Advances in Vitreo-retinal Surgery: 23-gauge Sutureless Pars Plana Vitrectomy

Dr. Gary KY LEE
MBBS, MRCSEd, FCOphthHK, FHKAM(Ophth)
Resident (Specialist), Hong Kong Eye Hospital

Dr. Timothy YY LAI
MBBS, MD, MMedsC, FRCSEd(Ophth), FCOphthHK, FHKAM(Ophth)
Associate Professor, Department of Ophthalmology & Visual Sciences, the Chinese University of Hong Kong

Introduction

Pars plana vitrectomy is one of the most common surgical procedures performed for the treatment of various vitreo-retinal diseases such as retinal detachment, vitreous haemorrhage, proliferative diabetic retinopathy, epiretinal membrane and macular hole. Traditionally, most vitrectomy surgical systems utilise the 20-gauge instruments pars plana vitrectomy includes multiple incisions including peritomy (opening of the conjunctiva) and sclerotomy. In the past few years, advances in the development of surgical instruments have enabled the performance of vitrectomies using smaller gauge instruments such as 23 and 25-gauge, and thus allowing the performance of sutureless vitrectomies. The 23-gauge sutureless vitrectomy system has the advantages to overcome the excessive flexibility of instruments associated with a 25-gauge pars plana transconjunctival sutureless vitrectomy system which might cause difficulties in manoeuvring the globe during surgery. Most major vitreo-retinal surgical instrument manufacturers have already made a 23-gauge vitrectomy system available. With the increasing availability and better designed instruments, the 23-gauge sutureless system has become one of the preferred vitrectomy systems in the vitreo-retinal community in recent years.

Operative Techniques

Anaesthesia

As with conventional 20-gauge pars plana vitrectomy, 23-gauge pars plana vitrectomy can be performed under general anaesthesia or retrobulbar anaesthesia. In cases of using retrobulbar anaesthesia, proper techniques should be taken to avoid subconjunctival accumulation of the local anaesthetic agent. Any ballooning of the bulbar conjunctiva would render subsequent insertions of the transconjunctival cannulas more difficult to perform and might potentially increase the risk of postoperative wound leakage due to poor wound construction.

Two-step Sclerotomy Technique

The original method of inserting the transconjunctival microcannulas was described by Eckardt. This method involves a two-step technique with the use of a specially designed pressure plate and a 23-gauge stiletto blade for entering into the vitreous cavity. The first step involves displacing the conjunctiva over the intended sclerotomy site with a pair of forceps or a cotton applicator. This displacement of the conjunctiva over the scleral tunnel should be 23

Applies firmly on the displaced conjunctiva against the sclera during the incision with the stiletto blade would increase the length of the scleral wound and enhance the self-sealing effect.

With the pressure plate held firmly in place, a 45°-angled-stiletto blade is used to create a 30° blique scleral tunnel (Fig. 1B). The scleral tunnel should be made parallel to the corneoscleral limbus in order to ensure that the full length of the wound is in equal distance from the limbus and within the pars plana. During the passage of the stiletto blade, the surgeon may experience some rotation of the globe in the direction of the incision. This can be avoided by...
using a new sharp blade and by stabilising the globe with the pressure plate. Some surgeons advocate an antero-posterior scleral tunnel with the blade aiming towards the posterior pole. It is thought that this technique would allow splitting rather than cutting of the concentrically arrange scleral fibres, allowing faster postoperative wound healing. However, this benefit is offset by the potential risk of retinal damage if the internal opening is created too close to the ora serrata.

The pressure plate should be kept in place after withdrawal of the blade (Fig. 1C). With the DORC system, the microcannula is inserted through the conjunctival incision into the scleral tunnel with a blunt inserter. During the insertion of the microcannula, the direction of insertion should be shifted from the original tangential path to a more perpendicular direction towards the centre of the globe (Fig. 1D). This manoeuvre helps exert the necessary pressure on the globe to minimise any rotational movements. The pressure plate can be slowly withdrawn before the complete insertion of the trocar. During removal of the trocar, the microcannula should be held in place with forceps to avoid dislodgement. The microcannula is then left in place and plugged. Normally, the first microcannula is inserted at the inferotemporal quadrant for the infusion line. Two more microcannulas are then placed at the superotemporal and superonasal quadrants for the microsurgical instruments. In case of combined phaco-vitrectomy, the micocannulas should be inserted before the phacoemulsification procedures as this allows better control of vitreous pressure during phacoemulsification.

**Single-step Sclerotomy Technique**
The main limitation of the previously described two-step sclerotomy technique is the difficulty in identifying and tracing the original conjunctival incision after the first stiletto cut. This might cause problems during insertion of the blunt inserter and result in double-incision through the conjunctiva. To tackle this limitation, major manufacturers such as Alcon and Bausch & Lomb have introduced one-step trocar/cannula systems (Fig. 2). With the one-step technique, the blunt inserter is replaced with a sharp needle trocar for the creation of the conjunctival incision and scleral tunnel without the use of a stiletto blade. Similar to the two-step system, a scleral tunnel at a 30° angle parallel to the limbus is created after the conjunctiva is displaced. Compared with the stiletto blade, the needle trocar has slightly greater tissue resistance during incision and this might occasionally result in a more significant globe rotation. However, newly designed needle trocar systems have greatly enhanced the blade design and the increased sharpness has allowed less resistance during wound construction with a more water tight wound.

**Vitrectomy**
Techniques of vitrectomy using the 23-gauge system are similar to the conventional 20-gauge system due to the similar stiffness of the instruments. Nevertheless, forceful insertion and manipulation of instruments can lead to bending within the metal cannula and later difficulties during removal of instruments. Careful handling of instruments is important to prevent this complication. Dislodgement of microcannula during vitrectomy is another potential problem for the 23-gauge system. It is usually related to incomplete insertion of the microcannula at the start of the operation. With the help of a blunt inserter, the dislodged microcannula can usually be re-inserted smoothly into the original sclerotomy. Gentle and slow removal of microsurgical instruments through the lumen of the cannula will also be useful in preventing dislodgement of the microcannula. Since no suture is used to hold the infusion line, dislodgement of the infusion line may sometimes occur and can lead to sudden hypotony and collapse of the globe. Extra caution is therefore needed when securing the connection of the infusion line before starting vitrectomy.

**Figure 2. Steps for insertion of the 23-gauge vitrectomy microcannulas using the one-step technique.** (A) The conjunctiva is displaced over the intended sclerotomy site and pressed firmly against the sclera using the pressure plate. (B, C) A sharp trocar needle is used for the transconjunctival scleral tunnel incision through the central opening of the pressure plate at an angle of 30°. (D) A forceps can be used to provide a counterforce and to hold the cannula in place while the needle is being withdrawn. (E) A third transconjunctival sclerotomy is being created by the sharp needle at a 30° angle. (F) All three sclerotomy microcannulas with plugs in place.

**Removal of Microcannulas**
Removal of the microcannulas should be started by lowering the intra-ocular pressure to about 20mmHg. The two superior cannulas for the surgical instruments should be plugged before removal and the infusion cannula is removed last. The microcannulas are held by forceps and withdrawn along the direction of the scleral tunnel (Fig. 3). A cotton wool applicator is used to press on the conjunctiva and rotate back the conjunctiva over the sclerotomy immediately after removing the microcannulas. Sustained pressure for 30 to 60 seconds is generally adequate to allow self opposition of the sclerotomy wounds and to stop any bleeding from the wound area. Globe pressure and the external opening of the scleral tunnels should be checked carefully. In case of persistent leakage from the sclerotomy and overt hypotony, the scleral wound should be sutured and the
globe reinflated with air, gas or balanced salt solution as required.

Indications of 23-gauge Sutureless Vitrectomy

There has been a continuous expansion in the clinical indications for the 23-gauge vitrectomy system. With the increase in the spectrum of various 23-gauge instruments and improved surgical techniques, the indications for any 23-gauge system are now almost identical to the conventional 20-gauge system. These include macular conditions such as epiretinal membrane and macular hole, vitreous haemorrhage, retinal detachment, proliferative diabetic retinopathy and removal of low viscosity silicone oil.

The 23-gauge vitrectomy system offers a clear advantage over the conventional 20-gauge system in less complicated surgical conditions, such as for removal of vitreous haemorrhage followed by endolaser panretinal photocoagulation. Macular pathologies, including macular hole, epiretinal membrane and vitreomacular traction syndrome are also amongst the most suitable indications for 23-gauge surgery. In general, most studies have demonstrated good success rates in using 23-gauge vitrectomy for macular hole and epiretinal membrane peeling.\(^2,3\) 23-gauge vitrectomy has also been successfully applied in the treatment of retinal detachment and the primary anatomical success rate appeared to be comparable with conventional 20-gauge pars plana vitrectomy.\(^4\)

Moreover, 23-gauge vitrectomy is also feasible in complex retinal detachment surgery with silicone oil tamponade for retinal detachments associated with proliferative vitreoretinopathy, diabetic tractional retinal detachment, and giant retinal tear.\(^5\) Removal of silicone oil of low viscosity is also possible with 23-gauge system by expelling the oil passively through the microcannula under the hydrostatic pressure from the infusion line. In cases with high viscosity silicone oil, such passive removal would be excessively time-consuming and impractical. In this instance, one sclerotomy can be enlarged to 20-gauge in order to accommodate the use of conventional 20-gauge instruments.

Contraindications of 23-gauge Sutureless Vitrectomy

Conditions that involve ultrasonic endo-fragmentation of retained lens fragments are amongst the few contraindications of 23-gauge vitrectomy. At the time of writing, a 23-gauge phacoemulsifier is still not yet commercially available. The design of the microcannulas also prohibits the passage of various angled tools. For conditions that require the use of such special instruments, 23-gauge vitrectomy may not be the preferable choice. Nonetheless, some 23-gauge instruments with retractable and bendable materials are now available and these instruments can facilitate intraoperative procedures by allowing improved accessibility.

Advantages of 23-gauge Sutureless Vitrectomy

One of the most obvious advantages of using 23-gauge vitrectomy is the shortening of operation time during creation and closure of sclerotomies. The wound opening and closure time was significantly shorter for the 23-gauge system when compared with the conventional 20-gauge system. In addition to shortening the operation time, patients who had 23-gauge pars plana vitrectomy also had significantly less pain compared with the 20-gauge system.\(^6\) The increased level of patients’ comfort can be attributable to the absence of sutures and conjunctival peritomy, thereby allowing a faster wound healing and less inflammatory reaction (Fig. 4). The smaller wound sizes in 23-gauge surgery also allow a shorter recovery time and minimise postoperative discomfort.

Reoperations in patients who have previously undergone multiple conventional 20-gauge vitrectomies can be challenging not only due to the extensive conjunctival scarring, but also because of the difficulty in finding a new site for sclerotomy. The sutureless transconjunctival approach of 23-gauge surgery enables the surgeon to preserve the mobility of the conjunctiva even after repeated operations. This is especially important in glaucoma patients who may later require filtering surgeries. The smaller diameter of the scleral wound in 23-gauge vitrectomy also leaves more fresh sites for future sclerotomies. Compared
with conventional 20-gauge vitrectomy, there is less surgically induced astigmatism following 23-gauge vitrectomy. This allows for faster stabilisation of postoperative refraction and faster visual rehabilitation of the patients.

In paediatric patients, post-operative inflammation after intra-ocular surgery is known to be more severe compared with their adult counterparts. The smaller wound size of the 23-gauge vitrectomy system can help to minimise surgical trauma and decrease the post-operative reaction in this age group. The faster wound healing also allows an early rehabilitation for the developing visual system.

Disadvantages of 23-gauge Sutureless Vitrectomy

Eckardt noted in his original series of 23-gauge vitrectomies that the vitreous cutter was ‘somewhat slower’ for extensive vitrectomies when compared with using the conventional 20-gauge system. This slower cutting is due to the limitation in flow rate by the smaller lumen of the 23-gauge cutter. A simple vitrectomy using a 23-gauge system may need up to 30% more time than using a 20-gauge system. The decrease in aspiration efficiency is also obvious when using a 23-gauge silicone tube for removal of non-clotting blood in the vitreous cavity and during gas/fluid exchange. The cutting performance of some newer 23-gauge cutters has been improved by the thin-wall design that increases the lumen diameter. When a vitrectomy is performed under a high flow rate, the difference in cutting efficiency between a 23-gauge and 20-gauge is now minimal.

In conventional 20-gauge vitrectomy, examination and assessment of the peripheral retina by scleral indentation is facilitated by opening the conjunctiva and exposing the anterior sclera. In 23-gauge vitrectomy, due to the intact conjunctiva, scleral indentation might be less efficient and more difficult to perform. This limitation in scleral indentation is especially obvious over the nasal anterior retina and near the equator. Moreover, scleral indentation should be performed more cautiously due to the potentially easier dislodgement of the infusion line. Another difficulty with 23-gauge vitrectomy might develop during fluid-air exchange. Due to the potential space between the lumen of the cannula and the microsurgical instrument, bubbles might foam up due to air leak around the instrument and this can obscure the surgical view. This can be prevented by avoiding the use of an excessively viscous material to lubricate the ocular surface during the surgery.

Complications of 23-gauge Sutureless Vitrectomy

Subconjunctival haemorrhage
Subconjunctival haemorrhage is usually the consequence of damaging conjunctival or episcleral vessels during insertion or removal of the microcannulas. Apart from cosmetic concerns, inspection of the sclerotomy for leakage at the end of the operation can be made difficult by the overlying blood. In patients taking aspirin or anti-coagulants, withholding the medications before the operation might help to decrease the risk of this complication.
**Wound leak and hypotony**

Postoperative hypotony due to leakage from sclerotomies, though not common, may sometimes result in choroidal detachment and warrant reoperations for suturing of the scleral wound. Such sclerotomy leakage is most commonly related to poor techniques during wound construction and removal of the microcannulas. A leaking sclerotomy can be detected by observing the formation of a subconjunctival bleb over the sclerotomy site. It is imperative for the surgeon to examine for any leakage at the end of the operation and to close any leaking sclerotomy with suture. The incidences of postoperative hypotony have been estimated to be 11.3% at 2 hours and 3.8% at 1 day. It has been shown that up to 11% of cases which had 23-gauge pars plana vitrectomy required intraoperative suture placement for leaking sclerotomies. Risk factors of leaking sclerotomies include prior vitrectomy, young patients, high myopia and vitreous base dissection.

**Endophthalmitis**

Endophthalmitis or intraocular inflammation of the eye is one of the most serious complications of intraocular surgery. In a large retrospective case series, the incidence of endophthalmitis after 25-gauge vitrectomy has been shown to be 12 times higher than conventional 20-gauge vitrectomy. The sutureless nature of the scleral wound poses a definite risk for this devastating complication. However, subsequent series using 25- and 23-gauge transconjunctival vitrectomy have shown that there were no obvious increased incidence of endophthalmitis compared with 20-gauge vitrectomy. Wound leakage and postoperative hypotony should be avoided in order to minimise the chance of bacterial entry and hence the risk of endophthalmitis.

**Conclusions**

The safety and efficacy of 23-gauge transconjunctival sutureless vitrectomy in the management of various vitreo-retinal conditions have been demonstrated in multiple studies in recent years. The use of 23-gauge sutureless vitrectomy allows faster postoperative recovery and less surgical discomfort after the surgery. Unlike its 25-gauge counterpart, the 23-gauge sutureless vitrectomy system has the benefits of allowing microincisional sutureless procedures while working with instruments with greater stiffness and higher flow dynamics similar to the conventional 20-gauge system. With the increasing availability of different 23-gauge instruments, the 23-gauge vitrectomy system has good potential to replace the 20-gauge system as the standard of vitreo-retinal surgery.

**References**