Micro Incision Vitrectomy Surgery (MIVS): An Overview

Pramod S. Bhende and Aneesha Lobo

Introduction
In today’s world of nano-technology where bigger no longer means better, everything from smartphones to surgical incisions are getting smaller and more refined. The advantages of smaller surgical incision have resulted in faster postoperative recovery.

Vitreoretinal surgery is no exception. We have come a long way since the time of open sky vitrectomy and Machemer’s first 17-gauge closed pars plana vitrectomy (PPV) in 1971.1 In 1974, O’Malley and Heintz2 introduced a smaller 20-gauge (G) vitrector (0.9 mm diameter) for use with the three-port sclerotomy system that became the gold standard for modern PPV and has been the standard of care for almost three decades.

However, in current times, just attaching the retina is not enough. Variables like patient comfort (both intra and post-operative), surgical time and precision, post-operative recovery time, surgical induced refractive error, cosmesis, etc. are becoming increasingly important. To take these factors into account, ‘Transconjunctival sutureless vitrectomy’ (TSV), subsequently renamed and popularly known as microincision vitrectomy system (MIVS) has come about. The 25-gauge vitrectomy was introduced3 in 2002 by Fujii et al4 followed by the 23 gauge in 2005 by Eckardt5 and Stanley Chang which combined the benefits of 20 and 25 gauge. In 2010, Oshima introduced even smaller, 27-gauge instrumentation.6

As a result of these advances, vitreoretinal surgeons now have multiple choices when determining their operative approach. In this article, we would like to give a brief overview of the various MIVS systems available.

Instrumentation
In MIVS, three micro-cannulas are inserted in the pars plana (with the help of insertion trocar) through the conjunctiva and sclera through a two-step incision. The infusion line and vitreoretinal instruments are then introduced into the vitreous cavity through these cannulas. At the end of the procedure, the cannulas are removed without suturing either the sclera or the conjunctiva.

The inner diameters of the 25- and 23-gauge cannulas are 0.57 and 0.65 mm, respectively,1,4 in contrast to the 0.9 mm diameter of a conventional 20-gauge incision while that of the 27-gauge cannula is 0.4 mm.5 These narrow incisions do not need to be sutured, thus providing minimal surgical trauma and brief recovery times.

In comparison to 20 gauge, the MIVS cutter port is smaller and closer to the tip (Fig. 1). A smaller port and a proximity closer to the tip maybe advantageous when performing complex manoeuvres, such as shaving of the vitreous base, working near detached mobile retina, membrane segmentation or delamination. The MIVS system also comes equipped with higher cutting rates extending up to 5000–8000 cpm; which reduces the likelihood of uncut vitreous fibers going through the cutter port, thereby reducing dynamic vitreoretinal traction with less chance of iatrogenic retinal tears and damage to the retinal surface. To achieve this high cutting rate without vibrations for better stability and precision cutting newer cutters do not have spring to drive the guillotine.

Rigidity
The main concern while using the smaller gauge instruments is the bending or breakage of the flexible instruments and difficulty in manoeuvring the globe with the help of these flimsy instruments. This problem is more noticeable with the 25- and 27-gauge instruments as compared to 23 gauge. In order to overcome this, second generation instruments, 25+ and 27+, respectively, have been introduced by adding 5 mm supporting sleeve near proximal end to make instruments stiffer and less malleable. However, this reduces the effective working length of the instrument which is disadvantageous while operating on eyes with longer axial lengths. Careful positioning of the sclerotomies can also reduce tool flexion.

Illumination
Reducing the diameter of a light pipe by 20% theoretically reduces the amount of illumination by ~35%. The conventional illumination (halogen) used in 20-gauge PPV is not adequate for MIVS. Currently, with the new-generation xenon and mercury vapor illumination sources, illumination inside the vitreous cavity has greatly improved. When combined with chandelier illuminators or multifunction instruments, these sources have made bimanual microincision vitrectomy a reality.

Aspiration and flow rates
In accordance to the Poiseuille’s law, which states that the flow through a tube is proportional to the fourth power of the radius of the tube, it is evident that even a minor reduction in the inner diameter of the tubing will result in a significant reduction in the flow across the tube. As a result

Sci Med Vis Foun June 2015 | volume XXXIII | number 2 | 57
**Fig. 1.** 23G cutter port is closer to tip compared to 20G cutter

**Fig. 2.** Dual actuation lines (ALCON) allows duty cycle control, to make cutting more effective

**Fig. 3.** Comparison between B&L and Alcon 25 gauge probe
of different flow characteristics imparted by a reduction in the size of the opening of small-gauge vitreous cutters, higher infusion and aspiration rates are necessary to optimize flow and vitreous removal. Higher aspiration flow rates will reduce the surgical time but at the cost of risking inadvertent breaks and retinal engagement in the cutter port, especially when working in the periphery or with detached retina. ’Aspiration flow limit’ is a feature complimentary to variable duty cycle and high cut rate in newer machines and once set, it maintains continuous state of fluidic stability in the eye, preventing sudden decrease in intraocular pressure and pulsatile traction on the retina.

Complications

Wound leakage

Post-operative wound leak has always been a concern with MIVS. Previous sclerotomy sites are structurally weaker because of scarring and fibrosis and reduced rigidity of the sclera could increase the likelihood of wound leakage. A clinical study using 25-gauge MIVS did correlate younger age as a contributing factor for early postoperative hypotony. Gupta et al. found post-operative day 1 intraocular pressure to be statistically lower than preoperative pressures, when eyes were left fluid filled. This was not the case in air or gas filled eyes.

Post-operative endophthalmitis

Kaiser et al. in their presentation at the 2007 Vail Vitrectomy meeting reported 0.23% incidence of endophthalmitis in 3103 consecutive eyes undergoing MIVS. This is in contrast to only one case of endophthalmitis in 5498 consecutive 20-gauge vitrectomies (an incidence of 0.0018%) performed by the same surgeons, at the same institution, over the same period. However, four other studies (three with level II evidence) that compared rates of acute endophthalmitis between 20- and 25-gauge vitrectomy did not show a statistically significant difference in incidence of endophthalmitis. In a similar comparative study of 23-gauge and 20-gauge cases, no case of endophthalmitis was observed among 943 eyes after 23-gauge PPV.

Indications of MIVS

23 Gauge

Though it can be used universally, 23-gauge system is ideally suited for rhegmatogenous retinal detachment surgery and for diabetic vitrectomies. It can also be used in cases of endophthalmitis and trauma especially foreign body removal.

25 and 27 Gauge

They are more suitable for macular surgery (Macular hole/macular pucker/epiretinal membrane) and simple cases of vitreous hemorrhage.
Branch vein decompression (sheathotomy) can also be performed. 25G instruments are also preferred in pediatric cases.

**Advantages of MIVS over conventional 20 gauge**

- Sutureless procedure: so better patient comfort.
- Less inflammation: faster healing and recovery of visual acuity.
- Less surgery induced refractive error.
- Reduced conjunctival scarring: Useful for patients requiring multiple surgeries and also prior to or anticipated glaucoma filtering surgeries or candidates with ocular surface disorders.
- Port design helps in more complete vitrectomy and easier dissection of proliferative membranes.
- Higher cut rates and smaller port aperture reduces the chances of inadvertent retinal breaks.

**Disadvantages of MIVS when compared to 20 gauge**

- Actual time for performing vitrectomy may be longer
- Not suitable for cases where extensive dissection is needed and in eyes where fragmatome have to be used
- Higher infusion pressure may cause optic nerve damage
- Smaller incision may limit the maximum flow across the port
- Flimsy instruments which may deform or break during surgery
- With long trocar blade, there is an increased risk of retinal injury in eyes with anteriorly displaced retina
- Increased risk of post-operative hypotony, choroidal detachments and endophthalmitis due to gaping wounds

**Conclusion**

The development of MIVS has provided surgeons with new options in the surgical treatment of vitreoretinal diseases. Each system has its advantages and disadvantages. The optimum gauge and settings have to be selected after careful deliberation to provide the best possible surgical outcome.

**References**


The authors have no commercial associations that may pose a conflict of interests in connection with this article.