Microsurgical Suturing Techniques: Closure of the Cataract Wound 4

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Key Points

Surgical Indications
- The placement of a suture in a cataract wound should be considered if there is any concern about:
  - The integrity of the wound
  - Inadequate wound closure
  - A larger incision
  - Thermal wound burn

Instrumentation
- Microtipped needle holder
- 0.12-mm forceps
- Vannas-style scissors
- Micro-tying forceps
- 10-0 monofilament nylon suture

Surgical Technique
- Radial interrupted suture
- X-stitch
- Fine's infinity suture
- Shepherd's horizontal mattress suture
- Running suture
- Shoelace suture

Complications
- Induced astigmatism
- Wound leak
- Full thickness suture with wound leak

4.1 Introduction

Historically, one of the most common microsurgical challenges that the ophthalmologist would face was closure of the cataract wound. Prior to phacoemulsification, most cataract surgeries were performed using an intracapsular or extracapsular technique that would utilize a large limbal incision beneath a conjunctival flap [1]. These long incisions would require multiple and varied suturing techniques to ensure adequate wound closure, and allowed ophthalmic surgeons to become very proficient and adept at their suturing skills. With the advent of phacoemulsification and foldable intraocular lenses, cataract wounds evolved and dramatically decreased in size [1, 2]. Large limbal wounds were first replaced by smaller scleral tunnel incisions, which in turn were replaced by even smaller clear corneal incisions. With each advancement, the role of suture placement in the closure of the cataract wound was greatly diminished. Indeed, with modern cataract extraction, it is now considered routine to see small, self-sealing, clear corneal incisions that do not require any suture placement.

Unfortunately, as the role of suturing has diminished in modern cataract surgery, so have the suturing skills for many ophthalmologists. It is not uncommon to speak with eye surgeons finishing their training who still have difficulty with proper suturing technique despite having performed a large number of cataract extractions. The purpose of this chapter is to review the basic principles involved with closure of the cataract wound, specific suturing techniques that can be utilized to close the cataract wound, and to discuss suturing options when faced with the intraoperative complication of thermal wound burn.

4.2 Surgical Indications

4.2.1 The Cataract Incision

To understand the closure of the cataract wound, one must first familiarize oneself with the different types of cataract incisions that are employed in modern cataract surgery. The cataract wound can be divided into three major categories: limbal, scleral tunnel, and clear corneal [4]. The limbal incision has traditionally been used with an intracapsular or extracapsular cataract extraction. The technique usually involves the creation of a conjunctival flap exposing underlying bare sclera. A uniplanar incision is created using a razor knife at the gray area of the limbus to enter the anterior chamber (Fig. 4.1; [4]). The incision is then enlarged with corneoscleral scissors to the right and left, creating a large incision to facilitate removal of the lens nucleus (Fig 4.2). Although initially described with a uniplanar incision, some surgeons advocate a more shelved mul-

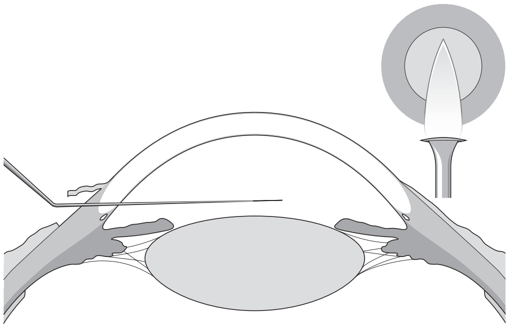

Fig. 4.1 Limbal cataract incision showing entry into the anterior chamber at the gray line of the limbus using a razor knife

Fig. 4.2 Limbal extracapsular cataract incision

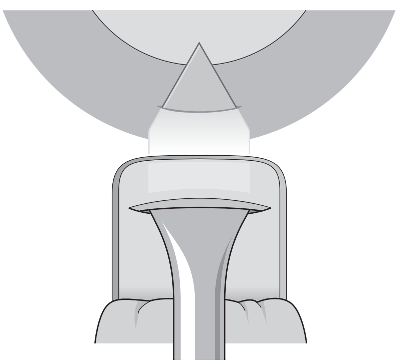

Fig. 4.3 Scleral tunnel incision

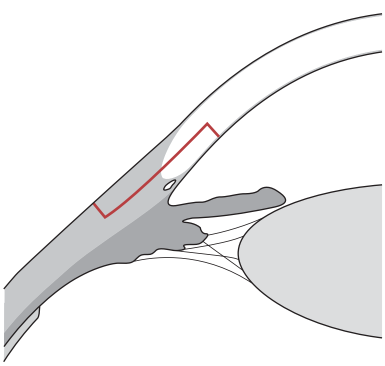

Fig. 4.4 Scleral tunnel triplanar incision

triplanar incision, which can minimize iris prolapse and help to facilitate wound closure [5].

The scleral tunnel incision was created in response to the rapid advancements in phacoemulsification, and offered cataract surgeons the option of a surgical entry site that was more astigmatically neutral and self-sealing [5, 6]. The incision is created under a fornix-based conjunctival flap exposing underlying sclera. A half-depth vertical groove incision is first created posterior to the limbus. Using a crescent blade, the incision is then tunneled forward into clear cornea so that the leading edge of the dissection is just beyond the limbal arcades. At this point, a paracentesis is created, the anterior chamber filled with a viscoelastic, and a keratome is used to enter the anterior chamber (Fig. 4.3). Using this technique, the scleral tunnel incision has a triplanar configuration that provides for a self-sealing incision up to 6 mm in length (Fig. 4.4; [8]).

The most common incision used in modern phacoemulsification is the clear corneal incision. The clear corneal incision is started immediately anterior to the limbal arcades, and a shelved incision is created until the anterior chamber is entered. The incision can be created in a uniplanar, biplanar, or triplanar incision; the formation is dependent on the creation of an initial groove (Fig. 4.5). The triplanar incision is preferred as it provides a self-sealing capacity with incisions up to 4 mm in length. Another advantage of a clear corneal incision is that it spares conjunctiva in patients with previous glaucoma surgeries or conjunctival disease. Because of the incisions close proximity to the central cornea, the major disadvantage is induced astigmatism, especially if the wound requires suturing [9].

Whereas suturing cataract wounds has been employed since the inception of modern cataract surgery, there remains some question as to when a cataract wound requires suture placement. It is important to remember that with any surgical wound, the primary role of sutures is to facilitate wound healing by holding the edges of a wound in apposition. In cataract surgery, sutures also help to minimize wound leaks and subsequent hypotony, prevent epithelial ingrowth, and help to decrease the risk of endophthalmitis. With this in mind, the placement of a suture in a cataract wound should be considered if there is any concern about the integrity of the wound, inadequate wound closure, a larger incision, or the presence of a thermal wound burn. The simple placement of a suture can help to avoid serious postoperative complications, and if a surgeon suspects a wound may need to sutured, he or she probably should.

4.3 Instrumentation

Closure of a cataract wound requires minimal basic instrumentation including:

1. A fine-tipped microneedle holder appropriate for holding a small needle
2. Small, fine-toothed forceps to stabilize and not macerate the tissue, such as a 0.12-mm forceps
3. A fine monofilament suture with high tensile strength on a spatulated cutting needle
4. Small, sharp scissors to cut the suture, such as a Vannas-style scissors
5. Micro-tying forceps to cut and bury the suture

When properly used, it is possible to tie the suture utilizing the tying platform on the 0.12-mm forceps and the needle holder. The needle holder can also be used to bury the suture knot if the suture is grasped without creating a torque or twisting motion. Using this technique, the need for tying forceps is eliminated. However, it is important to avoid grasping the suture with the teeth of the 0.12-mm forceps, as these can also cause suture breakage.

4.4 Surgical Technique

A complete discussion as to proper microsurgical technique goes beyond the scope of this chapter and is covered more fully elsewhere in this volume; however, it does bear repeating that when approaching the suturing of a cataract wound, proper microsurgical techniques must be observed as to ensure a quality surgical outcome. These include [12]:

1. Grasping the needle two thirds of the way from the point of the needle
2. Holding the needle at a 90° angle from the needle holder
3. Avoiding excessive tissue manipulation or tissue laceration when placing sutures

When suturing a cataract wound, the major goals are to create a watertight wound and to minimize any astigmatic effect from the placement of the sutures. In order to achieve a watertight incision, one must achieve adequate tissue compression with the suture. This area was described as a "zone of compression," which was equal to the length between the entry and exit sites of the suture [11, 13]. Long sutures would create a larger area of compression as compared with smaller sutures. Therefore, when closing longer incisions that require multiple sutures, a slight overlap of these compression zones must exist to assure adequate closer (see Chap. 4). In addition, one must be aware that sutures will flatten tissue immediately beneath the suture, but usually steepen the tissue nearer the visual axis [9, 13]. This effect will be more pronounced when the placement of the suture is closer to the visual axis [9, 13]. This is especially problematic when closing clear corneal cataract incisions; large levels of astigmatism may be induced from a tightly placed suture.

Throughout the evolution of cataract surgery, there have been many described techniques to close the cataract wound. The following examples are not meant to be an all-inclusive summary of the varied suturing techniques, but rather a set of effective methods to allow closure of the majority of cataract wounds. In a simplified form, most suturing techniques are classified into three major categories: interrupted, running, or a combination of the two [14]. All suturing techniques are completed using a standard 3-1-1 surgeon's knot or slipknot with the suture being trimmed flush with the knot using a sharp blade [12].

4.5 Interrupted Sutures

The simplest and most common form of wound closure is achieved with a single interrupted suture. The suture is usually placed in a radial fashion perpendicular to the cataract wound (Fig. 4.6). While allowing for

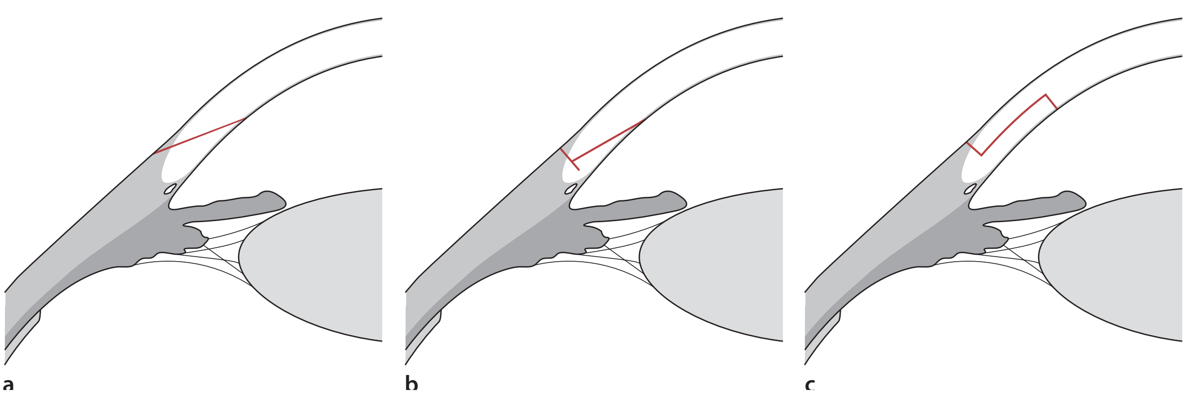

Fig. 4.5 Uniplanar (**a**), biplanar (**b**), and triplanar (**c**) clear corneal incisions

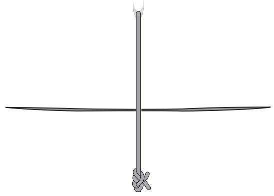

Fig. 4.6 Single interrupted radial suture

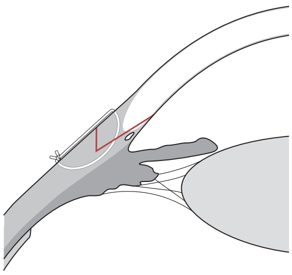

Fig. 4.7 Proper closure should include the floor of a tunnel incision

adequate closure of today's small incision cataract wounds, the major disadvantage of this suture is the risk of inducing large amounts of astigmatism given its perpendicular orientation to the wound. When placing an interrupted suture in a tunnel incision, care should be taken to ensure that the floor of the incision is incorporated into the suture pass to help stabilize the wound (Fig. 4.7; [15]). Likewise, it is important not to pass through the full thickness of the tissue, as this could result in a suture track wound leak. Placement of the suture should not distort tissue, but provide enough compression to produce a watertight closure, not tissue override. Tissue override can also be avoided if the suture is placed in a way to evenly distribute the deeper tissues of the cataract wound rather than the superficial layers (Fig. 4.8; [11, 13]). If the surgeon chooses to tie the suture outside of the wound, the knot should

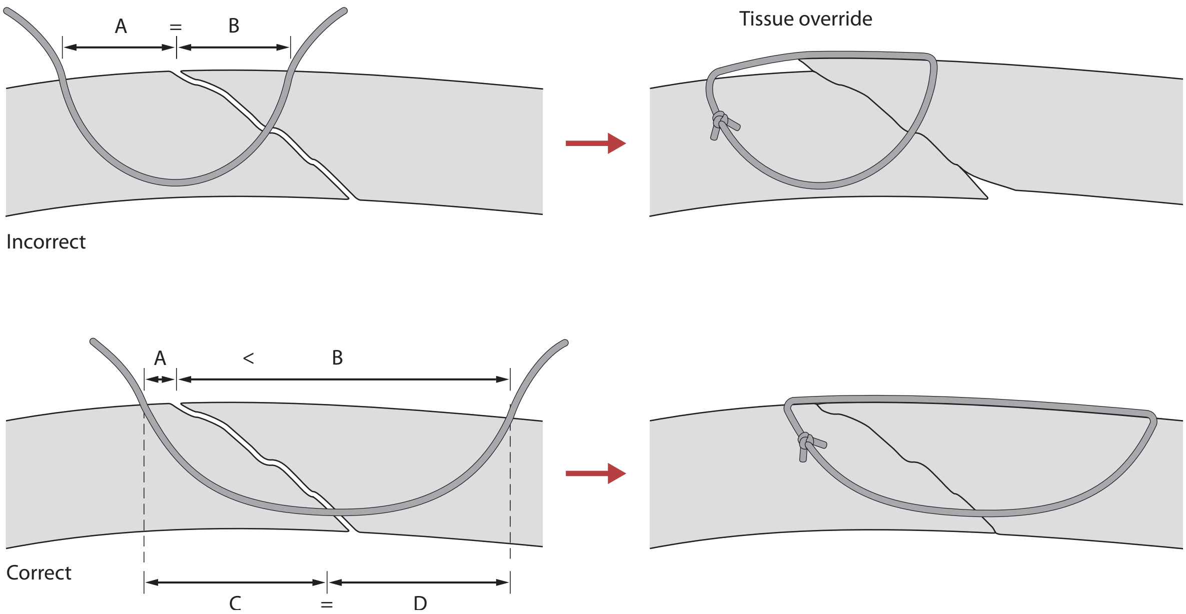

Fig. 4.8 Even tissue distribution of the deeper layers of a shelved incision results in less tissue override and better wound closure

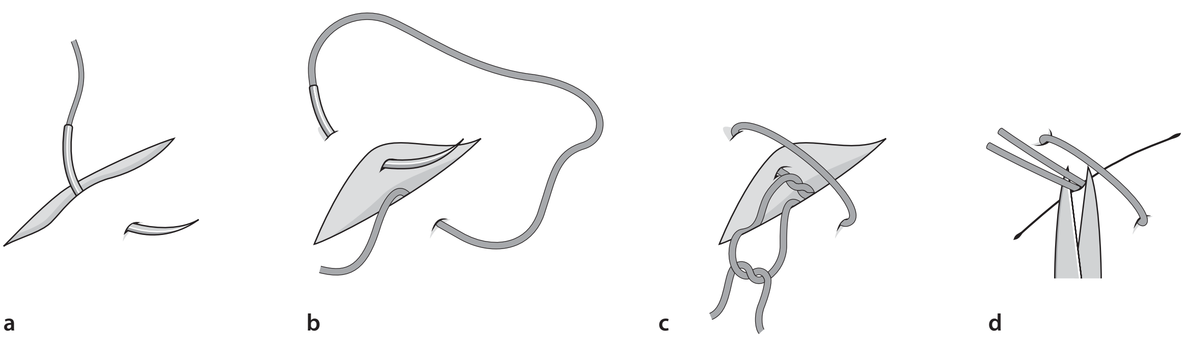

Fig. 4.9 **a** The suture is initially started with a pass from the cut edge, or the initial pass is placed in the wound. **b** The second pass is from the surface toward the wound. Care must be taken that the passes are of equal depth on both sides of the wound to avoid tissue override. **c** The ends are tied so that the wound is apposed, and the knot is formed in the wound. d The ends are pulled taught, and they are cut short so that the knot falls into the wound and the tissue is apposed

be trimmed and rotated into the underlying tissue; otherwise, the suture can be placed so that the knot can be buried within the wound to help minimize patient discomfort (Fig. 4.9).

Other interrupted types of sutures include the X-stitch, Fine's infinity suture, and Shepherd's horizontal mattress suture [1, 10]. The X-stitch could be considered as an interrupted or mini–running suture with two passes. In using two passes, the radial forces are spread over a larger area, but the risk of induced astigmatism still exists (Fig. 4.10). The infinity suture (Fig. 4.11) and horizontal mattress technique (Fig. 4.12) each use suture placement in a horizontal fashion to provide wound apposition and theoretically less induced astigmatism.

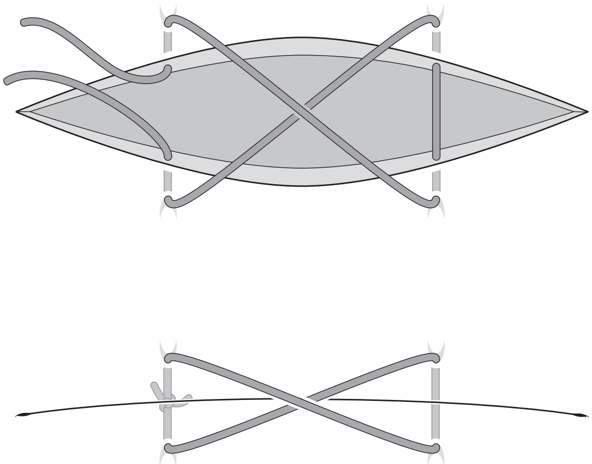

Fig. 4.10 X-stitch

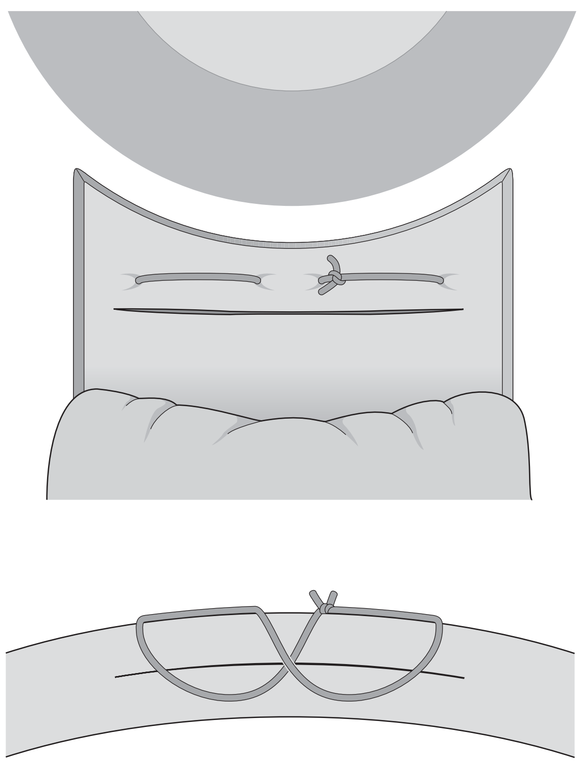

Fig. 4.11 Infinity suture

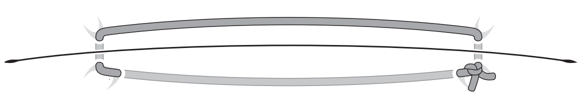

Fig. 4.12 Horizontal mattress suture

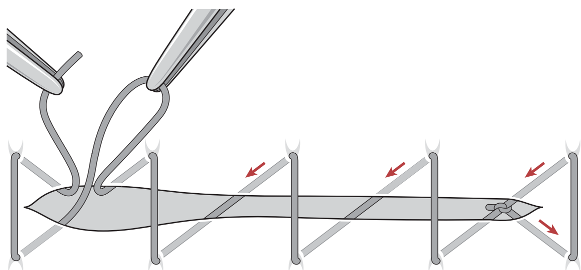

Fig. 4.13 Simple running suture

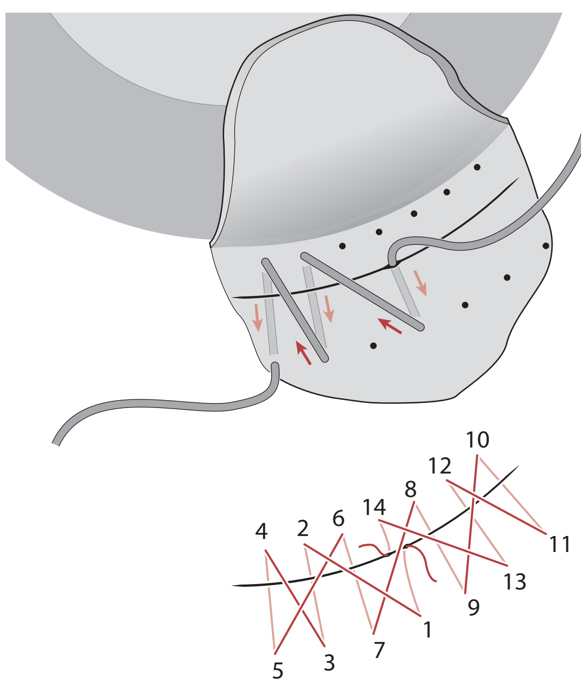

Fig. 4.14 Shoelace suture (numbers indicate suture placement). The first and last pass are within the wound to facilitate burying the knot

4.6 Running Sutures

The running suture is most commonly used with large cataract incisions, as seen in intracapsular or extracapsular cataract extractions. These incisions are rarely seen in phacoemulsification, but there remains the occasional need for the closure of a large cataract wound, and the running suture is ideal for this situation. In most situations the running suture can be placed so as to bury the knot within the cataract wound (Fig. 4.13; [11]).

Perhaps the most complicated suturing technique is the shoelace suture (Fig. 4.14). Intended for use with large cataract incisions, it is a running suture in a cross-stitch pattern. The first pass is made within the wound with each subsequent pass, as illustrated in Fig. 4.14. The final pass exits within the wound to allow the knot to be buried in the wound [14, 15].

One of the most frustrating intraoperative complications that the ophthalmologist can face is thermal wound injury, or wound burn. Thermal wound injury results when excess heat is generated during the phacoemulsification process, causing thermal damage to the surrounding cataract wound and contraction of the adjacent tissues [16]. Several factors have been reported as an etiology of thermal wound injury [3, 16, 17]. The most common is some type of interruption in the delivery of balance salt solution to the anterior chamber. This may occur from an equipment malfunction or a tight wound that causes compression on the outer sleeve of the phacoemulsification hand piece. Other causes can include blockage of the infusion ports with a viscoelastic agent, the delivery of excessive amounts of ultrasound energy during the phacoemulsification process, or the inappropriate use of thermal cautery to the wound edge. Regardless the cause, the result is the same: a gaping cataract wound that is often difficult to appose (Fig. 4.15).

When faced with this challenge, the first inclination of the inexperienced surgeon is to simply place a radial interrupted suture across the incision to appose the anterior and posterior edges of the wound. Unfortunately, because the contraction of tissue, closure of the wound usually requires a great deal of tension to be placed upon this radial suture, almost guaranteeing an extremely high level of induced astigmatism. Osher has proposed that a horizontal suture be used to appose the anterior edge of the wound to the bed of the wound rather than the posterior edge [18]. By doing so, closure of the wound is achieved without inducing high levels of astigmatism. To the surgeon, this technique may be unsettling, as the internal aspect of the wound is secured, but the posterior or external aspect of the wound may appear to gape at the end of the case. In severe cases of thermal wound injury, a patch graft may need to be used.

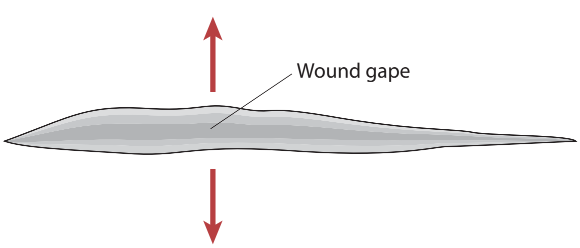

Fig. 4.15 Thermal wound injury resulting in wound gape

Postoperatively, the sutures must be removed unless they are covered by conjunctiva as in a scleral wound. The timing of suture removal is at the discretion of the individual surgeon. However, removal too early can induce the risk of wound dehiscence. In the case of new inflammation of the surrounding tissues or loosening of the suture, removal is not elective. Placement of one drop of povidone iodine or antibiotic solution prior to removal is recommended. Postremoval antibiotic drops may be indicted, depending on the trauma to the tissue created at the time of removal. Removal of a slipknot is easier than a surgeon's knot. After cutting the suture with a needle at the split lamp, the exposed suture end is grasped and pulled from the wound; as always, the knot should not be pulled across the wound to minimize the risk of wound dehiscence, should this occur, immediate resuturing is required.

4.7 Complications

The complications most frequently encountered in closure of the cataract wound are wound leakage, induced astigmatism, and rarely, a suture abscess. Each can have significant, devastating results, compromising an otherwise-flawless surgery. A wound leak may be the result of failure to overlap the zones of compression of each suture, nonradial placement, inadvertent full thickness passage of the suture through the cornea, or failure to recognize a thermal injury to the tissue. In each case, removal and replacement of the suture is indicated. In the case of a thermal injury, a horizontal suture may be required. Avoidance of induced astigmatism can be achieved by attention to suture placement initially. However, the induced astigmatism may not be recognized until the postoperative period. In the vast majority of cases, removal of the offending suture will incite regression of the induced astigmatism as the wound relaxes. If the astigmatism persists, correction may require spectacles, contact lenses, or refractive surgery including limbal relaxing incisions or laser reshaping procedures. A suture abscess may be sterile or infectious. In the noninfectious case, the surrounding tissue reaction to the foreign substance (the nylon suture) is the usual cause. Regardless of the etiology, removal of the suture is required. Treatment with topical antibiotics is indicated immediately before and after suture removal. In the case of an abscess formation, culturing of the wound is required, with the intense use of topical antibiotics in the same manner as a corneal ulcer is treated.

Suturing of the cataract wound is much less common in modern phacoemulsification, but is still an important microsurgical skill for the ophthalmologist. While less frequent, there remain definite clinical situations in which suturing of the cataract wound is indicated. Familiarity with the wound, proper microsurgical skills, and knowledge of the different types of suturing techniques will help the ophthalmologist close most types of cataract wounds without difficulty ensuring a quality surgical result.

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