Chapter

8 Hand and Upper Extremity

Subhro K. Sen, MD and Jesse A. Taylor, MD

Hands, and in particular opposable thumbs, have played a large role in human ascendancy to dominance over the animal kingdom. The ability to use our hands forms the basis of much social and economic interaction. Thus, functional and cosmetic deficits in the hands are devastating.

Anatomy

The hand is a stable bony construct with mobile joints, functional muscle-tendon units, and intact sensation with a supple skin covering. The engineering and anatomy are complex, and this brief description will be somewhat superficial. However, an introduction to the functional anatomy will give you some feeling for the clinical issues faced by hand surgeons.

Bones

The radius and ulna comprise the bony forearm, articulating with the humerus proximally and the carpus distally. The wrist, or carpus, contains eight carpal bones made up of two rows of four bones each. From radial to ulnar, the proximal row consists of the scaphoid, lunate, triquetrum, and pisiform. The distal row consists of the trapezium, trapezoid, capitate, and hamate. The proximal row articulates with the ulna and radius. The distal row articulates with the five metacarpals, the bones of the palm of the hand. The heads of the metacarpal bones, which form the knuckles, articulate with the proximal phalanges. The thumb has two phalanges (proximal and distal); each of the other fingers has three (proximal, middle, and distal). The bones of the hand and wrist are held together by a complex system of ligaments.

Muscles

Extrinsic Flexors

Wrist flexors include the flexor carpi ulnaris (FCU) and the flexor carpi radialis (FCR). The eight tendons of the flexor digitorum superficialis (FDS) and profundus (FDP), the tendon of the flexor pollicis longus (FPL), and the median nerve pass through the carpal tunnel. The synovial and fibrous flexor sheaths cover the inner and outer surface of each tendon in the palm, respectively. The tendon of the FPL inserts onto the anterior surface of the base of the distal phalanx of the thumb. The tendons of the FDP course through the fibrosseous flexor tendon sheath to insert onto the volar surface of the bases of the distal phalanges. The tendons of the FDS split into two slips at the level of the shaft of the proximal phalanges to pass over the FDP tendon and insert onto the radial and ulnar sides of the middle phalanges. Although the fibrosseous flexor tendon sheaths are thick over the phalanges, they are attenuated over the joints.

Synovial sheaths cover the outer surfaces of the tendons to allow maximal glide and minimal friction. The synovial sheath of the FPL extends from the carpal tunnel to the distal phalanx. The common flexor synovial sheath (ulnar bursa) extends from the carpal tunnel to the palm of the hand. The digital synovial sheath to the small finger is contiguous with the ulnar bursa. The index, ring, and long fingers have separate digital synovial sheaths that extend from the metacarpophalangeal (MCP) joint to the insertion of the FDP tendons on the distal phalanges.

Extensors

The extensor tendons pass from the forearm, beneath the extensor retinaculum, and into the dorsum of the hand. The extensor retinaculum divides the extensor tendons into six compartments numbered from radial to ulnar.

1st compartment: abductor pollicis longus and extensor pollicis brevis
2nd compartment: extensor carpi radialis longus and brevis
3rd compartment: extensor pollicis longus
4th compartment: extensor digitorum and extensor indicis
5th compartment: extensor digiti minimi
6th compartment: extensor carpi ulnaris

Distal to the MCP joint, the extensor digitorum tendons broaden to form a highly specialized "extensor hood." This extensor expansion splits into three parts: a central slip that inserts on the base of the middle phalanx, and two lateral bands that converge to insert onto the base of the distal phalanx. The extensor indicis proprius and the extensor digiti minimi also join the extensor expansion of the index and small fingers, respectively.

The extensor carpi ulnaris (ECU) inserts onto the posterior side of the base of the fifth metacarpal to extend and ulnarly deviate the wrist. The abductor pollicis longus (APL) inserts onto the lateral side of the base of the first metacarpal bone to abduct the thumb. The extensor pollicis brevis (EPB) and longus (EPL) insert onto the dorsal base of the proximal phalanx and distal phalanx of the thumb, respectively, to extend the thumb. The extensor carpi radialis longus (ECRL) and brevis (ECRB) insert onto the base of the second and third metacarpal bones, respectively, to extend the wrist.

Intrinsic Muscles of the Hand

The four groups of intrinsic muscles are the lumbricals, interossei, thenar, and hypothenar. The palmarly based intrinsic muscles occupy the space between the metacarpals. The thenar and hypothenar compartments contain an abductor, an opponens, and a flexor muscle for the thumb and little finger, respectively.

The four lumbricals arise from adjacent sides of the tendons of the flexor digitorum superficialis and profundus to flex the MCP joints and extend the interphalangeal joints. Each lumbrical inserts onto the radial side of the base of the proximal phalanx of its corresponding finger. The lumbricals to the index and long fingers are innervated by the median nerve; the lumbricals to the ring and small fingers are innervated by the deep branch of the ulnar nerve.

There are four dorsal and three palmar interosseous muscles located in intervals between the metacarpal bones. All are innervated by the deep branch of the ulnar nerve. The first palmar interosseous muscle arises from the ulnar side of the base of the second metacarpal bone and inserts into the ulnar aspect of the index finger's proximal phalanx. The second and third originate from the radial aspect of the fourth and fifth metacarpals and insert onto the radial aspect of the proximal phalanges of the ring and small fingers, respectively. They adduct the fingers toward the hand's meridian. Additionally, they flex the MCP joints and extend the proximal interphalangeal (PIP) joints.

The dorsal interossei originate from the surface of adjacent metacarpals and insert onto the base of the proximal phalanges. The first and second insert onto the radial aspect of the index and long fingers, respectively. The third and fourth insert onto the ulnar aspect of the ring and small fingers, respectively. They act to abduct the fingers away from the meridian of the hand. Additionally, they flex the MCP joints and extend the PIP joints.

■ Arteries

The radial artery courses along the radial aspect of the volar forearm, passes dorsal to the tendon of the EPL, then passes palmarly between the two heads of the first dorsal interosseous muscle to form the deep palmar arch. The deep palmar arch joins with the deep palmar branch of the ulnar artery.

The ulnar artery descends on the radial border of the FCU muscle, passes over the flexor retinaculum on the ulnar side of the wrist, and enters the palm with the ulnar nerve via Guyon's canal. After giving off a deep palmar branch, it forms the superficial palmar arch, which is located between the palmar aponeurosis superficially and finger flexor tendons. Both the superficial and deep palmar arches connect under normal conditions so that the hand can survive off of blood supply by a single artery.

The patency of the palmar arches can be determined by Allen's test. Both arteries are occluded by manual pressure while the patient pumps the fist several times. Pressure is released from one artery, and capillary refill should be noted in the fingertips within 10 seconds. Failure to provide capillary refill in all fingers denotes vessel occlusion or incomplete arches.

■ Nerves

Radial Nerve

The radial nerve innervates the brachioradialis, anconeus, and ECRL proximal to the elbow, then divides into the sensory branch of the radial nerve and the posterior interosseous branch. The sensory branch of the radial nerve continues along the deep surface of the brachioradialis then surfaces just proximal to the radial styloid to pass to the dorsum of the hand to provide sensory feedback from the dorsum of the hand, thumb, index finger, long finger, and radial side of the ring finger to the level of the distal interphalangeal (DIP) joint.

The posterior interosseous nerve (PIN) pierces the fascia of the supinator muscle (the so-called "arcade of Frosche," which can cause nerve compression), then innervates the extensors of the wrist and hand. The last muscle to receive innervation from the PIN is the extensor indicis. Thus, it is useful to test the extensor indicis to differentiate partial and complete PIN injuries.

Median Nerve

The median nerve enters the forearm medial to the biceps tendon and lateral to the brachial artery. Near the elbow, it is next to the lacertus fibrosis and the pronator teres, both of which can cause nerve compression. As it courses distally, it assumes a position between the FDS and FDP, innervating all tendons of the FDS, the FPL, the pronator quadratus, and the index and long finger FDP. The palmar cutaneous branch of the median nerve exits just proximal to the carpal tunnel to provide sensory feedback from the base of the thenar eminence. The median nerve enters the hand via the carpal tunnel to supply the thenar muscles (abductor pollicis brevis, flexor pollicis brevis, opponens pollicis) and the radial two lumbrical muscles. Sensory fibers supply the palmar surface of the thumb, index finger, and long finger, and radial half of the ring finger (including their nail beds).

Ulnar Nerve

The ulnar nerve enters the forearm via the cubital tunnel, which is formed by the medial epicondyle and the medial wall of the olecranon. It passes deep to the two heads of the FCU, supplying motor innervation. It continues distally in the forearm deep and radial to the tendon of the FCU, giving off motor branches to the FDP to the ring and small fingers. Proximal to the wrist crease, the sensory branch of the ulnar nerve surfaces to provide sensory feedback from the small finger, ulnar half of the ring finger, and the ulnar border of the hand. The remainder of the ulnar nerve enters the hand via Guyon's canal to innervate the hypothenar muscles (abductor digiti minimi, flexor digiti minimi, opponens digiti minimi), all the interossei, and the ulnar two lumbricals.

Hand Injuries

History

A complete history of a hand injury should include hand dominance, time of injury, mechanism of injury, environment, overall medical condition, medications and allergies, tetanus status, any previous injury or hand surgery, occupation, and hobbies. Most hand injuries are work-related injuries in otherwise healthy individuals.

Physical Examination

Vascular Assessment

Vascular assessment begins by observing the color and temperature of the affected extremity. Skin turgor and capillary refill are assessed in each digit. Pulses are palpated; if nonpalpable, they are assessed with Doppler ultrasonography. Comparison with the contralateral upper extremity can be helpful. Allen's test determines patency of the palmar arches.

Sensory Assessment

The radial, median, and ulnar nerves are assessed by their distributions described above. A pinprick determines a patient's ability to distinguish sharp from dull. Light touch can be measured with a cotton tip applicator. Two-point discrimination may be tested with a paperclip (normal two-point discrimination is 2–3 mm at the fingertip).

Motor Assessment

Inferences about motor function often can be made prior to initiating the physical examination. Normally there is a gentle cascade of digits with increasing flexion going from index to small finger. Disrupted flexor tendons leave a digit's extensor mechanism unopposed, and thus the finger lies in a position of relative extension. Similarly, when extensor tendons are cut, the resting posture is a position of flexion. Thus, tendon injuries interrupt the hand's normal cascade of digits.

Motor function is assessed by isolating various joints and testing the muscles that move them. For instance, the FDP is tested by isolating the DIP joint in extension and asking the patient to flex it. The FDS is tested by stabilizing all fingers in extension and asking a patient to flex at the PIP joint. The muscles of the thenar and hypothenar compartments are tested by opposing the thumb and small fingertips (this is a good test of median nerve function as well). Ulnar nerve function is tested by asking the patient to extend the fingers and spread them apart, a test of interosseous muscle function. The radial nerve is tested by asking a patient to extend the digits with the wrist in extension. EIP and EDM can be tested separately from the extensor digitorum by asking the patient to extend the index and small fingers in isolation. The ECRL and ECRB are intact if the patient can hold the wrist in extension while the examiner applies a flexion force.

Diagnostic Imaging

Fracture is suspected if hematoma, deformity, decreased range of motion, or persistent local tenderness follows any injury. Plain radiographs, at least two views at 90 degree angles, provide a baseline assessment and are usually all that is needed to adequately diagnose and treat a fracture. CT scans, in general, are more sensitive for fractures and dislocations. MRI has become the procedure of choice for soft tissue injuries, including ligamentous and musculotendinous disruptions. Ultrasonography can be helpful in localizing fluid collections or imaging vessels. Fluoroscopy in the form of a C-arm is used extensively in the operating room to assess adequacy of reduction and fixation of a fracture.

■ **Treatment** (Box 8-1)

Fractures and Dislocations

The goal in management of fractures and dislocations is to restore bony alignment to regain the maximum amount of motion and strength possible when the patient has finally healed. How that is achieved—whether with splint or cast immobilization, percutaneous K-wire fixation, or plate and screw fixation—has significant impact on long-term hand function. The hand surgeon must keep the soft tissues in mind, especially those tendons expected to glide over bones, when choosing the method of fixation. Length of immobility may also have a profound effect, because

BOX 8-1 Acute Management Tips

- Irrigate all wounds copiously; débride devitalized tissue conservatively.
- Control bleeding with pressure and extremity elevation. Never blindly clamp bleeding vessels. A tourniquet or inflated BP cuff may be used to control bleeding for examination and treatment.
- Administer tetanus prophylaxis and antibiotics as needed.
- Complete the sensory examination before administering local anesthesia.
- Splint all hand injuries in intrinsic position as soon as possible. Splinting will help to control pain and stabilize injuries while diagnostic imaging is performed.
- Extensor tendon injuries may be treated in the emergency room.
- All flexor tendon injuries, open fractures, nerve injuries, and vascular injuries causing hemorrhage not controllable by direct pressure are best managed in the operating room.

stiffness and adhesions that develop as a result of immobility may limit long-term function. Healed fractures and dislocations require aggressive physical therapy regimens to improve strength and range of motion.

Tendon Injuries

FLEXOR TENDON INJURIES

Flexor tendon injuries are repaired with four sutures (e.g., 4-0 braided nonabsorbable) through the core for strength, and a fine epitendinous suture (e.g., 5-0 monofilament, nonabsorbable) for alignment. Injuries are classified into five zones (Figure 8-1) for purposes of physician communication and comparison of outcomes. Zone I is at the DIP level, where the FDP inserts into the base of the distal phalanx. Most flexor tendon injuries at this level require reinserting the tendon onto bone. Zone II is from the MCP joint to the DIP joint of the fingers, the region of the fibrosseous flexor tendon sheath. Zone II used to be called "no man's land" because of poor outcomes, largely due to formation of adhesions between the tendons and the tendon sheath. Additionally, portions of the flexor tendon sheath, termed pulleys, which keep the flexor tendons from bowstringing, must be cut to provide access to tendons and repaired in order to avoid bowstringing. Zone II injuries remain challenging, but better outcomes are achieved with a sturdy repair and early, aggressive hand physical therapy.

Zone III extends from the distal aspect of the carpal tunnel to the MCP joint, an area that is relatively easy to access. Injuries in zone IV, the carpal tunnel, are rare because the transverse carpal ligament protects the tendons. Zone V includes the area proximal to the transverse carpal ligament. In the distal portion of zone V the tendons are discrete structures, but in the proximal portion of

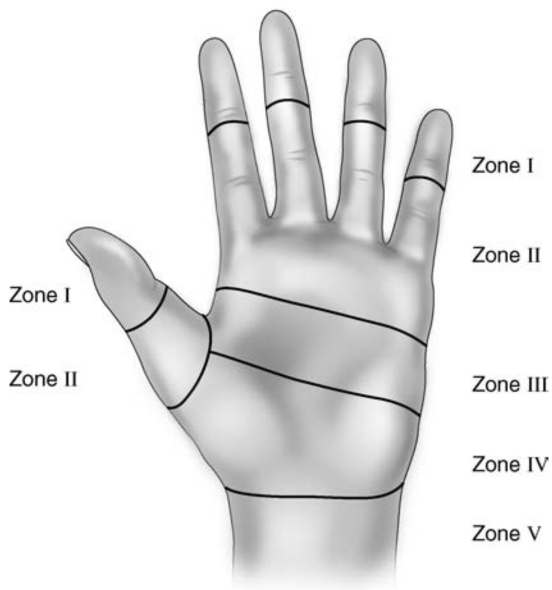

Figure 8-1 • Flexor tendon zones.

zone V there is the musculotendinous junction, which is a very poor site for repair because the tendons become thinner and fan out to join the muscle belly. Early, aggressive hand therapy is critical in maximizing long-term function.

EXTENSOR TENDON INJURIES

Extensor tendon injuries are repaired in a variety of ways based on the location of the injury. Proximally, where their shape mimics that of flexor tendons, repair is with four strong core sutures and a fine epitendinous suture. Distally, where they are flat bands, their ends are approximated with a single layer of interrupted stitches (e.g., 4-0 braided nonabsorbable). Extensor tendon injuries are classified into eight zones (Figure 8-2). Zone I is the area over the DIP joint and distal phalanx. Disruption of the tendon in zone I will cause **mallet finger**, where the DIP is slightly flexed at rest. Zone I injuries may be splinted if minimal; the tendon is reinserted into bone if there is complete transsection.

Zone II is the region over the middle phalanx of the digits and proximal phalanx of the thumb. Here the lateral bands of the extensor hood are frequently lacerated as they course toward their insertion. Primary repair with interrupted sutures is indicated if over 50% of the tendon is cut.

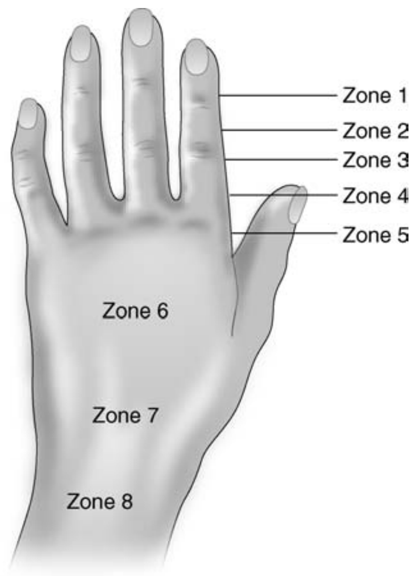

Figure 8-2 • Extensor tendon zones.

Zone III is over the PIP joint of the digits, where the central slip of the extensor hood inserts on the base of the middle phalanx and the MCP joint of the thumb where the extensor pollicis brevis inserts on the base of the proximal phalanx. Zone III injuries are treated by reinsertion of the central slip/EPB into the base of the corresponding phalanx, and centralization and repair of the lateral bands. Injuries in zone III can lead to a **boutonniere deformity** (PIP joint flexion and DIP extension) if the lateral bands slip volarly.

Zones IV and V correspond to the proximal phalanx and MCP joint, respectively. Repair is best performed with horizontal mattress sutures in a single layer. Injuries in Zones VI and VII on the dorsal hand are repaired with a four core and epitendinous repair. Zone VIII injuries in the distal forearm are treated similarly. Like flexor tendon repairs, all extensor tendon repairs require early, aggressive hand therapy to achieve maximal functional results.

Nerve Injury

Disrupted nerves are repaired primarily with fine (8-0), nonabsorbable suture. If tension-free coaptation cannot be achieved, a nerve graft (see Chapter 3) is used. When proper alignment of nerve fascicles is readily apparent, or if only a part of a nerve is lacerated, an epineural (outer covering of a nerve) repair may be used. When a nerve injury includes a crushing component or when there is a delayed repair, grouped fascicular repair is preferred. It is important to align motor and sensory fascicles by visual inspection when repairing large motor and sensory nerves such as the median and ulnar nerves. Epineural repair of severed digital sensory nerves is standard.

Amputation and Replantation

Initial management of an amputated part involves cleaning it, wrapping it in saline-moistened gauze, placing it in a plastic bag, and placing the plastic bag in ice water. Both the patient and the amputated part should undergo a standard physical and radiographic examination.

Children have an amazing capacity to heal, and virtually all amputated parts should be reattached regardless of circumstances. Considerations for replantation in adults include level of injury, location of injury, mechanism of injury, patient age, hand dominance, occupation, and suitability for rehabilitation. Relative contraindications include single digit amputations except for thumb, avulsion injuries with a large burden of devitalized tissue, previous injury to the amputated part, extreme contamination, warm ischemia time of over 6 hours, and advanced age. Most replanted parts make it out of the hospital alive, but long-term functional results depend largely on regaining sensation in the part, which takes months to assess. Range of motion in replanted joints is usually about half of normal, and most manual laborers require permanent job changes due to loss of dexterity. Best results are obtained with replantation of digits distal to the insertion of the FDS and hands at the wrist.

When replantation is not a consideration, treating an amputation involves débridement of devitalized tissue, shaping the remaining bone, burying any nervous tissue to avoid neuroma formation, obtaining hemostasis, and shaping soft tissue flaps to create a new fingertip. Patients usually recover rapidly from the surgery, and are back to work much more quickly than the replantation patients.

NERVE COMPRESSION SYNDROMES

Carpal Tunnel Syndrome

The carpal tunnel release is one of the most frequently performed operations in the United States. Carpal tunnel syndrome

(CTS) usually presents in the fifth and sixth decades of life, and the majority of patients are women. Just over half of patients with CTS present with bilateral symptoms.

The majority of cases are idiopathic, and are thought to be associated with overuse of the forearm and hand flexors. Patients with diabetes, thyroid disorders, amyloidosis, inflammatory arthritis, and alcoholism have higher rates of CTS. Masses or tumors in the region of the carpal tunnel may produce symptoms.

Clinical Manifestations

Typical symptoms are pain, paresthesia, hypesthesia, or numbness in the thumb, index finger, long finger, and radial aspect of the ring finger. Patients frequently complain of pain and numbness that awakens them from sleep in the middle of the night. Activities that require prolonged wrist flexion or gripping (driving a car, typing) may aggravate symptoms. Resting or splinting the forearm usually causes symptoms to subside.

On examination, the patient has numbness in the median nerve distribution of the hand. A positive **Tinel's sign**, which is a painful sensation of the fingers induced by percussion of the median nerve at the level of the palmar wrist, indicates regenerating median nerve fibers, a sign associated with CTS. **Phalen's test**, in which both wrists in a flexed position reproduces symptoms of CTS, is also sensitive for CTS.

Diagnostic Tests

The gold standard for diagnosing CTS is electromyography (EMG) and nerve conduction velocity (NCV). On EMG, patients have decreased fibrillation potentials in the abductor pollicis brevis. NCV in the median nerve is decreased.

Treatment

Patients with mild CTS who have no thenar atrophy can be treated with conservative therapy, which includes a resting splint with the wrist in neutral position and NSAIDs. Steroid injections of the carpal tunnel may be effective. If EMG shows impaired conduction of the median nerve at the wrist, if symptoms do not improve with 6 weeks of conservative treatment, or if there is evidence of thenar muscle wasting, a carpal tunnel release is indicated. Carpal tunnel release consists of dividing the flexor retinaculum, a procedure that may be performed via open technique or endoscopically. Patients are usually splinted for a short period after surgery, and a brief period of postoperative hand physical therapy is the norm.

Cubital Tunnel Syndrome

Cubital tunnel syndrome, or compression of the ulnar nerve at the elbow, occurs in approximately 10% of adults, a small percentage of whom actively pursue treatment. Those with a history of trauma to the medial aspect of the elbow are at risk for developing cubital tunnel syndrome.

Clinical Manifestations

Numbness in the ulnar hand is the chief complaint. Some patients notice an increased frequency of dropping objects from within their grip as well. A positive **Tinel's sign** is present over the ulnar nerve at the elbow. Patients also have a positive **Froment's sign**, a hyperflexed thumb interphalangeal joint when the thumb is pinching against the side of the base of the index finger (normally the interphalangeal joint is extended to provide maximal pinch). This is a sign of ulnar nerve palsy, because a lack of pinch power by the adductor pollicis (innervated by the ulnar nerve) is compensated for by the FPL.

Diagnostic Tests

As with CTS, EMG and NCV are the gold standard for diagnosing cubital tunnel syndrome.

Treatment

Mild cases are treated with nocturnal splinting to prevent extreme elbow flexion. Symptomatic patients with positive EMG/NCV require ulnar nerve decompression. Ulnar nerve decompression is accomplished by releasing the ligament of the cubital tunnel, medial epicondylectomy, subcutaneous ulnar nerve transposition, or submuscular ulnar nerve transposition. Postoperatively, patients are splinted for a week and undergo a short course of physical therapy thereafter.

HAND INFECTIONS

The most common cause of hand infections is trauma. Other predisposing conditions include diabetes and other neuropathic conditions. Ninety percent of infections are caused by gram-positive organisms: *Staphylococcus aureus*, *Streptococcus viridans*, group A *Streptococcus*, and *Staphylococcus epidermidis*. All hand infections require elevation and splinting of the affected extremity in addition to other therapies described below.

Infected Paronychia

An infected paronychia is an abscess of the soft tissue around the base of the fingernail. Patients typically present with pain, redness, and swelling at the base of the fingernail, which can be localized to one side of the nail, or diffuse, involving the entire paronychia. Treatment consists of incision and drainage of all pus, partial or complete nail removal, and twice daily cleansing of the affected digit until the wound is healed. Cultures usually grow *S. aureus*, for which an oral cephalosporin may be given.

Chronic paronychial infection may occur in individuals who immerse their hands in water throughout the day, like dishwashers. Cultures typically grow *Candida albicans*, and incision, drainage, and an oral antifungal are usually effective in treating the condition. Recurrent cases may require marsupialization (creation of an open pouch) of the paronychia.

Felon

A felon is an abscess of the volar pulp of the finger. Patients usually have a history of a puncture wound 5 to 7 days prior to the onset of symptoms. Extreme pain, redness, and swelling ensue. Treatment consists of draining the abscess, local wound care, and an oral cephalosporin. Cultures typically grow *S. aureus*. Severe felons cause necrosis of bone and soft tissues of the distal phalanx, requiring amputation and intravenous antibiotics.

Flexor Tenosynovitis

This painful infection of the tendon sheath and its contents presents with fusiform swelling of the finger, tenderness over the flexor tendon sheath, and pain on passive extension. The finger is usually held in slight flexion. Drainage of the infected synovial fluid (which can be purulent) is a surgical emergency. Delay in treatment may lead to loss of tendon function.

Bites

Human bites infect the hand most commonly with *S. aureus*, but also with *Eikenella corrodens* in a high percentage of clenched fist "fight bites." Resultant cellulitis may occur at any area of inoculation, but the classic fight bite occurs over the dorsal aspect of the MCP joint. Patients often present with a small laceration over the MCP (which has already closed by secondary intention), spreading redness around the laceration, and extreme pain with joint movement. Treatment of these penetrating injuries includes joint exploration, débridement, and irrigation. Multiple trips to the operating room for reexploration may be required to adequately treat the infection. Broad-spectrum intravenous antibiotics are administered as well.

Domestic animal bites and scratches commonly cause cellulitis, which can be treated with an oral penicillin on an outpatient basis. Deep puncture wounds demand attention similar to those of human bites, especially when they occur over a joint.

HAND TUMORS

Hand tumors vary from benign growths to malignant soft tissue tumors. Diagnosis is usually made from the history and physical examination, although radiographs and even tissue biopsy may be required.

The vast majority of tumors on the hand are benign. The most common are ganglion cysts, mucous cysts, giant cell tumor of the tendon sheath, epidermal inclusion cysts, and lipomas. The majority of these tumors can be left alone or treated by excision.

Vascular malformations can also occur in the hand. Lesions that are stable and asymptomatic are observed; those that progressively enlarge should be removed. Excision must be carefully planned around critical structures. Often a debulking procedure is enough to control the symptoms of the tumor.

Malignant bone tumors are commonly worked up with a CT scan and biopsy prior to definitive treatment. Malignant soft tissue tumors are best imaged with MRI. Resection is a common treatment modality, leaving patients with large functional and cosmetic deficits.

CONGENITAL ANOMALIES

The degree of deformity varies from minor, such as a digital disproportion, to severe, such as total absence of a bone. The Swanson classification of congenital hand anomalies groups deformities into broad categories:

1. **Failure of formation of parts.** This arrest in development causes complete absence of a part of the hand or upper extremity. Surgery is usually not performed, and these children are introduced to prosthetic devices early in childhood. Radial club hand, a deformity that involves all of the tissues on the radial side of the forearm and hand, is an example of failure of formation of parts.

2. **Failure of separation of parts.** With this type of deformity, parts of the hand and upper extremity fail to separate, a good example of which is syndactyly, or fusion of digits. Syndactyly is the most common congenital hand deformity, occurring in 7 of every 10,000 live births. It usually involves both hands, and males are more often affected than females. Complex syndactyly involves both bony and soft tissue fusion. Simple syndactyly implies only soft tissue involvement.
3. **Duplications of parts.** Duplication of digits is also known as polydactyly. The small finger is most commonly affected.
4. **Overgrowth of parts.** Overgrowth of parts is extremely rare. It is more commonly seen in males, and usually affects the index finger. Surgical treatment is complex, and the outcomes often poor. Amputation of the enlarged digit may be best.
5. **Undergrowth of digits.** Underdeveloped fingers or thumbs are associated with many congenital hand deformities. Surgical treatment is not always required to correct these deformities. Underdeveloped fingers may include the following: small digits, missing muscles, underdeveloped or missing bones, or absence of a digit.
6. **Congenital constriction band syndrome.** Thickened amniotic bands may wrap around an extremity *in utero* and cause ischemia or necrosis. Bands that form around an arm or a digit may cause hypoplasia distal to the constriction. If bands cause necrosis, children may be born without an extremity or digit.