GLAUCOMA SURGERY

JOHN V. THOMAS

C. DAVIS BELCHER III RICHARD J. SIMMONS

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NOT FOR RESALE

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To

our teachers

PAUL A. CHANDLER and W. MORTON GRANT

Preface

The primary goal of this book is to serve as a guide to glaucoma surgery. Operative techniques have been described in detail, and emphasis has been placed on indications, preoperative care, instrumentation, postoperative care, and complications. We recognize that any such book has limitations and that in surgery there is no substitute for direct experience. Nevertheless, we hope this book will provide the beginning glaucoma surgeon with a foundation on which to build surgical skills and confidence in the care of patients undergoing glaucoma surgery.

J.V.T.
C.D.B.
R.J.S.

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We wish to extend thanks to the contributing authors for the thought, concern, and time they devoted to their writing. We would like to gratefully acknowledge Laurel L. Cook for her outstanding illustrations, which are an especially important feature of this book. We offer our special thanks to Lisa LeBlanc for typing the manuscript. Her cheerful willingness to help with the many revisions required contributed greatly to making this book possible. We appreciate the assistance of Tom Monego with photographs of surgical instruments and thank Bob Pisinski of the Storz Instrument Company for providing the instruments. We are grateful to Kim Kist, Penny Rudolph, Shauna Sticht, and the staff at Mosby–Year Book, Inc. for their help in the preparation of this book.

J.V.T.
C.D.B.
R.J.S.

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1 General Considerations

John V. Thomas

THE DISEASE

Glaucoma is a blinding disease with enormous personal, medical, and social consequences. It accounts for 10% of all blindness in the world[1] and is devastating in a number of respects. From the standpoint of an individual who suffers a significant loss of vision, it is a personal loss that affects the quality of life. From the standpoint of a community, it is an economic cost resulting from loss of manpower and cost of social services. Although worldwide demographic and economic data relating to glaucoma are largely unavailable, an appreciation for the significance of glaucoma in the United States and the importance of treating it effectively may be gained by a review of the following facts:

- Glaucoma is a leading cause of blindness in the United States and accounts for 7% to 13% of cases.
- 2% to 3% of the population 35 years of age and over have glaucoma.
- There are 1 million people who currently have undetected glaucoma.
- 300,000 new cases of glaucoma occur each year.
- 2.6 million office visits are made each year by glaucoma patients to doctor's offices.
- 36,000 patients require hospitalization each year.
- 95,000 patients lose some degree of sight from glaucoma each year.
- 5,500 patients go blind from glaucoma each year.
- African-Americans are four to five times more likely to develop glaucoma, and up to six times more likely to go blind from it.
- Direct treatment costs for glaucoma each year are estimated to be $1.5 billion.[2]
- Cost of loss of productive work time because of glaucoma each year is estimated to be $235 million.[2]

THE SURGEON

In recent years there has been a tendency among some ophthalmologists to trivialize eye surgery, especially that done for cataract. The eye surgeon should remember that glaucoma surgery is different from cataract surgery in some significant respects. In the ideal case, if a glaucoma operation is successful, no further loss of visual field occurs and the patient can live a normal life. If the operation fails, more loss of visual field occurs and in advanced cases, may lead to blindness. Therefore the difference between success and failure in glaucoma surgery is one of the greatest magnitude and every effort should be made by both surgeon and patient to ensure its success.

The quality of training a glaucoma surgeon receives is critical in determining his or her ability to perform successful surgery. Observing experienced glaucoma surgeons performing several operations of various types is an important part of the training of the beginning glaucoma surgeon. The many fine points of operative technique and surgical principles such as adequate surgical exposure, excellent hemostasis, and the avoidance of unnecessary manipulation or alteration of tissues are initially best learned by observation. Being assisted in the first few glaucoma operations by an experienced surgeon is also important in learning to correctly perform these procedures. In addition the beginning surgeon should pay careful attention to details of preoperative and postoperative care because they are important to the long-term success of glaucoma surgery.

Surgeons who perform glaucoma surgery should be thoroughly familiar with all its aspects, have the skill to perform a variety of procedures, perform a significant number of cases, and very importantly, be able to deal with unexpected complications. It is also important that the surgeon keep abreast of changing operative techniques and be willing to adopt new methods when they become useful. Surgeons who perform occasional glaucoma cases will find that some of their cases will be successful regardless of the quality of their surgical technique. This should not be misinterpreted as excellent surgery but simply that some cases are going to succeed no matter how they are done. In many eyes, especially those undergoing filtering operations, there is a fine line between success and failure, and it is the subtleties of surgical technique and management that determine whether an eye that would have taken an unfavorable course is shifted toward a more favorable outcome.

The surgeon should always aim to operate under ideal circumstances if possible and should consider postponing an operation if conditions are not optimal. For example, if the patient has an upper respiratory infection, or if there is even the slightest suspicion of a conjunctivitis, it is best not to proceed.

It is important for the surgeon to achieve control over the operating environment and over every step of the operation. Before any tissue is incised, the surgeon should feel comfortable with his positioning, the positioning of the patient, and the surgical exposure achieved. When a patient is being operated on under local anesthesia, gossip, criticism of the quality of instruments and nurses, mention of errors in technique, and other similar remarks do not contribute to the patient's peace of mind and should be avoided.

The surgeon should remember that the speed with which an operation is completed is not important and does not necessarily indicate surgical ability. Although time should not be wasted, it is important not to rush, because one may sacrifice attention to details of operative technique that may make a difference in whether or not the operation is successful. The goal should be to achieve a perfect operation and not a rapid demonstration of the surgeon's dexterity.

THE PATIENT

Developing a good rapport between the patient and surgeon is an important step before glaucoma surgery. Patients should be educated about glaucoma by discussing it with their physician and by having printed materials that explain the disease in lay terms made available to them. Patients should understand the seriousness of glaucoma, its potentially devastating impact on themselves and society, and that it is a disease that causes irreversible blindness, whereas cataract does not. They should be familiar with the usual sequence of glaucoma therapy (i.e., first medication, second laser treatment, and finally surgery). They should realize that a glaucoma operation is not a casual operation, that it is being done to prevent a permanent loss of vision, and that the results are not guaranteed. It is important that patients understand that the vision lost from glaucoma will not be restored by the operation. In fact it is important for them to realize that their vision may be worse for one of several reasons (e.g., cataract formation) even if the operation is successful in lowering intraocular pressure. Patients should also understand the need for frequent follow-up visits after glaucoma operations such as filtering surgery, the rationale for adjunctive measures such as laser suture lysis, and 5-fluorouracil injections and how they relate to the ultimate success of the surgical procedure.

The energies of the physician and patient should be devoted to a cooperative effort to improve the likelihood of success because glaucoma surgery is of the utmost importance in the life of a patient with glaucoma. As Simmons[3] has stated:

> "Because so much is at stake for the patient undergoing a glaucoma operation, our philosophy is to utilize any and all measures that we believe favor success of the procedure, no matter how time-consuming or involved, since success or failure may be a turning point in the life of the patient, deciding his course to a normal life or to a life of increasing disability or blindness."

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2 Surgical Anatomy

M. Bruce Shields

All surgical procedures for glaucoma are designed to reduce the intraocular pressure by either increasing the rate of aqueous humor outflow or reducing aqueous humor production. The anatomic structures involved therefore are the channels of aqueous outflow at the limbus and the site of aqueous production in the ciliary body. To properly perform any of the laser or incisional operations that make up the necessary skills of glaucoma surgery, the surgeon must be familiar with both the internal (gonioscopic) and external aspects of these structures.

AN OVERVIEW OF THE ANATOMY

The structures involved in aqueous humor dynamics, (i.e., of aqueous production and aqueous outflow) are in immediate proximity to each other in the periphery of the anterior ocular segment. To better understand the interrelationship between these structures, it may be helpful to consider their step-wise construction in a schematic model (Fig. 2-1). At the junction between the cornea and the sclera is the transitional zone of connective tissue known as the limbus. On the inner surface of the limbus, extending 360 degrees, is a depression, referred to as the scleral sulcus. The anterior margin of this sulcus slopes gradually into the peripheral cornea, whereas the posterior margin contains a lip of connective tissue, called the scleral spur. This spur might be thought of as the dividing point between the structures of aqueous outflow anteriorly and those of aqueous production posteriorly. The trabecular meshwork attaches in part to the anterior side of the scleral spur and extends forward to blend into the sloping anterior wall of the scleral sulcus, which converts that structure into Schlemm's canal. The bulk of aqueous humor in the anterior chamber flows through the trabecular meshwork into Schlemm's canal, where it leaves the eye by means of intrascleral channels and episcleral veins. The ciliary body attaches to the posterior portion of the scleral spur. This is actually the only firm attachment of the ciliary body, with the remaining surfaces between the sclera and the ciliary body creating a potential space, referred to as the supraciliary space. The ciliary processes—the actual site of aqueous production—occupy the innermost and anterior-most portion of the ciliary body. The iris inserts into the ciliary body just anterior to the ciliary processes. A peripheral iridectomy will often allow visualization of the ciliary processes. The insertion of the iris is usually such that a portion of the anterior ciliary body remains gonioscopically visible between the iris root and the scleral spur. This is referred to as the ciliary body band. The remainder of the trabecular meshwork (i.e., that which does not attach to the scleral spur) attaches to this band and the peripheral iris.

GONIOSCOPIC ANATOMY

See Fig. 2-2 for an illustration of this discussion. The posterior-most structure of the anterior chamber angle is the peripheral iris. It is helpful to remember that this portion of the iris is thinner than the more central iris, which makes it, among other reasons, the preferred site for a laser iridotomy. The ciliary body band, located just anterior to the root of the iris, typically is dark gray or brown. The width of this band will vary considerably from one patient to the next, with myopes often having a wide band and hyperopes a narrow band. Care must be taken to avoid confusing this pigmented band with the trabecular meshwork in patients with lightly pigmented trabecular meshwork. This is especially important during laser trabeculoplasty, and the patient will usually let the surgeon know when this mistake is made, because the ciliary body contains nerve endings and is sensitive to the application of laser energy.

The scleral spur is seen as a sharp white line just anterior to the ciliary body band. In some patients, however, the visualization of the spur may be obscured to variable degrees by iris processes or heavy pigment dispersion. In the early stages of neovascular glaucoma, new vessels may be seen extending across the scleral spur from the iris and ciliary body to the trabecular meshwork. In some cases these vessels may be treated with argon laser as they cross the scleral spur, a procedure referred to as goniophotocoagulation.

Just anterior to the scleral spur is the functional portion of the trabecular meshwork (i.e., that portion adjacent to

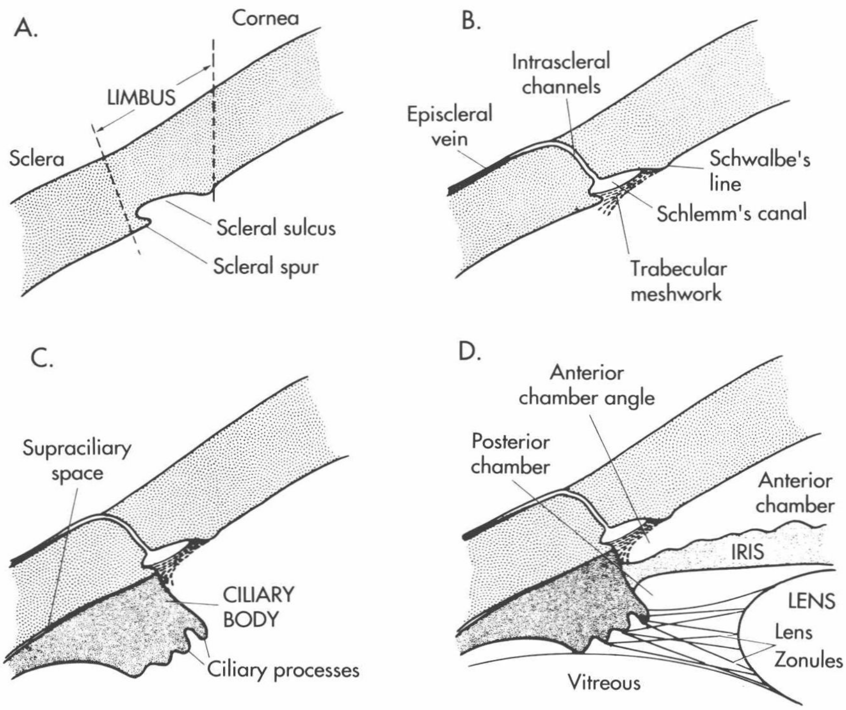

Fig. 2-1 Step-wise construction of a schematic model depicting the relationship of structures involved in aqueous humor dynamics. **A,** Limbus. **B,** Main route of aqueous outflow. **C,** Ciliary body (site of aqueous production). **D,** Iris and lens. (From Shields MB: Textbook of glaucoma, ed 2, Baltimore, 1987, Williams & Wilkins.)

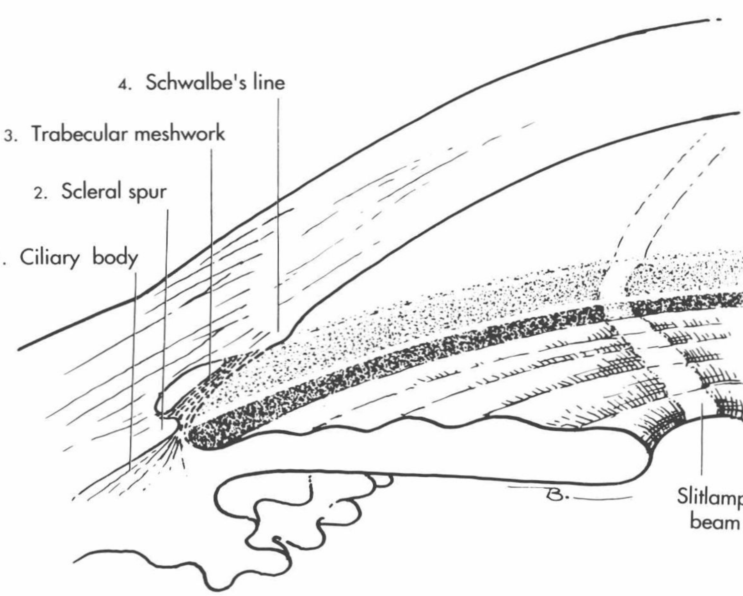

Fig. 2-2 Gonioscopic anatomy of normal adult anterior chamber angle showing gonioscopic appearance (right) and cross-section of corresponding structures (left). *1*. Ciliary body band. *2*. Scleral spur. *3*. Trabecular meshwork. *4*. Schwalbe's line. (From Shields MB: Textbook of glaucoma, ed 2, Baltimore, 1987, Williams & Wilkins).

Schlemm's canal) through which the aqueous humor flows. This portion of the meshwork is demarcated gonioscopically by the presence of variable amounts of pigment. Because this pigment is carried to the meshwork from uveal tissue by aqueous humor flow, it will be very light in young patients and will vary considerably in older patients according to the amount of pigment dispersion. In some pathologic states such as the pigment dispersion syndrome and exfoliation syndrome the meshwork will be heavily pigmented. The laser energy should be applied to this pigmented portion of the trabecular meshwork during laser trabeculoplasty. It should be kept in mind, however, that there is another less pigmented portion of the meshwork just anterior to the functional, pigmented portion. When performing laser trabeculoplasty, it has been found that overlapping the laser beam between the pigmented and nonpigmented portions of the meshwork (i.e., along the anterior border of the pigmented portion) may help to reduce the complications of transient postoperative pressure increase and peripheral anterior synechia formation.

The anterior-most structure in the anterior chamber angle is the junction between the nonpigmented portion of the trabecular meshwork and the peripheral cornea. At this junction is a small ridge, referred to as Schwalbe's line. This structure is normally difficult to visualize gonioscopically, unless there has been a moderate degree of pigment dispersion, in which case there may be a buildup of pigment along the anterior side of the ridge, especially inferiorly.

Care must be taken to avoid confusing this pigmented line with the trabecular meshwork when performing laser trabeculoplasty. In other cases, in which there is very minimal pigmentation, it is often helpful to establish the location of Schwalbe's line gonioscopically to help determine the depth of the peripheral anterior chamber. A fine beam of light from the slit lamp can be seen reflecting from both the anterior and posterior surfaces of the peripheral cornea. As the clear portion of the peripheral cornea approaches Schwalbe's line, it is replaced externally by opaque limbal tissue, which causes these two lines to converge at Schwalbe's line, thus providing a useful way for determining the location of this structure.

EXTERNAL ANATOMY

On the external surface of the eye (Fig. 2-3) the anterior boundary of the limbus is defined as the termination of Bowman's membrane, which is approximately 0.5 mm anterior to the insertion of the conjunctiva and Tenon's capsule. This has been referred to as the corneolimbal junction (CLJ) or the apparent or anterior limbus. Note that the conjunctiva inserts more anteriorly in the superior and inferior quadrants. Consequently, the limbus will be wider in these quadrants, ranging between 1 and 1.5 mm and will gradually taper to the narrowest width in the nasal and temporal quadrants, where the range is between 0.3 mm and 0.5 mm. When performing glaucoma filtering surgery, some surgeons choose to take advantage of the wider areas of the limbus by placing the surgical site at the 12 o'clock position. When performing surgery that involves the ciliary body, such as a cyclodestructive procedure, remember that these structures will be slightly more posterior in relation to the apparent limbus in the superior and inferior quadrants.

The conjunctiva and Tenon's capsule cover the limbus. The adhesions between conjunctiva and Tenon's capsule are moderately firm; consequently, sharp dissection is usually required when dissecting between these two structures, as is done in some techniques of preparing the conjunctival flap for glaucoma filtering surgery. The adhesion between Tenon's capsule and the underlying limbus and sclera is less firm, and these structures can often be separated with blunt dissection. However, Tenon's capsule inserts into the connective tissue of the limbus approximately 0.5 mm posterior to the conjunctiva, which creates a potential space. When preparing a limbus-based conjunctival flap, it is necessary to dissect this adherence between the capsule and limbus tissue to adequately expose the limbus.

When the conjunctiva and Tenon's capsule have been reflected, the posterior boundary of the limbus can now be seen. This has been referred to as the sclerolimbal junction (SLJ) or the surgical or posterior limbus. It is identified as the junction of the opaque, white sclera posteriorly and the translucent, bluish-gray limbus anteriorly. This boundary of the limbus is more useful in glaucoma surgery because it helps to identify the location of the deeper structures of the anterior chamber angle. The scleral spur is located just posterior to the SLJ; therefore Schlemm's canal would be found just anterior to this line. When performing an external trabeculotomy, a radial scratch incision across this line should reveal Schlemm's canal in the posterior portion of the bluish-gray zone. When performing a trabeculectomy, a circumferential incision at the CLJ will enter the anterior chamber just in front of the trabecular meshwork. By extending the dissection posteriorly to the SLJ, a flap of deep-limbal tissue will be created that can be reflected to expose the anterior chamber angle structures and can be excised along the scleral spur. If the latter incision is mistakenly made more posteriorly, brisk bleeding from the ciliary body may occur.

The ciliary body will begin at approximately the posterior portion of the SLJ and extend posteriorly. The pars plicata is approximately 3 mm wide. The anterior ciliary arteries enter the ciliary body behind the scleral spur in locations corresponding to the positions of the rectus muscle tendons. When possible, these vessels should be avoided during surgery to avoid excessive bleeding.

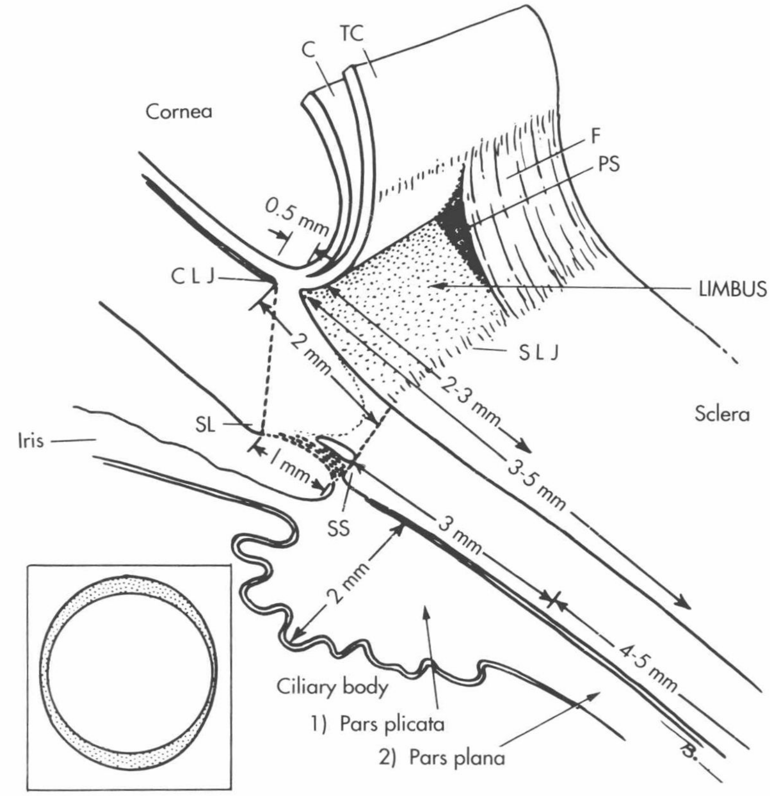

Fig. 2-3 Surgical anatomy in glaucoma. The limbus is bounded internally by Schwalbe's line *(SL)* and the scleral spur *(SS)*. It is bounded externally by the corneolimbal junction *(CLJ)* and sclerolimbal junction *(SLJ)*. The CLJ is also known as the apparent or anterior limbus. The SLJ is also known as the surgical or posterior limbus. Inset shows the width of the limbus, which varies from a maximum superiorly to a minimum on the sides. The conjunctiva *(C)* and Tenon's capsule *(TC)* fuse before inserting approximately 0.5 mm behind the CLJ. A potential space *(PS)* is created by a splitting of Tenon's capsule and a fusion *(F)* to episclera near the SLJ. The ciliary body is divided into the pars plicata and pars plana. (From Shields MB: Textbook of glaucoma, ed 2, Baltimore, 1987, Williams & Wilkins).

3 Instruments, Lenses, and Supplies

John V. Thomas

This chapter illustrates some of the surgical instruments,* lenses, and supplies used in the operative procedures described in this book.

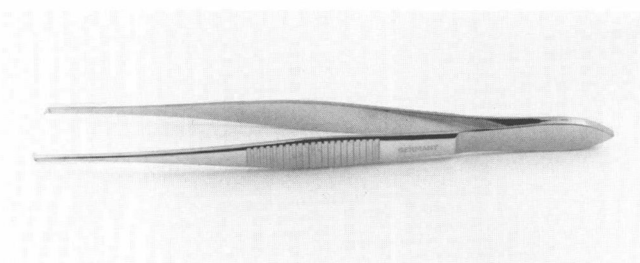

Fig. 3-1 A Elschnig fixation forceps.

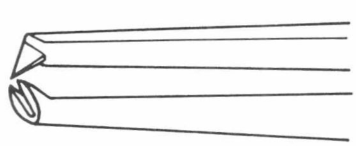

Fig. 3-1 B Tips of Elschnig fixation forceps.

*Instruments shown in this chapter courtesy Storz Instrument Company, St. Louis, Mo.

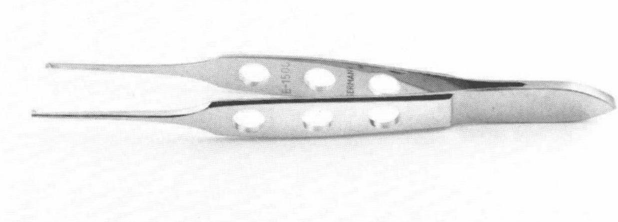

Fig. 3-2 A Bishop-Harmon straight tissue forceps.

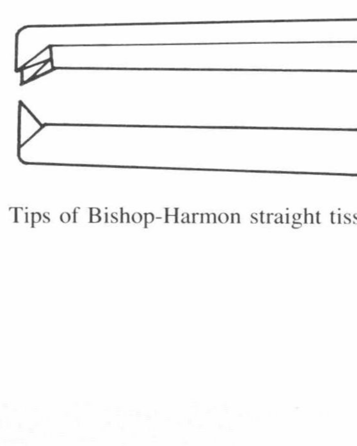

Fig. 3-2 B Tips of Bishop-Harmon straight tissue forceps.

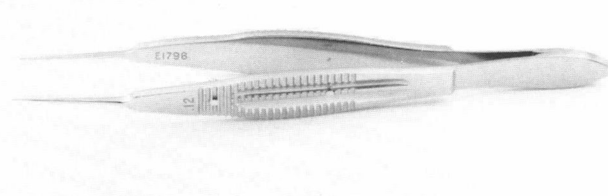

Fig. 3-3 A Castroviejo 0.12 mm toothed forceps.

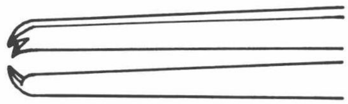

Fig. 3-3 B Tips of Castroviejo 0.12 mm toothed forceps.

Fig. 3-4 A Elschnig-O'Connor locking fixation forceps.

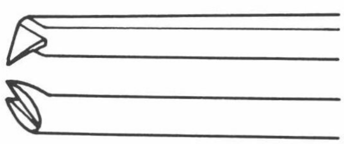

Fig. 3-4 B Tips of Elschnig-O'Connor locking fixation forceps.

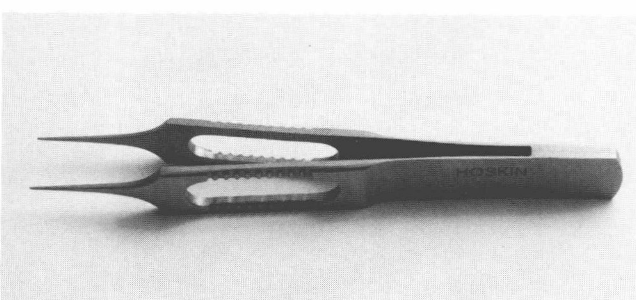

Fig. 3-5 A Pierse-Hoskin tissue forceps (straight).

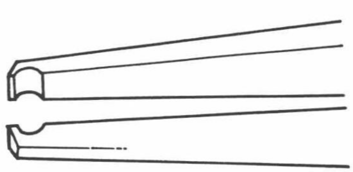

Fig. 3-5 B Tips of Pierse-Hoskin tissue forceps (straight).

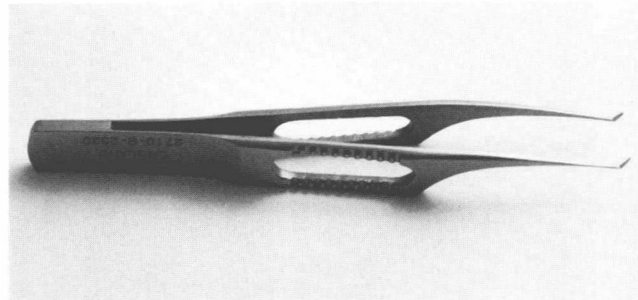

Fig. 3-6 A Pierse-Hoskin tissue forceps (curved).

Fig. 3-6 B Tips of Pierse-Hoskin tissue forceps (curved).

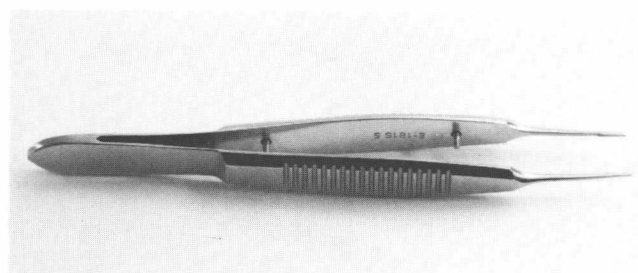

Fig. 3-7 A McPherson tying forceps (straight).

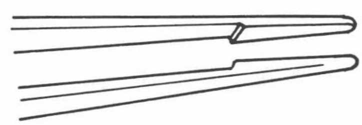

Fig. 3-7 B Tips of McPherson tying forceps (straight).

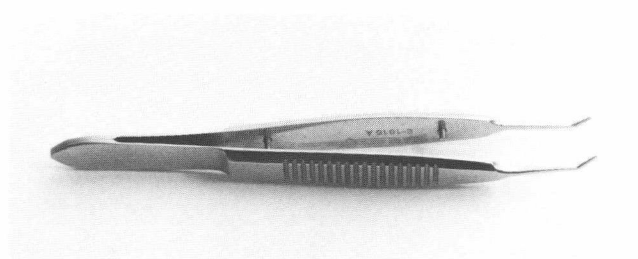

Fig. 3-8 A McPherson tying forceps (angled).

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