THE ROYAL COLLEGE OF OPHTHALMOLOGISTS

Focus

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Small gauge vitrectomy

Evolving through the first 14-gauge instrument and the later 17-gauge single port device, perhaps the most important milestone in small gauge vitrectomy was the development of 20-gauge approach in 1974 by O'Malley et al. This technique involved the introduction of three ports through the sclera after a peritomy and suture closure of the sclerotomies and the conjunctiva.

The quest to improve surgical outcomes, decrease the operating time and minimize tissue trauma led on to the development of small gauge sutureless vitrectomy systems. The aim of this article is to review the technique, the instrumentation, advantages and disadvantages of the small gauge trans-conjunctival sutureless vitrectomy systems.

Although first described in the 1990s, the 25 gauge popularized by Fuji and colleagues in 2002 and the 23 gauge popularized by Eckardt et al in 2005 are the two main small gauge vitrectomy systems in current vitreo retinal practice.

Surgical technique

Wound construction

One of the most important steps in sutureless vitrectomy technique is the wound construction. The conjunctiva is displaced using a cotton applicator or forceps. Trocar-guided cannulas are passed through conjunctiva and sclera into the vitreous cavity. The angle of entry into the sclera influences the sealing of the sclerotomy after the removal of the cannulas. The more oblique the path through the sclera, the better the re-apposition of the edges after the removal of cannulas, and lesser the leakage from sclerotomies.[1] Some favour a bi-planar scleral incision, with a more oblique initial and a more perpendicular final entry into the vitreous to create a two-step incision in cross section. (Figures 1a and b). The infusion is usually placed into the infero-temporal with the two other ports used for endoillumination and the active instrument. Newer entry systems have a blade-like configuration which allows improved wound configuration.

Fluid dynamics

The factors that influence the rate of vitreous removal are the infusion pressures, the aspiration pressures and the duty cycle of the vitrector. With higher cut rates of up to 5000 cpm on modern machines, the resulting 'bites' of vitreous are smaller, creating less shear forces and better flow rates.

Compared to the 20-gauge probe, where the infusion pressures vary between 30 to 40mmHg, vitrectomy with small gauge systems works at higher infusion pressures in the range of 50mmHg. Because of the smaller internal diameter of a tube, the flow rate is less with small gauge probes compared to the 20-gauge probes. Increasing the infusion pressure improves the vitreous removal rates in small gauge systems.

Higher aspiration pressures are used in small gauge systems to achieve a reasonable rate of vitreous removal. The maximum aspiration varies between 400 to 600mmHg compared to 150mmHg in 20-gauge systems.

The duty cycle is the length of time the vitrector port is

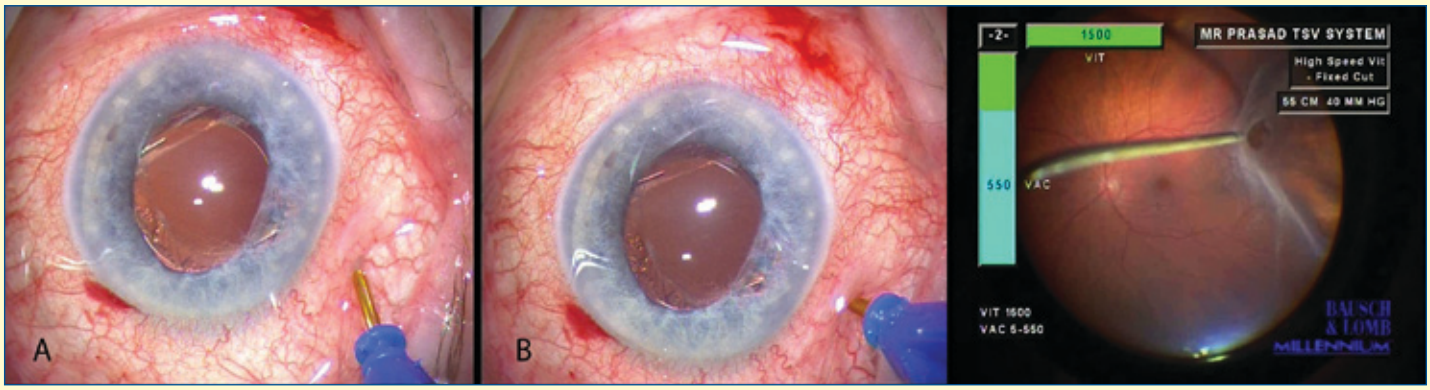

Figure 1a, b: Photograph showing the bi-planar entry used in small gauge vitrectomy (oblique and perpendicular steps) 1c: Photograph showing the wide field illumination with a Chandelier light along with indentation.

open compared to the time it is closed. Duty cycles with a longer port opening time results in higher flow rates thus compensating for the decreased flow in the smaller diameter instruments.

Illumination systems
Evolving from an external slit illuminator outside the eye, refinement and minification of the instruments have created small-diameter endoillumination probes to allow a panoramic view of the posterior segment. Of the recent systems, the fibre-optic illumination pipe which remains fixed to the cannula without the need for suture placement (a chandelier type illumination) has enabled the execution of bi-manual surgery and provides wide illumination of the vitreous cavity (Figure 1c).

Completion of surgery
The cannulas are removed and the conjunctiva is displaced over the sclerotomies with a cotton tip applicator and no sutures are needed. Some surgeons advocate the use of an air bubble of about 15% in the eye even if gas is not needed and posture the patient supine for 24 hours. This places the air bubble in apposition to the sclerotomies and helps to keep them closed in the first day postoperatively thereby decreasing the chances of hypotony.[2]

While leakage from sclerotomy wound is not a common problem, patients who have had previous vitrectomy and conjunctival scarring, eyes with thin sclera and those of young children appear to be at a higher risk of leak and have to be carefully assessed after removal of the cannulas.[3]

Complications

Intraoperative complications
During the surgery, increased intraocular pressure during the placement of trocar cannulas can put undue stress on prior corneal or limbal wounds such as in eyes that have had sutureless cataract surgery or recent corneal transplants. Suture closure of any recent corneal and scleral wounds before trocars are inserted may be desirable.

Secondly, spontaneous dislocation of the cannula can occur during the exchange of instruments between the ports and also more importantly, the cannula attached to the infusion line can dislocate during scleral depression causing intraoperative loss of volume. Re-positioning of the cannula should repressurize the eye.

Thirdly, the incidence of iatrogenic breaks have been reported with a wide variation with some studies finding relatively higher incidence with 25 gauge (15.8%),[4] while other studies found lesser incidence compared to 20 gauge.[5]

Postoperative
Reports have shown the prevalence of up to 20% of post-surgical hypotony using 25 gauge in earlier series. In most cases IOP values normalized within a few days with no residual problems. The only factor that has been found to be significant in the formation of hypotony with sutureless vitrectomy has been young age of the patient.3 Better wound construction has now minimized this problem.

Postoperative endophthalmitis was initially suspected to occur more frequently after sutureless vitrectomies. Earlier series reported rates ranging from 0.04% to 0.84%. More recently published large retrospective studies do not indicate that sutureless small gauge vitrectomy is associated with higher rates of endophthalmitis than in 20 gauge.[6,7] We are currently conducting a prospective BOSU study on this topic and hope to throw some more light on this issue.

Advantages of small gauge systems

The most obvious advantage is the ability for direct insertion through the conjunctiva and sclera and removal without need for any sutures. Shorter surgical times, rapid postoperative and visual recoveries are also very attractive advantages of the sutureless vitrectomy systems.

The smaller port size of the instruments increases the ability to remove vitreous with very little traction or to remove epiretinal membranes without risking incarceration of retina in the port.

Many of the studies with small gauge vitrectomy have found decreased inflammation and pain postoperatively and improved patient comfort. Also, astigmatism following 23- and 25-gauge vitrectomy has been shown to be less than 20 gauge resulting in rapid visual recovery.

Disadvantages

Creation of a PVD with suction alone could theoretically be more difficult with the smaller vitrectomy probes.

One of the main issues with the small gauge vitrectomy systems have been the increased flexibility of the instruments. This could cause difficulty with dissection of peripheral membranes in proliferative vitreoretinopathies. The use of oblique incisions to achieve water-tight closure exacerbates this problem as torsion on the probe is required to hold the instruments perpendicular to the sclera when removing the vitreous. Different approaches to circumvent this problem include the use of bi-planar incision which has a perpendicular final entry, thereby negating the problem. The development of newer probes which are stiffer and have a wider internal diameter has helped to improve flow rates and also provide better access to the peripheral vitreous. Also the ability to do bimanual surgery and perform scleral indentation during vitrectomy thereby bringing peripheral vitreous centrally has helped in reducing problems with instrument flexion.

Conclusions

Development of small gauge vitrectomy systems has definitely expanded the treatment options available to patients and surgeons. A variety of conditions can now be treated with less inflammation, less patient discomfort and faster recovery. Rates of retinal tears and retinal detachment are low and consistent with available evidence. Modifications in instrumentation, case selection and surgical technique have considerably reduced the incidence of various complications including hypotony. The concern regarding increased risk of endophthalmitis stands unsupported as various studies have shown this risk to be comparable to 20-gauge cases. We hope that the current prospective BOSU study with consistent selection criteria, standardized outcome measures and long-term follow up will inform us of long-term visual results and adverse events as well as recommend ways to reduce complications and optimize outcomes. Clearly, exciting times are ahead for the vitreo retinal surgeons.

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