PART 2

GENERAL PRINCIPLES AND INSTRUMENTATION FOR CRANIAL NEUROSURGERY

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Optimizing operative results requires the careful selection of instruments for the macro-operative portion of the operation done with the naked eye and the micro-operative part done with the eye aided by the operating microscope.[4,6] In the past, surgeons commonly used one set of instruments for performing conventional macrosurgery with the naked eye and another set with different handles and smaller tips for microsurgery done with the eye aided by the microscope. A trend is to select instruments having uniform handles and tactile characteristics for macrosurgery and microsurgery and to change only the size of the tip of the instrument, depending on whether the use is to be macro-operative or micro-operative. For example, forceps for macrosurgery have grasping tips as large as 2 to 3 mm, and those for microsurgery commonly having tips measuring 0.3 to 1.0 mm.

f possible, the instruments should be held in a pencil grip between the thumb and the index finger rather than in a pistol grip with the whole hand (Figure 1). The pencil grip permits the instruments to be positioned by delicate movements of the fingers, but the pistol grip requires that the instruments be manipulated with the more coarse movements of the wrist, elbow and shoulder.

The author prefers round-handle forceps, scissors and needle holders, because they allow finer movement. It is possible to rotate these instruments between the thumb and forefinger rather than having to rotate the entire wrist (Figure 2). The author first used round-handled needle holders and scissors in performing superficial temporal-to-middle cerebral artery anastomosis and later found that the advantage of being able to rotate the instrument between the thumb and the fingers also improved the accuracy of other straight and bayonet instruments used for dissection, grasping, cutting, and coagulation. Round-handled straight and bayonet forceps may be used for both macrosurgery and microsurgery.

The addition of straight round-handled forceps with teeth, called tissue forceps, increases the use of the set of instruments with round handles to include grasping muscle, skin, and dura. A tissue forceps with large teeth is used on the scalp and muscle, and ones with small teeth are used on dura. The addition of round-handle forceps, called dressing forceps, which have fine serrations inside the tips, makes the set suitable for grasping arterial walls for endarterectomy and arterial suturing.

The instruments should have a dull finish, because the brilliant light from highly polished instruments reflected back through the microscope can interfere with the surgeon's vision and detract from the quality of photographs taken through the microscope. Sharpness and sterilization are not affected by the dull finish.

The separation between the instrument tips should be wide enough to allow them to straddle the tissue, the needle, or the thread to cut or grasp it accurately. The excessive opening and closing movements required for widely separated tips reduce the functional accuracy of the instrument during delicate manipulation under high-power magnification. The finger pressure required to bring widely separated tips together against firm-spring tension often initiates a fine tremor and inaccurate movement. Micro-operative tissue forceps should have a tip separation of no more than 8 mm; microneedle holder tips should open no more than 3 mm. Microscissors tips should open no less than 2 mm and no more than 5 mm, depending on the length of the blade and the use of the scissors.

The length of the instruments should be adequate for the particular task that is being contemplated (Figure 3). Bayonet instruments (eg,

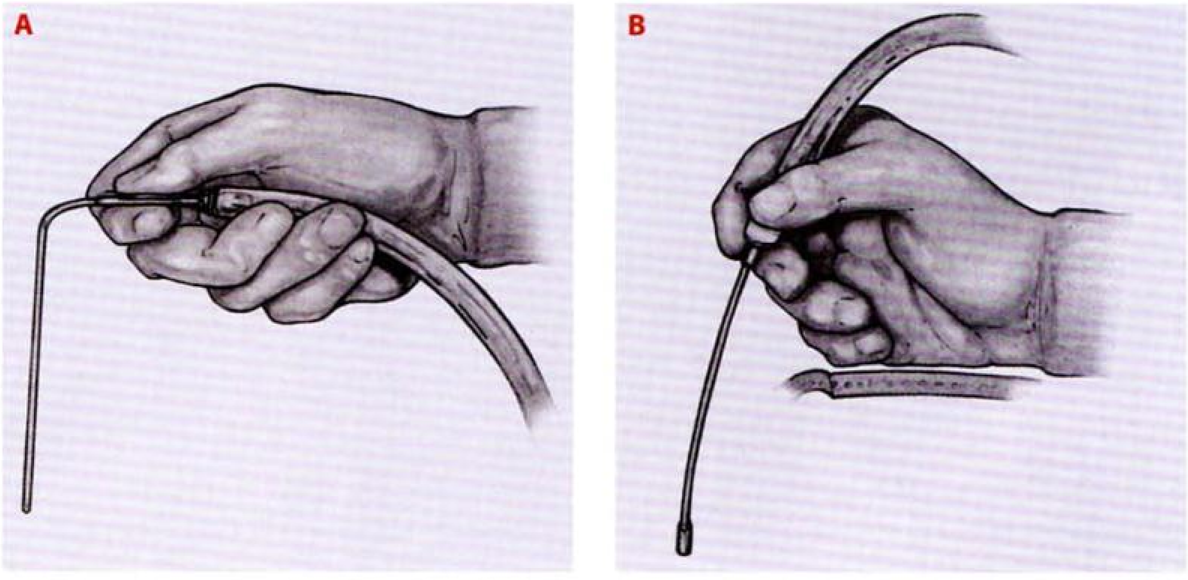


FIGURE 1

The two most common grips for holding a surgical instrument. The grip is determined largely by the design of the instrument.

ⓐ pistol grip
ⓑ pencil grip

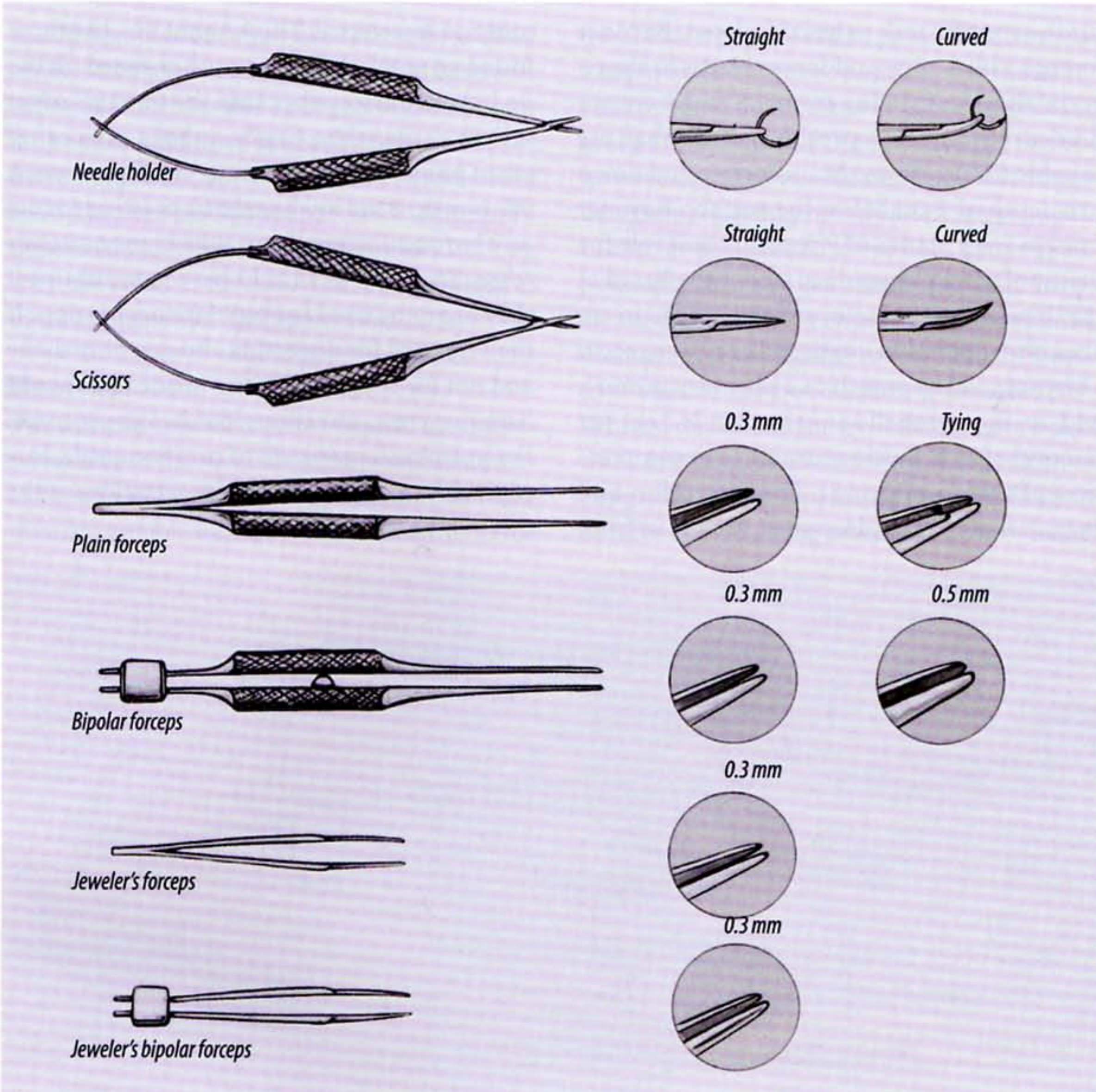


FIGURE 2

Straight Rhoton instruments with round handles and fine tips for use at the surface of the brain suitable for micro-operative procedures, such as an extracranial-to-intracranial arterial anastomosis.

forceps, needle holders, scissors) should be available in at least the three lengths needed for the hand to be rested while the surgeon operates at superficial, deep, and extra deep sites.

Bayonet forceps

Bayonet forceps are standard neurosurgical instruments. The bayonet forceps should be properly balanced so that when its handle rests on the web between the thumb and index finger and across the radial side of the middle finger, it remains there without falling forward when the grasp of the index finger and thumb is released. Poor balance prevents the delicate grasp needed for micro-operative procedures.

It is preferable to test forceps for tension and tactile qualities by holding them in the gloved rather than the naked hand. Forceps resistance to closure that is perceived as adequate in the naked hand may become almost imperceptible in the gloved hand. The forceps may be used to develop tissue planes by inserting the closed forceps between the structures to be separated and releasing the tension, so that the blades open and separate the structures. This form of dissection requires greater tension in the handles than is found in some delicate forceps.

In selecting bayonet forceps, one should consider the length of the blades needed to reach the operative site and the size of the tip needed for the specific task to be completed. Bayonet forceps with 8-, 9.5- and 11-cm blades in a variety of tip sizes ranging from 0.5 to 2.0 cm are needed. Bayonet forceps with an 8-cm shaft are suitable for use on the brain surface and down to a depth of 2 cm below the surface. Bayonet forceps with blades of 9.5 cm are suitable for manipulating tissues deep under the brain at the level of the circle of Willis (eg, in an aneurysm operation), in the sellar region (eg, in a transcranial approach to a pituitary tumor), and in the cerebellopontine angle (eg, for removal of an acoustic neuroma or decompression of a cranial nerve). For dissection and coagulation in extra deep sites, such as in front of the brain stem or in the depths of a transsphenoidal exposure, forceps having blades of 11 cm are used. Some surgeons prefer that the forceps be coated with an insulating material to ensure that the current is delivered to the tips, but the coating should not be so thick that it obstructs the view of the tissue being grasped when operating under the microscope.

A series of bipolar bayonet forceps having tips of 0.3 to 2.0 mm will allow coagulation of a vessel of almost any size encountered in neurosurgery. For coagulating larger structures, tips with widths of 1.5 and 2 mm are needed. For microcoagulation, forceps with 1.0-, 0.7-, or 0.5-mm tips are selected. The 0.3-mm tips, like those found on jeweler's forceps, are not suited for use on bayonet forceps because the fine tips often scissor rather than firmly oppose each other when prepared in the bayonet configuration. A 0.5-mm tip is the smallest that is practical for use on a bayonet forceps that is used in the posterior fossa. The forceps should have smooth tips if they are to be used for bipolar coagulation. If they are used for dissecting and grasping tissue and not for coagulation, the inside tips should have fine cross-serrations like dressing forceps. For grasping large pieces of tumor capsule, forceps with small rings with fine serrations at the tips may be used.

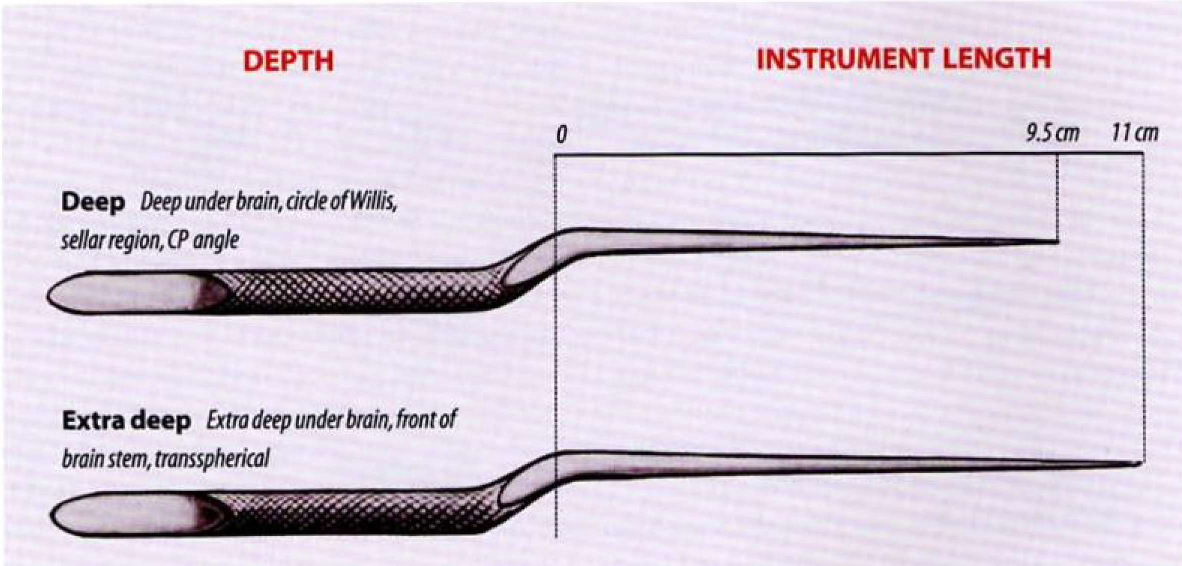


FIGURE 3

Rhoton dissecting bayonets with fine (0.5 cm) tips for use at deep and extra deep sites. Fine cross-serrations inside the tips aid in grasping and manipulating tissue.

Scissors

Scissors with fine blades on straight and bayonet handles are frequently used in micro-operative procedures. Cutting should be done by the distal half of the blade. If the scissors open too widely, cutting ability and accuracy suffer. Delicate cutting near the surface, such as opening an artery for anastomosis or embolectomy, should be done with straight, not bayonet, scissors with fine blades approximately 5 mm long that open approximately 3 mm. Only delicate suture material and tissue should be cut with such small blades. Bayonet scissors with an 8-cm shaft and curved or straight blades are selected for areas 3 to 4 cm below the cranial surface. Bayonet scissors with a 9.5-cm shaft are selected for deep areas, such as the cerebellopontine angle or suprasellar region. The blades should be 14 mm long and should open approximately 4 mm. For extra deep sites, such as in front of the brain stem, the scissors should have an 11-cm shaft. Scissors on an alligator-type shank with a long shaft are selected for deep, narrow openings, as in transsphenoidal operations (Figure 4).

Dissectors

The most widely used neurosurgical macrodissectors are of the Penfield or Freer types; however, the size and weight of these instruments make them unsuitable for microdissection around the cranial nerves, brain stem, and intracranial vessels. The smallest Penfield dissector, the No 4, has a width of 3 mm. For microsurgery, dissectors with 1- and 2-mm tips, such as those on the Rhoton dissectors, are needed (Figure 5). Straight, rather than bayonet, dissectors are preferred for most intracranial operations, because rotating the handles of the straight dissector does not alter the position of the tip, but rotating the handle of a bayonet dissector causes the tip to move through a wide arc.

Round-tipped dissectors, called canal knives, in the number 1, 2, and 3 position in the Rhoton set, are used for separation of tumor from nerve. An alternative method of fine dissection is to use the straight and angle, pointed instruments located in the 11 and 12 position, that the author calls needled dissectors.[7] It may be difficult to grasp the margin of the tumor with forceps; however, a small needle dissector introduced into its margin may be helpful in retracting the tumor in the desired direction. This type of pointed instrument can also be used to develop a cleavage plane between tumor and arachnoid membrane, nerves, and brain. Spatula dissectors similar to, but smaller than, the No 4 Penfield dissector, located in the 6, 7, and 8 position, are helpful in defining the neck of an aneurysm and in separating the neck from the adjacent perforating arteries. The 40°-angled teardrop dissectors at the 16 and 17 position are especially helpful in defining the neck of an aneurysm and in separating arteries from nerves during vascular decompression operations, because the tip slides easily in and out of tight areas without inadvertently avulsing perforating arteries or catching on delicate tissue.[5,8]

Any vessel that stands above the surface of an encapsulated tumor, such as an acoustic neuroma or meningioma, should be dealt with initially as if it were a brain vessel that runs over the tumor surface and can be preserved with accurate dissection. The surgeon should try to displace the vessel and adjacent tissue off the tumor capsule toward the adjacent

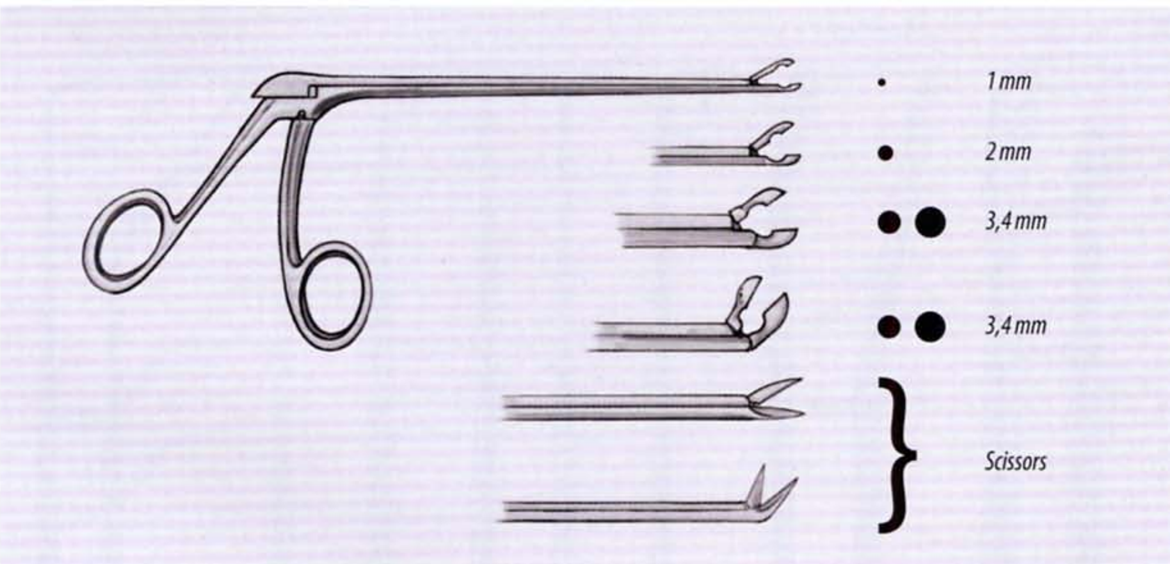


FIGURE 4

Straight and angled alligator cup forceps and scissors are needed in deep, narrow exposures, as in the depths of a transsphenoidal operation.

Table 1 Uses for suction tubes

Diameter*	Use
3 French	Smallest nerves, vessel anastomosis
5 French	Aneurysm neck, pituitary gland, medium nerves
7 French	Microsurgical resection of larger tumors
10-12 French	Heavy bleeding, bone dust, flap elevation

*3 French = 1 mm outer diameter

neural tissues by using a small dissector after the tumor has been removed from within the capsule. Vessels that initially appear to be adherent to the capsule often prove to be neural vessels on the pial surface when dissected free of the capsule.

If the pia-arachnoid membrane is adherent to the tumor capsule or if a tumor mass is present within the capsule and prevents collapse of the capsule away from brain stem and cranial nerves, there is a tendency to apply traction to both layers and to tear neural vessels running on the pial surface. Before separating the pia-arachnoid from the capsule, it is important to remove all of the tumor so that

A

B

FIGURE 5

Rhoton microdissectors for neurosurgery.

(a) Beginning on the left: dissectors (round, spatula, flat, and micro-Penfield), right-angled nerve hook, angled and straight needle dissectors, a microcuret and straight, 40°, and right-angled teardrop dissectors.
(b) A storage case and full set of instruments.

the capsule is so thin that it is almost transparent. If the surgeon is uncertain about the margin between the capsule and the pia-arachnoid membrane, several sweeps of a small dissector through the area will help clarify the appropriate plane for dissection.

For transsphenoidal operations, dissectors with bayonet handles are preferred because the handles aid in preventing the surgeon's hand from blocking the view down the long, narrow exposure of the sella.[9] The Rhoton blunt ring curets are frequently used during transsphenoidal operations to remove small and large tumors of the pituitary gland and to explore the sella (Figure 6). Initially, the author's transsphenoidal operations were done using a sublabial incision and extensive dissection along the nasal septum. More recently, this has evolved into an endonasal approach in which no incision is made under the lip or in the anterior nasal cavity and the speculum is introduced through the nasal passage to the front of the sphenoid sinus, which is opened without any incision under the lip or anterior part of the nose. A small Rhoton transsphenoidal speculum was developed for this approach. The advantages of the endonasal approach, in addition to the reduced operative trauma to the lip and nose, are the reduced operative discomfort and the elimination of postoperative nasal packing (Figure 7).

smooth movement that drives the needle easily. There should be no lock or holding catch on the microneedle. When such a lock is engaged or released, no matter how delicately it is made, the tip jumps, possibly causing misdirection of the needle or tissue damage.

Jeweler's forceps or straight needle holders are suitable for handling microneedles near the cortical surface. For deeper applications, bayonet needle holders with fine tips may be used. Bayonet needle holders with 8-cm shafts are suitable for use down to a depth of 3 cm below the surface of the brain. Shafts measuring 9.5 cm are needed for suturing vessels or nerves in deeper areas such as the suprasellar region,

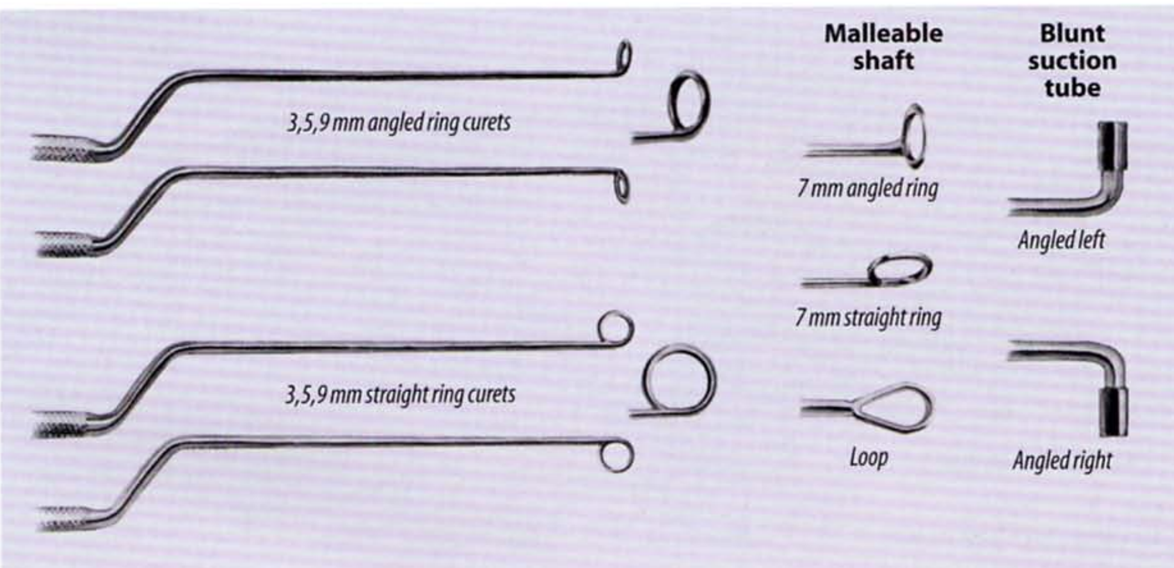


FIGURE 6

Rhoton blunt instruments for transsphenoidal operations.

Needles, sutures, and needle holders

The operating room should have readily available microsuture, ranging from 6-0 to 10-0, on a variety of needles, ranging in diameters from 50 to 130 microns.[12,13] For the most delicate of suturing, as in an extracranial-to-intracranial arterial anastomosis, nylon or Prolene suture of 22-micron diameter (10-0) on needles approximately 50 to 75 microns in diameter is used.

Jeweler's forceps are commonly used as a holder for grasping a microneedle, but they are too short for most intracranial operations. The handles of the microneedle holders should be round rather than flat or rectangular so that rotating them between the fingers yields a

around the circle of Willis, or in the cerebellopontine angle.

For tying microsuture, either microneedle holders, jeweler's forceps, or tying forceps may be used. Tying forceps have a platform in the tip to facilitate grasping the suture; however, most surgeons prefer to tie suture with jeweler's forceps or fine needle holders.

Suction tubes

Suction tubes of the Rhoton-Merz type with blunt, rounded tips are preferred. Dandy designed and used blunt suction tubes and his trainees have continued to use the Dandy-type tube.[11] Yasargil and colleagues and Rhoton and

Merz reported using suction tubes having blunt, rounded tips that allowed them to be used for the manipulation of tissue as well as for suction.[10,14] The thickening and rounding of the tips reduce the problem of the small S- and 5-French tubes becoming sharp when cut smoothly at right angles to the shaft. Some suction tubes, such as those of the curved Adson type, become somewhat pointed when prepared in sizes as small as 3- or 5-French, because the distal end of the tube is cut obliquely to the long axis of the shaft, making them less suitable for use around the thin walls of aneurysms.

The suction tube should be designed to be held like a pencil, rather than like a pistol. Frazier suction tubes are designed to be held like a pistol. The pencil-grip design frees the ulnar side of the hand so that it can be rested comfortably on the wound margin, affording more precise, delicate, and sturdier manipulation of the tip of the suction tube than is allowed by the unsupported pistol grip.

Selecting a tube of appropriate length is important because the arm tires during extended operations if the suction tube is too long to allow the hand to be rested. The Rhoton-Merz tubes with 8-cm shafts (ie, the length between the angle distal to the thumb piece and the tip) are used for suction at the level of the skull or near the surface of the brain (Figure 8). Tubes with 10-cm shafts allow the hand to rest along the wound margin during procedures carried out in deep operative sites, such as the regions of the cerebellopontine angle, suprasellar region, basilar apex, or around the circle of Willis. Suction tubes with 13-cm shafts may be used at extra deep sites such as in front of the brain stem and also for transsphenoidal operations. The suction tubes with 13-cm shafts, as used for transsphenoidal operations, in addition to having straight tips, have tips angled up and down for suction around the curves within the capsule of a tumor or for following asymmetrical extensions of tumor (Figure 9).

The suction tubes should encompass a range of diameters from 3 to 12 French, which allows them to be used for macrosurgery and microsurgery (Table 1). Conventional surgery done with the naked eye uses 9-, 10-, or 12-French size tubes. The French designation applies to the outer diameter. Three French units equal 1 mm. A 9-French tube has an outer diameter of 3 mm. The 10- and 12-French tubes are used during the opening of the scalp, muscle, and bone and for heavy bleeding. The most commonly used macrosuction tubes, the 9- and 10-French sizes, are too large for use after the dura is open. Stretched nerve fascicles or small vessels can easily become entrapped in such large tubes. Most micro-operative procedures require tube diameters of 5 and 7 French. The 3- or 5-French sizes

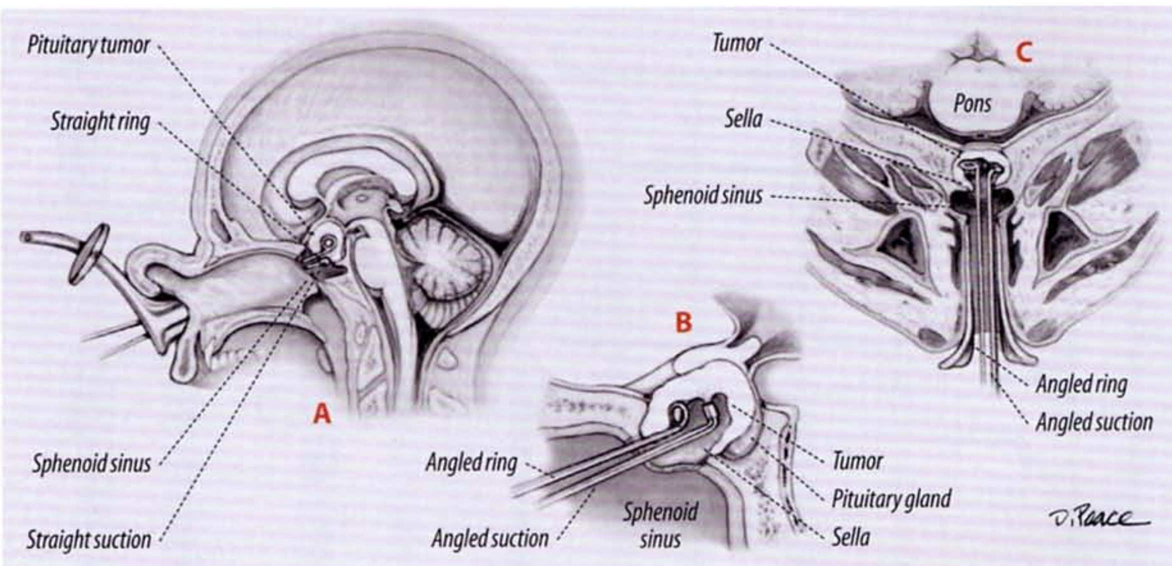


FIGURE 7

Transsphenoidal removal of a large pituitary tumor with suprasellar extension.

ⓐ Midsagittal view. The straight ring breaks up the intracapsular contents of a suprasellar tumor, and the straight transsphenoidal suction tube aspirates tumor tissue from within the capsule.

ⓑ Enlarged midsagittal view. The angled ring and angled suction tube are directed upward to remove the intracapsular contents of the suprasellar extension.

ⓒ Tumor removal from parasellar region using angled ring.

are suitable for delicate applications such as suction around the facial nerve during the removal of an acoustic neuroma. The 5-French suction tube with a 10-cm shaft may be used as a suction-dissector in defining the neck of an aneurysm or as a suction-dissector in the cerebellopontine angle and near the cerebellar arteries and cranial nerves. The 7-French tube is commonly used in completing the intracapsular removal of an acoustic neuroma or meningioma of medium or large size. The 3-French tube is too small for most micro-operative procedures, but it is suitable for applications such as suction along the suture line of an extracranial to intracranial arterial bypass.

the effectiveness of the bipolar coagulation forceps and reduces the adhesiveness of the tips to tissue. Constant bathing by cerebrospinal fluid has the same effect.

Irrigation with physiological saline is also helpful in cooling the drill tip, which may transmit heat to nearby neural structures, and in washing bone dust from the incision. The irrigation should be regulated so that the solution does not enter the operative field unless the surgeon's finger is removed from the suction release hole.

Brain retractors

Self-retaining retraction systems are routinely used for most intracranial operations.[1,6,14] They

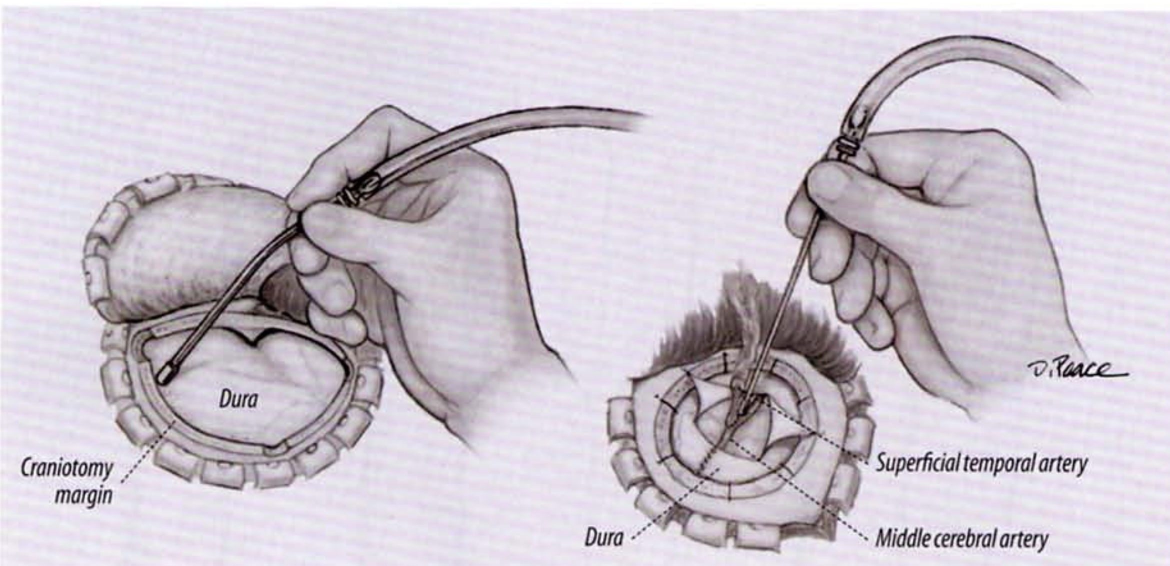


FIGURE 8

Short blunt suction tubes (8-cm shafts) are used when turning a bone flap or during other operations near the surface of the brain.

The power of the suction is regulated by adjusting the degree to which the thumb occludes an air hole. The air holes should be large enough that the suction at the tip is markedly reduced when the thumb is off the hole; however, the suction pressure may need to be adjusted at its source to avoid the danger of entrapping and damaging fine neural and vascular structures.

A continuous stream of irrigating fluid, which is often delivered through another tube that is fused to the suction tube, can be helpful during part of the operation. Irrigation discourages the formation of small blood clots and their adherence to the dissected surfaces; it also increases

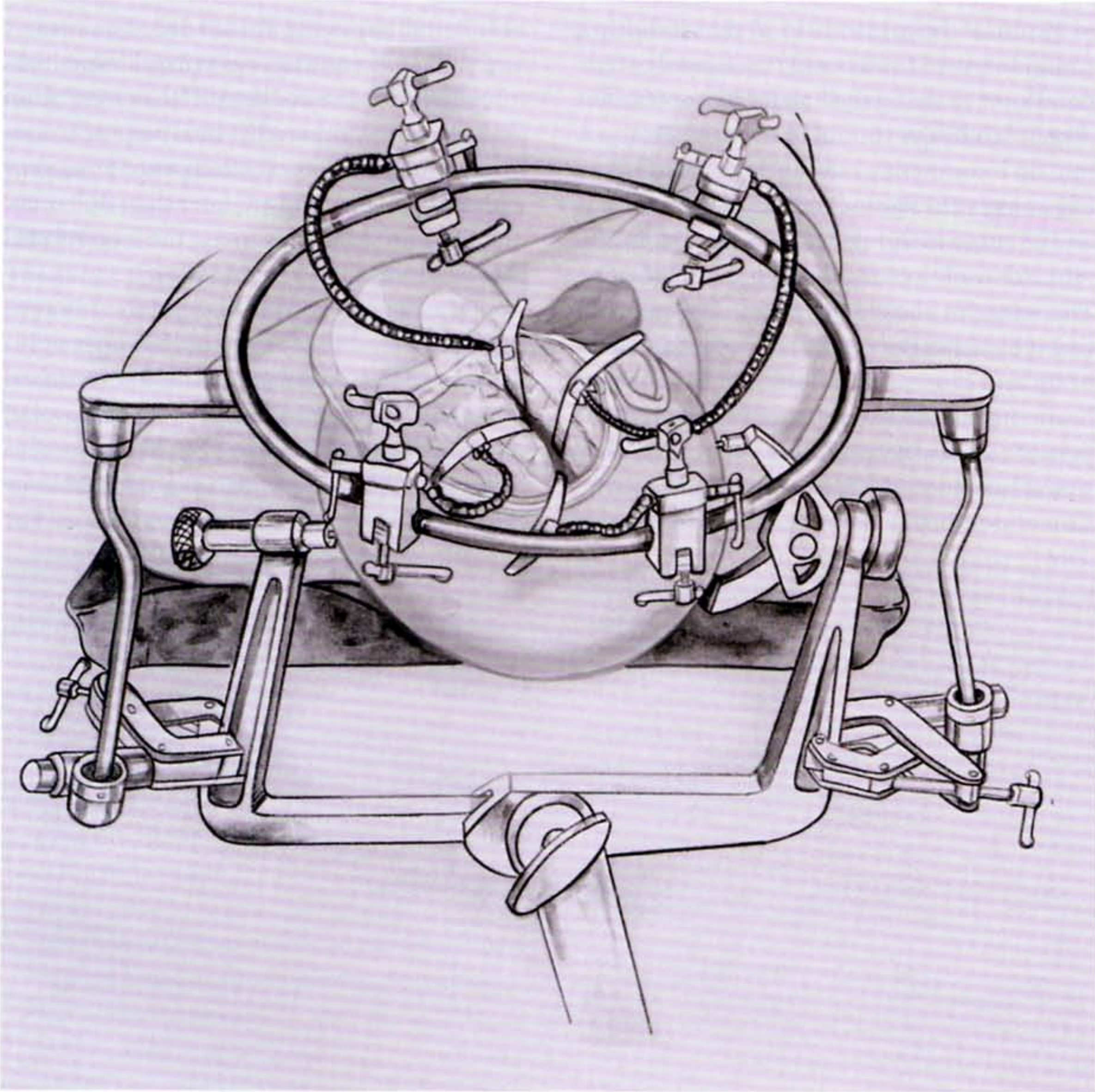
allow the surgeon to work in a relatively confined space unhindered by an assistant's hand. They are more dependable than the surgeon's or assistant's hand in maintaining constant, gentle elevation of the brain. The retraction system should include tapered and rectangular brain spatulas that are applied to the protected surface of the brain; flexible arms that can support the brain spatulas in any position within the operating field; and a series of clamps and bars for attaching the system to the pinion head holder or the operating table (Figure 10). The most frequently used self-retaining retractor systems have flexible arms that consist of a series of ball-and-socket units, resembling a string of pearls, with an internal cable that holds in the desired position when tightened.

The stability of the system is increased if the flexible arms that hold the brain spatulas are constructed so that they are tapered, having the largest pearls near the bar to which the arm attaches and the smallest pearls on the end that holds the brain spatulas. Two lengths of flexible arms (30 and 48 cm) will allow the system to be used at diverse operative sites. Greater flexibility in positioning the flexible arms can be achieved if the arms are attached to the rigid bars with the use of a coupling that allows them to be rotated through a 360° arc. The flexible arms are directed to a short bar that is fixed to the pinion head holder, or they may be attached to longer bars that are attached to the operating table or head holder. The short handles used to tighten the flexible arms and joints in the system should be broad and flat rather than narrow and round, as found in some systems. The broad, flat handles increase the ease of adjustment of the arms and joints.

The clamps that attach the retractor system to the head holder or operating table should be firmly fixed in place prior to affixing the flexible arm. The clamps should be affixed to the head holder as close to the operative field as possible and yet should not block the ease and freedom with which the surgeon moves other instru-

FIGURE 9

Rhoton-Merz suction tubes for transsphenoidal operations. The transsphenoidal tubes have 13-cm shafts and are made in three sizes: 5-, 7- and 10 French. They have straight, angled-up, and angled-down tips in each of the three sizes.



ments into the operative site. The retractor system should include straight and curved bars, a jointed bar, and a ring that can be attached to a clamp that fits on the head holder and a long bar that can be attached to the operating table.

The flexible arms should be led into the operative site in such a way that they rest closely against the drapes around the margin of the operative site. If the flexible arms are not positioned close to the drapes, the suctioned tubing or cable on the bipolar coagulator may become entangled with the arms and brain spatulas. Positioning near the drapes also reduces the chance that the hand passing instruments will bump the flexible arms. If the bar for holding the flexible arms is positioned between the head of the patient and the surgeon, the bar should be sufficiently close to the patient's head that the surgeon does not bump against it if he or she moves from one position to another around the head of the patient.

A series of tapered and rectangular brain spatulas of the Rhoton or other types should be available at the various operative sites (Figure 11). Paired brain spatulas of the same size are frequently used for separating the edges of the Sylvian fissure or a cortical incision, and a single spatula is commonly used for elevating the surface of the brain away from the cranial base, tentorium or falx. A single spatula tapered from 15

FIGURE 10

Self-retaining retractor system developed by Rhoton and Merz

(V Mueller, Chicago, IL)

to 25 mm at the base to 10 to 20 mm at the tip is commonly used for elevating the frontal or temporal lobes or the cerebellum for tumor removal. A spatula having a 10-mm base that tapers to a 3-mm tip is commonly used during operations for trigeminal neuralgia or hemifacial spasm.

The surgeon should learn to manipulate the retractor while looking through the microscope. The retractor should not be applied so firmly that it blanches the vessels on the surface of the brain and causes infarction of the underlying brain. Infarction occurs infrequently if blood pressure is normal; however, if induced hypotension is used intraoperatively, inadequate perfusion under the retractor may cause infarction and subsequent hemorrhage after the retractor is removed.

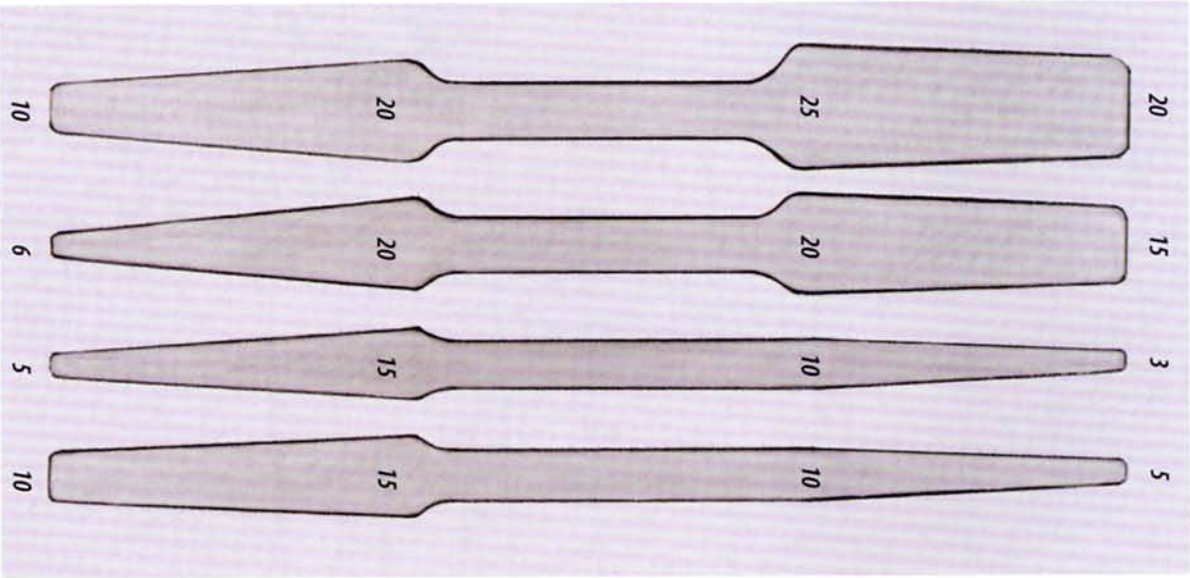


FIGURE 11

Rhoton-tapered brain spatulas shown in various widths (measured in mm) may be needed depending on the site and size of the lesion.

Bone curets

Small curets are frequently used for removing the last shell of bone between a drill surface and neural or vascular structures. Straight and angled curets located in the 13 and 14 position in the Rhoton rack are used frequently. Curets angled at 45° frequently are used for special purposes, such as removing the last thin shell of bone over the internal acoustic meatus or anterior clinoid process or curetting a fragment of tumor from the lateral margin of the acoustic meatus or other areas. Curets with tips as small as 1.5 mm frequently are needed. The curet is held so that the cutting edge is in full view. Pressure should be directed parallel to or away from important structures rather than perpendicularly toward them. Properly sharpened curets cut with less pressure and are safer than dull ones. The surgeon should try to use the largest curet that can do the job.

Cup forceps

A cup forceps such as that used for intravertebral disc removal is commonly used for removal of tumors. The most frequently used cup forceps have a tip 3, 4, or 5 mm wide, which is suitable for the intracapsular removal of large tumors. For removal of small tumors or small fragments of tumor in critical locations, such as on the cranial nerves, in the acoustic meatus, or within the fourth ventricles, cup forceps with a diameter of 1 to 2 mm are used. For grasping small bits of tumor directly on or within the cranial nerves, the 1-mm cup forceps is used. The 2- and 3-mm cups are suitable for the intracapsular removal of small tumors. Angled microcup forceps enable the surgeon to reach around a corner to grasp tissue or remove tumor. A cup forceps angled to the right is used to reach laterally to the right (eg, to reach a right parasellar extension of a pituitary adenoma or behind the facial and acoustic nerves in the right acoustic meatus), and the cup forceps angled to the left is used on the left side. The angled cup forceps can also be used to reach to either side of a small capsular opening for intracapsular removal or for reaching laterally into an intervertebral foramen for disc removal.

Conclusion

The surgical technologist plays a pivotal role in smoothly and successfully completing a neurosurgical procedure. With careful operative planning and experience, they are often able to anticipate what the surgeon's needs are before the surgeon realizes what is needed. The cooperative application of the principles outlined in this paper will increase the sense of well being of the operative team and improved outcome for the patient.

About the author

Dr Rhoton was a speaker at AST's Annual National Conference in Orlando, Florida, in 1999. See related story on page 26.

References

1. Greenberg IM. Self-retaining retractor and handrest system for neurosurgery. *Neurosurgery* 8:205, 1981.
2. Greenwood J. Two point coagulation. A new principle and instrument for applying coagulation current in neurosurgery. *Amer J Surg* 50:267, 1940.
3. Malis LL. Bipolar coagulation in microsurgery. In Yasargil MG, ed. *Microsurgery Applied to Neurosurgery.* New York: Academic Press, 1969, 41-45.
4. Rhoton AL Jr. General and Micro-operative Techniques. In: Youmans JR, ed. *Neurological Surgery.* Vol. 1. Philadelphia: WB Saunders Co. 1996, 724-766.
5. Rhoton AL Jr. Anatomic Foundations of Aneurysm Surgery. *Clin Neurosurg* 41:289, 1994.
6. Rhoton AL Jr. Instrumentation. In Apuzzo MJL, ed. *Brain Surgery: Complication, Avoidance and Management,* Vol. 2. New York: Churchill-Livingstone, 1993, 1647-1670.
7. Rhoton AL Jr. Microsurgery of the internal acoustic meatus. *Surg Neurol* 2:311, 1974.
8. Rhoton AL Jr. Microsurgical Anatomy of Decompression Operations on the Trigeminal Nerve. In Rovit RL, ed. *Trigeminal Neuralgia,* Baltimore: Williams & Wilkins, 1990, 165-200.
9. Rhoton AL Jr. Ring curets for transsphenoidal pituitary operations. *Surg Neurol* 18:28, 1982.
10. Rhoton AL Jr, Merz W. Suction tubes for conventional or microscopic neurosurgery. *Surg Neurol* 15:120, 1981.
11. Rizzoli H. Personal communication.
12. Yasargil MG. Suturing techniques. In Yasargil MG, ed. *Microsurgery Applied to Neurosurgery.* New York: Academic Press, 1969, 87-124.
13. Yasargil MG. Suture material. In Yasargil MG, ed. *Microsurgery Applied to Neurosurgery.* New York: Academic Press, 1969, 55.
14. Yasargil MG, Vise WM, Bader DCH. Technical adjuncts in neurosurgery. *Surg Neurol* 8:331, 1977.