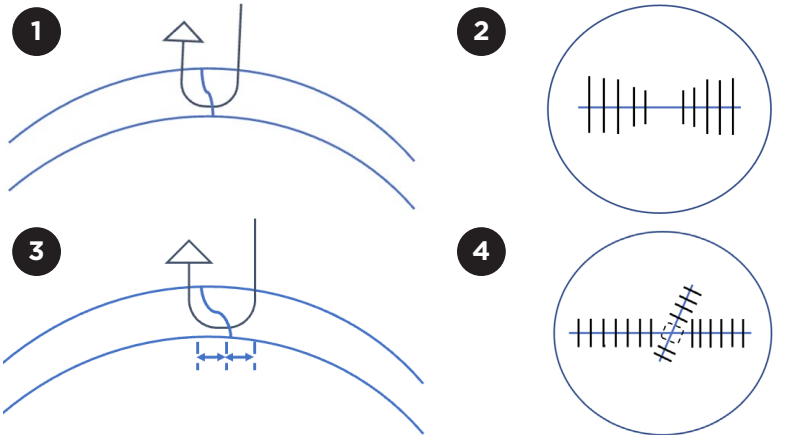
Surgical Principles for Management of Corneal Lacerations

Ocular trauma is a leading cause of preventable vision loss. A recent meta-analysis estimated that up to 24.5 million people in the United States have suffered an eye injury, with roughly 7% of those experiencing visual impairment and 0.6% no light perception in the affected eye.[1] Injuries to the eye can vary greatly in severity, from simple abrasions of the cornea to more extensive open-globe injuries. Corneal lacerations can range from simple partial-thickness corneal injuries, which can be repaired at the slit lamp or in a minor procedure room, to more complex wounds requiring surgical repair in an OR.



SUTURING. *(1) To ensure appropriate closure, the corneal suture is passed at 80% to 90% depth with symmetric passes on either side of the wound. (2) For astigmatism control, longer sutures and shallower passes are placed peripherally, and shorter, deeper passes are placed more centrally to flatten the periphery and steepen the central cornea. (3) For oblique corneal lacerations, the suture is passed in equal lengths from the posterior aspect of the wound to ensure adequate closure. (4) For stellate corneal lacerations, the central dotted lines represent either a horizontal mattress or purse-string suture at the apex prior to closure of the linear portions of the wound.*

Evaluation and Preoperative Management

Evaluation. The initial diagnosis of a corneal laceration may be challenging, particularly in cases of severe patient discomfort or in the trauma bay with an unstable or obtunded patient. A thorough initial exam should be performed, including a vision test, a pupil check, and a slit-lamp evaluation. The fellow eye should also be examined carefully to rule out bilateral injury.

A CT scan is necessary to rule out the presence of intraocular foreign bodies, and it can aid in assessment of globe shape or potential locations for globe injury. Measurement of IOP is typically deferred when a full-thickness globe injury is present or suspected.

A negative Seidel test is helpful in assessing for a full-thickness corneal laceration. However, in cases of corneal swelling or edema, a Seidel test may be negative unless the wound is provoked and carefully reevaluated.

Partial-thickness lacerations can be challenging to diagnose via clinical exam, and suspicious wounds may need to be explored in the OR. Careful inspection of the wound is necessary to identify any perpendicular or shelved areas of the laceration. Ideally, this is performed with the slit lamp or anterior segment OCT (AS-OCT), as the view through the operating microscope limits the 3D examination of the cornea. When available, AS-OCT is an excellent tool for assessing the depth of the lacerations and for monitoring healing over time.[2]

Pre-op management. A corneal laceration requires prompt, thorough wound evaluation and wound closure to reduce the risk of endophthalmitis, avoid tissue necrosis, and decrease patient discomfort. Deep lacerations, even if not full thickness, can cause significant astigmatism if left untreated. Repair of lacerations should generally be performed within 24 hours of initial trauma. The decision to perform a

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repair at the slit lamp or in a minor procedure room versus the OR depends on a variety of factors, including the patient's clinical status as well as the depth and extent of the injury.

Patients should abstain from food or liquids by mouth (NPO status) in case general anesthesia is necessary. If repair will be done in the OR, NPO status is maintained, and several steps are taken to protect the globe and prepare for the procedure. The eye should be covered with a protective hard shield to prevent further injury. Broad-spectrum antibiotics are administered through topical, intravitreal, or systemic routes, depending on the extent and nature of the injury. Administration of antiemetic and analgesic medication can be considered to reduce further pressure on the globe.

Intraoperative Management

General anesthesia is typically used for patients undergoing operative repair of a corneal wound, as it maximizes patient comfort and minimizes potential tissue extrusion through the wound, which can occur with retrobulbar or peribulbar blocks. Intravenous mannitol can also help to reduce tissue extrusion through an open wound. It is imperative that the wound is thoroughly evaluated and that necrotic tissues are excised. A culture of the wound edges may help guide the postoperative antibiotic regimen.

Intraoperatively, the anterior chamber should be re-formed and maintained with filtered air, bacteriostatic saline, or cohesive viscoelastic. A well-pressurized anterior chamber can minimize creeping of intraocular tissue into the wound space prior to or during closure.

Corneal Suturing Principles

Corneal suturing techniques and materials have largely been standardized since the 1970s with some refinements of techniques. Typically, monofilament 10-0 nylon suture material on a fine spatula surgical needle is used for corneal suturing.

Depth. Corneal sutures are usually not full thickness but rather pass at 80% to 90% depth to avoid creating a conduit for intraocular microbial invasion and infection, although the ideal depth remains a topic of debate. Suture depth less than 80% can cause the wound to gape posteriorly, so securing an adequate depth is crucial.

Passes. Suture passes should be symmetric on each side of the wound to ensure appropriate wound edge approximation (Fig. 1), except in the setting of a shelved wound. When a suture is passed through the cornea, the needle must enter perpendicular to the corneal surface and should be passed in a single throw to avoid multiple entries.

Needles. A bicurve needle with a small radius of curvature, resulting in shorter and deeper passes, can be used centrally and, in theory, may reduce astigmatism and minimize visually significant scarring (Fig. 2). A needle with a larger radius of curvature that results in longer, more shallow passes can be used peripherally to flatten the corneal periphery and subsequently steepen the central cornea (Fig. 2). When possible, avoid sutures entering the pupil area in order to minimize vision-threatening scarring. However, the primary goal of wound closure is to create a watertight seal, even if placement of central sutures is unavoidable.

Knots. All suture knots should be trimmed short and superficially buried in the stroma away from the pupil to maintain their structural integrity while also allowing for easy removal if necessary. Exposed corneal knots cause significant patient discomfort and require coverage with a bandage contact lens, and they may pose a risk of infection.

Tightening. Sutures should be tightened enough to avoid a leaky wound; astigmatism resulting from overtightening can always be relaxed with suture removal in the postoperative period. Slipknots may be helpful, as they can easily be loosened or tightened after the entire wound is secured to provide adequate and even tension. Close examination of the wound integrity with fluorescein can be performed to ensure an adequate watertight seal prior to completion of any case.

Management Strategies by Laceration Depth

The goal of any corneal laceration repair, regardless of depth or shape, is to create a watertight wound closure. Minimal scarring and reconstruction of the native corneal contour are also important goals. Management depends on the extent and depth of the laceration.

Partial-thickness lacerations. Shallow, partial-thickness lacerations can be managed conservatively with a soft bandage contact lens, with or without tissue adhesive. However, suture repair should be considered for deeper lacerations with a risk for inducing astigmatism. Tissue glue can be applied at the bedside or in the OR, making it a versatile management option. Techniques for application of both cyanoacrylate and fibrin glue have been described in numerous articles.[3] Both adhesive materials have been found efficacious and are widely used; however, a study by Sharma and colleagues demonstrated that cyanoacrylate may provide longer adherence to the cornea in exchange for higher rates of deep stromal neovascularization and giant papillary conjunctivitis.[4] Thus, choice of tissue adhesive depends largely on availability or surgeon preference.

Partial-thickness corneal lacerations should be managed with topical antibiotic therapy to minimize the risk of keratitis. In addition, large shelved partial-thickness wounds may benefit from suture closure or realignment. These may also need to be explored in the OR to confirm that there is no full-thickness area in the wound.

Full-thickness lacerations <2 mm. Full-thickness lacerations less than 2 mm wide without tissue incarceration and with well-apposed wound edges can be managed with use of a pressure patch, bandage contact lens, aqueous suppressants (topical or systemic), or tissue adhesive such as cyanoacrylate or fibrin glue. However, many surgeons still opt for definitive suture closure in these cases. Full-thickness injuries carry a higher risk for endophthalmitis and require prophylactic IV antibiotics, of which vancomycin (1 g IV every 12 hours) and ceftazidime (1-2 g IV every 8 hours) are initially recommended, in addition to appropriate periocular and topical antibiotics.[5]

Full-thickness lacerations ≥2 mm.

If a watertight closure of a small full-thickness laceration cannot be completed via any of the above techniques or if the full-thickness laceration measures greater than 2 mm wide, suture placement is required.

Repair Techniques Based on Laceration Shape

Linear lacerations. Suture placement should start at the midpoint of the laceration. The resulting halves should then be bisected until the wound is sealed. In cases where shelved and perpendicular portions are present, the perpendicular portions should be closed first to re-form the anterior chamber and to allow adequate apposition of the shelved portions. This also minimizes the number of sutures needed for wound closure.[6,7]

Oblique lacerations. In oblique injuries, it is important that the suture is passed in equal lengths from the posterior aspect of the wound to avoid wound override (Fig. 3). This may create an irregular anterior appearance, but posterior or internal wound apposition and avoidance of anterior override take precedence. The suture should be tightened so as to avoid tension over the shallow portion of the wound while ensuring adequate closure.[6,7]

Stellate lacerations. Stellate lacerations can be the most challenging to repair. In some scenarios, the linear portions of the wound can be closed separately, which sometimes allows the apex to self-seal. If necessary, a horizontal mattress suture can be placed at the apex prior to repair of the linear portions of the wound (Fig. 4).[6] An alternative purse-string technique described by Eisner is used by some surgeons.[8] In this technique, a guarded diamond knife set to 0.3 mm is used to incise the normal corneal stroma to half-stromal thickness depth. Then, a 10-0 nylon suture is passed from the depth of these diamond knife incisions through the adjacent stroma and laceration and out through the neighboring incision until repair of all sides of the apex has been accomplished. Tightening of the suture will approximate the apical edges, and the knot is typically buried within the stroma. The remaining linear portions of the wound can then be closed in standard fashion.

Corneoscleral lacerations. An initial 8-0 or 9-0 nylon suture should be placed at the limbus to properly restore the alignment of the cornea and sclera. The corneal aspect should then be addressed first to avoid tissue prolapse and to stabilize the globe, followed by repair of the scleral portion.

Lacerations with tissue loss. In cases with large amounts of tissue loss, a lamellar corneal autograft, tectonic lamellar patch graft, or donor cornea or sclera can be used to fill the defect. Although an autologous graft is more technically challenging and not always possible in larger corneal lacerations, it can be beneficial, as it minimizes the risk of graft rejection. Techniques for corneal patching with minimal graft tissue to reduce rejection and scarring and to spare donor tissue have been described.[9] Amniotic membrane tissue can be used as an adjuvant material to improve healing and to further secure the wound.[10] In the most severe cases with large wounds or significant tissue loss, a penetrating keratoplasty may be required.

Postoperative Care

The medication regimen in the post-op period can widely vary depending on the extent of the ocular injury. In most instances, patients are maintained on topical antibiotics in conjunction with topical corticosteroids and strong cycloplegia. Strict protective precautions are given, including the use of protective eyewear.

Timing of suture removal is based on several factors, which include patient age, size of the defect, and amount of induced refractive change. Removal may need to be done in steps rather than all at once in cases such as limbus-to-limbus or stellate wounds. Corneal tomography can be helpful in some cases to guide the suture removal process.

Rigid gas-permeable lenses, hybrid contact lenses, or scleral lenses are excellent noninvasive options to improve patient vision and comfort without additional surgery. In selected cases, a refractive keratoplasty can be performed to optimize visual potential.

Complications

Complications following repair of corneal lacerations can be reduced with proper surgical techniques and appropriate antibiotic therapy.

The most dreaded complication is endophthalmitis, with reported incidences as low as 0.9% in cases with prompt initiation of prophylactic IV antibiotics and as high as 11.9% in other reports.[5,11] Other possible complications include infectious keratitis, retained intraocular foreign bodies, and wound leaks. Loose or broken sutures can be conduits for infection or cause patient discomfort, and sutures can induce significant astigmatism requiring removal. Permanent vision loss can occur from corneal scarring. Although rare, sympathetic ophthalmia is a lifelong risk for patients.

Conclusion

Corneal lacerations present in various depths, shapes, and sizes. Prompt treatment and management following established principles can yield the best visual outcomes and minimize the risk of developing vision-threatening complications.

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