Robert Machemer developed vitreous infusion suction cutter (VISC) in 1970s and is known as the “father of modern vitreous surgery”. The multifunctional probe provided endoillumination and removal of vitreous through one instrument inserted through the parsplana, although it required a 3.3mm sclerotomy. Later Carl Wang devised the Ocutome 800, which became the actual fore runner of the modern 20 gauge vitreectomy probes.

Generally, the same techniques of vitrectomy were adopted till the end of the 20th century. However the quest of mankind to reduce the incision size, improve the fluidic physics and hasten the recovery period, not to mention the yearning for increased efficiency of vitreous surgery finally resulted in the new era of micro incision vitreous surgery (MIVS). MIVS is defined as 23 or 25 gauge surgery using smaller probes and using a trans conjunctival scleral incision. It is in fact the most commendable advances in the field of vitreous surgery in the past decade.

Visitech in 1980s and Stanley Chang in 1993 devised 23 gauge cutters, but were not popular because of fluidic problems. However the recent interest in MIVS came with Eugene De Juan introducing his 25 gauge probe in 2001 and Eckhart later in 2005, his own 23 gauge probe. The advantages of small gauge vitreous surgery was immediately recognised by the retinal surgeons worldwide. This led to the MIVS revolution which gained momentum after 2004. Now most retinal surgeons, all around the world have shifted to small gauge MIVS for most conditions.

MIVS offers a lot of advantages including improved perioperative and post operative comfort, reduced inflammation, shorten operating times, reduced healing and recovery times, short hospital stay, increased day care rate, faster recovery and rehabilitation for patients. It has also reduced the topical medication requirements and has a positive impact on ocular surface and post surgical astigmatism. MIVS preserves conjunctiva for any future surgeries like trabeculectomy or repeat surgeries. “If you think about it, it’s pretty analogous to the transition from ECCE to clear cornea phaco,” Dr David Chang said.

The criticism to small gauge MIVS was that sutureless incisions caused hypotony and thus had increased propensity for infections. Initial experiences with 25 gauge vitrectomy before 2005 had some shortcomings like poor efficiency of cutting, low illumination and reduced efficiency apart from flimsy instrumentation. It was generally agreed upon that MIVS cannot handle more difficult surgery. However over the last 5 years, technological advancements have improved the cutter and suction efficiency of MIVS and have improved tremendously the illumination and rigidity of instruments. The rigidity of 23 gauge is almost at par with the 20 gauge instrumentation. Learning curve of most surgeons has reduced all the complications related to the wound.

When it was started, MIVS was used for macular surgery and short uncomplicated surgeries like vitreous hemorrhage, nucleus drops and uncomplicated retinal detachments with posterior breaks. However in recent times, most surgeons have shifted themselves to small gauge MIVS for almost every indication including complicated membrane dissection in PDR and retinal detachment with PVR. More and more surgeons are now converting from 20 gauge to MIVS for more and more indications.

The disadvantages of micro-incision vitrectomy in the early days were that the 25-gauge vitreous cutter was less efficient, that there was also only a limited array of instruments available, and those that were available were overly flexible and fragile. However, over the past five years refinements in the technology have addressed these problems.

**Advances in illumination**

The introduction of a xenon light source to the vitrectomy system has greatly enhanced endoillumination during micro-incision procedures. The xenon light has a bulb-life of approximately 300 hours, and the 23-gauge and 25-gauge fibre optics and light pipes have been modified to enable viewing of almost the entire field of the posterior pole. There is also a Torpedo light for a chandelier effect. The superior illumination of the new 25-gauge Torpedo light has proved to be particularly advantageous in traction retinal detachment surgery. The light can be guided by an assistant, which leaves the surgeon’s hands free to perform scleral de-pressure and clear the periphery in ways which were not possible before.

**Disposable forceps and scissors**

The disposable forceps and scissors are smaller and hence go under smaller membranes than the 20 g instrumentation. But since the probe itself is much smaller, it is possible to introduce the probe under the membranes for dissection.

**Advances in probe dynamics**

The outstanding probe, with a cut rate of 2500 cuts per minute, compared to 1500 cuts per minute with the 25-gauge probe. The probe is stiffer and less flexible and the port is closer to the tip. The greater proximity of the probe’s port
to its tip makes it easier to shave tissue close to the surface of the retina and the smaller tip enables access into smaller spaces than is possible with 20-gauge. Furthermore, the high speed cutting reduces the traction on the retina as it is being cut and can reduce the need for scissors in the eye.

### Port based flow limitations

Many surgeons as well as vitrectomy system manufacturers seem to have the misconception that higher flow rates are better. Lower flow rates are always safer and are an issue only if they significantly increase operating times, which has not been the case with 25-g systems. High-speed cutters were initially promoted using vague terms like cutting efficiency or better cutting when in fact the actual advantage is port-based flow limiting; a term I defined. Port-based flow limiting is inherently produced by smaller lumens. I have defined pulse flow as the volume of fluid that goes through the port with each open-close cycle; port-based flow limiting reduces pulse flow. Reduced pulse flow increases fluidic stability, thereby reducing cutter-induced motion of detached retina enabling safer removal of peripheral vitreoretinal traction. In addition, port-based flow limiting fluid surge after sudden elastic deformation of dense epiretinal membranes through the port, facilitating safer conformal cutter delamination for diabetic traction retinal detachments. The crucial point is that 25-g cutter lumens are smaller than 23-g and therefore produce better fluidics performance because of increased port-based flow limiting.

Now let us see, how small gauge vitrectomy would fare in the presence of some challenges during retinal surgery

1. **Corneal, limbal and scleral involvement and melt**

   Corneal and limbal as well as scleral involvement is not infrequent in endophthalmitis. It may spread out from the region of the surgical wound or the area of trauma. The sclera and cornea may start sloughing out and may even need tectonic support to save the globe. Small gauge vitrectomy will help us in this stage as we can easily go in through the non necrotic areas and without any sutures take the instruments out of the eye. In an ordinary 20 gauge vitrectomy, the scleral port sutures may be difficult to be placed through sloughed sclera.

2. **Cheese wiring of sutures**

   Again, since the sutures may cheese wire through the sclera and cornea, it may be always better to consider doing sutureless procedures in vitrectomy for endophthalmitis. With large openings of 20 gauge surgery chances of cheesewiring will increase.

3. **Poor visibility due to corneal haziness or pupillary fibrin**

   No gross difference between 20 gauge or small gauge vitrectomy in media haze. However if the media haziness is secondary to anterior or posterior capsular opacification or fibrin, then the small gauge probe can help us remove the opacification or fibrin through a small paracentesis or through the port in a more controlled fashion than with a 20 gauge probe.

4. **Lens management**

   If one has to do a lensectomy or phacoemulsification to remove the crystalline lens, the advantage of sutureless vitrectomy is lost because there is no small gauge phacoemulsifier and lensectomy with small gauge probe may be more time consuming. However the improved fluidics of small gauge vitrectomy including lesser turbulence can be of value in managing the surgery. Lesser fluid turbulence can help in reducing endothelial loss in anterior segment management of endophthalmitis surgery.

5. **IOL dislocation or intended removal of IOL**

   In cases where there is a dislocated IOL or where there is a need to remove the IOL, then we may have to enlarge the limbal incision and here too, the advantage of sutureless incision is lost. However more fluidic stability and less turbulence may help in reducing endothelial loss during such surgeries which also requires an IOL removal.

6. **Infusion placement in the presence of choroidal edema or exudates**

   Infusion placement in any vitreous surgery is a very critical step. In many cases, there will be choroidal edema and thickening and exudates are very close to the insertion of the port that a blunt MVR blade or a blunt trocar/ cannula system can cause a dialysis and the cannula can become suprachoroidal or subretinal. It is more common in small gauge vitrectomy system because the sharp edge of the trocar is followed by the blunt tubing of the port. Another reason is that the canula is about 4 mm only in small gauge. We routinely use 6 mm infusion cannulas in such cases where in doubt so that this complication does not arise. However in 25 or 23 gauge systems, we do not a this point of time have 6 mm infusion cannula.

7. **Shift of infusion or active port from one port to another**

   During the course of vitrectomy, one may need to change the active port from one port to another or need to change the infusion cannula from one port to another. This is easily achieved in a small gauge vitrectomy system as one can easily pluck out the infusion cannula from one port and insert it onto another port to suit our need and necessity for the active port. This can help us in virtually having the active instrument through any of the three ports including the infusion port.
8 Poor flow as infusion can get blocked with exudates.

The rate of flow through a small gauge 25 g system is much lesser than that through a classical 20 gauge system and because of this and the narrow bore of the 25 g system, the small gauge probe gets blocked very quickly with exudates. Even though at the beginning of surgery, the tip of the port is visualized, during the course of surgery, since the flow of fluid is small, it may easily be blocked by the thick exudates of endophthalmitis. Once the cannula is blocked, it may give rise to sudden hypotony and its complications.

9 Absence of PVD

Posterior vitreous detachment may be absent in many cases. In most cases, we can very carefully induce a PVD, and a more controlled induction may be possible with a small gauge system. In cases where PVD is difficult to be induced, we may use the probe to go as close to the retina as possible to shave the exudates. In such a scenario, it is always better to have the small probe, with its tip very close to the edge of the probe.

10 PVD induction in fragile retina causing retinal tear

If the PVD is not easily inducible, and if we continue pulling on the vitreous to induce a PVD, it could cause tears in fragile and inflamed retina. The incidence will be lesser with a small gauge probe as there will be more fluidic control for the same.

11 Retinal Dialysis of the active port

When there are a lot of exudates around the sleeve of the port and when blunt instruments go in and out of the port, there can be chances of retinal dialysis. The chances of such dialysis are lesser in a port with a sleeve as in small gauge surgery as the instrument always passes in and out of the eye through the sleeve. However in a large gauge probe, the entries are risky in terms of retinal dialysis.

12 Peripheral tears during vitrectomy

The incidence of peripheral tears during vitrectomy may be the same with both small gauge and large gauge systems. But in the management of such a tear, closer shaving and relief of vitreous traction on the tear may be more efficient with a small gauge vitrectomy system than a classical 20 gauge system.

Our results of small gauge diabetic vitrectomy

We had evaluated our own results of the small gauge diabetic surgeries done for the last 5 years.

Aims of the study

To study the results of small gauge 23 and 25 gauge sutureless diabetic vitrectomies done in our center between January 2006 and April 2010.

The primary outcome measures were
1) Duration of surgery
2) Intraoperative patient comfort
3) Post operative pain
4) Anterior segment reaction
5) Visual acuity
6) Complications
7) Day case rate

Results

We retrospectively reviewed a consecutive series of 211 eyes of 198 patients who underwent 25 or 23-gauge transconjunctival vitrectomy at the Vitreo Retinal Services, Amrita institute of medical Sciences from January 2006 to April 2010. Surgical indications were vitreous hemorrhage, traction retinal detachments, taut posterior hyaloids and neovascular glaucoma.

211 eyes of 198 patients who underwent sutureless vitrectomy for diabetic retinopathy, with a mean age of 62.1 years, were observed for a mean of 6.3 months, ranging from 6 to 26 months. Mean overall visual acuity was improved from 20/100 (LogMAR, 0.69 ± 0.47) preoperatively to 20/38 (LogMAR, 0.33 ± 0.21) at final visit (P <0.001). The overall results in each subgroup are summarised in Table 1.

Table 1 summarizing the results including duration of surgery, intraop and post op comfort score, anterior segment reaction and pre and post op visual acuity

<table>
<thead>
<tr>
<th></th>
<th>Mean Duration in minutes</th>
<th>Intraop comfort score</th>
<th>Post op comfort score</th>
<th>Ant segment reaction</th>
<th>Pre op vision logMAR</th>
<th>Post op vision logMAR</th>
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<tbody>
<tr>
<td>VH</td>
<td>35.4</td>
<td>96.3</td>
<td>91.4</td>
<td>1.1</td>
<td>1.4</td>
<td>0.2</td>
</tr>
<tr>
<td>Taut hyaloid</td>
<td>69.4</td>
<td>82.7</td>
<td>78.4</td>
<td>2.8</td>
<td>1.7</td>
<td>0.8</td>
</tr>
<tr>
<td>TRD</td>
<td>73.2</td>
<td>84.5</td>
<td>71.3</td>
<td>2.1</td>
<td>1.1</td>
<td>0.6</td>
</tr>
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</table>
The mean overall preoperative intraocular pressure was 14.4 ± 3.8 mm Hg (mean ± standard deviation), ranging from 9 to 27. The mean overall postoperative intraocular pressure on day 1, week 1, and at final visit were 11.2 ± 5.3 mm Hg (range, 1 to 31), 13.6 ± 7.8 mm Hg (range, 6 to 24) and 14.3 ± 3.3 mm Hg (range, 11 to 23), respectively. The decrease in intraocular pressure was statistically significant on postoperative day 1 (P < 0.001), but no differences were significant thereafter (P > 0.05).

Suture placement to at least one sclerotomy site was required in 89 eyes. They were the cases with rhegmatogenous retinal detachments and tractional retinal detachment associated with proliferative diabetic retinopathy. All of these cases required peripheral vitreous shaving with scleral indentation and/or intraocular manipulation at the peripheral retina.

**Complications**

There were 7 complications in the study which were of serious concern. (0.011%) There were 3 during entry and 4 during PVD induction. The entry related complications were subretinal infusion cannula in 1 case, suprachoroidal infusion in another and intraoperative lens touch and cataract in another. The complications during PVD induction were all retinal tears. They were identified and correction applied.

**Conclusion**

Compared to most 20 gauge surgeries which require admission, the 25 gauge and 23 gauge patients could be sent home the same day as day case. A total of 82.2% patients were done in a day case manner. Only 10.6 % of patients were admitted, out of which 70 % was admitted for insurance. which has made small gauge vitrectomies as patient friendly as phacoemulsification.

**References**