This problem was finally solved by placing the sclerotomies for the microcannulas not perpendicular but tangential to the sclera as self-sealing tunnel incisions.

My preliminary experience on 23-gauge transconjunctival surgery is published in RETINA and is included in this VitreoTech Special.

Since I am now performing more than 90% of my cases with the 23 gauge technique, I like to share my and other well-experienced surgeon's techniques in order to create a world-wide 23-gauge platform for more broad knowledges.

Claus Eckardt, MD

TRANSCONJUNCTIVAL SUTURELESS 23-GAUGE VITRECTOMY

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One of the most innovative vitreoretinal surgery techniques introduced in recent years is transconjunctival sutureless vitrectomy developed by Fujii et al.[1,2] In this procedure, three polyamide microcannulas are inserted transconjunctivally through the sclera in the area of the pars plana. The vitreoretinal instruments and infusion line are then introduced through these cannulas into the vitreous cavity. Because a thin 25-gauge instrumentarium is used, the incisions left in the sclera after removal of the cannulas are so small that they self-seal without suturing.
The procedure has quickly found many advocates. It causes no surgical trauma to the conjunctiva, requires no scleral suture (and thus leaves no postoperative suture-related astigmatism), and entails a distinctly reduced rehabilitation time. Many vitreoretinal surgeons, however, reject the method at all or accept it only for special indications. One of the most frequent objections is that the 25-gauge instruments are too flexible for many of the complicated tasks performed on the retina and vitreous body.
A method for transconjunctival sutureless vitrectomy using a 23-gauge instrumentarium that overcomes this flaw is presented.

METHODS

PRINCIPLE

As in transconjunctival sutureless 25-gauge vitrectomy, 3 microcannulas for the instruments and infusion line are inserted transconjunctivally into the area of the planned sclerotomy. The incisions are not made perpendicular to the scleral surface (i.e., toward the posterior pole) but at a 30° angle parallel to the corneoscleral limbus (Fig. 1). The tunnel-like nature of these incisions facilitates the self-sealing of the wound after removal of the cannulas.

FIG. 1. POSITIONS AND DIRECTIONS OF THE SCLERAL TUNNEL INCISIONS. TO OBTAIN SCLERAL TUNNELS PARALLEL TO THE CORNEO-SCLERAL LIMBUS, THE SCLERAL INCISIONS ARE MADE RADIAL TO THE CORNEO-SCLERAL LIMBUS. EACH TUNNEL IS 0.72 MM WIDE.

FIG. 2. SPECIALLY DESIGNED PRESSURE PLATE FOR HOLDING THE CONJUNCTIVA FIRMLY AGAINST THE SCLERA DURING CONJUNCTIVAL AND SCLERAL INCISION WITH THE STILETTO BLADE AND INSERTION OF THE MICRO-CANNULAS.

TECHNIQUE

The procedure is started by pushing the conjunctiva 1 mm to 2 mm laterally (i.e., parallel to the corneal limbus) in the infero-temporal, superotemporal, and superonasal quadrants using a special pressure plate (DORC, Zuidland, Holland) to hold it firmly to the sclera (Fig. 2). A 23-gauge stiletto blade (45° angle; DORC 1282-D-0.6, Zuidland, The Netherlands) is then inserted at a 30° to 40° angle through the conjunctiva, sclera, and pars plana 3.5 mm from the corneoscleral limbus (Fig. 3). To obtain scleral tunnels parallel to the corneoscleral limbus, the scleral incisions are made radial to the corneoscleral limbus (Fig. 1). The incision with the 23-gauge stiletto blade is 0.72 mm wide. Constant pressure is applied to the pressure plate while the incision is made and during withdrawal of the stiletto blade to prevent slippage of the conjunctiva

THE AUTHOR HAS A PROPRIETARY INTEREST IN THE MICROCANNULA/INSERTER SYSTEM. REPRINT REQUESTS: CLAUS ECKARDT, AUGENKLINIK STAEDTISCHE KLINIKEN FRANKFURT AM MAIN-HOECHST, GOTENSTRASSE 6–8, 65929 FRANKFURT, GERMANY; E-MAIL: C.ECKARDT@EM.UNI-FRANKFURT.DE REPRINT FROM RETINA: FEBR./MARCH 2005, 25(2): 208-211

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ECKARDT 23-GAUGE VITRECTOMY SYSTEM

Dr. Claus Eckardt has developed a new 23-gauge transconjunctival sutureless surgical system which allows minimally invasive ophthalmic surgery without the surgical constraints of smaller instrumentation.

The specially developed Pressure Plate compresses the conjunctiva into the sclera bed and provides a fixation point from which to make the entry into the eye. Once the 23-gauge incision is made, the cannulas are gently placed into the wound site, allowing for a very smooth, non-traumatic insertion.

1272-E06

ECKARDT 23 GAUGE VITRECTOMY SYSTEM, CONSISTING OF:
• 3 X BLUNT INSERTOR • 3 X INSTRUMENT CANNULA • 2 X INFUSION CANNULA • 1 X INFUSION LINE • 3 X CLOSURE PLUG - LONG • 3 X CLOSURE PLUG - SHORT

1272-ED06

DISPOSABLE ECKARDT 23 GAUGE VITRECTOMY SYSTEM, CONSISTING OF:
• 3 X BLUNT INSERTOR • 2 X INSTRUMENT CANNULA
• 1 X INFUSION CANNULA • 1 X INFUSION LINE
• 3 X CLOSURE PLUG - LONG

2115
PRESSURE PLATE

1282-D06
23-GAUGE 45° HOOKED STILETTO (STERILE, BOX/5)

3269-SB06
SPAIDE TOTALVIEW ENDOILLUMINATION PROBE, UNIQUE TIP DESIGN COMBINED DIRECT AND DIFFUSE WIDE FIELD ILLUMINATION, 23 GAUGE / 0.6 mm. (BOX/6 STERILE)

against the sclera. Should displacement occur, it would be difficult if not impossible to subsequently locate the incision in the conjunctiva and sclera.

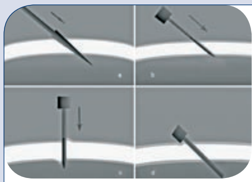

FIG. 3. TECHNIQUE FOR TUNNEL INCISION AND INSERTION OF THE MICROCANNULAS. **A**, A 23-GAUGE STILETTO BLADE IS INSERTED TRANSCONJUNCTIVALLY INTO THE SCLERA AT A 30° TO 45° ANGLE. **B**, THE INSERTER IS INTRODUCED INTO THE TUNNEL INCISION. **C**, TO INSERT THE MICROCANNULAS INTO THE TUNNEL, THE INSERTER IS MOVED FROM ITS ORIGINAL TANGENTIAL POSITION INTO A POSITION PERPENDICULAR TO THE SCLERAL SURFACE, WHERE IT EXERTS THE NECESSARY PRESSURE ON THE GLOBE. **D**, MICROCANNULA IN PLACE WITHIN THE TUNNEL INCISION AFTER REMOVAL OF THE INSERTER.

The microcannula is then inserted through the conjunctival incision and into the scleral tunnel using a specially designed blunt inserter (DORC). The microcannula and the inserter are both made of steel. The length of the cannula (without its head) is 4 mm, the internal diameter of the cannula is 0.65 mm, and the external diameter is 0.75 mm. The inserter is not a beveled trocar but a blunt instrument whose spatula like tip merges with a cylindrical body holding the microcannula (Fig. 4). The external openings of two of the three cannulas are funnel shaped (Figs. 5 and 6) to facilitate insertion of the instruments. The instruments used for transconjunctival sutureless 23-gauge vitrectomies are a vitreous cutter, widefield endoillumination, flute needle with back flush handle, endgripping forceps, scissors, endolaser probe, and endodiathermy probe. A pneumatic or electromagnetic vitreous cutter was attached to the vitrectomy unit (Associate, DORC). A cutting rate of up to 1,200 per minute and suction of up to 500 mmHg were used.

PATIENTS

In a retrospective study, transconjunctival sutureless 23-gauge vitrectomy was performed on 41 consecutive eyes. The indications for vitrectomy were macular pucker in 12 cases, macular hole in 11, proliferative or nonproliferative diabetic retinopathy in 9, rhegmatogenous retinal detachment in 8, and central retinal vein occlusion in 1. Twenty-two of the eyes received gas tamponade at the end of the operation. Perfluorocarbon liquid was injected intraoperatively in seven eyes to reattach the retina. During injection with a conventional blunt cannula, the infusion line was opened using a three-way stopcock to allow superfluous liquid to flow out of the vitreous cavity. In 14 eyes, **vitrectomy was combined with phacoemulsification** and implantation of a posterior chamber lens.

In these cases, the three cannulas were emplaced before phacoemulsification. During the subsequent cataract surgery, which was performed via the clear cornea approach, the openings were sealed with plugs. Sixteen eyes were already pseudophakic; in 10 eyes, the clear crystalline lens was not removed. At conclusion of the operation, the cannulas were simply withdrawn from the scleral tunnels. The conjunctiva was pushed laterally using a cotton-wool applicator to separate its incision from the scleral incision. After surgery, the patients were given antibiotics and corticosteroid eye drops; corresponding substances were not injected into the subconjunctival space.

The patients were examined daily for the first 4 days after the procedures and at ≈ 4-week intervals thereafter. The follow-up period lasted from 4 weeks to 11 weeks (average, 5 weeks).

RESULTS

In about one third (15/41) of the eyes, the scleral incision with the stiletto blade led to microbleeding from episcleral vessels. Usually this was only a small hemorrhage for which diathermy was never necessary. The pressure plate enabled successful insertion of the cannulas into the conjunctival and scleral incision in all eyes. Placement of the cannula within the tunnel always resulted in stoppage of the bleeding. Use of the cannulas was free of complications in all 41 eyes. Not even in cases requiring extensive scleral indentation for visualization of the extreme retinal periphery did slippage or loss of the cannula occur. There were also no cannula-induced lesions of the posterior capsule in phakic or pseudophakic eyes.

The vitreoretinal instruments used in the present study (end-gripping forceps, scissors, flute needle, endodiathermy probe, and endolaser probe) are similar in design and utility to standard 20-gauge instruments. Only the 23-gauge vitreous cutter was somewhat slower at performing the extensive vitrectomy than a 20-gauge cutter. The slight flexibility of the instruments had no negative intraoperative effects. Especially the 23-gauge flute needle, endolaser probe, and endoillumination probe showed significantly lesser flexibility than the corresponding 25-gauge instruments. Compared with 20-gauge instruments, the different 23-gauge instruments could almost be used identically to guide the eye when vitreoretinal surgery in the extreme periphery was necessary.

FIG. 4. INSERTER WITH MICROCANNULA. THE INSERTER HAS A BLUNT SPATULA-LIKE TIP FOR EASY INSERTION INTO THE PREPARED SCLERAL TUNNEL. THE LENGTH OF THE CANNULA (WITHOUT ITS HEAD) IS 4 MM. THE OUTER DIAMETER IS 0.75 MM.

FIG. 5. FUNNEL-SHAPED OPENING OF THE CANNULA HEAD TO FACILITATE INSERTION OF THE INSTRUMENTS.

Withdrawal of the cannulas occasionally resulted in minor subconjunctival bleeding or accumulation of liquid -never gas- in the area of the sclerotomy. The bleeding came mainly from episcleral vessels, occasionally though also from the sclerotomies; it could always be stopped by applying light pressure with a cotton-wool applicator. A small subconjunctival hemorrhage, which was seen at the end of the surgery in some cases, usually absorbed within 2 days or 3 days after the operation. Sutures were not used in any of the cases to close the conjunctival or scleral incisions.

At follow-up examination, the intraocular pressure (measured with Haag-Streit Goldmann applanation tonometry) was consistently in the normal range or slightly elevated. Not a single eye had an intraocular pressure of <12 mmHg on the first postoperative day or at any other later date during the control examinations. No postoperative subconjunctival gas was observed. The retinal findings were similar to those after conventional 20-gauge vitrectomy. Two of the eyes with proliferative diabetic retinopathy exhibited slight bleeding into the vitreous cavity in the early days after the operation. By performing 23-gauge vitrectomy, the retina could be reattached in all eyes operated on for retinal detachment.

DISCUSSION

Sutureless self-sealing sclerotomies for pars plana vitrectomy were first described by Chen[3] in 1996. Other researchers have since reported their experience with and modifications of this technique.[4-8] Instead of the usual right-angled incision through the sclera, a tunnel-like tangential incision is made at a 30° angle through the sclera. Suture closure is not required because the wound borders are pressed together by the intraocular pressure ensuing from the oblique course of the incision. The tunnels can be made in the posterior-anterior direction (i.e., in the direction to the corneoscleral limbus),[3,5] in the anterior-posterior direction,[6] or parallel to the corneoscleral limbus.[4,9] Unlike conventional sclerotomies, which are always accompanied by temporary postoperative astigmatism secondary to suture closure,[10] tunnel incisions rarely give rise to astigmatism and lead only to a slight postoperative inflammatory reaction.

Although the conjunctiva is always opened more or less wide in most sutureless self-sealing sclerotomy techniques, transconjunctival vitrectomy described by Fujii et al.[1,2] requires merely a point incision for the microcannulas. Sclerotomies in 25-gauge vitrectomy require no suturing because they are only ≈ 0.5 mm in diameter compared with the 1.15-mm width oft he sclerotomies in conventional 20-gauge vitrectomy. If 23-gauge instruments are used in combination with microcannulas, the sclerotomies are too large to allow perpendicular scleral incisions without suture closure (C. Eckardt, unpublished data). My group therefore examined whether the cannulas can be placed in tunnel incisions (0.72 mm wide) running tangential to the scleral surface. In our preliminary investigations on eyes from eye banks, we began by using a beveled trocar in accordance with the technique of Fujii et al.[1,2] We found, however, that the trocar did not cut well enough to make a tunnel incision and instead used a stiletto blade. The cannulas were then inserted into the tunnel with the aid of a special blunt inserter. The cannulas remained firmly in place in all eyes, even during lengthy procedures requiring extensive vitrectomy on the retinal periphery under circular scleral indentation. In a few eyes, a slight accumulation of infusion liquid drained from under the conjunctiva when the cannulas were withdrawn at the end of the operation. The fact that the intraocular pressure never dropped on the first postoperative day indicates that tight self-sealing of the tunnel incision occurred. By contrast, Fujii et al[2] occasionally observed transient postoperative hypotony after vitrectomies with the 25-gauge system. It appears therefore that the size of the incision is not as important for closure of the sclerotomies as is the angle of the incision through the sclera.

The 25-gauge vitrectomy system has the advantage over the 23-gauge vitrectomy system that the microcannulas can be positioned in a single step using the sharp trocar. The tangential tunnel incision of the 23-gauge vitrectomy system described here, by contrast, requires that the conjunctiva first be pressed against the sclera using an additional tool, followed by making the tunnel incision with the stiletto blade and insertion of the cannulas using the blunt inserter. In our opinion, however, this shortcoming is compensated for by the comparably easy insertion of the cannulas into the tunnel incision and by the advantages associated with the use of the larger and more stable 23-gauge instruments.

In summary, the sutureless 23-gauge vitrectomy procedure appears to be a viable alternative to 25-gauge vitrectomy. It offers all of the advantages of the minimally invasive transconjunctival vitrectomy system developed by Fujii et al1,2 plus the benefits of a sturdier and larger instrumentarium.

Key words: pars plana vitrectomy, self-sealing sclerotomies, transconjunctival sutureless vitrectomy.

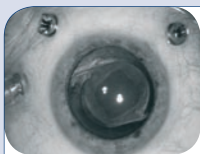

FIG. 6. STANDARD POSITION OF THE THREE MICRO-CANNULAS IN A RIGHT EYE. NOTE THE FUNNEL-SHAPED OPENING OF THE SUPERONASAL AND SUPEROTEMPORAL CANNULAS FOR EASY INSERTION OF THE VITREORETINAL INSTRUMENTS.

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23-GAUGE TRANSCONJUNCTIVAL VITRECTOMY SYSTEM:

EASIER AND MORE EFFICIENT THAN 25G SYSTEM

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The Eckardt 23-gauge vitrectomy system makes it possible to perform transconjunctival sutureless vitreous surgery easier and more efficiently than the 25-gauge system.

Recently, more and more vitreoretinal surgeons are using the 25-gauge instead of the 20-gauge transconjunctival vitreous surgery system that was developed by de Juan et al. This 25-gauge system has many advantages over the conventional 20-gauge system; e.g., shorter surgical time, less surgical invasiveness, less postoperative discomfort, and faster visual recovery time. These features are attained because the instruments are smaller in diameter (~0.5 mm) than the 20-gauge (~0.9 mm) system, and also because of a trocar-cannula system that eliminates conjunctival openings or postoperative sutures.

However, the use of small diameter instruments is accompanied by some undesirable features; e.g., they are too flexible and ineffective in cutting and aspirating vitreous gel and in dissecting fibrous membrane. In addition, postoperative hypotony is commonly experienced if vitrectomy is performed at the vitreous base. Due to these disadvantages, the 25-gauge vitreous surgery system is recommended for use only on relatively simple cases, such as epiretinal membrane peeling, vitrectomy for macular edema and macular hole, simple vitreous hemorrhage, and not for more complex vitreoretinal disorders that require membrane removal and/or complete peripheral vitrectomy. This may be why there are still many surgeons who hesitate to use and others who have abandoned the 25-gauge system.

To counter these problems, DORC has introduced the Eckardt 23-gauge transconjunctival vitrectomy system. Although the difference in diameter between 25-gauge and 23-gauge (0.6 mm) is only 0.1 mm, the flexibility of the instruments is completely different. The difference in the stiffness of the 23-gauge and 25-gauge vitreous cutters was examined by hanging a 60 gram weight (Figure 1). The angle of the bend was approximately 10° for the 23-gauge and 21° for the 25-gauge vitreous cutter. We also measured the aspiration rate (aspirated fluid volume/time) of the 23- and 25-gauge vitreous cutter at the same aspiration pressure. Our preliminary data showed that the aspiration rate of the 23-gauge vitreous cutter was approximately 1.5 times greater than that of the 25-gauge cutter. This difference is probably related to the ratio of the cross sectional area of the 23- and 25-gauge vitreous cutters.

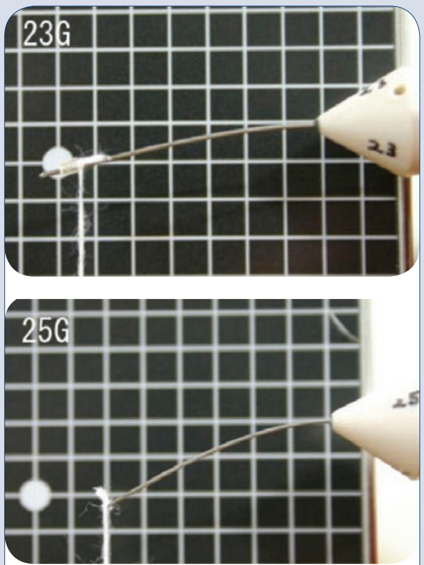

FIG. 1. WITH 60 GRAM WEIGHT, 23-GAUGE CUTTER SHOWS MORE STIFFNESS.

My experience with the 23-gauge system was gained from performing surgery on 55 eyes; 11 eyes with epiretinal membrane proliferation, 8 with diabetic retinopathy, 4 with diabetic macular edema, 7 with a macular hole, 7 with rhegmatogenous retinal detachment, 7 with vitreous hemorrhage, 4 with retinal vein occlusion, and 7 other eyes. In all cases, there was no need to convert to the 20-gauge system, except for one lens dislocation case in which a 20-gauge fragmatome was necessary.

After at least a 6 month postoperative follow-up, the surgical complications included; 1 eye with an iatrogenic retinal tear, 1 eye with subretinal infusion, 6 eyes with low intraocular pressure (<10 mmHg) one day after the surgery, but the pressure returned to normal levels (≥ 10 mmHg) within a few days. A postoperative vitreous hemorrhage was observed in one case of diabetic retinopathy that required a second operation. No other cases required a second operation. No other complications such as postoperative retinal tear or retinal redetachment was experienced.

Compared to my experience on over 150 eyes with the 25-gauge vitrectomy system, the surgical maneuvers with the 23-gauge system were much easier than with the 25-gauge system. This was most evident when performing vitreous gel cutting at the vitreous base, and peeling of epiretinal and internal limiting membranes. These surgical maneuvers were sometimes difficult with the 25-gauge instruments, because the shafts of the instruments were too flexible and the heads (platforms) of the forceps were too small. Overall, the manipulation of the 23-gauge system was more like that of the conventional 20-gauge system.
In addition, the 23-gauge light pipes can provide brighter illumination than the 25-gauge light pipe, although with the recently developed bright light source, the 25-gauge light pipe can now provide enough brightness.

Creating 3-ports for the cannula-trocar system required some experience. However, the procedures are not complex and can be acquired relatively quickly. In order to have a self-sealing wound, the sclerotomy should be oblique (30 degree tangential) to the sclera. Once this is properly performed, in most cases, a self-sealing wound can be achieved even after peripheral vitreous gel cutting. f there is a fluid leakage from the wound, I prefer using air tamponade up to approximately 50% of the vitreous cavity and instruct patients to maintain a supine position postoperatively. Placing a stitch is another option, although it causes a foreign body sensation.

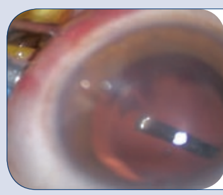

FIG. 2. INTRAOPERATIVE VIEW OF 23-GAUGE VITRECTOMY. VITREOUS GEL CUTTING CAN BE EASILY PERFORMED WITH SCLERAL INDENTATION.

Low intraocular pressure (<10mmHg) was observed in approximately 20% of the cases after 25-gauge vitrectomy and 11% of the cases after 23-gauge vitrectomy in my experience. Self-sealing of the wound seems more easily achieved with 23-gauge vitrectomy because of the difference in shape and length of the scleral tunnel. After 25-gauge vitrectomy, the shape of the wound is linear, sometimes invisible, and the scleral tunnel is considered to be longer. With the 25-gauge vitrectomy system, the shape of the wound is Y-shape, clearly visible, and the scleral tunnel is shorter (Figure 3).

Good surgical indications for using the 25-gauge vitrectomy, such as epiretinal membrane proliferation, macular edema, macular hole, and simple vitreous hemorrhage, are also good for the 23-gauge vitrectomy system. In addition, with more stiffness and efficiency with the 23-gauge instruments, more complex cases, such as rhegmatogenous retinal detachment, proliferative vitreoretinopathy, and diabetic retinopathy can be treated more easily.

Although it does not appear possible to eliminate the conventional 20-gauge vitrectomy system, the 25-gauge vitrectomy system could be replaced by the 23-gauge vitrectomy system in the near future because of the many advantages of 23-gauge vitrectomy system over 25-gauge vitrectomy system.

FIG. 3. POSTOPERATIVE PHOTOGRAPH OF THE RIGHT EYE (LEFT PANEL AFTER 23-GAUGE VITRECTOMY) AND LEFT EYE (RIGHT PANEL AFTER 25-GAUGE VITRECTOMY) OF THE SAME PATIENT. THE SCLERAL WOUND IS DIFFICULT TO IDENTIFY AFTER 23-GAUGE VITRECTOMY (LEFT PANEL), WHILE THE Y-SHAPED WOUND (ARROW) IS CLEARLY VISIBLE AFTER 25-GAUGE VITRECTOMY (RIGHT PANEL).

"IN MY OPINION, 23-GAUGE VITRECTOMY IS THE NEW STANDARD OF SURGERY"

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Since the introduction of 25-gauge surgery several years ago, I have used this transconjunctival technique in simple vitrectomies, such as removal of vitreous opacities. I've often tried to expand the application of the 25-gauge technique to more complicated cases, such as macular surgery, which was unsuccessful for several reasons. First, the 25-gauge endolight did not provide enough illumination. Next, all 25-gauge instruments such as the vitrectome, endolaser probe, endoforceps are highly flexible, and bend easily when the eye is manipulated for peripheral retinal work. Thus, complete removal of the vitreous up to the vitreous base, and peripheral endolaser coagulation is hard, if not impossible to obtain.

Therefore, even after several years of experience and instrument improvement (xenon light, stiffer instruments), less than 5% of all my surgeries were performed using the 25-gauge technique. In a significant number of patients, hypotony due to leakage through the sclerotomies was found during the first postoperative days, needing repeated secondary suturing of the sclerotomies. Moreover, the need to dispose of the 25-gauge trocar system made these surgeries more expensive compared to 20-gauge, without an increased reimbursement.

After having performed the first 23-gauge "trial" vitrectomies in April 2005, I have immediately decided to adopt the 23-gauge technique as routine for the majority of my cases. The routine application of the 23-gauge technique was started in September 2005, after adjusted custom-packs were designed and produced.

ADVANTAGES OVER 20-GAUGE

1) For the patient
Since no conjunctival peritomy is needed, no resorbable sutures have to be used at the end of the surgery. This markedly increases patient comfort after the surgery, and allows patients to be discharged from the hospital after only one night, rather than the usual two night stay required after 20-gauge surgery. Secondly, the postoperative wound healing goes much faster, and the eyes are less inflamed allowing the patient to return to work more quickly.

In patients that underwent a previous filtering surgery for glaucoma, the 23-gauge technique allows me to perform a vitrectomy without the need for a peritomy without compromising the function of the filtration bleb. Moreover, if a patient who received the 23-gauge approach needs to undergo filtration surgery afterwards, the surgeon can use an intact conjunctiva to create a filtration bleb, with a much higher success rate compared to patients operated with a conjunctival peritomy.

2) For the surgeon
The surgeon can skip performing a conjunctival peritomy and suturing the infusion at the beginning of the surgery. At the end of the surgery, the 23-gauge plugs are removed from the eye and closed by simple "massaging" of the sclerotomies, without the need for suturing all three sclerotomies and closing the conjunctiva. This saves surgery time.

During the vitrectomy, almost the same amount of endoillumination is available especially when a xenon light source is used. Although the diameter of the 23-gauge vitrectome is smaller compared to 20-gauge, removing the vitreous can be done in the same amount of time when the machine settings are appropriately adjusted. I typically double the amount of vacuum used during 20-gauge surgery. Careful inspection of the sclerotomies for incarcerated

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ECKARDT 23-GAUGE VITRECTOMY INSTRUMENTS

As the tensile strength of 23-gauge instruments is similar to current 20 gauge instruments, there is no limitation to the type of surgical procedure that can be performed. Severe diabetic retinopathy and PVR can now be successfully managed with this new 23-gauge system.

A complete line of intraocular forceps, scissors, membrane and backflush instruments and laser probes are available:

1286-W06

MICROFORCEPS: ECKARDT ENDGRIPPING

1286-WD06

MICROFORCEPS: DISPOSABLE, ECKARDT ENDGRIPPING (STERILE, BOX/5)

1286-M-0.6
MICROSCISSORS : HORIZONTAL

1281-BTD-0.6
DISPOSABLE BRUSH BACKFLUSH INSTRUMENT WITH 23-GAUGE BRUSH NEEDLE (STERILE, BOX/5)

1290-DSS-0.6
DIAMOND-DUSTED SWEEPERS, 23-GAUGE (STERILE, BOX/5)

LASERPROBES:

7123-ALC

23G STRAIGHT LASERPROBE WITH ALCON ADAPTOR (STERILE BOX/6)

7123-HGM
23G STRAIGHT LASERPROBE WITH HGM ADAPTOR (STERILE BOX/6)

7223-IRI
DIRECTIONAL LASERPROBE, WITH IRIDEX ADAPTOR, 23 GAUGE / 0.6 MM. (STERILE, BOX/6)

7223-ALC
DIRECTIONAL LASERPROBE, WITH ALCON ADAPTOR, 23 GAUGE / 0.6 MM. (STERILE, BOX/6)

7223-HGM
DIRECTIONAL LASERPROBE, WITH HGM ADAPTOR, 23 GAUGE / 0.6 MM. (STERILE, BOX/6)

(DIRECTIONAL LASERPROBES ARE NOT AVAILABLE IN THE U.S.A.)

vitreous fibres can be skipped, since the 23-gauge plugs prevent vitreous incarceration. Finally, since the 23-gauge system is a closed “non-leaking” type of surgery, much less BSS is used, resulting in a “dryer” operating field.

3) For the operating room personnel
Compared to a 20-gauge vitrectomy, less than half the number of instruments is required, since many surgical steps (suturing) are skipped. Therefore, preparing the instrument table takes significantly less time. Also the learning curve for new scrub nurses is much faster. Moreover, a smaller number of instruments needs cleaning after the surgery, again saving time.

ADVANTAGES OVER 25-GAUGE

Removing the vitreous with a 25-gauge vitrectome takes significantly more time compared to a 23-gauge or 20-gauge vitrectome, even at the maximal aspiration rate. When a vitreous hemorrhage is removed with a 25-gauge vitrectome, the clotted blood easily occludes the vitrectome. This is rarely the case with a 23-gauge vitrectome. The higher rigidity of the 23-gauge vitrectome allows a more complete removal of the vitreous up to the vitreous base.

Unlike the 25-gauge instrument, the “feeling” of a 23-gauge endgripping forceps is comparable to a 20-gauge forceps. While the 25-gauge forceps makes it very difficult to perform a complete peeling of the inner limiting membrane. the newly designed smoothly curved laser probe is available which slides through the 23-gauge instrument cannulas. This allows effortless laser operation on the peripheral retina, which is hard to perform using a straight 25-gauge laserprobe.

Although xenon light sources can allow adequate endoillumination with a standard 25-gauge light pipe, the output is insufficient when a wide-field illuminator is used. However, the diameter of a wide-field 23-gauge handheld lightpipe allows enough light to enter the eye for a good illumination.

A major advantage over the 25-gauge is that the 23-gauge instrument cannulas allow the injection of silicone oil. When a narrow-wall polyamide 23-gauge cannula is fitted on the injection syringe, a complete oil-fill can be obtained in less than one minute.

Since the sclerotomies are made with an MVR-blade, creating a slit-like incision instead of a round incision as in 25-gauge, and are made oblique in the sclera, the incisions are always self-sealing and post-operative hypotony is not an issue.
The DORC 23-gauge system can be reused, which markedly reduces the surgery cost compared to a 25-gauge procedure.

SURGICAL RESTRICTIONS COMPARED TO 20-GAUGE SURGERY

Some limitations still exist in 23-gauge surgery. A phacofragmentation needle does not yet exist on my vitrectomy machine. This necessitates the use of 20-gauge instruments in the case of a dropped lens nucleus. Since the 23-gauge instrument cannulas are tubular, no curved instruments can be inserted into the eye. Therefore, I still prefer to operate with 20-gauge instruments on highly complex cases, such as tractional diabetic retinal detachments, or macular translocations. Although “standard” silicone oil can be removed from the eye, at present, heavy silicone oil cannot be extracted yet through 23-gauge instrument plugs. Lastly, when an encircling band is sutured around the globe, which is still often performed in retinal detachment cases, the use of the 23-gauge technique is obsolete.

At present, I perform approximately 60% of my surgeries using 23-gauge instruments, and this percentage will probably further increase as new instruments are being designed. Therefore, in my opinion, 23-gauge surgery is the new standard type of surgery.

TRANSCONJUNCTIVAL SUTURELESS SILICONE OIL REMOVAL IN PHAKIC EYES WITH 23 GAUGE INSTRUMENTATION

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The innovation of 23-gauge instrumentation allows for minimally invasive vitreoretinal surgery utilizing smaller sutureless incisions, as compared with conventional pars plana vitrectomy. The procedure is started by pulling the conjunctiva a couple of millimeters laterally using a special pressure plate to hold it firmly to the sclera. A 23-gauge stiletto blade with 45° angle is inserted at a 25-30° angle through the conjunctiva, sclera and pars plana 3.5 mm from the corneoscleral limbus. The incision with 23-gauge stiletto blade is 0.72 mm wide. The microcannula is then inserted through the conjunctival incision and into the scleral tunnel using a specially designed blunt inserter by DORC. The length of the cannula is 4 mm, the internal diameter is 0.65 mm, and the external diameter is 0.75 mm. (*)

Silicone oil removal is an easy and short procedure in aphakic eyes. Two self sealing clear corneal incisions are being used to remove the silicone oil in the aphakic eyes. After insertion of anterior chamber maintainer, the silicone oil is aspirated or passively removed through the second corneal incision. In phakic eyes, one has to perform a peritomy and sclerotomies to remove the silicone oil and the incisions should be sutured at the end of the surgery.

We investigated the 23 gauge cannulas to remove the 1000 cs silicone oil in phakic eyes. Three 23-gauge cannulas were used to remove the silicone oil (one for infusion and the other two for silicone oil removal). Also in another group, the silicone oil was aspirated with a 23-gauge polyamide cannula (Figure-A). In the second group only two cannulas were inserted, one for infusion and the other one for aspiration (Figure-B). In the latter group (active aspiration with polyamide cannula) the silicone oil removal time was three times shorter than passive removal through two 23-gauge cannulas.

* Eckardt C. Transconjunctival sutureless 23-gauge vitrectomy. Retina 25:208-211, 2005

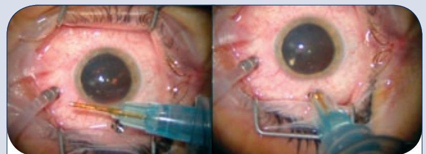

FIG. A
23 GAUGE SUTURELESS ACTIVE SILICONE OIL REMOVAL WITH 23 GA POLYAMIDE CANNULA.

FIG. B
SUTURELESS PASSIVE SILICONE OIL REMOVAL WITH TWO 23 GAUGE CANNULAS.

COMPARISON BETWEEN 25-GAUGE AND 23-GAUGE SUTURELESS VITRECTOMY TECHNIQUES

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OBJECTIVE: To describe suitable indications, applicability of various surgical procedures and complications that occurred using 25-gauge and 23-gauge sutureless vitrectomy techniques.

DESIGN: Retrospective review of two consecutive interventional case series.

PARTICIPANTS: Two-hundred eyes that underwent vitrectomy using one of two suture-less techniques: one-hundred using 25-gauge and one-hundred using 23-gauge. In the 25-gauge series the largest number of cases included vitreomacular interface disorders and floaters (in 75% of eyes). In the 23-gauge series, besides simple cases like vitreomacular interface disorders (in 38% of eyes), there was a significant number of cases with more complex pathology including proliferative diabetic retinopathy, rhegmatogenous retinal detachment and proliferative vitreoretinopathy (in 49% of eyes).

RESULTS: Good instrumentation in both series made it possible to apply most of the standard procedures with the exclusion of perfluorocarbon liquid and silicone oil injections which were applied in the 23-gauge series exclusively. The average operating time in the 25-gauge series was 45 minutes (range, 20-80 minutes) and in the 23-gauge series it was 60 minutes (range, 35-90 minutes). Complications in the 25-gauge series occurred in 54% and in the 23-gauge series in 36% respectively. The most frequent complication in both series was a transitory postoperative hypotony (<10 mmHg), which occurred in 41% of eyes operated with 25-gauge compared to 14% of eyes operated with the 23-gauge technique. The difference was statistically significant (p<0,001; chi-2=18,28). Neither this nor any other complication that occurred interfered with the final visual outcome.

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CONCLUSION: 25-gauge and 23-gauge sutureless vitrectomies are safe and minimally invasive surgical techniques that reduce the operative duration and enhance the postoperative recovery by simplifying the surgical procedure. **23-gauge is superior to 25-gauge vitrectomy because it offers advantages of sutureless surgery and is safer regarding the postoperative hypotony. It offers benefits of a sturdier instrumentation and is suitable for larger number of indications.**

REVIEW

One of the most innovative techniques in vitreoretinal surgery introduced in recent years is transconjunctival sutureless vitrectomy developed by Fujii et al. [1,2]. In this procedure, three polyamide microcannulas are inserted transconjunctivaly through sclera in the area of pars plana. The vitreoretinal instruments and infusion line are then introduced through these annuals into the vitreous cavity. Because of the small size of sclera incisions measuring 0,5 mm, the openings left in the sclera after removal of the annuals are so small that they allow for self-sealing.

The procedure has quickly found many advocates, due to reduced surgical trauma to conjunctiva and sclera, absence of suture-related astigmatism and enhanced postoperative recovery. Other vitreoretinal surgeons, however, rejected the method because of difficulties to perform complicated tasks caused by the extreme flexibility of the instruments and problems with some procedures such as perfluorocarbon- and silicone oil injection. This has limited the use of the 25-gauge technique to a small number of simple indications. Eckerd 3 has recently improved the transconjunctival sutureless technique introducing the 23-gauge sutureless vitrectomy system, which overcomes all limitations mentioned above. Twenty-three-gauge instruments are similar in design and utility to the standard 20-gauge and less flexible than 25-gauge instruments. It is easy to perform all the standard procedures, which makes the technique suitable for almost all indications.

MATERIAL AND METHODS

We retrospectively studied two consecutive series that underwent sutureless vitrectomy: one-hundred eyes with 25-gauge instruments and one-hundred with 23-gauge. The indications for 25-gauge vitrectomy included idiopathic piratical membrane (32 cases or 32 %), macular hole (30 cases/ 30 %), vitreomacular traction syndrome (3 cases), floaters (13 cases), proliferative diabetic retinopathy (5 cases), rhegmatogenous retinal detachment (2 cases), non-diabetic vitreous hemorrhage (4 cases), diabetic cystoids macular oedema (6 cases) and complications of anterior segment surgery (5 cases). The indications for 23-gauge vitrectomy included idiopathic piratical membrane (21 cases or 21%), macular hole (17 cases/ 17 %), vitreomacular traction syndrome (3 cases), proliferative diabetic retinopathy (26 cases), rhegmatogenous retinal detachment (20 cases), proliferative vitreoretinopathy (3 cases), retinal detachment with a giant tear (1 case), non-diabetic vitreous hemorrhage (6 cases), diabetic cystoids macular oedema (1 case), complications of anterior segment surgery (1 case) and postoperative endophthalmitis (1 case).

The transconjunctival sutureless 25-gauge vitrecomy surgical technique consisted of a transconjunctival insertion of a cannula using a bevelled trocar that created a conjunctival and scleral incision measuring 0,5 mm. Three incisions using trocar cannulas were made in the inferotemporal, superotemporal and superonasal quadrants. An infusion cannula was inserted into the inferotemporal cannula. Plugs were used to temporarily close other entry sites.

Instruments used for the transconjunctival sutureless 25-gauge vitrecomy included vitreous cutter, wide-field endoillumination, back flush needle, membrane pick, end-gripping forceps, micro-scissors, endoalser probe and endodiathermy probe. All instruments are made by DORC/Netherland. A pneumatic cutter was attached to the vitrectomy unit (Accurus, Alcon). A cutting rate up to 1200 per minute and suction up to 600 mmHg were used.

Membrane peeling was performed in 83 eyes (83%). Thirty-three eyes (33%) received gas tamponade at the end of the operation. In 59 eyes (59%) vitrectomy was combined with phacoemulsification and implantation of a posterior chamber lens. In those cases the infusion cannula was inserted before phacoemulsification.

The surgery was completed by removal of the entry site alignment cannulas without conjunctival and scleral suturing. The conjunctiva above the sclerotomy was slightly displaced to disrupt the alignment between both entry sites. A mixture of antibiotics and corticosteroids was then injected into the subconjunctival space.

The transconjunctival sutureless 23-gauge vitrecomy surgical technique consisted of a transconjunctival tunnel incision parallel to the corneoscleral limbus in the inferotemporal, superotemporal and superonasal quadrants. The incisions were made with a 23-gauge stiletto blade (45° angle; DORC 1282-D-0.6, Zuidland, The Netherlands), which was inserted at a 30° to 40° angle through the conjunctiva, sclera and pars plana 3,5 mm from the corneoscleral limbus. The microcannula was then inserted through the conjunctival incision and into the scleral tunnel using a specially designed blunt inserter (DORC), as described by Eckardt[3]. The length of the cannula is 4 mm, the internal diameter 0,65 and the external diameter 0,75 mm. The inserter is a blunt instrument which is holding the microcannula. The external openings of two of the three cannulas are funnel shaped to facilitate insertion of instruments[3].

Instruments used for the transconjunctival sutureless 23-gauge vitrecomy included vitreous cutter, wide-field or chandelier endoillumination, back flush needle, membrane pick, end-gripping and micro-end-gripping forceps, micro-scissors, endolaser probe and endodiathermy probe. All instruments are made by DORC/Netherland. A pneumatic cutter was attached to the vitrectomy unit (Accurus, Alcon). A cutting rate up to 1200 per minute and suction up to 600 mmHg were used.

Membrane peeling was performed in 65 eyes (65%). Forty-six eyes (46%) received gas tamponade at the end of the operation. In 61 eyes (61%) vitrectomy was combined with phacoemulsification and implantation of a posterior chamber lens. In those cases the infusion cannula was inserted before phacoemulsification. Perfluorocarbon liquid was injected peri-operatively in 27 eyes to reattach the retina. During injection with a conventional blunt cannula the other sclerotomy was left open to allow superfluous fluid to flow out of the vitreous cavity. The retina was observed in those cases using the chandelier illumination (Photon/Synergetics). Silicone oil was used as a tamponade in 6 eyes. The silicone oil injection did not take longer time as compared with the injection using the standard 20-gauge technique.

At the end of the operation the cannulas were simply withdrawn from the scleral tunnels, the same way as using the 25-gauge system. The conjunctiva above the sclerotomy was slightly displaced to disrupt the alignment between both entry sites. A mixture of antibiotics and corticosteroids was then injected into the subconjunctival space.
Patients in both series were examined on the first, the second and the seventh day after surgery and at one month intervals thereafter. The mean follow-up period was 10 weeks (range, 8 to 12 weeks).

RESULTS

In both series it was possible to apply most of the standard procedures, such as membrane peeling, endodiathermy, endolaser, gas tamponade and combined phacoemulsification and implantation of a posterior chamber lens. Thus, perfluorocarbon liquid- and silicone oil injection could be used without technical difficulties in the 23-gauge series exclusively. Perfluorocarbon liquid was injected pre-operatively in this series in 27 eyes (27%) and silicone oil in 6 eyes (6%).
The vitreoretinal instruments used in the 25-gauge series were too flexible as compared with 23-gauge instruments which made it almost impossible to guide the eye during manipulations in the far periphery (Figure 1). On the other hand the 23-gauge instruments could be used almost identically as compared with the standard 20-gauge

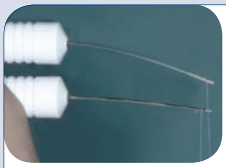

FIG. 1
COMPARISON OF DIFFERENT FLEXIBILITY OF 25-GAUGE AND 23-GAUGE INSTRUMENTS. THE 25-GAUGE LIGHT-PIPE FLEXES MORE THAN THE 23-GAUGE WHEN THE SAME WEIGHT OF 25 GR. IS HANGED ON THEIR TIPS. (COURTESY OF PROF. C. ECKARDT)

instruments (Figure 2).
Both the 25-gauge and the 23-gauge vitreous cutter were somewhat slower for performing vitrectomy than the 20-gauge cutter (Figure 3), but this did not influence significantly the total operating time. The mean operating time in the 25-gauge series was 45 minutes (range, 20-80 minutes) and in the 23-gauge series it was 60 minutes (range, 35-90 minutes). Longer operating time in the 23-gauge series depended on more complex cases that

FIG. 2
COMPARISON OF DIFFERENT SIZE OF END-GRIPPING FORCEPS. THE 23-GAUGE FORCEPS IS SIMILAR IN DESIGN AND UTILITY TO THE STANDARD 20-GAUGE AS COMPARED WITH THE 25-GAUGE FORCEPS. (COURTESY OF PROF. C. ECKARDT)

were treated using this technique.
After removal of cannulas at the end of the procedure minimal or no leakage of intraocular fluid was observed in any of two series. Occasionally some gas leakage was seen in the 25-gauge series only. Sutures were not used in any of the series to close the conjunctival or scleral incisions. The mean preoperative intraocular pressure in the 25-gauge series was 17 mmHg (range, 10-38 mmHg), on the first postoperative day it was 12 mmHg (range, 0-49 mmHg), on the second day 14 mmHg (range, 4-34 mmHg)

FIG. 3
COMPARISON OF DIFFERENT SIZE OF VITREOUS CUTTERS. DIAMETERS OF 25-, 23- AND 20-GAUGE CUTTERS ARE 0,5 MM, 0,6 MM AND 0,9 MM RESPECTIVELY. THE LUMEN OF 23-GAUGE CUTTER IS 1,5 TIMES BIGGER, AND THE LUMEN OF 20-GAUGE CUTTER IS 4 TIMES BIGGER THAN THE LUMEN OF 25-GAUGE CUTTER. (COURTESY OF PROF. C. ECKARDT)

and on the seventh postoperative day 18 mmHg (range, 7-54 mmHg) (Figure 4). The mean preoperative intraocular pressure in the 23-gauge series was 15 mmHg (range, 6-36 mmHg), on the first postoperative day it was 17 mmHg (range, 0-49 mmHg), on the second day 23 mmHg (range, 8-45 mmHg) and on the seventh postoperative day 19 mmHg (range, 6-39 mmHg) (Figure 5).

Withdrawal of cannulas resulted occasionally in minor subconjunctival bleeding. The bleeding came mainly from episcleral vessels, though in some cases even from the sclerotomies. This resulted in transitory postoperative vitreous hemorrhage in 2 eyes (2%) in the 25-gauge series and in 1 eye (1%) in the 23-gauge series.

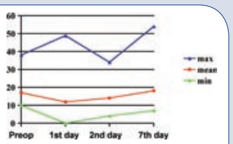

FIG. 4
VARIATIONS OF THE PERIOPERATIVE INTRAOCULAR PRESSURE USING THE 25-GAUGE SYSTEM. (PREOP=PREOPERATIVE; 1ST,2ST, 7TH DAY= THE FIRST, THE SECOND AND THE SEVENTH POSTOPERATIVE DAY). NOTICE HOW THE LOWER MEAN IOP ON THE 1ST AND 2ST POSTOPERATIVE DAY RETURNS TO THE PREOPERATIVE VALUE WITHIN A WEEK AFTER SURGERY.

Complications in the 25-gauge series occurred in 54% and in the 23-gauge series in 36% of operated eyes respectively. The most frequent complication in both series was transitory postoperative hypotony (<10

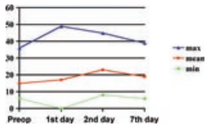

FIG. 5
VARIATIONS OF THE PERIOPERATIVE INTRAOCULAR PRESSURE USING THE 23-GAUGE SYSTEM. (PREOP=PREOPERATIVE; 1ST,2ND, 7TH DAY= THE FIRST, THE SECOND AND THE SEVENTH POSTOPERATIVE DAY). NOTICE THE ABSENCE OF THE POSTOPERATIVE HYPOTONY WHEN THE MEAN IOP IS CONCERNED.

mmHg), which occurred in 41% of eyes operated with 25-gauge compared to 14% of eyes operated with 23-gauge technique. The difference was statistically significant (p<0,001; chi-2=18,28).

Other complications in the 25- and 23-gauge series included: retinal detachment, which occurred in 1% and 2% of eyes respectively; retinal tears, in 4% and 8% of eyes respectively; transitory elevation of intraocular pressure, in 3% and 9% of eyes respectively; unintended retinal touch, in 2% of eyes in each of two series and transitory vitreous hemorrhage, as mentioned above. In one eye which had a dense vitreous hemorrhage the 25-gauge system was converted to the standard 20-gauge peroperatively (Table 1). None of complications that occurred interfered with the final visual outcome.

DISCUSSION

TABLE 1	25 GAUGE %	23 GAUGE %
HYPOTONY<10MMHG	41	14
IOP ELEVATION	3	9
RETINAL DETACHEMENT	1	2
RETINAL TEBAR	4	8
RETINAL TOUCH	2	2
VITREOUS HEMORRHAGE	2	1
CONVERSION TO 20-GAUGE	4	
TOTAL	**54**	**36**

Sutureless self-sealing sclerotomies for pars plana vitrectomy have been proposed initially by Chen[4] and were since modified by other researches[5,6,7]. The techniques were based on conventional scleral tunnels. Several complications have been reported using those techniques, including wound leakage, dehiscence, hemorrhage, vitreous and retinal incarceration, retinal tears and dialysis[8,9]. In addition, the conventional scleral tunnel technique and its modifications still require conjunctival dissection and suturing of conjunctiva.

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CONTINUED FROM PREVIOUS PAGE: ZORAN TOMIC, NASSER JADIDI GILI, IOANNIS THEOCHARIS ▼

Sclerotomies in the 25-gauge vitrectomy by Fujii et al[1,2] require no suturing because they are only 0,5 mm in diameter. Since the 23-gauge cannulas are 0,72 mm in diameter they have to be placed in tunnel incisions to allow for self-sealing. In this situation the wound borders are pressed together by the intraocular pressure ensuing from the oblique course of the incision3. In our comparison between the two techniques we have found that in the 23-gauge vitrectomy the postoperative hypotony occurs less frequently than in the 25-gauge which is statistically high significant ($p<0,001$). It appears therefore as Eckardt[3] has stated, that the size of the incision is not as important for closure of sclerotomies as it is the angle of the incision through sclera.

In both series it was possible to apply most of the standard procedures. Thus, perfluorocarbon liquid- and silicone oil injection could be used without technical difficulties in the 23-gauge series exclusively. This resulted in applicability of the 23-gauge technique to the larger number of indications. Besides simple cases like vitreomacular interface disorders in this series (in 38% of eyes), it was possible to treat a significant number of cases with more complex pathology including proliferative diabetic retinopathy, rhegmatogenous retinal detachment and proliferative vitreoretinopathy (in 49% of eyes).

The vitreoretinal instruments used in the 25-gauge series were too flexible as compared with 23-gauge instruments which made it almost impossible to guide the eye during manipulations in the far periphery. On the other hand, 23-gauge instruments could be used almost identically as compared with the standard 20-gauge instruments. Further, the 23-gauge technique showed a capability to replace both the 25-gauge and the standard 20-gauge technique offering benefits of both a sutureless system and sturdier and larger instrumentation. Having only one system instead of two that covers most of indications is certainly simpler for both the staff and the surgeon, cheaper and less time consuming.

Today we perform vitrectomy using the 23-gauge sutureless system in all cases with the exception of full macular translocation.
Both the 25-gauge and the 23-gauge vitreous cutter were somewhat slower by performing vitrectomy than the 20-gauge cutter, but this did not influence significantly the total operating time. On contrary, the operative duration was reduced, since the time for conjunctival dissection, fixation of the infusion line and suturing of both sclerotomies and conjunctiva was avoided.

Complications in the 25-gauge series occurred in 54% and in the 23-gauge series in 36% of operated eyes respectively, but none of them interfered with the final visual outcome. The most frequent complication in both series was transitory postoperative hypotony, which occurred less frequently in eyes that underwent the 23-gauge than in those that underwent the 25-gauge vitrectomies. The difference was statistically significant ($p<0,001$). The mean postoperative intraocular pressure did not show lower values in the 23-gauge- as it did in the 25-gauge series. In the 25-gauge series it returned spontaneously to the normal values within a week (Figure 4 and 5).
In summary, 25- and 23-gauge sutureless vitrectomies are safe and minimally invasive. They reduce the operative duration and enhance the postoperative recovery. According to our experience the 23-gauge vitrectomy system is superior to the 25-gauge because it offers advantages of both sutureless system and sturdier and larger instrumentation. It is suitable for larger number of indications and safer regarding the postoperative hypotony than the 25-gauge vitrectomy system.

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TRANSCONJUNCTIVAL SUTURELESS 23-GAUGE VITRECTOMY

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Innovative surgeons creating new surgical techniques are accelerating technological developments. As in the transition from classic extra-capsular cataract extraction to tunnel incision sutureless phacoemulsification surgery, a similar trend toward minimally invasive surgical intervention with smaller incisions and self-sealing wounds has revealed the concept of transconjunctival sutureless vitrectomy.

The recent development of a 25-gauge transconjunctival vitrectomy system pioneered by Fujii et al [1], has made an important contribution to and also promoted a great interest in sutureless vitrectomy. Nevertheless, 25-gauge vitrectomy has been limited to certain cases with macular diseases such as idiopathic macular hole or macular pucker in which no considerable manipulations in the peripheral retina are needed, because of the flexibility of the instruments used. In a 25-gauge vitrectomy system, microcannulas have been placed transconjunctivally through the incisions created perpendicular to the sclera. It is not possible to obtain self-sealing incisions postoperatively using thicker and more stable instruments if incisions wider than 25-gauge are created with a perpendicular incision.

However, a 23-gauge vitrectomy system very recently developed by Eckardt [2] has added a new dimension to the surgery of sutureless vitrectomy. In this technique, the sclerotomy incisions are made parallel to the limbus at an angle of about 30° to 45°. It is possible to expand the indications of sutureless vitrectomy to a broader spectrum by using the less flexible 23-gauge instruments and still achieve a self-sealing incision even when a wider entry has been created, as long as it is at a particular angle to the sclera. Sutureless transconjunctival vitrectomy techniques preserve the advantages of sutureless vitrectomy including less traumatic scleral manipulation, less postoperative intraocular inflammatory reaction, less postoperative corneal astigmatism, greater patient comfort, shorter postoperative rehabilitation time and rapid visual recovery as well as no need to dissect the conjunctiva.

SURGICAL TECHNIQUE

23-gauge vitreoretinal instrumentation designed by Eckardt and produced by the DORC Company was used in surgery. As described previously by Eckardt, three-port sclerotomy at the superior temporal, superior nasal and inferior temporal quadrants was carried out 3.5 mm away from and parallel to the corneo-scleral limbus at an angle of about 20 degrees with a 23-gauge stiletto knife.

The microcannulas were then inserted into the scleral tunnel using blunt-tipped special inserters. The first microcannula was inserted into the inferotemporal sclerotomy and then an infusion line was connected to the microcannula. The instruments used, all of which were 23-gauge, were pneumatic vitreous cutter, endoillumination probe, straight forceps, scissors, back flush needle, endodiathermy probe and endolaser probe. As described by Eckardt, a cutting rate of up to 1200 per minute and suction of up to 500 mmHg were used. The twin light chandelier illumination system (DORC No : 3269-MBD2) was used as a light source in cases where bimanual work was necessary.

During the injection of perfluorocarbon liquid, superfluous fluid within the eye was allowed to retrograde flow out of the vitreous cavity by opening the infusion line using a three-way stopcock as described by Eckardt. However, in cases where the twin light illumination was used as a light source for bimanual surgery, opening the infusion line using a three-way stopcock was not necessary since one of the upper sclerotomies was free to allow the flow of the fluid from the vitreous cavity . Because twin light was used as a light source in all cases in which silicone oil-perfluorocarbon liquid exchange was made, silicone oil (1000 cs) was given with a 23-gauge needle through one of the superior sclerotomies while perfluorocarbon liquid was removed with a back-flush needle through the other superior sclerotomy to perform the exchange. The infusion was closed before starting the silicone oil- perfluorocarbon liquid exchange. The microcannulas were withdrawn after having closed the sclerotomies by plugs and the infusion line having been stopped to prevent vitreous incarceration to the wound site. Gentle pressure was applied briefly to the site of the sclerotomies using a cotton-tipped applicator.

Case series:
66 eyes of 65 consecutive patients that had undergone 23-gauge transconjunctival sutureless vitrectomy were documented. The mean patient age at the time of surgery was 52.2 years (range 14 to 81 years). The indications of vitrectomy included severe proliferative diabetic retinopathy in 24 eyes, idiopathic epiretinal membrane in 10 eyes, nonclearing vitreous hemorrhage in 10 eyes, idiopathic macular hole in 7 eyes, rhegmatogenous retinal detachment in 7 eyes, silicone oil extraction in 5 eyes, vitreo-macular traction syndrome in 2 eyes and giant tear retinal detachment in 1 eye. Eleven out of 66 eyes had undergone vitrectomy previously.
Perfluorocarbon liquid was injected during surgery in 21 eyes. Gas tamponade was applied in 16 eyes while silicon oil tamponade was applied in 11 eyes. Pars plana vitrectomy was combined with phacoemulsification and posterior chamber intraocular lens implantation in 13 eyes. In the combined cases, vitrectomy was performed after the intraocular lens implantation. The mean postoperative follow-up time was 6.6 months with a range of 3 to 11 months.

The surgery was successfully completed with the 23-gauge vitrectomy system in all eyes. Preparation of the sclerotomies caused minor intravitreal hemorrhage in only 3 out of the 66 eyes. The cannulas remained stable in place in all surgeries including long lasting cases when manipulations or maneuvers in the extreme retinal periphery were performed. No complication related to manipulation of the microcannulas like slippage or loss of cannulas and damage to crystalline lens or retina were observed. During surgery the instruments were observed not to be as flexible as 25-gauge instrumentation, although were a little more flexible than 20-gauge instrumentation, and all the surgical manipulation could be performed easily. Even far peripheral manipulations which necessitate working in the vitreous base especially could be performed without any noteworthy difficulty. During the withdrawal of the microcannulas at the conclusion of the operation, minor hemorrhage from the episcleral vessels or sclerotomies which were seen as a subconjunctival hemorrhage after surgery were observed in 19 of the 66 eyes which were stopped by a short tamponade with gentle pressure without any extra intervention. In 8 of 39 eyes which did not undergo intraocular tamponade application, a transient slight accumulation of fluid was observed under the conjunctiva due to escape of fluid through the scleral tunnel. Neither leakage of tamponade materials from sclerotomies at the end of surgery nor subconjunctival gas or silicone oil in the early postoperative period was seen in any eyes in which gas or silicone oil tamponade was applied.
We needed to place sutures in one sclerotomy in three patients at the end of surgery due to excess leakage of fluid. These eyes had previously undergone vitrectomy and we observed that in all of the three eyes, the new scleral tunnel sites performed by 23-gauge stiletto blade had coincided with the old sclerotomy sites. Postoperative temporary hypotony (< 12 mmHg) developed in 2 eyes on the first day postoperatively. Both eyes had previously undergone vitrectomy. Intraocular pressure returned to a normal level within 3 days of the operation in both eyes without a requirement for sutures.
One day after surgery, none of the eyes showed any sign of disturbance as 20-gauge operated eyes usually do. Anatomical successful results were recorded in all except 4 eyes. One or more Snellen line visual acuity improvement was recorded in 15 out of 24 eyes in cases with proliferative diabetic retinopathy, and 24 out of 33 eyes in the other etiologies.
Sutureless self-sealing incisions for pars plana vitrectomy was reported first by Chen[3] in 1996. Although various modifications of sutureless sclerotomy have been reported by other investigators [4-8] subsequently, the use of microcannulas for sutureless vitrecto-

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my was reported in 2002 by Fujii et al [1]. In this technique, sclerotomies have been described as being created perpendicular to the sclera. However, in the 23-gauge vitrectomy technique pioneered by Eckardt [2], a sclerotomy created with an oblique incision at angle of 30 to 45 degrees was described for entry of 23-gauge instrumentation that is thicker and less flexible than 25-gauge instruments. The aim of this technique was to obtain a scleral tunnel with self-sealing wound recovery. This opinion is similar to the technique of small-incision manual extracapsular cataract extraction (mini-nuc technique) [9] in which scleral tunnel incision plays an important role in achieving a self-sealing wound. Eckardt originally described performing the sclerotomy at an angle of 30-45 degrees. However, we are of the opinion that it is better to perform a sclerotomy with an angle below 30 degrees (15° -20°) to obtain safer sclerotomies in view of leakage. The scleral tunnel becomes more reliable as a longer tunnel which is created by a more inclined incision.

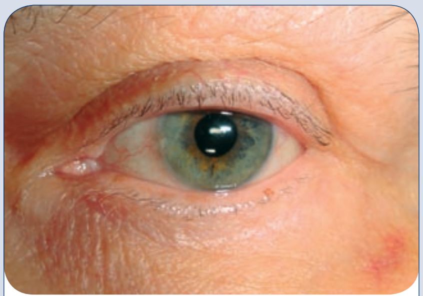

FIG. 1
POSTOPERATIVE ONE DAY. NO SIGNS OF DISTURBANCE.

Of the 66 eyes on which we performed 23-gauge sutureless vitrectomy, the conversion to 20-gauge vitrectomy system was not needed in any eye. Three eyes required suture placement at the end of surgery because of fluid leakage. All of the three eyes in which placement of a suture was needed had previously been operated on by conventional three port pars plana vitrectomy with 20-gauge instruments. We observed that in all three eyes, the new scleral tunnel sites performed by 23-gauge stiletto coincided with the old sclerotomy sites performed and this was a possible cause of fluid leakage. Therefore care should be taken to perform scleral tunnel sites away from previous sclerotomy sites to avoid superimposed sclerotomies in cases of re-operation. Postoperative hypotony developed in 2 eyes which were operated on for the second time for vitreoretinal surgery. Neither of these two eyes with hypotony required suturing postoperatively and returned to normal ocular tonus within 3 days without intervention or complication. The reason for the hypotony in the eyes undergoing re-operation was probably coincidental with sclerotomies with similar mechanism. All the cases where slight accumulation of fluid under the conjunctiva was observed or which needed suture placement or the cases which developed postoperative hypotony the eyes were not filled with a tampon substance at the conclusion of the surgery. We assumed that tampon substances, especially gas due to surface tension, were more effective to tamponize the sclerotomies. A normal intraocular pressure observed postoperatively may indicate that a successful self-sealing tunnel incision had been achieved in the rest of our cases. This also supports the hypothesis suggested by Eckardt that the angle of the incision through the sclera is more important than the size of the incision for the closure of the sclerotomies.

A considerable number of the eyes in our study were difficult cases (24 eyes with severe proliferative diabetic retinopathy) from the aspect of vitreoretinal surgery. The light was used in a different way in all of these cases for bimanual manipulation. Even in these eyes, we did not feel any important influence of the slight flexibility of the instruments on intraoperative maneuvers. The retina was successfully reattached with the 23-gauge instruments in all eyes with retinal detachment. Thus severe cases including giant tears and PVR can be managed with this technique. As the tensile strength of 23-gauge instruments is similar to 20-gauge instruments, there is no limitation to the type of surgical procedure.

In conclusion, we were able to accomplish the surgical goal in all cases. One day after surgery, none of the eyes showed any signs of disturbance as 20-gauge operated eyes usually do. Our series suggests that 23-gauge sutureless vitrectomy is a safe and effective technique for the broader range of indications for vitreoretinal surgery including severe proliferative diabetic retinopathy and retinal detachment. The 23-gauge vitrectomy system is a good alternative to a 25 gauge vitrectomy system because it meets broader vitreoretinal indications with the advantages of 25-gauge system. In addition, we considered that if one of the sclerotomies is modified as is in the 20-gauge sclerotomy, all vitreoretinal procedures including drop nucleus and intraocular foreign bodies can be managed with this system by replacing 20-gauge system.

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