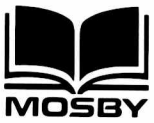

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THE HAND

Preface

This book was first published in 1971 as a treatise on general hand surgery; it was an exact reproduction of the chapter on hand surgery in *Campbell's Operative Orthopaedics,* fifth edition. Included were numerous techniques for skin coverage, as well as techniques for treating the bones, muscles, tendons, and nerves of the hand. This made it appealing to plastic and general surgeons, as well as to orthopaedic surgeons. The book was translated into several languages, including French, Spanish, and Japanese.

The second edition, published in 1982, added techniques of microsurgery and an expanded section on the treatment of carpal bone pathology. Over 400 new references were listed and a selected bibliography was added, which suggested to the reader certain review articles and articles of special clinical significance.

The third edition of THE HAND follows the tradition of the first edition. The hand surgery and microsurgery chapters are an exact reproduction of those chapters in the seventh edition of *Campbell's Operative Orthopaedics*. This third edition has been completely reorganized, dividing the material into nineteen distinct chapters, each with its own bibliography. At the beginning of each chapter, the subject material is listed in detail to avoid the need for frequent index referral. *The Hand* has continued to be a single author publication with the exception of the chapter on microsurgery. This section has been expanded and more fully illustrated under the editorship of my friend and partner, Phillip E. Wright II, M.D. The past editions have proven popular with not only hand surgeons but also plastic and orthopaedic surgeons, general surgeons, and trauma surgeons. I am gratified to find that physical therapists and occupational therapists have also found it especially useful to review the illustrative material that accompanies the descriptions of surgical procedures.

I hope that this book continues to be helpful to all physicians and therapists who treat the complex problems of the hand.

Lee Milford, M.D.

Contents

CHAPTER 1

Surgical technique and aftercare

ARRANGEMENT AND ROUTINE IN OPERATING ROOM

The results of surgery largely depend on the skill and judgment of the surgeon: fatigue or uncertainty lowers efficiency. The surgeon should therefore set up a *standard routine* (Fig. 1-1), to which he adheres and on which every assistant can depend. The surgeon should never disrupt the functions of assistants by unexpected, sporadic, or irregular demands; they in turn should know exactly what is expected of them at every moment and should perform without hesitation or wasted motion. Only a standard routine can make this possible.

When local anesthesia is used, the atmosphere of the room should be quiet and pleasant, without sudden loud remarks or gushes of conversation that might alarm the patient.

The stool on which the surgeon sits should be firm and comfortable and absolutely stable. It should allow him to sit with the knees almost level with the hips, the feet resting flat on the floor without strain. The working surface should be at elbow height. To avoid shadows, the light should be above the surgeon's left shoulder (if he is right-handed) and should shine directly on the operative field. The assistant, seated opposite, should view the operative field from 7.5 to 10 cm higher than the surgeon so that he can see clearly without bending forward and perhaps obstructing the surgeon's view. The primary function of the assistant is to hold the patient's hand firm and motionless, with the fingers retracted, so as to present to the surgeon the best possible access to the operative field (Fig. 1-2). Several hand-holders have been designed but none have replaced a well-trained assistant.

The operating table should be immobile and should allow room both for the patient's hand and for the resting elbows of the surgeon and assistant; thus muscle fatigue is kept to a minimum. The surgeon should always sit at the axillary side of the extremity on which he is working so that the anatomy of either hand is always presented to him in the same relative position. The tray holding the basic instruments should be placed on an extension of the operating table that is level with the working surface. The instruments should always be arranged in the same order. To save time the surgeon routinely reaches for and selects instruments from the basic tray; with practice this can be done without looking. He discards an instrument after use, and the nurse returns it to its proper place on the tray. This is called the "drop technique." The nurse does not, however, remove the momentarily discarded knife, tissue forceps, or dissecting scissors from the operative field, for these are in almost constant use by the surgeon. Any special instruments are quickly handed to the surgeon on request from a large table nearby. Any special sutures should already be threaded, and additional knife blades should be waiting.

Preparation and draping for elective surgery

To standardize routine and permit mobility without contamination, the method of preparation and draping of the forearm and hand are always the same, no matter what the operation. Preparations of additional fields, however, for obtaining skin, tendon, and bone grafts will vary. After the patient is anesthetized, the tourniquet is applied by the surgeon but is not inflated. After scrubbing for surgery and putting on sterile gloves, the surgeon or assistant now sponges the hand and forearm to just above the elbow with half-strength tincture of iodine, which when dry is removed with alcohol, being careful that neither solution runs under the tourniquet. Next a sterile pad and then a sheet are placed under the arm of the patient. After putting on a gown and changing gloves, the surgeon completes the draping with sterile sheets as illustrated in Fig. 1-1.

The surgeon now takes his seat and the operating lights are adjusted. If multiple incisions are anticipated, they may be outlined on the skin by a sterile skin pencil or by methylene blue applied with a toothpick or sharpened applicator. Only then is the extremity exsanguinated by a gum rubber Martin bandage 4 inches (10 cm) wide and the tourniquet inflated.

Tourniquet

A bloodless field is essential for accurate dissection without damaging vital small structures. Although a tourniquet is necessary, it is dangerous and should always be handled with respect. The pneumatic tourniquet is less

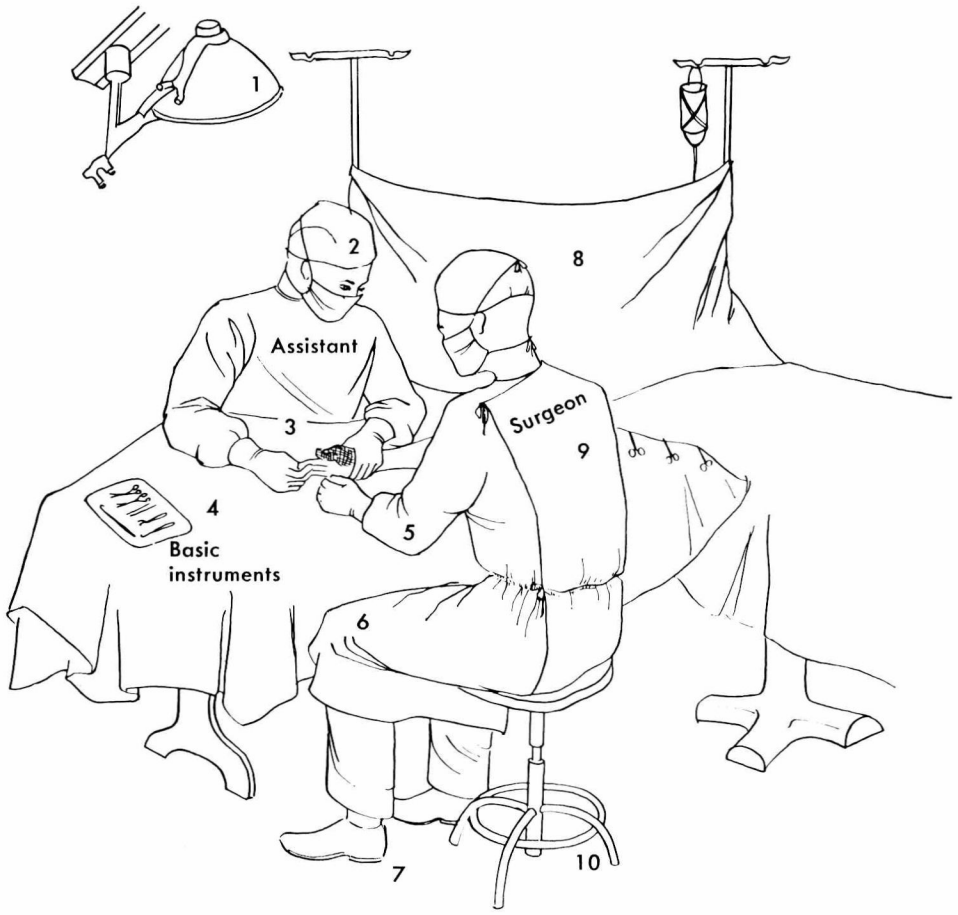

Fig. 1-1. Standard routine is used in operating room, regardless of procedure being performed. Light, *1*, passes over surgeon's left shoulder. Assistant's head, *2*, is 7.5 to 10 cm higher than surgeon's. Assistant holds patient's hand, *3*, firm and motionless. Basic instruments, *4*, are always arranged in same order. Surgeon's elbows, *5*, rest on sturdy table, knees, *6*, are almost level with hips, and feet, *7*, rest flat on floor. Vertical draping, *8*, prevents contamination of operative field by patient's face or by anesthesiologist. Surgeon holds back, *9*, comfortably erect and sits on a stool, *10*, which is firm and absolutely stable. See Fig. 2-1 for a description of hand table.

likely to cause permanent paralysis of the forearm and hand than an elastic or rubber bandage, but unless used judiciously, it may cause disproportionate or prolonged edema, stiffness, loss of acute sensation, and temporary weakness or paralysis. Pneumatic tourniquets are now available in several widths with Velcro fasteners, which are more efficient and less bulky than buckles (Fig. 1-3).

After several layers of cotton sheet wadding have been wrapped smoothly around the middle of the upper arm, an unwrinkled tourniquet is applied by the surgeon or an experienced assistant. The slightest wrinkle may pinch and blister the skin. The extremity is then either elevated for 2 minutes or is wrapped with a Martin bandage 4 inches (10 cm) wide from the fingertips to just distal to the tourniquet. The tourniquet is now inflated rapidly, thus preventing blood from being trapped in the arm after the first rise in pressure has obstructed the venous return.

The tourniquet pressure should not exceed 300 mm Hg for adults and 250 mm Hg or less for children; smaller cuffs are now available for the latter.

A recently designed tourniquet attached to an air pump and pressure gauge permits setting the pressure at 100 mm Hg above the systolic blood pressure and for a specific amount of time before an alarm is sounded. There is no rule as to how long a tourniquet may safely remain inflated on the arm. The usual limit is considered to be 1 hour or perhaps 1½ hours; this limit has sometimes been exceeded, but the risk of temporary or permanent paralysis is increased. If the operation lasts longer than 1½ hours, the tourniquet is released for 15 or more minutes while the arm is elevated about 60 degrees, and pressure is applied to the incisions with sterile dressings. Then, after the arm has been wrapped again with a Martin bandage, the tourniquet is reinflated.

Once the tourniquet is released, both it and the underlying cotton wrapping (sheet wadding) pad should be immediately removed to avoid venous congestion.

An excellent report by Wilgis seems to indicate that complete cellular anoxia for 2 hours requires marked extension of recovery time. Flatt has emphasized the need to

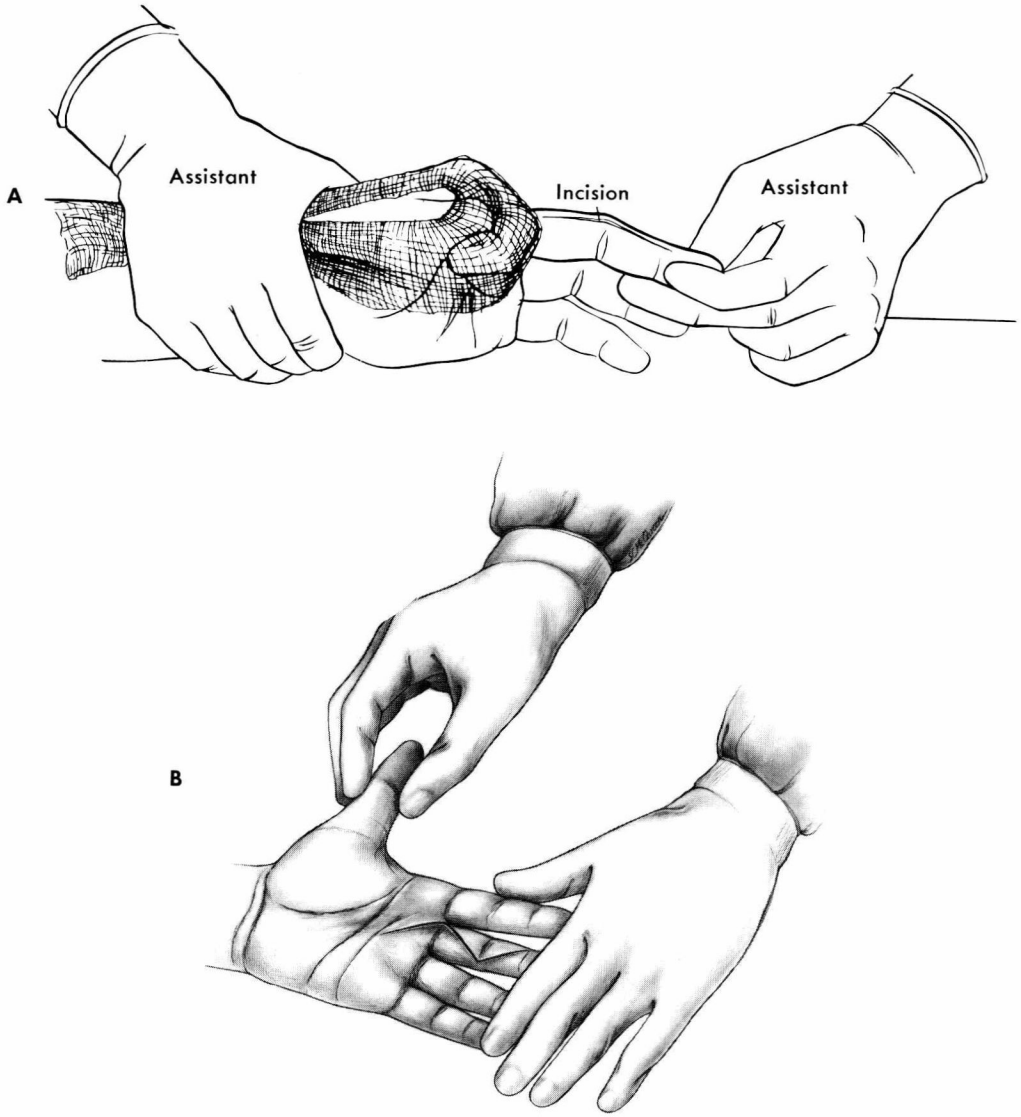

Fig. 1-2. A, Assistant holds patient's hand firm and motionless and exposes operative field for a midlateral digital incision. **B,** Ideal position for assistant to stabilize patient's hand as surgeon makes zigzag incision.

check the calibration of the pressure indicator gauge of tourniquets with a mercury manometer. He also reports that extreme pressures caused by a faulty gauge even over a short period of time may produce nerve damage that requires weeks for recovery.

For operations with the patient under local anesthetic and lasting less than 30 minutes, a Martin bandage alone may be used. Beginning at the fingertips and proceeding proximally, the bandage is applied in layers that overlap less than 6 mm. At the midforearm four or five layers are completely overlapped without wrinkles. Remember that each layer increases the pressure and that only moderate stretching is necessary. Beginning distally the bandage is then unwrapped up to the midforearm; here the layers are not disturbed until the operation is finished. When the patient is properly sedated, a pneumatic tourniquet may be used above the elbow for 30 minutes.

Neimkin and Smith recently reported using a double tourniquet on the upper arm to alternate the sites of pressure at 1 hour intervals. This ingenious method applies compression alternately to two segments of a nerve, and allows each segment to recover alternately. In 1000 consecutive patients, the proximal tourniquet was inflated about 100 mm Hg above the systolic blood pressure, but never over 280 mm Hg. After 1 hour, the proximal tourniquet was released and the distal cuff was inflated. The process was reversed at hourly intervals. They used the alternating cuff technique for up to 3½ hours in some patients. The constant pressure caused constant ischemia of the hand, but resulted in no apparent permanent clinical sequelae. They also devised a monitoring device for each tourniquet consisting of a mercury manometer attached by a T-tube to a freon gas tourniquet box and to the tourniquet cuff. It is placed so that the surgeon can see the manome-

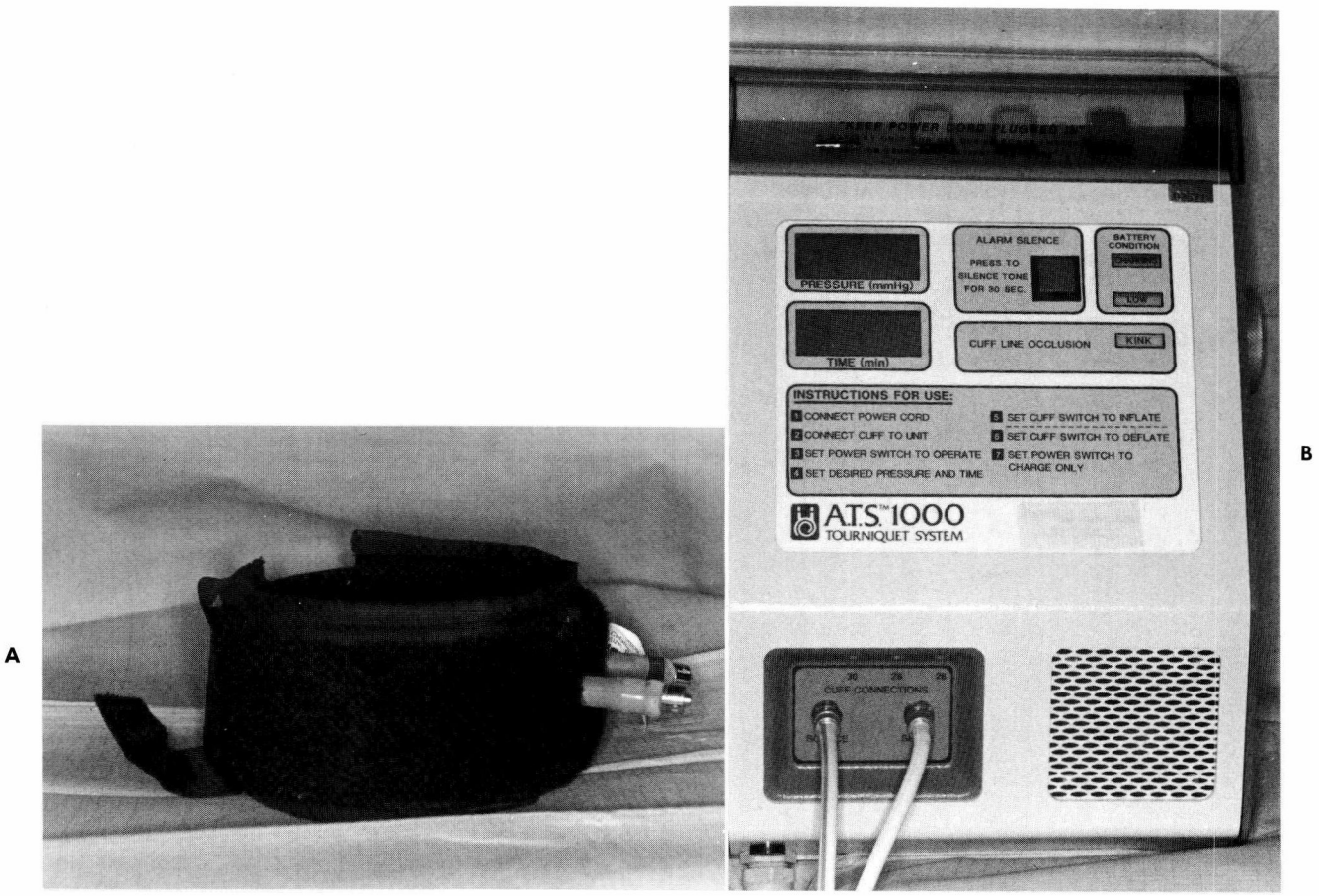

Fig. 1-3. A, Tourniquet of appropriate size with a Velcro fastener that eliminates buckle seems to be safer and more efficient. **B,** Air pump that permits continuous reading of pressure.

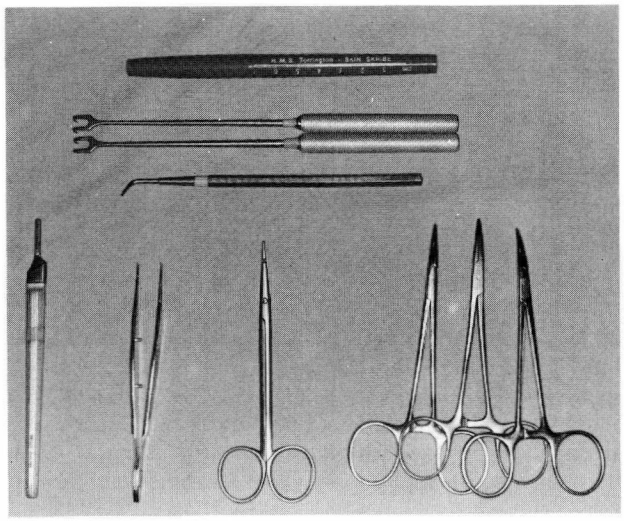

Fig. 1-4. Basic instruments for any surgical procedure on hand. Octagonal-shaped knife handle is preferable to flat handle because knife is more commonly held by precision pinch in hand surgery. Instruments are knife handle, small rat-tooth forceps, dissecting scissors, small hemostats, ruler-marking pencil, double-hook Lovejoy retractors, and probe.

ter at all times and thus can monitor the pressure dial on the tourniquet box at any time.

Instruments

For the accurate work required in hand surgery, instruments with small points are necessary; the handles, however, should be large enough to allow a firm, secure grip.

The four basic instruments are the knife, the small forceps, the dissecting scissors, and the mosquito hemostat (Fig. 1-4). The knife blade, which should be firmly attached to the handle, is changed often. The knife should be used for most dissection, rather than tearing through the tissues with a blunt instrument. The forceps should be carefully checked before surgery for cleanliness and precision of closure, since this instrument will touch the tissues most often. The scissors should have sharp double points, preferably curved, to dissect neurovascular bundles. Instruments used for fine surgery on soft tissues are shown in Figs. 1-5 to 1-10.

A mosquito hemostat is preferred for clamping vessels. Vessels should be clamped as seen, even when a tourniquet is used. An electric cautery is helpful; only minimal tissue is damaged if the vessels are carefully grasped by a small forceps or hemostat. Retractors should be of the

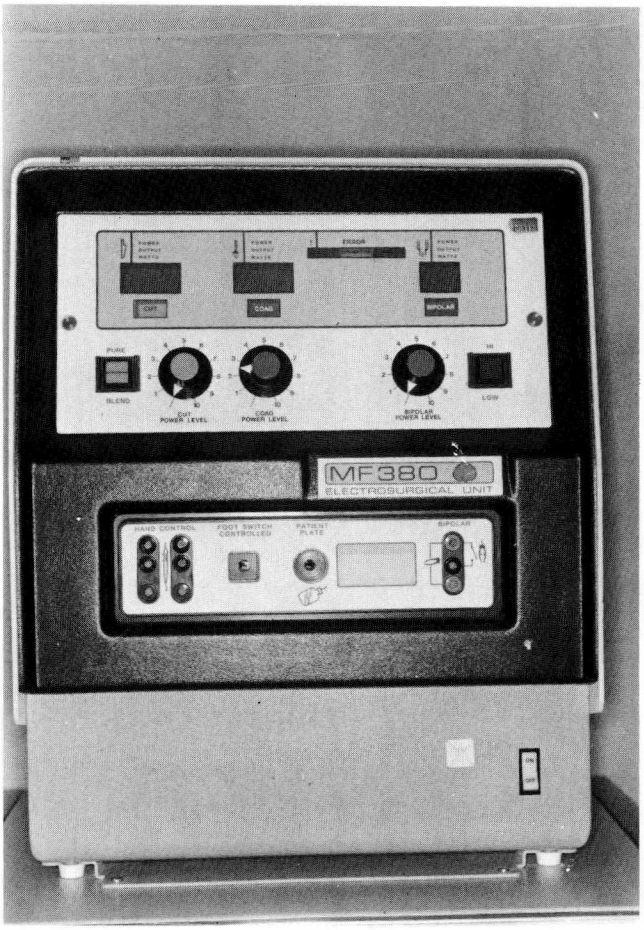

Fig. 1-5. Example of electric cautery with unipolar and bipolar power that can be controlled by hand or foot.

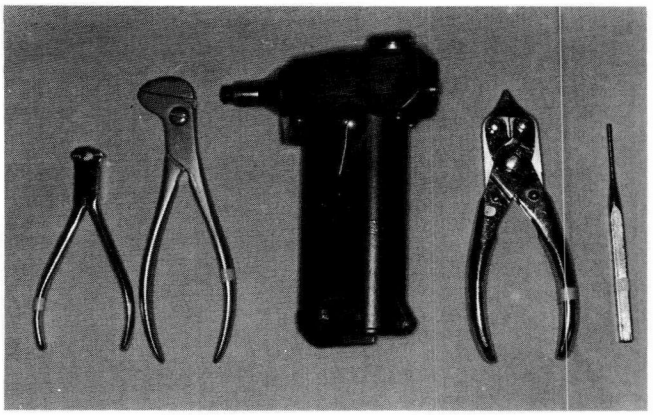

Fig. 1-6. Instruments useful for inserting Kirschner wires include end cutters, side cutters, lightweight battery-driven driver, pliers, and nail set.

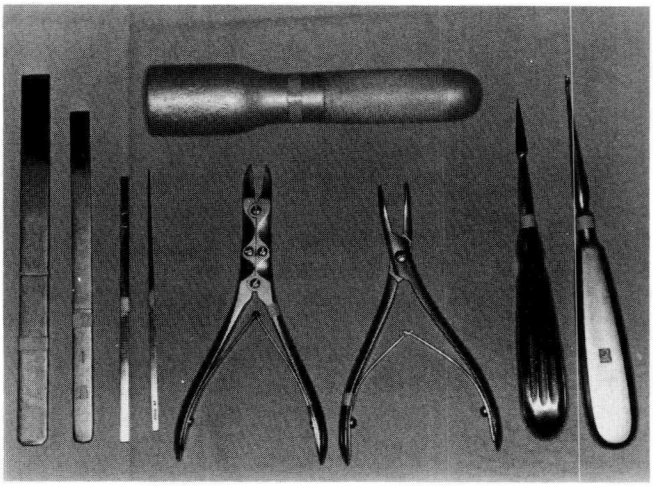

Fig. 1-7. Instruments for small bone surgery include ostetomes, bone cutter, rongeur, awl, small curet, and small hammer.

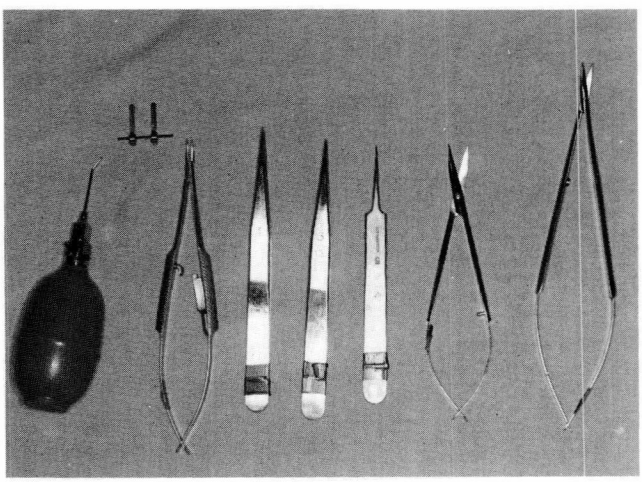

Fig. 1-8. Instruments useful in microvascular and digital nerve surgery include small irrigation bulb, microvascular clamp, microneedle holder, pickups, and scissors of assorted lengths.

small single- or double-hook type and should have handles long enough to keep the assistant's hands away from the surgeon's working area.

For drilling holes in bone, small No. 60 carbon steel twist drill points with a mechanic's pin vice are satisfactory; small sharp-pointed Kirschner wires and a Bunnell or a battery driven hand drill may be used. If tying sutures with a needle holder is preferred, the Webster model, having the proper shape with smooth jaws for holding the finest materials, is helpful. Wire suture as well as nylon is now commercially packaged with curved or straight swaged needles of appropriate size.

Choice of anesthetic

Whatever the choice of anesthetic, if it fails to completely anesthetize the part, the results of surgery will be compromised. In hand surgery the operative procedure must be completely painless, since for accurate work the part must be held motionless. Because all anesthetics, whether general, regional, or local, carry some danger, the choice of agent and method of administration are determined by several factors. Some of these will be considered here; the techniques of their administration are not discussed.

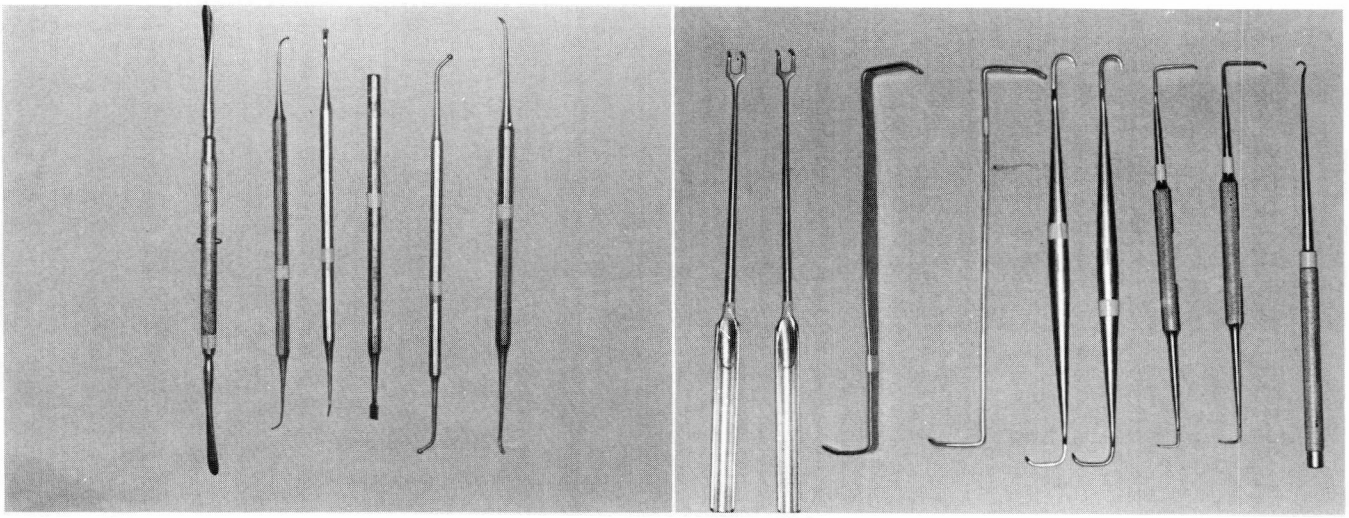

Fig. 1-9. A, Certain dental instruments are often useful for dissection of ligaments and bone. **B,** Retractors of numerous designs have been used in hand surgery, but modified tonsil prong *(left)* has proved to be the most useful.

A general anesthetic is usually preferred for extensive hand surgery or when at the same time surgery is required elsewhere on the body. A general anesthetic or a proximal regional block may be demanded by the presence of infection, which a local injection may spread. The temperature and age of the patient are other considerations.

Regional anesthetics such as brachial, axillary, or peripheral nerve blocks are particularly desirable at times, especially so in acute injuries occurring after the patient has eaten. However, the surgeon must be patient when using such an anesthetic; after the injection he must wait at least 5 minutes by the clock, or longer in some instances, before making any incision. Satisfactory sedation before surgery is as important here as when general anesthetics are used. When peripheral nerve blocks are done, direct penetration of the nerves is neither necessary nor desirable (Fig. 1-11).

Pneumothorax has been reported after 1% to 5% of supraclavicular brachial blocks, depending on the skill of the operator, but this complication can be avoided by using axillary blocks. Brachialgia, although usually temporary, is rarely reported as another complication.

Axillary blocks are satisfactory for any operation distal to the elbow; in these instances encircling of the subcutaneous tissues of the proximal arm with a local anesthetic agent helps prevent pain from pressure of the tourniquet by blocking the intercostobrachial nerve.

A regional block at the wrist or at a more distal level is sometimes useful because then the patient can move his fingers during surgery; thus in certain operations, such as tenolyses and capsulotomies, the surgeon can observe any improvement in function and proceed accordingly.

A tourniquet is used and the patient is kept comfortable but semiconscious by adequate sedation before surgery and by an intravenous drip of thiopental (Pentothal) or by administration of fentanyl-droperidol (Innovar) during surgery; under these circumstances the tourniquet is tolerated well for 30 minutes or longer.

The common digital nerves proximal to the finger webs may be more safely injected than the digital nerves at the base of the fingers. Although its cause is not completely understood, gangrene occasionally occurs after a local anesthetic is used to encircle the base of the finger; certainly this possibility is greater when epinephrine is added and a tight, narrow tourniquet is used at the base of the finger.

Intravenous anesthesia with double tourniquets at times makes a useful regional anesthetic. A solution of 1% lidocaine (Xylocaine) is introduced intravenously (40 ml in a 70 kg patient) into the arm after it is exsanguinated and the more proximal tourniquet is elevated. Only a few minutes are required to obtain a workable block. The more distal tourniquet is elevated over the anesthetized area once the more proximal tourniquet becomes painful. Leakage of solution into the wound sometimes is a worrisome problem. Surgery must be completed and the wound closed before release of the tourniquet because anesthesia is lost rapidly. The tourniquet should remain elevated for a minimum of 30 minutes after injection to avoid flooding of the anesthetic solution from the arm into the general circulation. After 30 minutes cellular fixation of the drug in the arm is sufficient.

Drugs used for local and regional anesthesia should become effective within a few minutes after injection, should cause no local irritation, and should have low systemic toxicity. Lidocaine seems to fulfill these requirements. For regional blocks, a total of up to 50 ml of 1% solution is the recommended safe dosage in a 70 kg adult. Mepivacaine (Carbocaine) acts longer but may be slower in onset and has been found to have about the same toxicity. The recommended dosage is up to 40 ml of 1% solution in a 70 kg adult. Bupivacaine (Marcaine) is preferred by many in replantation surgery, because it is effective for 8 hours

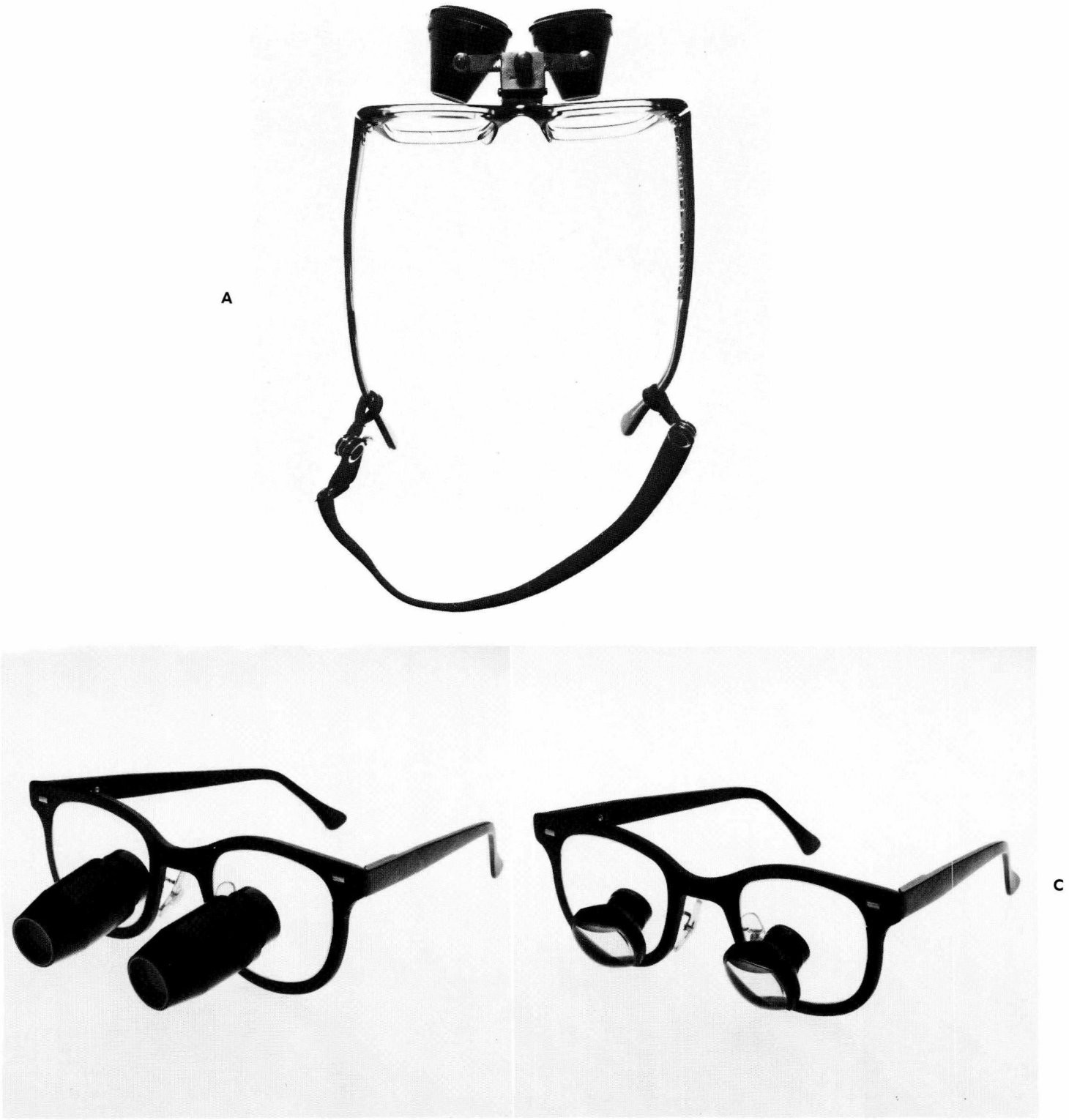

Fig. 1-10. A, Magnifying glasses for fine surgery on soft tissues. Either two or three magnifications may be chosen. Working distance is 20 to 25 cm. Glasses are stable, may be used over ordinary corrective glasses, and may be raised out of visual field at will. **B,** It is possible to achieve magnification up to 6× with magnification lens on glasses frame. However, magnification lens becomes too heavy for mounting if more than 6× magnification is needed. **C,** Magnification lens set within corrective lens is easy to use with magnification and pupillary distance set for individual surgeon.

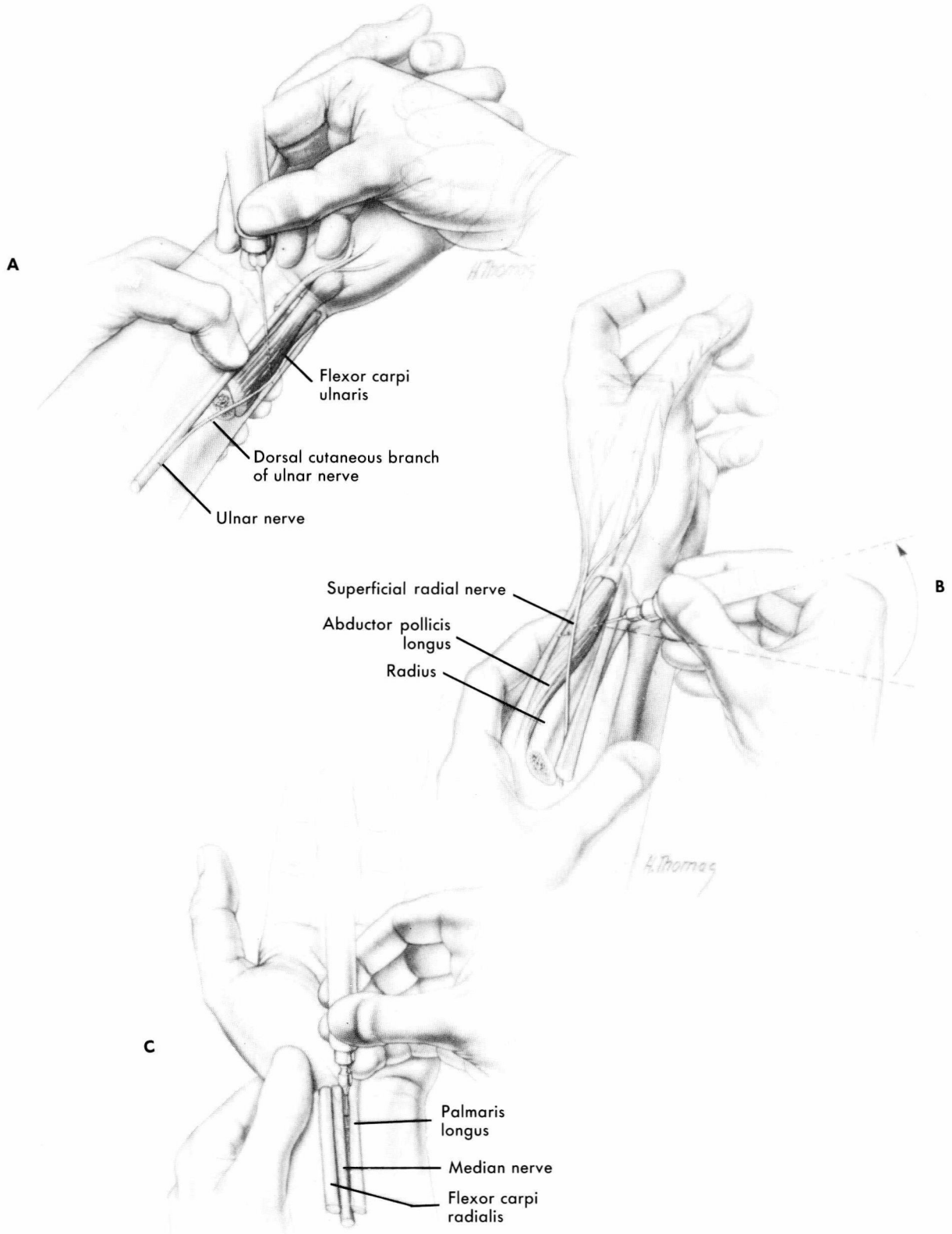

Fig. 1-11. Technique of peripheral nerve blocks. **A,** Ulnar nerve, superficial branch. **B,** Superficial radial nerve. **C,** Median nerve. (From Abadir, A.R.: Diagnostic nerve blocks. In Omer, G.E., Jr., and Spinner, M.: Management of peripheral nerve problems, Philadelphia, 1980, W.B. Saunders Co.)

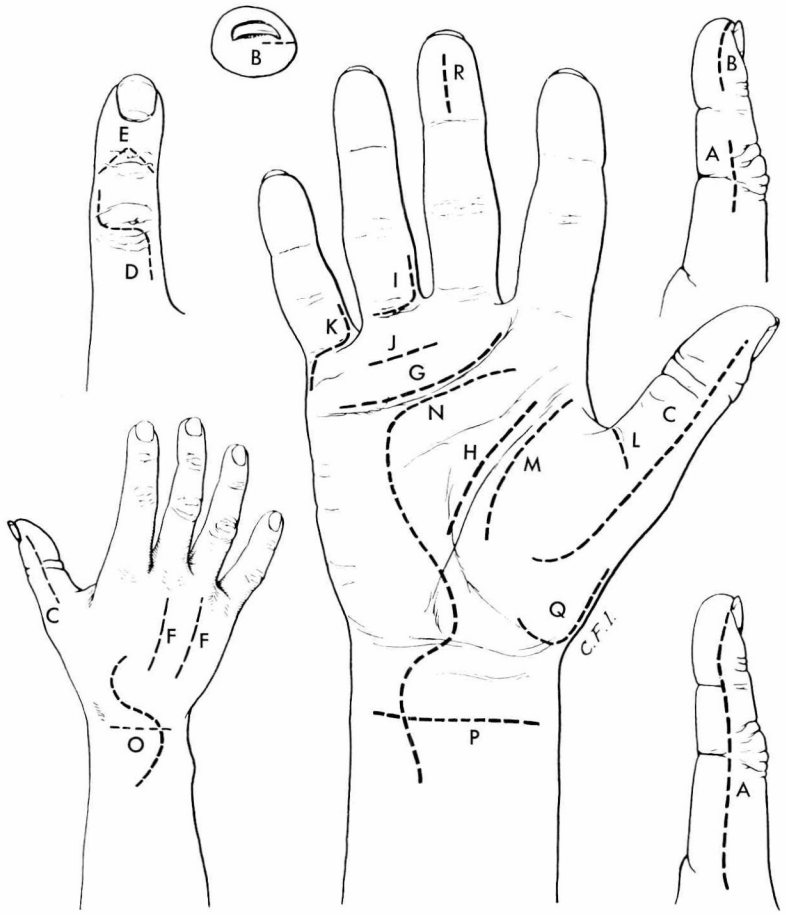

Fig. 1-12. Correct skin incisions in hand. *A*, Midlateral incision in finger. *B*, Incision for draining felon. *C*, Midlateral incision in thumb. *D*, Incision to expose central slip of extensor tendon. *E*, Inverted V incision for arthrodesis of distal interphalangeal joint. *F*, Incision to expose metacarpal shaft. *G*, Incision to expose palmar fascia distally. *H*, Incision to expose structures in middle of palm. *I*, L incision in base of finger. *J*, Short transverse incision to expose flexor tendon sheath. *K*, S incision in base of finger. *L*, Incision to expose proximal end of flexor tendon sheath of thumb. *M*, Incision to expose structures in thenar eminence. *N*, Extensive palmar and wrist incision. *O*, Incisions in dorsum of wrist. *P*, Transverse incision in volar surface of wrist. *Q*, Incision in base of thumb. *R*, Alternate incision to drain a felon. (Modified from Bunnell, S.: J. Bone Joint Surg. **14:**27, 1932; and Bruner, J.M.: Br. J. Plast. Surg. **4:**48, 1951.)

or more. It can be used as an axillary block to avoid the use of a general anesthesic.

BASIC SKIN TECHNIQUES

Incisions

As long as certain principles are observed, skin incisions can be made anywhere on the hand and not just in or near major skin creases (Figs. 1-12 and 1-13). In fact, they should not be placed within deep creases; here subcutaneous fat is scarce, and moisture tends to accumulate. An incision should be long enough to expose the deep structures without excessive stretching of the skin edges; greater exposure is possible if the skin and subcutaneous fat are dissected from the underlying fascia. The incision is always converted into a mobile oval or elliptic opening. Generally, shorter incisions are possible on the dorsum of the hand because here the skin is more mobile. For example, through a 7.5 cm lazy-S incision on the middorsum of the wrist, structures can be exposed from the extreme radial side of the wrist to the extreme ulnar side or from the tendon of the extensor pollicis brevis to that of the extensor carpi ulnaris.

Rarely should an incision be made in a straight line. If gently curved, the scar is more graceful and less noticeable and conforms better to natural lines. A curved incision can also later be extended with freer choice of direction. Exposure is always better on the concave side of a semicircular incision; an S-shaped incision gives even more latitude.

The placement of an incision applies only to the skin; entries into deeper structures are made according to their anatomy and may be opposite in direction to those made in the skin. For example, the skin incision over the radial surface of the wrist in de Quervain's disease is transverse, but the underlying incision in the stenosed sheath is longitudinal.

Parallel or nearly parallel incisions that are too close together or too long should be avoided, for healing may

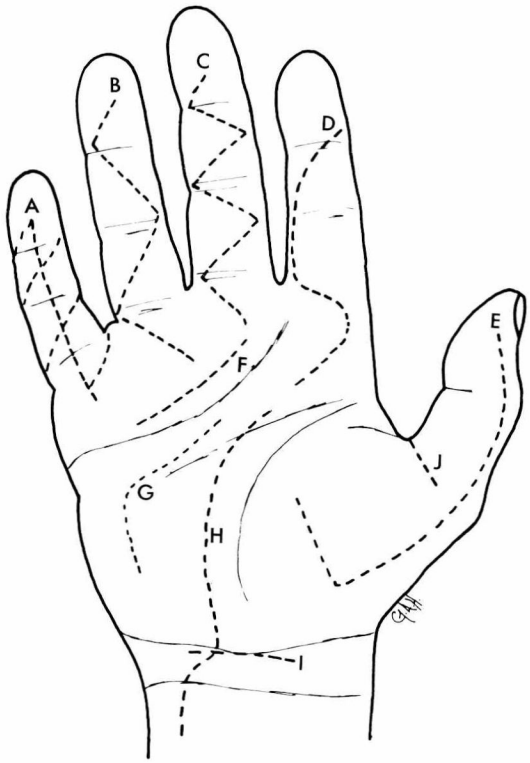

Fig. 1-13. Additional correct skin incisions in hand. *A*, Z-plasty incision often used in Dupuytren's contracture (McGregor). *B* and *C*, Zigzag incisions for Dupuytren's contracture or exposure of flexor tendon sheath. *D*, Volar flap incision. *E*, Incision to expose structures in volar side of the thumb and thenar area. *F*, Incision in distal palm for trigger finger or other affections of proximal tendon sheath. *G*, Incision to form flap over hypothenar area. *H*, Incision to expose structures in middle of palm; it may be extended proximally into wrist. *I*, Short transverse incision in volar surface of wrist. *J*, Short transverse incision to release trigger thumb.

be slow or a slough may even develop because of impairment of the blood supply. Scars that adhere to the underlying structures, especially bone, should be avoided if possible. The offset incision is helpful: the first incision is carried through the skin and subcutaneous fat, and after a flap is undermined on one side, the deep approach is made through the fascia and muscle parallel with but offset from the skin incision.

The plane of motion of a part is approximately perpendicular to the long axis of skin creases. Therefore an incision should not cross a crease at or near a right angle, since the resulting scar, being in the line of tension created by motion, will hypertrophy; indeed, it may limit motion, since a mature scar will not stretch like skin. Although true elsewhere in the body, this principle is more important when dealing with the hand.

At times incisions may be outlined on the skin with a sterile skin pencil especially if multiple incisions are needed. They may then be made without hesitation, thus saving time after the tourniquet is inflated.

FINGER INCISIONS

The first basic finger incision, the midlateral, has sometimes been misunderstood because of poor drawings and illustrations. With this incision the neurovascular bundle may be carried volarward with the volar lip of the incision, or it may be left in place by carrying the dissection superficial to it.

To carry the neurovascular bundle volarward, begin the incision on the midlateral aspect of the finger at the level of the proximal finger crease and carry it distally to the proximal interphalangeal joint just dorsal to the flexor skin crease; continue it distally along the middle phalanx, again dorsal to the distal flexor skin crease, and proceed toward the lateral edge of the fingernail (Fig. 1-14). Since flexor skin creases extend slightly over halfway around the finger, the incision is in fact slightly posterolateral. Develop the dorsal flap a little to aid in closure of the incision. On the radial sides of the index and middle fingers and the ulnar side of the little finger is a dorsal branch of the digital nerve that should be preserved when possible (Fig. 1-15). Develop the volar flap by continuing into the subcutaneous fat over the proximal and middle phalanges, but since fat is scanty over the proximal interphalangeal joint, be careful not to enter it by mistake. Immediately after incising the fat, carry the dissection volarward deep to the neurovascular bundle and expose the tendon sheath. The sheath can then be incised, or the neurovascular bundle can be exposed by further dissection (Fig. 1-16). The opposite neurovascular bundle can also be exposed because of its anterolateral position.

The second basic midlateral incision is developed superficial to the neurovascular bundle. Make the same midlateral skin incision, but just distal to the distal skin crease carry the incision obliquely into the pulp of the finger. As the volar skin flap is developed through the subcutaneous fat, carefully isolate the neurovascular bundle; it can best be found at the middle of the middle phalanx. Then expose the bundle by dissecting the fat from its volar surface and expose the flexor tendon sheath by carrying the dissection toward the bone. If necessary, the skin flap can be developed further by dissecting into the depths of the pulp distally, being careful not to disturb the nerves and arteries, and by extending the incision into the palm proximally.

Using the principles just outlined and illustrated, many less extensive exposures of the finger are possible.

Surprisingly, new incisions and approaches are still being described that allow more direct access to deep structures. The recently popularized zigzag finger incision (Fig. 1-13, *B* and *C*) does not require mobilizing either neurovascular bundle and directly exposes the volar surface of the flexor tendon sheath. However, when used on a contracted skin surface it tends to straighten out and result in a more linear scar than is desirable; here multiple Z-plasty incisions are more satisfactory. In either type of incision care must be taken to protect the neurovascular bundles.

THUMB INCISIONS

Midlateral incisions described for the fingers are also suitable for the thumb; the radial side is more accessible, and an incision here can be extended by curving its proximal end at the midmetacarpal area and creating a flap on the palmar surface of the thumb (Fig. 1-12, *C*). Care should be taken to avoid the dorsal branch of the superfi-

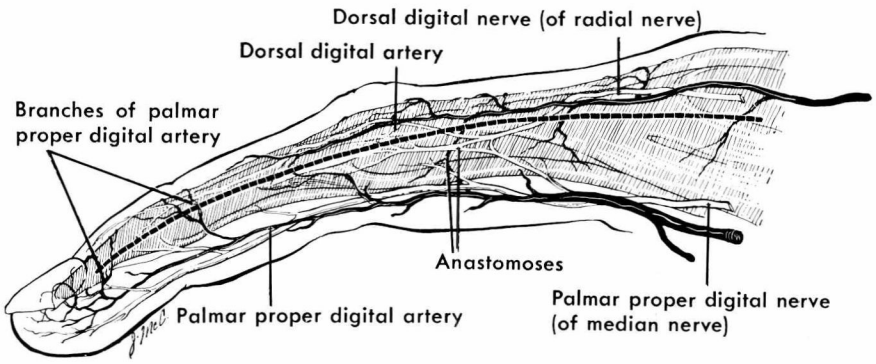

Fig. 1-14. Midlateral skin incision in finger extending from metacarpophalangeal joint to lateral edge of nail. To avoid flexor skin creases, it is placed slightly posterolateral. (Modified from Anson, J.B., and Maddock, W.G.: Callander's surgical anatomy, ed. 3, Philadelphia, 1952, W.B. Saunders Co.)

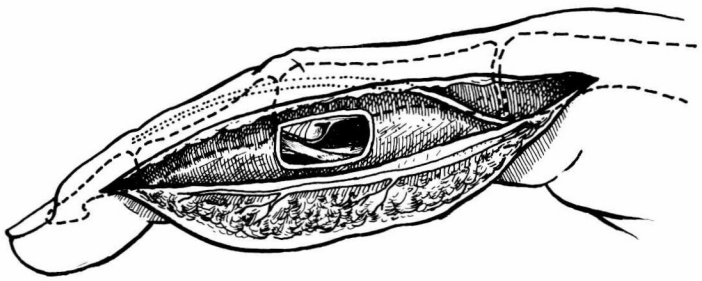

Fig. 1-15. Midlateral approach especially to expose flexor tendon sheath. On radial sides of index and middle fingers and on ulnar side of little finger is dorsal branch of digital nerve that should be preserved if possible. Volar flap containing neurovascular bundle has been developed and reflected. Window has been cut in sheath to show relations of flexor tendons.

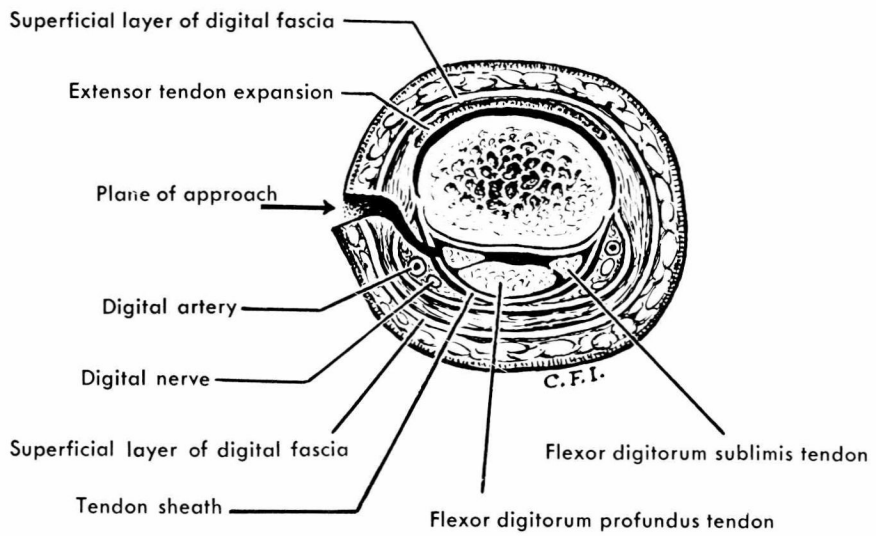

Fig. 1-16. Cross section of finger to show midlateral approach when used to expose flexor tendons.

cial radial nerve to the radial side of the thumb. This incision may be used for tendon grafts without an additional palmar incision, since the flap can be developed sufficiently to expose most of the flexor surface of the thumb. Fat is scanty on the lateral aspects of the distal joint of the thumb, and the volar plate of the capsule may be opened by mistake when seeking the flexor tendon sheath.

When a transverse incision for trigger thumb is made at the level of the metacarpophalangeal joint, the two digital nerves of the thumb, located anterolaterally as in the fingers, must be carefully avoided (Fig. 1-12, *L*).

PALMAR INCISIONS

As a rule, distal palmar incisions are transverse; in the proximal palm they tend to be more longitudinal, with the distal end curving radially and paralleling the closest major skin crease, but at any desired distance from it. An incision of any desired length may be made across the palm, provided that the underlying digital nerves and other vital structures are protected. After the skin and underlying fat are incised, the latter is dissected from the palmar fascia and is carried with the skin flaps. It may be desirable, although tedious, to preserve small vessels perforating the palmar fascia if wide undermining of the skin flaps is necessary; otherwise most of the vital structures are deep to the palmar fascia. In the distal palm, structures lying between the metacarpal heads are not protected by the palmar fascia. After the skin flaps are retracted, the fascia can be incised in any direction necessary for ample exposure; excision of the fascia may be desirable. The tendons and their paralleling neurovascular bundles are then seen. The superficial volar arch can be ligated and cut at one end if deeper exposure is required. Incisions in the more proximal palm should parallel the thenar crease; however, when extended proximal to the wrist, they should not cross the flexor wrist creases at a right angle. The most important structure in the thenar area is the recurrent branch of the median nerve, which should be exposed and protected if its exact location is in doubt.

Basic skin closure techniques

Also see considerations for skin closure, p. 31.

Early closure but not necessarily immediate closure of all hand wounds lessens the chances of infection and excessive scarring, which destroy the gliding mechanism essential to hand movements. Immediate coverage is imperative when bone, cartilage, and tendon are laid bare, for without it these structures will not survive. Whenever possible, direct suture of the skin without tension is the best method of closure. On the dorsum of the hand or wrist this is sometimes possible even after considerable loss of the mobile skin by extending the wrist to relieve tension; care should be taken, though, not to hyperextend the metacarpophalangeal joints (Fig. 1-17). When a large defect here is closed in this manner, flexion of the wrist and fingers will be limited, and replacement of skin by grafting may be necessary later. The advantages of primary closure by direct suture are jeopardized unless each suture is accurately and patiently placed, for not just the epidermis, but each plane of tissue should meet its corresponding plane. Placing sutures too few in number and too close to the skin edges in attempting a ''plastic closure'' are errors of the

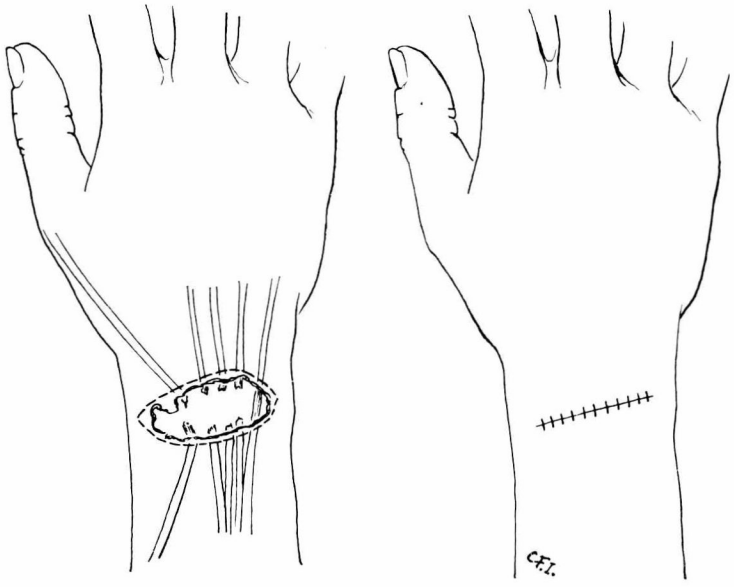

Fig. 1-17. Small defects in skin and subcutaneous tissue on dorsum of hand or wrist can be closed after wrist has been extended to relieve tension. This closure may require a graft later to permit wrist flexion while making a fist.

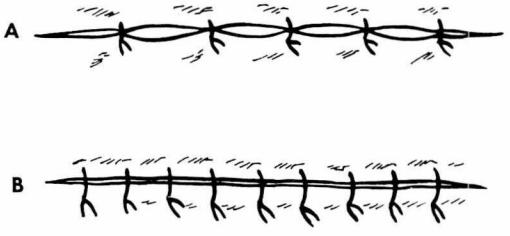

Fig. 1-18. A, Skin has been closed by an insufficient number of sutures placed too superifically and too close to skin edges. **B,** Skin has been closed by sufficient number of sutures placed more deeply and well away from skin edges.

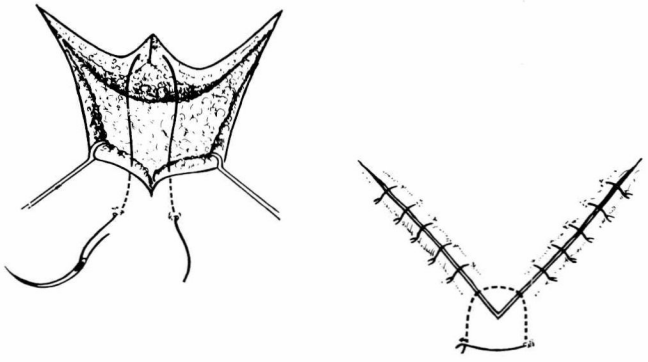

Fig. 1-19. Apical stitch is useful for suturing sharp angle in laceration or in elective flap.