Microvascular surgery: simplified instrumentation

Technical note

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The essential instruments required for performing microvascular surgery are described, as well as how to construct them oneself. These include ligature carriers, microhooks, microdissectors, microtourniquets, and various types of suction devices.

KEY WORDS microvascular surgery instrumentation

For several years efforts in the Neurosurgical Research Laboratory at the University of Vermont have been strongly oriented toward acquiring and improving microvascular surgical skills. During this period it has been found that most microvascular procedures may be performed with relatively few instruments. The burgeoning array of commercially manufactured microinstruments is distressingly expensive. However, many of these instruments can be easily made or obtained inexpensively from nonsurgical supply houses. This paper describes those instruments found to be essential in performing microvascular surgery and emphasizes various methods for reducing their cost.

Instrumentation

Instruments Adopted for Microsurgery

The basic instruments used routinely in this laboratory during the past 11 years are illustrated in Figs 1-3 (also see cover). Excellent descriptions of most of these including the bipolar coagulator may be found in texts on microneurosurgery. Several, however, require additional comments.

Forceps. A variety of forceps is available with either straight or angled ends, various tips, and straight or bayonet type handles. In most cases two pairs of the 16 cm Jacobson bayonet forceps with straight, nonserrated tips have proved to be quite satisfactory (Fig. 1 (1)). The bipolar forceps with the coagulator (Fig. 1 (2)) are an absolute necessity for microvascular procedures. Malis has described a simple inexpensive method for constructing bipolar forceps, which we have adapted with no sacrifice in the quality of the forceps.

A third pair of forceps, the Dumont No. 5 jeweler’s type (Fig. 1 (3)), are invaluable for handling delicate tissues and tying 9-0 and 10-0 suture. These provide a sure grasp on the adventitia of vessels as small as 1 mm in diameter and sutures may be firmly held while being tied. They can be purchased from most dental supply houses for approximately 7 dollars.

Scissors. From the available designs of
microscissors we have found the 18.5 cm straight spring-handled scissors with angled blades and a tip of 0.1 mm completely adequate for all surface work (Fig. 1 (4)). DeWecke’s iris scissors with sharp tips may also be used effectively for adventitial dissection and cutting fine sutures. Only in deep cavities have we found the bayonet type of microscissors necessary.

**Needle Holders.** Microneedle holders are differentiated by their various locking devices as well as by the straight versus bayonet design (Fig. 1 (5)). They are available with either a bypass catch, as used in most ophthalmic instruments, a ball and socket locking ratchet, or with no locking device at all. Some believe that extra movement is produced in opening and closing any type of locking device and thus prefer to remove them from the forceps, or purchase the forceps without such a device.

**Probes.** The one and two pronged Jacobson probes (Fig. 2 (3, 4)) are used to separate atraumatically the walls of incised and subsequently collapsed blood vessels and also as guides over which T-tubes can be inserted into small vessels. The two-pronged probe is also used in place of forceps as a counter pressor during suturing to avoid grasping and thus damaging the vessel wall.

**Scalpel.** The combination blade breaker and holder, as its name implies, is used to...
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break off small fragments from razor blades and then as a holder to serve as a microknife which in our experience has proved to be superior to scalpels for incising small vessels and cutting through delicate adhesions and arachnoid (Fig. 2(5)). A broach holder available from most dental supply houses for approximately three dollars can also serve as a very fine microknife. Fragments are broken from a razor blade with a hemostat, inserted into the holder and locked into place (Fig. 2(6)).

Dissector. The microdissector (Fig. 2(7)) is extremely useful and simple to make. A disposable 25-gauge needle is pulled from its plastic cap with a hemostat and inserted into a dental broach holder. The tip with the bevel up is then grasped with the hemostat and bent to any desired angle. This instrument has been particularly valuable in separating the arachnoid from cerebral vessels during aneurysm surgery as well as for dissection during experimental extracranial to intracranial bypass procedures. Often it can replace the microknife for fine dissection.

Instruments Easily Constructed

Some of the instruments illustrated in Figs. 2 and 3 are available from standard surgical supply houses. However, we have found that with just a few simple tools, such as a Moto-tool with attachments, a jeweler's file set and the materials generally available in most laboratories, they can be made.

T-Tubes. T-tubes are available for microvascular work in various sizes beginning with an inside diameter as small as 0.3 mm (Fig. 3(7)). Special sizes or designs are available on request from manufacturers. The application of these T-tubes in the repair of vessels with less than 3 mm in diameter has been well documented.

Sutures. For suturing vessels or nerves of less than 1 to 1.5 mm in diameter, 10-0 monofilament Nylon (22.1 μ diameter) is recommended. Nylon of 9-0 (40 μ diameter) and 8-0 (43 μ diameter) is used for vessels and nerves of 2 to 4 mm in diameter. Although these sutures are available with nee-

* Dremel Moto-Tool Company, Racine, Wisconsin.
† Extracorporeal Company, Mount Laurel Township, New Jersey; Codman & Shurtleff, Inc., Randolph, Massachusetts.

Fig. 3. 1) Spinal needle as microsuction tip. 2) Pliable microsuction tip. 3) Suction tip adapter. 4) Microligature carrier. 5) Microtourniquet. 6) Penrose drain as rubber dam. 7) T-tube.

dles of different sizes, we have found ETHICON'S atraumatic BV-3 needle (with a 3/8 curve, 6.35 mm length, 2.7 mm radius, and 0.127 mm diameter) applicable in virtually all situations where a needle of greater size (BV-2) might be considered; the converse has not been true. We, therefore, use the BV-3 needle with the appropriate size monofilament Nylon suture almost exclusively.

Suction Tips. A No. 5 French suction tip is suitable for most microwork. Occasionally, however, we have constructed smaller and longer tips by simply blunting and bending disposable spinal needles to the desired shape and connecting them to a cutoff suction adapter (Fig. 3(1,3)). For constant suction while working in small cavities, plastic tubing obtained from standard intracath or T-tube material (Fig. 3(2,7)) may be connected to the adapter and left in the wound thus obviating the need to hold the sucker in place.

Hooks. Sharp and dull hooks of any desired length or angle may be quickly constructed from disposable spinal needles or the buccal tubing available from dental supply houses (Fig. 3(8)).§ By using an emory wheel or Arkansas Stone, preferably under

§ Silverman's Company, 1216 Arch Street, Philadelphia 19107.
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Fig. 4. Steps in constructing sharp and dull microhooks and microprobes. Transect distal end of spinal needle (1a) and stylet (2a'). Insert transected stylet (b') into distal spinal needle (b) and then insert into distal end of buccal tubing (3) and crimp into place to obtain microhook (4).

from catching on adjacent structures or instruments.

A 20-gauge spinal needle with a 25-gauge distal tip will pass a 6-0 suture. If one desires a larger suture, but the space dictates the use of a more delicate ligature carrier, a 6-0 suture may be passed and a larger caliber suture tied to the distal end of the 6-0 suture and pulled through and around the vessel or the neck of an aneurysm.

Clips. The microtourniquets designed by Dr. K. M. Hunter (Fig. 3 (5)) have replaced Scoville and other clips for temporary occlusion of vessels especially when working in a limited area. They are simple to construct and can be used in conjunction with the ligature carrier as illustrated in Fig. 6. When tension is properly applied, temporary occlusion of bloodflow is obtained with minimal compression of the intima, and less subsequent edema. Furthermore, they occupy approximately 75% less space than the small-

magnification, the tip of the stylet inserted into the distal end of the buccal tubing and spinal needle can be bent and honed to any desired sharpness of curvature (Fig. 4).

Spatula. The angled microspatula is gently used to free certain vessels such as small cortical arteries from their delicate adventitial and arachnoidal coverings (Fig. 2 (1)). The instrument may be easily constructed by simply filing down the tip of an 18-gauge spinal needle under magnification. A universal handle which fits all standard needle hubs can be machined to specifications for approximately 6 dollars and used with this as well as other probes and hooks to be described (Fig. 2 (2)).

Ligature Carrier. The microligature (Fig. 3 (4)) is valuable for passing ligatures around vessels in confined areas. It is simply a blunted spinal needle with stylet removed and a second disposable needle of smaller diameter inserted and crimped into place (Fig. 5). By using a small file or emory wheel, holes are cut in the shaft of the spinal needle and the posterior aspect of the smaller needle after it has been bent into the desired angle or curve. These holes facilitate passage of the ligature through the needle and prevent it

Fig. 5. To construct microligature carrier: remove 25-gauge needle from disposable plastic cap. Blunt distal tip of a 20-gauge spinal needle (A). Insert disposable needle, bent to a right angle, into the blunted spinal needle (B) and crimp into place. Make holes in shaft of spinal needle and disposable needle as in (C). Thread with 6-0 silk to obtain microligature carrier (D).
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Rubber Dams. Rubber dams or strips are placed under a mobilized artery to prevent damage to underlying tissues. This also aids in hemostasis by providing temporary tamponading of the suture line when flow is re-established through an incised and repaired artery. These dams are cut from Penrose tubing or the fingers of rubber gloves (Fig. 3 (6)). Saran wrap or thin silicone rubber sheets may also be used.

Cottonoids. Until recently cottonoids or sponge materials have been made of cotton which tends to shred into loose strands which, under magnification, become quite annoying. Several companies are now manufacturing synthetic patties that obviate this problem and may also be cut to any desired size. Presently we are evaluating a hydrophilic polyurethane foam (Scott hydrofoam) which absorbs three to four times more fluid than any available cottonoid and which readily gives up its fluid upon suctioning.

Discussion

The total approximate cost of all of the microinstruments described including the bipolar coagulator, is less than $500.00. Besides fulfilling practically all microsurgical needs these instruments have proved to be extremely durable when used and cared for properly. All even including the scissors, have served the flow of surgeons who have spent from 2 weeks to 12 months at a time in our Microneurosurgical Research Laboratory. A similar set of instruments has been used extensively for the microscopic part of over 200 clinical neurosurgical cases which have included aneurysms, arteriovenous malformations, tumors, extracranial to intracranial shunts, and various peripheral nerve procedures.

Most operating microscopes already in use for eye, ear, nose and throat surgery can be easily and relatively inexpensively adapted for neurosurgical, orthopedic, and other uses. Information regarding objectives and attachments needed for specific purposes may be found in texts on microneurosurgery.\textsuperscript{5,6} A detailed discussion of operating microscopes is not our purpose; however, we have used the Zeiss binocular scope exclusively at this institution primarily because it was the first such instrument available. It has proved to be satisfactory in the laboratory as well as in the operating room, especially since the addition of a motor drive with foot control. Recently several different types of binocular systems have become available, ranging from the magnification lenses mounted in spectacle frames which cost several hundred dollars to highly automated microscopes costing several thousand.

There is no longer any question about the superior results obtainable with the microsuturing techniques in vessels and nerves of less than 3.5 mm diameter. Procedures on cerebral and peripheral vessels, cranial and peripheral nerves, ureters, vas deferens, fallopian tubes and coronary arteries have all been greatly facilitated and results improved. It is now possible to acquire the necessary instrumentation inexpensively. As with most
surgical skills, however, facility in using these tools is best acquired through diligent laboratory practice prior to clinical application.

Acknowledgments

Figure 6 was prepared by K. Michael Hunter, M.D., and used with his permission. We wish also to acknowledge the editorial and secretarial assistance of Elaine Lavigne and Ellen Scott.

References


Dr. Maroon is the Irene and John La Porte Given Scholar in Neurosurgery.

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