Current Trends in Hand Surgery

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Hand surgery became an established subspecialty between World Wars I and II. Prior to this time, hand injuries were cared for by various specialists—neurosurgeons, plastic surgeons, orthopedic surgeons, and general surgeons—each of whom would focus on their particular tissue within the hand. With the nearly 90,000 hand injuries sustained during World War II, military hospitals were created to deal solely with hand injuries, and hand specialists began to treat the hand as a single functional organ. This article briefly reviews the origin of the subspecialty and discusses current trends in hand surgery.

At the beginning of the 20th century, hand surgery was performed by a variety of surgeons—general surgeons, neurosurgeons, orthopedic surgeons and plastic surgeons. The injured hand could be operated on by multiple surgical teams, each focused on its particular area of interest or expertise,[1-3] and often, the care of the hand was left to the junior members of a group. It gradually became recognized that caring for the hand as a functional entity was more important than caring for each of the hand's individual parts. Thus, during the period between the two World Wars, hand surgery became a discrete specialty.[4] The publication of two text books contributed much to the development of hand surgery as a recognizable specialty: Kanavel's text *Infections of the Hand*, published in 1912, and Bunnell's *Surgery of the Hand*, first published in 1944.[1,5] During World War II, more than 89,000 hand injuries occurred, leading the goverment to the establish hand surgery centers.[2,6] Those centers were staffed by military and civilian surgeons who had a special interest and expertise in treating hand injuries. In 1946, 35 hand specialists created the American Society for Surgery of the Hand (ASSH).[6] The initial membership included general surgeons (14), plastic surgeons (13), and orthopedic surgeons (eight). As the field grew, the society became more inclusive; today the ASSH has approximately 1,300 members worldwide. As the specialty matured and as its knowledge base grew, academic hand surgeons discussed subspecialty certification.[6] It was decided that, rather than create a discrete boarded specialty as Sweden did, a surgeon in the United States wishing to specialize in hand surgery could do preliminary training in general, plastic or orthopedic surgery followed by a hand fellowship.[6,7]

This article highlights recent trends in hand surgery, focusing on techniques and procedures involving the entire hand as well as those that involve a particular tissue. Some of the procedures are relatively widely accepted, others are accepted but may not be performed often because of the rarity of the condition they correct, and still others are in transition as research attempts to determine their comparative effectiveness and optimal indications.

Two Developments

Surgery Without Sedation

For decades, medical students have recited a memorable rhyme: "No epinephrine in fingers, nose, gonads or toes." This cautionary statement began with the hypothesis that epinephrine added to local anesthetic could cause vasoconstriction and lead to tissue necrosis in terminal locations. Recent work has shown that early local anesthetic agents were chemically unstable and could be toxic to tissues, and that tissue damage was more likely to be related to the anesthetic agent rather than the epinephrine added to it. A large set of well-designed investigations has shown the safety and efficacy of local anesthesia containing epinephrine.[8,9] Epinephrine prolongs

the duration of the local anesthetic and decreases local bleeding. This allows hand surgery to be done without a tourniquet, and it is one reason why "wide-awake hand surgery" or surgery without sedation has gained popularity.[9]

Surgery without sedation has been promoted by Canadian plastic and hand surgeon Donald LaLonde, M.D.,[10] who demonstrated that procedures as varied as carpal tunnel release and certain tendon transfers can be done under local anesthesia in an office setting rather than in the operating room in patients of all ages.

■ Hand Transplantation

At the other end of the spectrum in terms of complexity is hand transplantation. The first successful hand transplant was performed in France in 1998.[11] However, because of episodes of rejection, the transplanted hand eventually was removed at the patient's request. At the time, members of the hand surgery community criticized the surgeons who performed the procedure, arguing that the patient was not a good candidate and that the case was done in a hasty manner. The following year, the first transplant with extended success was performed at the Kleinert Hand Institute.[12] Ensuing articles focused on ethics and opinions regarding the value of, the indications for and, finally, technical aspects of the procedure.[13-16] Despite early opposition, institutions throughout the world are now exploring the logistics of becoming hand transplantation centers, and there is now an international registry of hand transplantations to monitor outcomes.[17]

Skin and Adipose Tissue Procedures

■ Dermal Regeneration Templates

In conditions where the skin has been completely lost, skin grafts or local, regional or distant tissue flaps may be needed to cover deep structures such as tendon, nerve or bone. Problems associated with skin grafts include fragility, stiffness and loss of area with healing; in addition, flaps create a secondary wound and may be bulky or cosmetically undesirable. The use of dermal regeneration templates, collagen scaffolds that support wound healing and are made of natural (animal, human or plant sources) or synthetic or a blend of natural and synthetic materials, has become more widespread. They add durability, limit wound contracture and prevent the need for more invasive surgical procedures.[18] The dermal template is placed in the wound bed, and once it has been vascularized, a skin graft is placed over it. This does prolong treatment, but the ultimate outcome may be better than with a skin graft alone. Both skin grafting and placement of dermal templates are less invasive than flap surgery. Dermal templates are now used in patients with burns, in reconstruction of congenital hand deformities and following trauma.[18-21]

■ Collagenase and Fat Grafting for Dupuytren's Disorder

Dupuytren's disorder is a contracture of palmar fascia causing flexion deformities of the digits. Initially, it was believed to primarily affect males of northern European heritage; it has since been recognized in men and women from all ethnic backgrounds.[22-24] Treatment options have included stretching, dividing the palmar cords with needles, surgical excision and, most recently, dissolution with collagenase.[25-27] The use of collagenase is relatively straightforward when performed by trained surgeons for selected patients. The collagenase is injected into the cord, and the next day the patient returns to clinic where the cord is cracked and the finger is forced into extension. Complications have included local tissue redness that mimics infection, tearing of the skin and rupture of tendons (if the collagenase is injected too deeply).[26,28] ↳

Off-Label Use of Onabotulinum Toxin A for Hand Conditions

Onabotulinum toxin A has been used since the late 1980s for the treatment of blepharospasm, strabismus and glabellar lines. It decreases the ability of a muscle fiber to contract by inhibiting the release of acetylcholine from nerves. It is currently FDA-approved for those disorders as well as for treating chronic migraines, axillary hyperhidrosis, cervical dystonia and upper-limb spasticity.[1] Early evidence supports the use of botulinum toxin in an off-label fashion to treat palmar hyperhidrosis, focal hand dystonia, and Raynaud's and other vasospastic disorders.[2-7] It is also successful, for reasons yet unclear, in relieving vascular spasticity and controlling pain. Proposed mechanisms of action include inhibiting the release of inflammatory neuropeptides and decreasing the expression of pain receptors in the dorsal root ganglia.[8,9]

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In cases of recurrent and highly aggressive Dupuytren's disease of the palm, fat grafting has been proposed as a surgical adjunct to needle aponeurotomy. It is recognized that adult human adipose tissue contains pluripotential adipose-derived stem cells. These cells can be harvested from patients using liposuction and are capable of differentiating into multiple tissue types. In fat grafting, it has been proposed that pluripotent cells may act to improve the overlying tissue quality in a reparative fashion.[29, 30] More commonly, fat grafting has been used for improving the contour of the dorsal hand and masking prominent dorsal veins.[31] Fat grafting complications include resistant infections, contour irregularities, and the need for additional procedures. Refinements in the fat harvesting technique have reduced the need for multiple procedures.[31,32]

Tendon Procedures

■ Extensor Tendon Yoke Splinting

The most common complication of extensor tendon repair has been loss of flexion.[33] Dynamic extension splinting has improved the ultimate outcome of extensor tendon repair; but the technique is device-dependent and wearing the device can be unwieldy.[34,35] The most recent development ihas been allowing extensor tendon motion immediately after surgery.[35,36] By placing the injured finger in a slightly extended position, the tendon is under less stress, and the patient can immediately move the finger without risk of rupture. This method is easy to implement, results in better compliance on the part of patients than having to wear the standard bulky and complex dynamic splints, and ultimately achieves a near-normal range of motion.[35,36]

Bone and Joint Procedures

■ Hemi-hamate Joint Reconstruction

The proximal interphalangeal joint is responsible for much of the dexterity of the finger, and injuries can have long-term sequelae. Options for repair may be limited, and problems with scarring and stiffness are common.[37] Joint implants are sometimes possible, depending on the digit involved and the needs of the patient. Joint fusion provides stability at the expense of motion. Volar plate advancements may stabilize the joint but also lead to stiffness. Transferring vascularized joints from the toes has been offered as an option, but this is rarely done.[38] A procedure that has demonstrated slightly more predictable outcomes is the use of the hemi-hamate bone graft to reconstruct a partial joint loss at the base of the middle phalanx. One of the articular surfaces of the hamate bears a striking resemblance to the shape of the volar base of the middle phalanx, and unstable fracture dislocations can be treated by transferring this section of bone from the dorsal wrist to the volar aspect of the finger.[39] Repairing like with like is a goal, and this bone graft has shown promising results with range of motion being approximately 70 degrees to 85 degrees and grip strength between 80% to 95% of the contralateral, uninjured side.[39-41]

■ Low-Intensity Pulsed Ultrasound

The scaphoid bone in the wrist, historically called the navicular, is the one most frequently broken by a fall onto the outstretched hand. Unfortunately, the blood supply to the scaphoid is tenuous, and a fracture can be slow to heal.[42,43] Even if the scaphoid is in appropriate alignment or if it has been stabilized with a pin or screw, there is still a chance that a fracture may not heal, leading to scaphoid necrosis and arthritic destruction of the wrist. Nonunion rates approach 40%.[43,44] Risk factors for nonunion or delayed union are a proximal pole fracture, delayed diagnosis of the fracture and tobacco use. To promote revascularization of the scaphoid, pulsed ultrasound has been used if there is no evidence of healing within the first two months following fracture.[45-48] In studies using low-intensity pulsed ultrasound, union rates ranged from 86% to 100% within nine to 22 weeks.

■ Volar Plating

Distal radius fractures are commonly managed by hand surgeons as they are often associated with bone and ligament injuries to the carpus. The incidence of concomitant injury ranges from 7% to 100% depending on the intensity of the evaluation.[49-51] During the past 10 to 12 years, volar locking plates have come into vogue for treating distal radius fractures; but their widespread use is now being questioned. It may be associated with greater rates of complications compared with other treatment choices. Other accepted means of treatment include cast management, percutaneous pinning, dorsal plating, and use of external fixation devices. Current evidence does not indicate superiority of any single treatment,[52-56] and investigators are trying to determine the best indication for each technique.

Nerve Repair

■ Nerve Transfer

When a nerve is irreparable or if functional recovery of muscles in the hand cannot be expected with repair, nerve transfers have been offered as an option for recovery of distal function.[57] In much the same way that tendon transfers use a functional tendon to replace the one that is no longer available, a nerve transfer brings viable axons closer to a denervated muscle to allow for reinnervation during an acceptably short time span. Nerves grow at a maximum of one inch per month, and if a denervated muscle is not reinnervated within 18 months, it will be never be able to be reinnervated and its function will be lost. In the case of a lacerated ulnar nerve, an adjacent and expendable motor nerve, the anterior interosseous branch of the median nerve, can be cut distally and sewn to the distal branch of the ulnar motor nerve so that its branches reinnervate the muscles of the hand that are innervated with the ulnar nerve.[58] Because this nerve lies within a few inches of the ulnar innervated muscles, the patient has a better chance of functional recovery. The brain also can be

retrained to move the muscles of the hand in at least a rudimentary fashion while thinking of rotating the wrist. Nerve transfers also can compensate for injuries to the motor nerve and sensory injuries to the median and radial nerves.[59,60]

■ Nerve Conduit

When the ends of a transected nerve cannot be directly coapted because of retraction, scarring or loss of a segment of nerve, the nerve gap is generally grafted with an expendable nerve from elsewhere in the body. If the gap is short, if the patient or surgeon wishes to avoid a secondary surgical site or if the need for graft material is greater than the supply, bioabsorbable conduits through which native nerve can grow can be created.[61-63] The way this works is that the divided ends of a nerve are plugged into the conduit to allow nerve fibers to grow across the gap in a more controlled fashion. The use of nerve conduits has been studied extensively in animal models and in humans with nerve injuries; it has been found that the cut nerve will probably not consistently travel more than 2.5 cm across a conduit in an adult, although one recent meta-analysis found that the distance may be greater for the median nerve.[61,64] The nerve conduit probably is less effective when used in a larger mixed-motor and sensory nerve more proximal in the arm in adults. Future research will focus on materials and structural design to promote nerve ingrowth across longer distances.

Conclusion

Hand surgery is fascinating because of the complexity of the anatomy, the variety of problems that can be addressed and the potential for functional recovery. Since it became a specialty more than 60 years ago, the field has continued to attract surgeons with a temperament and philosophical bent to care for the hand as a unified organ rather than a collection of parts. Given the importance of hand function to daily life, the frequency of injuries and the increasing number of disorders associated with an aging population, a considerable amount of research has been taking place, some of which has generated controversy. Our knowledge and understanding of best practices will continue to evolve as researchers develop new ways to treat conditions and injuries affecting the hand. **MM**

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