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Wound Construction

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Abstract

Wound construction is critical in microincision vitrectomy surgery. The three main steps in constructing a proper wound include displacing the conjunctiva away from the sclera, flattening the sclera on insertion, and angling the incision. Each one of these steps helps create wounds that will not leak. Misaligning the conjunctiva from the scleral hole prevents a vitreous wick from extending external to the conjunctiva. Flattening the sclera on trocar insertion provides a longer wound cord length, which is less likely to leak, and angling the incision has been proven to seal better in both anterior and posterior segment incisions. When you make an angled incision, you initially insert the blade at a 30° angle (at least). This will make the wound more stable because it is less likely to cause internal disruption of the wound edges. These three basic steps are simple, but very important to follow when constructing a microincision wound in order to limit postoperative complications including wound leakage, gas leak, hypotony, and endophthalmitis.

While there have been reports of scissors to cut the vitreous in the past, the history of modern pars plana vitrectomy dates back to Dr. Robert Machemer, who in 1971 used a 17-gauge sclerotomy port for his first pars plana vitrectomy in a diabetic nonclearing vitreous hemorrhage [1]. Since then the field has changed dramatically and we have moved from 17-gauge to 20-gauge vitrectomy and more recently in 2002 to microincision vitrectomy surgery (MIVS) with gauges as small as 27 gauge [2]. MIVS has become very popular among retina surgeons over the past 11 years [3]. Advances in technology, biomedical engineering, and instrumentation have made it possible to consistently shrink the size of the entry cannula from 23- to 25-gauge and more recently to 27-gauge vitrectomy. Smaller incisions are less traumatic to the eye and do not require sutures. The absence of sutures helps with patient comfort, decreases surgical time, decreases postoperative inflammation, and speeds up recovery. However, the sutureless nature of MIVS poses risks related to postoperative hypotony, choroidal hemorrhage, gas or silicon oil leakage, and even endophthalmitis. Initial studies comparing endophthalmitis rates between microincision surgeries and 20-gauge vitrectomy revealed higher rates of endophthalmitis with microincision surgery [4, 5]. This was alarming to all retina surgeons. A careful analysis of the data, however, showed that different wound construction techniques had different endophthalmitis rates [6–8].

While other factors like the intraoperative use of corticosteroids, subconjunctival injection of antibi-

otics, and incomplete removal of the peripheral vitreous skirt have been hypothesized to result in bacterial in-growth predisposing the patient to endophthalmitis, the most critical part remains wound construction. The principal of wound construction is similar to a self-sealing limbal incision for phacoemulsification. The idea is to create a multiplanar wound that is stable and prevents bacterial migration in the eye. Herein, we will discuss the different techniques to successfully produce good wound construction in microincision surgery.

Instrumentation

Microincision surgery is predicated on introducing either flexible or rigid cannulas into the eye that allow the insertion of the microsurgical instruments without disrupting the sclera. The insertion of a cannula in the eye during vitrectomy is currently a single-step technique, although dual-step systems have been used in the past with success. The cannula fits over a sharp trocar, which allows simultaneous opening of the sclera and insertion of the microincision cannula. This creates an entry system that provides the vitrectomy instruments unobstructed access to the eye. Other components of the instrumentation include cannula plugs and an infusion line. Early-generation microvitreoretinal blades were stiletto-like. Beveled blades that created linear incisions replaced these because linear incisions tend to close easier. The newer EdgePlus microvitreoretinal blades (Alcon Laboratories Inc., Fort Worth, Tex., USA) have a hump perpendicular to the horizontal plane of the blade, which stretches the tissue and ensures a slit-like incision with minimal insertion force.

Globe Fixation and Site Preparation

The first step in wound construction is displacing the conjunctiva. Many surgeons will mark the entry site first with calipers (approx. 3–4 mm from the limbus depending on phakic status) and then hold the conjunctiva with nontoothed forceps in order to displace it away from the incision site. Care must be taken not to tear the conjunctiva. Others use a cotton swab or another instrument to displace the conjunctiva before entering with the trocar. The main benefit of misaligning the scleral and conjunctival incisions is to prevent any vitreous wick from extending beyond the sclera and through the conjunctiva.

Flattening the sclera is another critical step before inserting the trocar. The globe is a curved structure and by flattening it you will end up with a longer chord length within the sclera. This creates a better sealing wound. Thus, by not following the natural curve of the eye and by flattening the sclera you can create a wound with a longer cord length that is less likely to leak.

Some surgeons prefer the use of a fixation plate to fixate the globe, displace the conjunctiva, and flatten the sclera in one step. The pressure plate has caliper marks incorporated within the plate to measure the distance from the limbus, and on the undersurface it has serrations that allow displacement and holding of the conjunctiva. There are several different types of fixation plates on the market. Alternatively, one can even use a cotton tip applicator to fixate the globe.

Different Types of Incisions

Stab or Straight Incision

With the stab or straight incision, the direction of the trocar is kept perpendicular to the globe and enters without any angulation. Direct entry is made after conjunctival displacement at the pars plana. The advantage of this wound construction is that it is very simple to perform and fast. The disadvantage, as seen histologically, is that it is often not self-sealing and creates a gap that tends to leak, especially with larger-gauge vitrectomy, increasing the chances of postoperative endophthalmitis [9, 10] (fig. 1). In smaller-gauge surgery (>25

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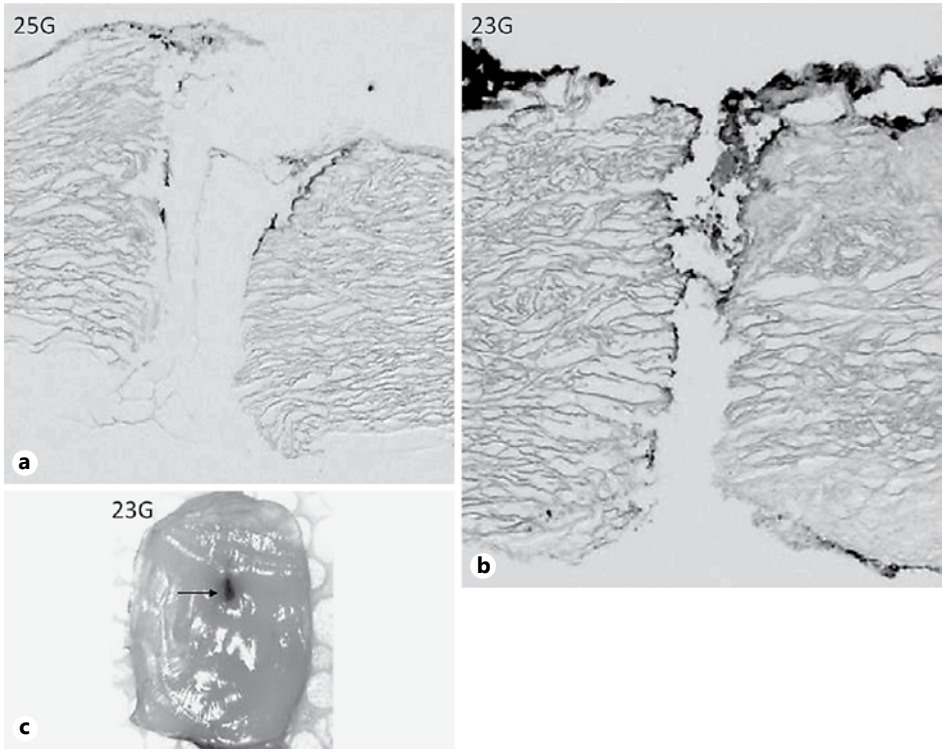

Fig. 1. Histopathology slide demonstrates gaping of straight 25-gauge (25G) (**a**) and straight 23-gauge (23G) (**b**) incisions and India ink (that mimics the size of bacteria) visible on and within straight incisions. **c** India ink is grossly visible at the internal hole (arrow) of the sclera of straight sutureless 23-gauge incision.

gauge), a stab incision is not ideal but often does not leak, whereas in larger gauges (<23 gauge) it is very likely to leak and is not recommended.

Oblique or Angled Incision

An oblique or angled incision is when the direction of the trocar is at least 30° to the sclera. The length of the incision inside the sclera is variable depending on the exact angle of insertion of the trocar. The angled incision has been proven by histology and anterior segment optical coherence tomography to be more stable and less likely to leak regardless of the pressure in the eye as compared to stab incisions [11]. When evaluated with spectral domain anterior segment optical coherence tomography, all 23- or 25-gauge stab incisions were open and readily visible immediately after removing the cannulas, whereas angled incisions had better apposition and were often very difficult to find. Experiments using India ink, which mimics the size of bacteria, placed on the surface of cadaver eyes after removing cannulas showed India ink inside the wound and often inside the eye in all 23- or 25-gauge stab incisions with penetration across the whole incision in some wounds, whereas no ink particles were observed in the wound or eye with angled incisions (fig. 2). This indicates the potential for surface fluid and bacterial inflow through stab incisions before the occurrence of any wound healing. This risk, however, is very low with angled incisions. Therefore, it has been speculated that angled inci-

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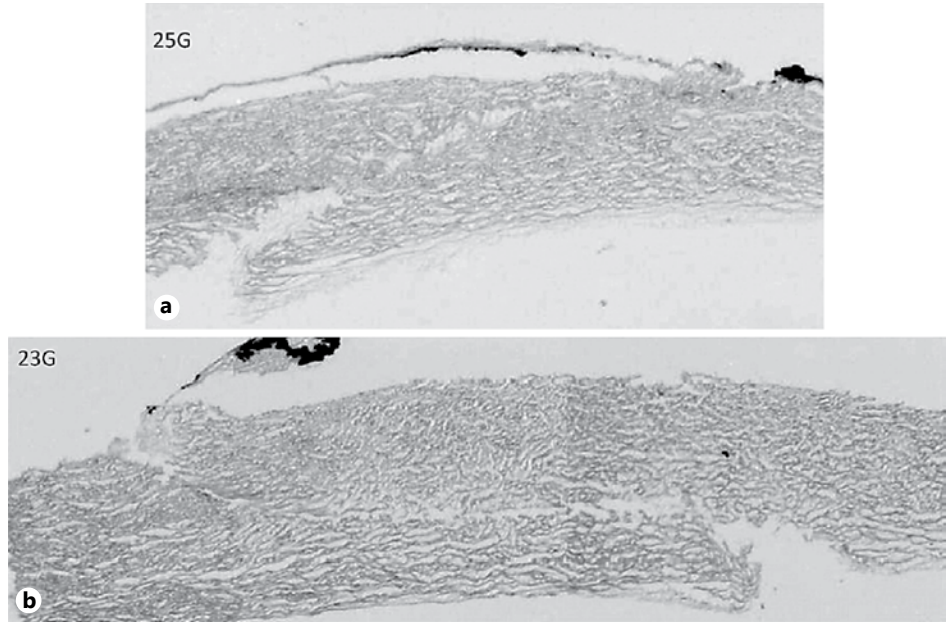

Fig. 2. Histopathology slide demonstrates good approximation and closure of angled 25-gauge (25G) (**a**) and angled 23-gauge (23G) (**b**) incisions. India ink is not visible on or within the angled incisions.

sions are safer postoperatively, leading to lower rates of endophthalmitis and infection. The main disadvantages of angled incisions are that the inner tissues when you enter obliquely in the vitreous may be disrupted as seen on histology, and it takes more time [9]. However, the advantages appear to far outweigh the disadvantages for this type of incision.

Regardless of incision type, it is important not to rotate the trocar as you enter the sclera. Many beginning surgeons mistakenly perform this maneuver when entering the globe thinking it helps with entry. In fact, this rotation of the trocar tears scleral fibers, thus creating a very unstable wound.

Wound Closure

Wound closure is critical after completing the vitrectomy. Careful inspection of the wound after removal of the cannula will help determine the stability of the wound and prevent postoperative leaks and hypotony. The formation of a conjunctival bleb is a sign of wound leakage. There are several tips to insure that this does not happen. When you remove the cannula, it is very important to place a solid instrument into the cannula as you are removing it to prevent suction from the removal of the hollow cannula from producing a vitreous wick through the wound. A light pipe or a plug can be used for this purpose.

Performing a partial or complete air-fluid exchange is also suggested before removing the cannulas. The air/gas bubble inside the eye will help close the internal lip of the wound by increasing the surface tension. Postoperative hypotony rates are less in eyes left with some degree of air fill compared to fluid-filled eyes [12, 13]. A small air bubble also makes it easier to visualize small wound leaks since small bubbles appear around leaks. In contrast, small leaks in a fluid-filled eye may be difficult to see as no bleb forms. More-

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over, when leaks of air occur, they are easy to displace to allow the surgeon to place a suture. In many cases, patience and pressure with a blunt-tipped instrument is enough to cause cessation of most instances of leakage.

It is important to note that if any incision is leaking or appears unusual at the end of the case, the threshold for placing a suture should be low. Other parameters that should make the surgeon consider placing a suture are prolonged time of surgery, excessive manipulation of instruments, monocular patients, highly myopic or uveitic patients with thin sclera, and active external infection such as conjunctivitis or severe blepharitis. Prolonged surgery times and excessive manipulation disrupts the wound architecture and causes swelling and subsequent gaping between the inner and outer wound leafs. If wound leaks are detected, placing a suture, preferably an absorbable 7-0 or 8-0 suture, is the best option given the increased risk of complications. Patients with blepharitis have increased secretions and bacterial load on the eyelids that can potentially enter the eye when the surgical wounds are unstable. Overall, the surgeon should be very cautious during wound closure even when a proper wound was constructed, evaluating carefully the wound at the end of the case and having low threshold for placing a suture.

Complications

Hypotony

Leakage through the sclerotomy is the main cause of hypotony, especially in the early postoperative period. Even a small amount of pressure on the eye while removing the speculum or patching the eye can cause a significant amount of leakage if the wound is unstable. Persistent hypotony can lead to potentially sight-threatening complications such as choroidal effusions and endophthalmitis. Early postoperative hypotony can create a siphon effect drawing bacteria into the vitreous cavity. Thus, all ports should be carefully observed for leakage, which usually manifests as a subconjunctival bleb. In this case, placement of a suture is indicated.

Endophthalmitis

There have been several reports of increased incidence of endophthalmitis associated with MIVS. This has been attributed to wound construction and straight or stab incisions. In the largest study to date, Kunimoto and Kaiser [4] reported an 11-fold increase in the rate of endophthalmitis from 0.018% after 20-gauge to 0.23% after 25-gauge sutureless vitrectomy. Similarly, Scott et al. [5] reported 0.03% with 20-gauge and 0.84% with 25-gauge sutureless vitrectomy, and Shaikh et al. [14] in a small case series noted 0.0% with 20-gauge and 1.6% with 25-gauge sutureless vitrectomy. In addition, Eifrig et al. [8] reported similar endophthalmitis rates after 20-gauge vitrectomy, approximately 0.03–0.05% [15–18]. Therefore, the increased incidence of endophthalmitis with MIVS was of great concern. However, a careful analysis of the studies mentioned above showed that the highest incidence of endophthalmitis was related to those cases that used a stab incision. Angled incisions had similar rates of endophthalmitis as 20-gauge incisions.

Conclusions

Wound construction is critical in microincision surgery and angled incisions are superior to straight incisions regardless of the gauge. Postoperative endophthalmitis is the major concern; however, after analyzing the data, we are comfortable that angled incisions are safe for patients. Linear incisions heal better compared to chevron-shaped incisions, and this observation led to the development of new trocars that make slit incisions. Wound closure is as important as wound construction. Partial or complete air-fluid exchange will help close the internal lip of the

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wound. However, since the surgery is sutureless, the surgeon should be very meticulous and observant at the end of the case for wound leakage. As surgeons become more comfortable with MIVS, their threshold to place a suture at the end of the case should be low, especially in the beginning of their career given the detrimental complications that open wounds can cause.

Disclosure Statement

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