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CHAPTER 10.1

Hand Surgery

Vincent R. Hentz, MD
Kimberley Wirsing, MD
Lindsey Vokach-Brodsky, MB, ChB, FFARCS
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Darrach Procedure

Surgical Considerations

Description: The **Darrach procedure** ([Fig. 10.1-1](#)) is a resection of the distal ulna. The distal 2 cm of the ulna is resected subperiosteally, and local soft tissues are used to stabilize and cover the remaining ulna. It is commonly performed in patients who have had a disruption of the distal radioulnar joint with subluxation of the ulna. It also is indicated for patients who have had a malunion of a distal radius fracture such that the radius has shortened relative to the ulna or is abnormally angulated, resulting in dorsal subluxation of the ulna and impingement of the ulnar head upon the carpus. This causes painful motion of the wrist and forearm and posttraumatic degenerative arthritis of the ulnar head, carpus, and sigmoid notch of the distal radius. Disorders of the distal radioulnar joint and degeneration of the ulnar head, which may lead to attrition rupture of the overlying extensor tendons, are common in rheumatoid arthritis. This dorsal prominence of the ulnar head is treated by **Darrach resection**, combined with a soft-tissue procedure to stabilize the remaining ulna. Osteoarthritic degeneration of the distal radioulnar joint, either 2° trauma (see above) or due to idiopathic osteoarthritis, responds well to this procedure.

Variant procedure or approaches: The Soavé-Kapandji procedure retains the articular portion of the distal ulna and fuses it to the sigmoid notch. The area of distal ulna that is resected is proximal to the joint; instability of the proximal stump may become problematic. Hemiresection with tendon interposition as well as distal ulnar arthroplasty are less common techniques for managing distal radio-ulnar arthritis.

Usual preop diagnosis: Arthritis or derangement of the distal radioulnar joint; rheumatoid arthritis; ulnar impingement syndrome; malunion of Colles' fracture or other fracture of the distal radius

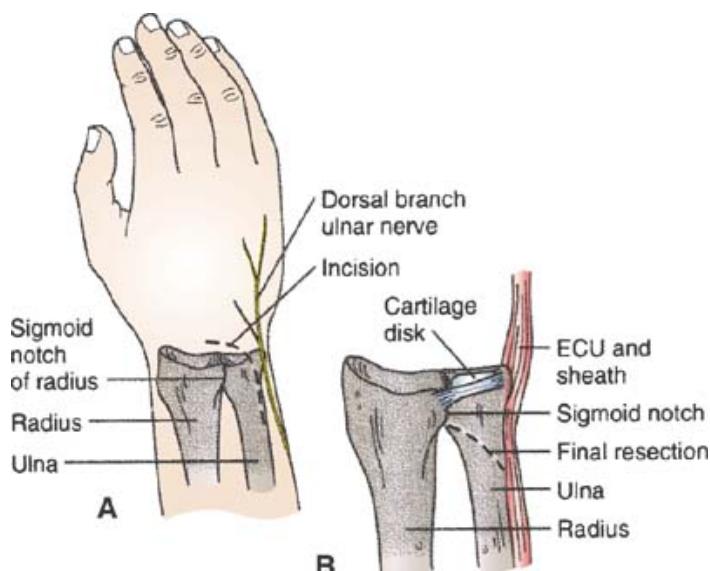


Figure 10.1-1. 1. The Darrach procedure. **A:** Skin incision. Avoid dorsal cutaneous branch of the ulnar nerve. **B:** The distal ulna is resected at the radioulnar articulation just proximal to the sigmoid notch. (ECU = extensor carpi ulnaris) (Reproduced with permission from Chapman MW: *Chapman's Orthopaedic Surgery*, 3rd edition. Lippincott Williams & Wilkins: 2001.)



Summary of Procedures

Position	Supine, with arm extended on hand-surgery table
Incision	Dorsal-ulnar, over distal ulna
Special instrumentation	Pneumatic tourniquet
Antibiotics	Cefazolin 1 g iv
Surgical time	1–2.5 h, depending on associated procedures
Tourniquet	150 mmHg above systolic; max time = 120 min
Closing considerations	Routine skin closure; postop splint placed at conclusion of procedure.
EBL	Minimal; performed under tourniquet control.
Postop care	PACU → home.
Mortality	None associated with procedure
Morbidity	Ulnar nerve injury: Rare
Pain score	Postop swelling (rarely requires specific treatment) 5–7

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Patient Population Characteristics

Age range	Adult population
Male:Female	Slight predominance of females, due to incidence of malunion of Colles' fractures in women with senile osteoporosis as well as incidence of inflammatory arthropathies in women
Incidence	Not uncommon
Etiology	See Usual preop diagnosis, above.
Associated conditions	Rheumatoid arthritis

Anesthetic Considerations

See [Anesthetic Considerations for Wrist Procedures, p. 914](#).

Suggested Reading

1. Nolan WB, Eaton RG: Darrach procedure for distal ulnar pathology derangements. *Clin Orthop* 1992;275:85–9.

Dorsal Stabilization and Extensor Synovectomy of the Rheumatoid Wrist

Surgical Considerations

Description: This procedure is indicated for patients with rheumatoid arthritis and extensor tenosynovitis refractory to medical treatment, as well as extensor tendon ruptures and/or intercarpal synovitis. The procedure is performed under tourniquet control through a straight dorsal incision over the wrist. A **radical tenosynovectomy** of the extensor tendons in all six extensor compartments is carried out. Tendon ruptures or impending ruptures are repaired with tendon grafts or side-to-side anastomoses. Bone spurs are removed and a synovectomy of the distal radioulnar joint is carried out. A **modified Darrach procedure**, with resection or osteoplasty of the distal ulna, is usually performed. If there is evidence of synovitis within the wrist joint, a synovectomy is performed through a dorsal arthrotomy. A flap of the extensor retinaculum is transposed beneath the extensor tendons to reinforce the dorsal wrist ligaments and, thus, stabilize the wrist to prevent volar subluxation of the carpus. A posterior



interosseous neurectomy is carried out at the same time. The remaining extensor retinaculum is divided into two transverse strips (*Print pagebreak 908*) and one is used to stabilize the distal ulna. The second strip is placed dorsal to the extensor tendons so they will not bowstring during wrist extension.

Usual preop diagnosis: Rheumatoid arthritis with extensor tendon tenosynovitis; extensor tendon rupture; distal radioulnar joint synovitis and/or subluxation

Summary of Procedures

Position	Supine, with arm extended on hand-surgery table
Incision	Dorsal wrist (Fig. 10.1-2)
Special instrumentation	Pneumatic tourniquet
Antibiotics	Cefazolin 1 g iv
Surgical time	2 h
Tourniquet	150 mmHg above systolic; max time = 120 min
Closing considerations	Postop splint
EBL	Minimal; tourniquet used until dressing in place.
Postop care	PACU → home.
Mortality	None associated with procedure
Morbidity	Extremity swelling (typically does not require treatment) Delayed healing 2° immunosuppression and steroid use Wound infection: Rare (unless patient is immunosuppressed)
Pain score	3–5

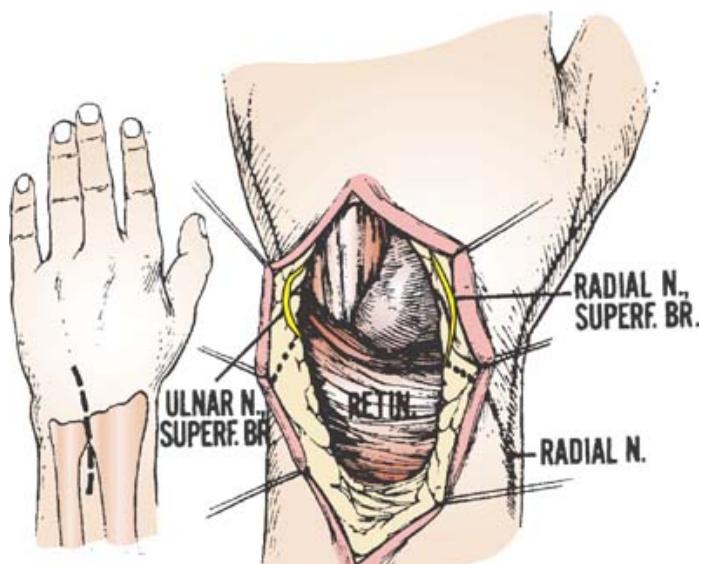


Figure 10.1-2. Incision and exposure for dorsal tenosynovectomy. Note superficial branches of radial and ulnar nerves protected in skin flaps. (Illustration by Elizabeth Roselius, 1988. Reproduced with permission from Green DP, RN Hotchkiss and WC Pederson, eds.: *Operative Hand Surgery*, 2nd edition. Churchill Livingstone: 1988.)

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Patient Population Characteristics

Age range	Procedure uncommon before 4th decade
Male:Female	As in all patients with rheumatoid arthritis, females more common.
Incidence	Not uncommon

Etiology

Connective tissue disorder; rheumatoid arthritis or variant
All conditions associated with connective tissue disorders, including active rheumatoid arthritis, steroid dependency, immunosuppressive therapy, and/or skin fragility

Associated conditions

Anesthetic Considerations

See [Anesthetic Considerations for Wrist Procedures, p. 914.](#)

Suggested Reading

1. Millender LH, Terrono AL: Synovectomy and tendon reconstruction. In *The Wrist*. Gelberman RH, ed. Raven Press, New York: 1994, 221–37.

Metacarpophalangeal and Interphalangeal joint Arthroplasty and Arthrodesis

Surgical Considerations

Description: Joint replacement in the hand is most commonly indicated in patients with rheumatoid arthritis with severe joint destruction → pain and dysfunction. Another option in these patients is arthrodesis or joint fusion, which involves removing the degenerative cartilaginous surfaces and using implanted metal to secure two opposing bone surfaces. Joint arthroplasty is rarely indicated in patients with osteoarthritis. The most common prostheses, made of silicone rubber and popularized by Swanson, differ from total joint replacement in the hip or knee in that they do not function as true joints, but rather as spacers in a **resection arthroplasty**. Most of the stability and motion of these joints depend on meticulous soft-tissue reconstructions involving tendon and ligament transfers, as well as intensive postop physical therapy. To obtain good results, patients must be well motivated and understand their disease process and what will be asked of them during the recovery period. The results for **metacarpophalangeal (MP) arthroplasty** are far better than those obtained in the proximal interphalangeal joints. **Proximal interphalangeal joint arthroplasty** is sometimes complicated by soft tissue deformities in rheumatoid arthritis such as swan-neck and boutonniere deformities. A swan-neck deformity consists of hyperextension of the PIP joint and flexion of the DIP joint. Conversely, a boutonniere deformity involves flexion at the PIP joint and hyperextension of the DIP joint. It is generally not indicated for the index finger due to the high stresses associated with pinch that may compromise the longevity or stability of an arthroplasty. **Distal interphalangeal (DIP) arthroplasty** is rarely performed, because these patients do well with fusions. The procedure for the MP joints is performed through a dorsal transverse incision under tourniquet control. The metacarpal heads are removed with an oscillating saw and the intramedullary canals reamed to accept the stems of the prostheses. After they have been placed with a no-touch technique, the capsule is closed and the supporting ligaments are reconstructed with centralization of extensor tendons. Technique for PIP joints is similar, although some surgeons will use a volar approach. A splint with support for each finger is placed at the conclusion of surgery. Reconstructive procedures of the wrist and fingers can be combined with arthroplasty.

Variant procedure or approaches: Some surgeons favor longitudinal incisions rather than a transverse incision for the approach to the MP joints. A volar approach to the PIP joint may be used.

Usual preop diagnosis: Rheumatoid arthritis or other connective-tissue disorder

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Summary of Procedures

Position

Supine, with arm extended on hand-surgery table

Incision

Dorsal hand, transverse, or longitudinal

Special instrumentation

MP or PIP joint prostheses and associated instruments for preparing the medullary canal; power for bone cuts; K-wires, plates, or wire loop for fusion; pneumatic tourniquet

Antibiotics

Cefazolin 1 g iv

Surgical time	2.5 h
Tourniquet	150 mm above systolic; max time = 120 min
Closing considerations	Critical postop splinting
EBL	Minimal; tourniquet used throughout procedure.
Postop care	PACU → home.
Mortality	None associated with procedure
Morbidity	Swelling (may require early splitting of dressing) Wound infection: Rare (if it occurs, requires removal of prosthesis) Prosthesis infection: Rare
Pain score	3–6

Patient Population Characteristics

Age range	>50 yr
Male:Female	As in rheumatoid arthritis, females predominate.
Incidence	Uncommon
Etiology	Rheumatoid arthritis or other connective-tissue disorder
Associated conditions	As in rheumatoid arthritis (e.g., skin fragility, steroid dependency, immunosuppression)

Anesthetic Considerations

See [Anesthetic Considerations for Wrist Procedures, p. 914](#).

Arthrodesis of the Wrist

Surgical Considerations

Description: A variety of arthrodeses can be performed about the wrist. These include **radiopancarpal arthrodesis (total wrist fusion)**, and radiolunate, radioscapolunate, and intercarpal arthrodeses (partial wrist fusions). Radiopancarpal arthrodesis is generally performed as a salvage procedure for wrist pathology that cannot be treated with a procedure that preserves wrist motion. These indications include: posttraumatic degenerative arthritis following fractures, dislocations and ligamentous injuries, idiopathic osteoarthritis, and/or rheumatoid arthritis. Predictable patterns of arthritis occur as a result of both scapholunate interosseous ligament injury (scapholunate advanced collapse) and scaphoid nonunion (scaphoid nonunion advanced collapse). As arthritic changes progress patients are no longer candidates for either reconstruction of the ligaments or fixation of the scaphoid. Another alternative to fusion is a proximal (*Print pagebreak 911*) row carpectomy, which is a motion preserving procedure that may be used in patients without advanced capitolunate arthritis. In the nonrheumatoid patient, an effective procedure is an arthrodesis using an iliac crest bone graft fixed with plate and screws. More recent techniques with improved plate designs may not require iliac crest bone graft. As another option, local bone from the distal radius may be utilized. It has been shown that a position of fusion in 10–15° of dorsiflexion provides the greatest grip strength. In the rheumatoid patient, a technique using intramedullary fixation with a large-diameter Steinmann pin is preferred. Rheumatoid bone is osteoporotic, 2° disuse and chronic steroid administration and screw fixation is not ideal in this soft bone. Bone graft is obtained locally in these patients, usually from the resected ulnar head. **Radiolunate fusion** also is indicated in rheumatoid patients who have progressive ulnar translation of the carpus. The lunate acts to block this translation of the carpus. **Radioscapholunate fusion** is indicated in patients with radiocarpal arthritis. This procedure preserves about 50% of wrist motion that occurs at the midcarpal joint. Bone graft is necessary and is easily obtained from the distal radius through the same incision. There are a variety of **intercarpal arthrodeses**, including **triscaphe** (scaphotrapezial trapezoid), **scaphocapitate**, **lunotriquetral** and **four-corner** (capitate-hamate-triquetal-lunate). These procedures are indicated for the treatment of intercarpal arthritis, carpal instabilities due to intercarpal ligament tears and Kienböck's disease (aseptic necrosis of the lunate). The **Cloward cervical spine instrumentation** is useful for obtaining a bicortical plug of bone from the iliac crest with minimal dissection. Local bone graft from the distal radius may be obtained using curettes or larger core needles.

Usual preop diagnosis: Posttraumatic arthritis; osteoarthritis or rheumatoid arthritis; Kienböck's disease; carpal instability

Summary of Procedures

Position	Supine, with arm extended on hand-surgery table. The iliac crest may be prepped and elevated with a sandbag beneath the ipsilateral buttock.
Incision	Dorsal wrist, transverse or longitudinal
Special instrumentation	Pneumatic tourniquet; possibly power for preparation of opposing bone surfaces; K-wires, screws or special instrumentation for fusion
Unique considerations	Bone-graft donor site
Antibiotics	Cefazolin 1 g iv
Surgical time	2 h
Tourniquet	150 mmHg above systolic; max time = 120 min
Closing considerations	Immobilization with splints
EBL	Minimal; procedure is performed under tourniquet control. If iliac crest bone graft is used, there may be increased blood loss.
Postop care	PACU → home, sometimes admission for pain control and elevation
Mortality	None associated with procedure
Morbidity	Nonunion of fusion: ≥ 20%
Pain score	5–7, if no iliac graft; 6–9, if iliac graft used

Patient Population Characteristics

Age range	> 40 yr
Male:Female	Females predominate in rheumatoid arthritis; males in posttraumatic arthritis.
Incidence	Common
Etiology	Trauma (common); rheumatoid arthritis (common)
Associated conditions	Typical for rheumatoid arthritis (e.g., skin fragility, steroid dependency, immunosuppression)

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Anesthetic Considerations

See [Anesthetic Considerations for Wrist Procedures, p. 914.](#)

Suggested Reading

1. Green DP, Pedereson WC, Hotchkiss RN, et al. eds: *Green's Operative Hand Surgery*, 5th edition. Churchill Livingstone, New York: 2005.

Total Wrist Replacement

Surgical Considerations



Description: The major indication for this procedure is rheumatoid arthritis of the wrist. **Total wrist replacement (TWR)** is often recommended in patients with bilateral wrist disease. An arthrodesis will be carried out on the nondominant helping hand and a TWR on the dominant hand to preserve dexterity. Many surgeons prefer to avoid **bilateral wrist arthrodesis**, although some patients with bilateral fusions have been able to function relatively well. Currently available prostheses are suitable only for low-demand patients, and are not indicated for high-demand patients with posttraumatic arthritis especially younger patients. These patients will do better with wrist arthrodesis. Silastic wrist prostheses are associated with a high failure rate and silicone synovitis, and their use has been abandoned by many surgeons. The most commonly used prostheses today are metal on ultra-high-molecular-weight polyethylene articulations that are fixed with methylmethacrylate cement or bone ingrowth into porous stems. The distal radius articular surface is resected to accept the implant, the proximal carpal row is resected and the distal carpus is prepared to accept the distal implant. All of these prostheses depend on intact, normally functioning wrist extensor tendons, especially the extensor carpi radialis brevis, for balance and function. Absence of this tendon is felt by many to be an absolute contraindication to this procedure. Because these tendons are so commonly affected by rheumatoid arthritis, the patient population for this procedure is limited. In addition to functioning tendons, meticulously accurate placement of the components in relation to the centers of rotation of the wrist is critical for success. If the centers of rotation of the prosthesis do not duplicate those of the normal wrist, early component loosening and failure is likely. Intraop radiographs are useful in verifying component position. These patients frequently have other upper extremity deformities that will require reconstruction. Because of the complexity of TWR, other reconstructive procedures are not carried out at the same time.

Usual preop diagnosis: Rheumatoid arthritis

Summary of Procedures

Position	Supine, with arm extended on hand-surgery table
Incision	Dorsal wrist
Special instrumentation	TWR instrumentation; power for bone cuts; pneumatic tourniquet
Antibiotics	Cefazolin 1 g iv
Surgical time	2 h
Tourniquet	150 mmHg above systolic; max time = 120 min
Closing considerations	Postop splint
EBL	Minimal; procedure performed under tourniquet control.
Postop care	PACU → home vs admission for pain control and elevation
Mortality	None associated with procedure
Morbidity	Infection: Rare (but requires removal of prosthesis and methylmethacrylate cement, if used) Poor wound healing
Pain score	4–8

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Patient Population Characteristics

Age range	Rare before 4th decade; most in 6th and 7th decades
Male:Female	Females outnumber males, as in rheumatoid arthritis.
Incidence	Rare
Etiology	Rheumatoid arthritis
Associated conditions	Rheumatoid arthritis

Anesthetic Considerations

See [Anesthetic Considerations for Wrist Procedures, p. 914](#).



Suggested Reading

1. Green DP, Hotchkiss, RN, Pederson, WC, et al, eds: *Operative Hand Surgery*, 5th edition. Churchill Livingstone, New York: 2005.

Thumb Carpometacarpal Joint Fusion/Arthroplasty/Stabilization

Surgical Considerations

Description: Patients with degenerative arthritis of the carpometacarpal (CMC) joint of the thumb present with subluxation, pain, and synovitis of the joint. A **synovectomy and ligament reconstruction** to restore stability will treat pain and may delay further degeneration. This procedure is performed through a curvilinear incision over the joint. A distally attached graft of the radial 1/2 of the flexor carpi radialis tendon is passed through a drill hole in the base of the metacarpal and woven into the joint capsule. In the later stages of degeneration, patients must be treated with either an arthroplasty or an arthrodesis. For more progressive arthritis a variety of **arthroplasty techniques** are available to the surgeon; most involve removal of degenerated articular surfaces, soft tissue interposition and often K-wire fixation to suspend the metacarpal is used. Cemented arthroplasty techniques were initially associated with a high loosening rate and fell out of favor. Newer designs and techniques do not have long-term follow-up yet. The status of the MCP joint of the thumb must be considered prior to CMC intervention. Hyperextension at the MCP joint will increase forces across any CMC procedure.

Variant procedure or approaches: Some surgeons choose to address CMC arthritis arthroscopically with joint debridement and sometimes material interposition.

Usual preop diagnosis: Osteoarthritis of CMC joint; basal joint arthritis; synovitis of CMC joint; CMC joint dislocation; trauma

Summary of Procedures

Position	Supine, with arm extended on hand-surgery table
Incision	Curvilinear over joint at base of thumb. If soft tissue interposition is used, additional incisions may be required.
Special instrumentation	Pneumatic tourniquet; power if K-wire suspension is to be used
Antibiotics	Cefazolin 1 g iv
Surgical time	1.5–2 h
Tourniquet	150 mmHg above systolic; max time = 120 min
EBL	Minimal; procedures performed under tourniquet control.
Postop care	PACU → home
Mortality	None associated with procedure
Morbidity	Nonunion of arthrodesis: ≥ 20% Particulate synovitis (silicone rubber prostheses)
Pain score	8–9

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Patient Population Characteristics

Age range	Joint stabilization in 3rd–5th decades; arthroplasty and arthrodesis in 5th-8th decades
Male:Female	Basal joint instability and arthritis much more prevalent in women
Incidence	Common

Etiology

Trauma may play a role in producing instability. Intraarticular fracture of the base of the first metacarpal with a nonanatomic reduction → incongruence of the joint → post-traumatic arthritis. Rheumatoid arthritis → instability and degeneration of the joint. Congenital ligamentous laxity → unstable basal joints and arthritis in many patients.

Associated conditions

Rheumatoid arthritis; osteoarthritis; carpal tunnel syndrome (CTS)

Anesthetic Considerations for Wrist Procedures

(Procedures covered: Darrach procedure; dorsal stabilization and extensor synovectomy of the rheumatoid wrist; metacarpophalangeal and interphalangeal joint arthroplasty; arthrodesis of the wrist; total wrist replacement; thumb carpometacarpal joint fusion/arthroscopy/stabilization)

Preoperative

Airway

Rheumatoid involvement of the C-spine, TMJ, and cricoarytenoid joint (CAJ) are common in this patient population. Erosion of cervical vertebrae → unstable C-spine (e.g., atlantoaxial subluxation) necessitates extreme care in head and neck manipulation. C-spine fusion (\downarrow neck ROM), TMJ arthritis (\downarrow mouth opening) and CAJ arthritis (laryngeal narrowing, hoarseness, DOE, stridor) portend difficult intubation and may necessitate awake fiber optic intubation ([p. B-5](#)). In the case of CAJ arthritis, use of a smaller ETT may be required.

Respiratory

Rheumatoid patients may exhibit Sx of pleural effusion (CXR) or pulmonary fibrosis (dyspnea, diffuse rales, \downarrow diffusing capacity, honeycomb appearance in CXR).

Tests: Consider CXR, PFTs, ABGs in affected patients.

Rheumatoid patients may suffer from pericarditis, myocarditis, valvular disease, and cardiac conduction defects. Because of the physical limitations imposed by the disease process, it may prove difficult to evaluate these patients' cardiovascular status; hence, cardiology consultation, ECG, and ECHO may be useful in preparing for surgery.

Tests: Consider ECG and ECHO, especially in patients with severe rheumatoid arthritis.

Rheumatoid patients may have cervical or lumbar radiculopathies that should be documented carefully preop. In addition, peripheral neuropathy with consequent sensory/motor defects may be present.

Tests: Consider C-spine radiographs to r/o occult subluxations in rheumatoid patients with neck pain or upper extremity radiculopathy.

Neurological

Bony deformities or muscle contractures may necessitate special attention to positioning.

Anemia, eosinophilia, and thrombocytosis may be present. Venous access may be difficult 2° vasculitis and \uparrow skin fragility (steroid-induced). Virtually all of these patients will be on some type of anti-inflammatory medication that may result in anemia or Plt inhibition. Ideally, patients should discontinue NSAIDs at least 5 d preop; aspirin, 7 d preop.

Rheumatoid patients may be on oral corticosteroids and require supplemental periop steroids (e.g., 100 mg hydrocortisone q 8 h iv) to treat adrenal suppression, although the routine use of

Musculoskeletal

Hematologic

Endocrine

Laboratory

Premedication

(Print pagebreak 915)

Intraoperative

Anesthetic technique: Regional anesthesia, GA, or a combination of the two is commonly used. A brachial plexus block via the supraclavicular, axillary, or infraclavicular approach is excellent for this procedure; it is a means of avoiding tracheal intubation for GA if airway difficulty is anticipated. Furthermore, it decreases admission rate, speeds discharge from PACU in day surgery setting, and increases patient satisfaction. Intravenous regional anesthesia (Bier block) is most useful for short procedures (<1 h). If regional anesthesia is contraindicated, rheumatoid patients may require awake fiber optic intubation (see [p. B-5](#)).

Regional anesthesia: 1.5% mepivacaine, 30–40 mL for routine, superficial cases; 0.5% bupivacaine, or 0.5% ropivacaine, 30–40 mL for procedures >2.5 h or if extended analgesia is desired. Epinephrine (2.5–5mcg/mL) should be added whenever possible to decrease peak plasma concentrations of local anesthetics.

Infraclavicular block

The coracoid approach makes this a safe and effective regional technique. A single injection will provide anesthesia distal to the midhumerus. No additional injections are necessary, and the patient's arm does not need to be abducted for block placement. If intraop sedation is necessary, propofol (50–100 mcg/kg/min) by continuous infusion or intermittent bolus injection of opioid/benzodiazepine are good choices.

The medial aspect of the upper arm is innervated by the intercostobrachial nerve (T2) and requires a separate subcutaneous field block in the axilla, especially when a tourniquet is used. The lateral cutaneous nerve of the forearm, a sensory branch of the musculocutaneous nerve supplying sensation to the lateral forearm, is frequently missed by the axillary approach to the brachial plexus. Thus, a block of this nerve at the elbow or within the proximal coracobrachialis muscle is sometimes necessary. If intraop sedation is necessary, propofol (50–150 mcg/kg/min) by continuous infusion or intermittent bolus injection of opioid/benzodiazepine are good choices.

The Bier block (intravenous regional anesthesia) is an excellent technique for short (<60 min), superficial wrist and hand surgeries. 40–50 mL of 0.5% lidocaine is commonly used. A very brief operative procedure may be an indication to reduce the dose of iv anesthetic agent by, for example, having the surgeon use a forearm tourniquet instead of an upper arm tourniquet. The OR staff should be alerted that iv regional anesthesia is being used, so that all are ready to proceed after the tourniquet is inflated (i.e., surgical prep ready to be performed; surgeons scrubbed, gowned, and gloved). Tourniquet pain and postop pain are reduced by adding ketorolac (20 mg) or clonidine (1 mcg/kg) to the lidocaine solution.

Axillary block

Bier block

(Print pagebreak 916)

General anesthesia:

Induction

Standard induction ([p. B-2](#)) in patients with normal airways

Maintenance

Standard maintenance ([p. B-2](#))

Emergence

Skin closure frequently is followed by application of a splint, and the patient should remain anesthetized during the splinting procedure. Cases with difficult airways require awake extubation.

Blood and fluid requirements

Minimal blood loss

IV: 18 ga × 1

NS/LR @ 1.5–3 mL/kg/h

Standard monitors ([p. B-1](#))

IV placed in the contralateral upper extremity.

Monitoring

Positioning

Special handling required.
and pad pressure points.
eyes.
C-spine instability.

As with nearly all orthopedic cases, positioning is a subtle, yet crucial aspect of anesthetic management. Rheumatoid patients may have contractures that require special attention. Steroid-dependent patients require special handling because of fragile skin.

Infraclavicular block complications

Local anesthetic toxicity
Inadequate block
Intravascular injection
Pneumothorax
Persistent paresthesia
Local anesthetic toxicity
Inadequate block
Intravascular injection
Persistent paresthesia
Axillary hematoma
Axillary artery thrombosis

Less frequent occurrence, compared with axillary block.

Pneumothorax is very rare with the lateral coracoid approach.

Very minimal doses of local anesthetic can cause CNS toxicity if reverse flow occurs during an intraarterial injection. Axillary thrombosis is extremely rare.

Axillary block complications

Local anesthetic toxicity
Inadequate block
Thrombophlebitis

Proper exsanguination and tourniquet function is critical. Tourniquet should remain inflated a minimum of 25 min. Systemic toxic reaction to the local anesthetic may occur as a result of tourniquet leak or inadvertent premature (< 20 min) tourniquet release. Treatment is supportive. Sz are controlled with STP or midazolam, with appropriate airway protection. Even with a functioning tourniquet, it is possible to overcome tourniquet pressure by injecting too vigorously. Care must be taken when switching from proximal to distal tourniquet; never deflate proximal tourniquet until verifying that distal tourniquet is working.

Bier block complications

Postoperative

Pain management

Regional or combined regional-general PCA ([p. C-3](#)), in combination with regional anesthetic techniques are excellent for wrist procedures, especially with respect to postop pain management.

Tests

None routinely indicated.

(Print pagebreak 917)

Suggested Readings



1. Gerancker JC: Upper extremity nerve blocks. *Anes Clin North Am* 2000; 18(2):1–16.
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11. Wilson JL: Infraclavicular brachial plexus block: parasagittal anatomy important to the coracoid technique. *Anesth Analg* 1998; 87(4):870–3.

Excision of Ganglion of the Wrist

Surgical Considerations

Description: Ganglion cysts about the wrist most commonly occur dorsally, originating from the scapholunate joint. The second most common site is volar to the scaphotrapezial joint. To prevent recurrence, these synovial fluid-filled outpouchings of the joint capsule must be excised completely. This requires isolating the stalk of the cyst to its origin, and excising a small cuff of normal joint capsule with the cyst. The joint, therefore, must be entered for a complete excision. For patients with dorsal ganglia who have considerable preoperative pain a posterior interosseous neurectomy may be done at the same time as the excision. Older studies found that the recurrence rate was decreased by the use of GA, as opposed to local or regional anesthetics. This was due to the fact that a more complete excision was performed when the patient was under GA. Hand specialists today feel that regional anesthetics are quite acceptable for this procedure, as long as the surgeon performs a meticulous excision. Volar wrist ganglions commonly are near the radial artery, which is at risk during excision. A preop Allen test should be performed to ensure that, if the radial artery is interrupted, there will not be ischemia in the hand. Primary small dorsal ganglions may be approached arthroscopically.

Usual preop diagnosis: Ganglion cyst, primary or recurrent

Summary of Procedures

Position
Incision

Supine, with arm extended on hand-surgery table
Longitudinal or transverse directly over cyst



Special instrumentation	Pneumatic tourniquet
Antibiotics	Cefazolin 1 g iv
Surgical time	0.5–1.5 h
Tourniquet	150 mmHg above systolic; max time = 120 min
Closing considerations	Routine skin closure. Large recurrent cysts may require a repair of the wrist capsule. Splint applied in OR.
EBL	Minimal; performed under tourniquet control.
Postop care	PACU → home
Mortality	None associated with procedure
Morbidity	Injury to radial artery: Rare (Because of the vascular interconnections between radial and ulnar arteries, loss of radial artery flow rarely → complications.)
Pain score	2–4

(Print pagebreak 918)

Patient Population Characteristics

Age range	Adults
Male:Female	1:1
Incidence	Very common
Etiology	Unknown. Trauma has been associated with 50% of ganglion cysts. Underlying carpal instabilities, such as scapholunate instability, have been implicated.
Associated conditions	Carpal instability; trauma (wrist sprains and strains)

Anesthetic Considerations

See [Anesthetic Considerations following Repair of Flexor Tendon Laceration, p. 921](#).

Palmar and Digital Fasciectomy

Surgical Considerations

Description: This procedure is indicated for the treatment of Dupuytren's contractures of the digits, which produces a neoplastic thickening of the palmar and digital fascia. These pathologic cords (whose active cell is the myofibroblast) contract and, through their connections with the skin, tendon sheath, and phalangeal bone, cause flexion contractures of the metacarpophalangeal, proximal interphalangeal, and distal interphalangeal joints. The disease is progressive, and the only treatment is surgical excision of the fascia. Research into nonsurgical options for treatment is ongoing, some surgeons perform needle aponeurectomy, which incises the diseased fascia, but does not remove it. In addition to the pathologic changes in the fascia of the hands, many patients also have thickening of the plantar fascia of the foot (Ledderhose disease) and the dorsal fascia of the penis (Peyronie's disease). Patients with severe contractures that have been neglected may require amputation. Because the pathologic fascia is so intimately connected to the skin, it is sometimes necessary to excise the skin and replace it with full-thickness skin grafts. The groin is an excellent donor site for these grafts.

Usual preop diagnosis: Dupuytren's contracture

Summary of Procedures

Position

Supine, with arm extended on hand-surgery table

**Incision**

Transverse or longitudinal palmar. Groin may be used as a full-thickness skin graft donor site.

Cephazolin 1g iv

1–3 h

150 mmHg above systolic; max time = 120 min. Because of the need to deflate tourniquet so that hemostasis can be obtained, Bier block is not suitable.

Must obtain meticulous hemostasis. Z-plasties and skin grafts used frequently.

Minimal; dissection done under tourniquet control. A small amount of blood loss occurs when tourniquet is released and hemostasis is obtained.

PACU → home

None associated with procedure

Hematoma (usually requires operative intervention)

Skin necrosis (may require secondary skin grafting)

Digital nerve and artery injury (Vascular injuries typically recognized immediately. An operating microscope may be needed, and the procedure will be prolonged.)

Reflex-sympathetic dystrophy (so-called sympathetic “flare” reaction; requires prompt treatment, including stellate ganglion blockade)

EBL**Postop care****Mortality****Morbidity****Pain score**

7–8

(Print pagebreak 919)

Patient Population Characteristics

Age range

Typically, 40–60 yr

Male:Female

More common in males

Incidence

Common

Definite heritance—associated with strong family Hx. Ethnic diathesis for northern Europeans with fair hair and skin, blue eyes. Almost never seen in Blacks. Experimental studies suggest that microhematomas 2° repetitive trauma may be important in the disease process.

Cigarette smoking; alcoholism; antiseizure medications

Associated conditions

Anesthetic Considerations

See [Anesthetic Considerations following Repair of Flexor Tendon Laceration, p. 921](#).

Repair of Lacerated Tendons/Nerves

Surgical Considerations

Description: The prognosis and difficulty of a flexor tendon repair depends on the anatomic site of the laceration. There are five zones of injury in the upper extremity ([Fig. 10.1-3](#)). Zone I is distal to the flexor digitorum superficialis (FDS) tendon insertion and involves only the flexor digitorum profundus (FDP) tendon. Zone II extends from the entrance to the fibroosseous sheath at the metacarpal head to the FDS insertion. Lacerations usually involve both the FDS and FDP. These are the most difficult to repair and have the worst prognosis, as the tendons are apt to become scarred to each other and limit gliding. Zone III is the palm; Zone IV is at the level of the carpal canal; and Zone 5 is in the forearm. Lacerations in these areas are easier to repair and have good prognoses for restoration of tendon gliding and, thus, digit motion. Associated injuries to the neural structures are common. Digital nerve

lacerations are seen in Zone II; median or ulnar nerve injuries, in Zone IV and proximal. Lacerations to the dorsal side of the hand involving the extensor tendons may be repaired in the emergency room as they often do not involve neurovascular (*Print pagebreak 920*) structures, and the extensor digitorum communis tendon as well as the junctura tendinea may prevent retraction of the proximal tendon into the forearm. The exception to this is the thumb and radial dorsal hand where the extensor and abductor tendons may retract, and the dorsal sensory branch of the radial nerve is at risk.

Zones of the Hand

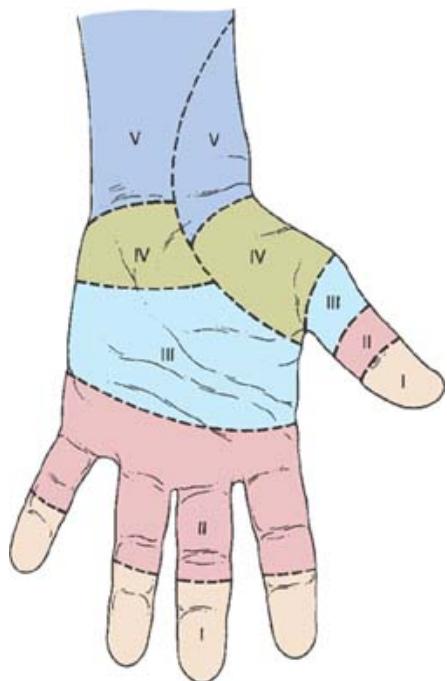


Figure 10.1-3. 3. Zone classification of flexor tendon injuries. (Reproduced with permission from Scott-Conner CEH, Dawson DL: *Operative Anatomy*, 2nd edition. Lippincott Williams & Wilkins, 2003.)

In general, nerve injuries are repaired at the time of the tendon repair. Depending on the surgeon, an operating microscope or loupe magnification may be used. Tendons lacerated in the finger are often pulled back into the palm by muscular contraction. A palmar incision is required to retrieve the tendon, which must then be threaded carefully through the pulleys in the digit. Suture techniques for tendon repair create a juncture that is far weaker than an intact tendon. For this reason, the juncture must be protected from mechanical stress for a period of 8 wk or more. This is done by splinting the hand with the wrist and digits flexed so that the pull on the tendon by its muscle is limited. It is important that the patient emerges gently from anesthesia to limit the stress on the repair. The best results are obtained when repair is carried out within 7 d of the injury, although primary repair can be performed up to 3 wk. After 7 d, the muscle begins to undergo irreversible contracture. If the flexor tendon is advanced after this has occurred, a flexion contracture results. If a flexor tendon laceration is neglected, a palm-to-fingertip tendon graft, using a different flexor tendon, should be performed. If the tendon bed is suitable for gliding, the graft can be accomplished in one stage. If not, a Silastic tendon spacer (rubber rod) must be placed at the first stage; 6–8 wk later, a palm-to-fingertip graft is placed in the bed prepared with the Silastic rod. Tendon graft donor sites include the palmaris longus tendon and toe extensors.

A variant of the sharp flexor tendon laceration is the FDP avulsion from its insertion in Zone 1. This is the so-called “jersey finger”—initially named for the classic mechanism of someone grasping the jersey of a ball carrier. This injury occurs during forceful grasp, and most commonly affects the ring finger. The FDP tendon retracts to various predictable levels per the classification system of Leddy. Type I retracts in to the palm; this injury is most likely to disrupt the blood supply to the tendon via the vinculae. Type II retracts to the level of the PIP joint, and type III retracts to the level of the DIP joint. In general, these injuries should be explored and repaired within 7 days. Repair may require mini-suture anchors or a button/pull out suture through the nail/distal phalanx, because there is not sufficient tendon distally for a primary repair. If neglected, these patients should be treated with a **distal interphalangeal (DIP) arthrodesis**. A flexor tendon graft through an intact FDS tendon usually is not indicated, because tendon adhesions will commonly interfere (*Print pagebreak 921*) with the function of the FDS, leading to decreased overall active motion of the digit. The most common complication is the development of tendon adhesions, which limit tendon gliding and digit motion. If these patients fail to improve within a 3- to 6-mo course of physical therapy, they require an operative tenolysis to lyse the adhesions.

Usual preop diagnosis: Flexor tendon laceration; FDP avulsion (“jersey finger”); digital nerve laceration; median nerve laceration

Summary of Procedures

Position	Supine, with arm extended on hand-surgery table. The foot may be prepped for a graft.
Incision	Zig-zag (Brunner) within the digits, extensile approach hand or wrist
Special instrumentation	Pneumatic tourniquet, possibly operating microscope for nerve injuries
Antibiotics	Cefazolin 1 g iv
Surgical time	1–2 h; may be extended for nerve repair and treatment of associated injuries.
Closing considerations	Tendon and nerve repairs must be protected with splints before emergence from GA. Smooth extubation (see Emergence, below).
EBL	Minimal; procedure performed under tourniquet control.
Postop care	PACU → home
Mortality	None associated with procedure.
Morbidity	Tendon adhesions: 25% Rupture of tendon repair: <5% Infection: Rare
Pain score	2–4

Patient Population Characteristics

Age range	Adult population, rarely children.
Male:Female	Slight male predominance, due to occupational injuries
Incidence	Not uncommon
Etiology	Trauma

■ Anesthetic Considerations

(Procedures covered: excision of ganglion of the wrist; palmar and digital fasciectomy; repair of flexor tendon laceration)

▲ Preoperative

The majority of patients presenting for these procedures are usually otherwise healthy. Many of them present for elective surgery as a result of progressive functional impairment and pain, and preop workup is routine.

Neurological

If regional anesthesia is contemplated, preexisting sensory or motor defects should be documented carefully.

Laboratory

Hb/Hct (healthy patients); otherwise, as indicated from H&P.

Premedication

Mild-to-moderate premedication (e.g., in adults, midazolam 1–2 mg iv, fentanyl 50–100 mcg iv, titrated to effect) is often desirable before placement of a regional block.

(Print pagebreak 922)

◆ Intraoperative

Anesthetic technique: Regional anesthesia (most common), GA, or a combination of the two may be used. Intravenous regional

anesthesia (Bier block) is most useful for short procedures that last for < 1 h (see [Anesthetic Considerations, p. 927](#)). A brachial plexus block via the axillary or infraclavicular approach is excellent for this procedure. Because most of these procedures are done on an outpatient basis, brachial plexus block without GA is usually preferred to promote early “street-readiness.”

Regional anesthesia: 1.5% mepivacaine 30–40 mL with alkalization for routine, superficial cases; 0.5% bupivacaine or 0.5% levobupivacaine/0.5% ropivacaine, if available, 30–40 mL for procedures > 2.5 h or if extended analgesia is desired. Epinephrine (2.5–5 mcg/mL) should be added whenever possible to decrease peak plasma concentrations of local anesthetics.

Ultrasound guided supraclavicular block

Using ultrasound guidance, the brachial plexus can be blocked at the supraclavicular level. Direct visualization of the plexus and surrounding structures reduces the risk of pneumothorax with this approach. This block provides adequate anesthesia for procedures distal to midhumerus.

Infraclavicular block

The coracoid approach makes this a safe and effective regional technique. A single injection will provide anesthesia distal to the midhumerus. No additional injections are necessary, and the patient's arm does not need to be abducted for block placement. If intraop sedation is necessary, propofol (50–100 mcg/kg/min) by continuous infusion or intermittent bolus injection of opioid/benzodiazepine are good choices.

Axillary block

The medial aspect of the upper arm is innervated by the intercostobrachial nerve (T2) and requires a separate subcutaneous field block in the axilla, especially when a tourniquet is used. The lateral cutaneous nerve of the forearm, a sensory branch of the musculocutaneous nerve supplying sensation to the lateral forearm, is frequently missed by the axillary approach to the brachial plexus. Thus, a block of this nerve at the elbow or within the proximal coracobrachialis muscle is sometimes necessary. If intraop sedation is necessary, propofol (50–100 mcg/kg/min) by continuous infusion or intermittent bolus injection of opioid/benzodiazepine are good choices.

Bier block

The Bier block (intravenous regional anesthesia) is an excellent technique for short (< 60 min), superficial wrist and hand surgeries. 40–50 mL of 0.5% lidocaine is commonly used. A very brief operative procedure may be an indication to reduce the dose of iv anesthetic agent by, for example, having the surgeon use a forearm tourniquet instead of an upper arm tourniquet. The OR staff should be alerted that iv regional anesthesia is being used, so that all are ready to proceed after the tourniquet is inflated (i.e., surgical prep ready to be performed; surgeons scrubbed, gowned, and gloved). Tourniquet pain and postop pain is reduced by adding ketorolac (20 mg) or clonidine (1 mcg/kg) to the lidocaine solution.

General anesthesia:

Induction

Standard induction ([p. B-2](#))

Maintenance

Standard maintenance ([p. B-2](#))

Emergence

Standard emergence ([p. B-3](#)). Skin closure is frequently followed by application of a splint; patient should remain anesthetized during splinting procedure.

Minimal blood loss

An 18-ga iv catheter placed in the

IV: 18 ga × 1

contralateral upper extremity should be adequate.

NS/LR @ 1.5–3 mL/kg/h

Standard monitors ([p. B-1](#))

and pad pressure points.

eyes.

Blood and fluid requirements

Monitoring

Positioning

Supraclavicular block complications

Inadequate block
Intravascular injection
Persistent paresthesia
Local anesthetic toxicity
Pneumothorax

Ulnar nerve sparing

Infraclavicular block complications

Inadequate block
Intravascular injection
Pneumothorax
Persistent paresthesia
Local anesthetic toxicity

Less frequent occurrence, compared with axillary block.

Pneumothorax is very rare with the lateral coracoid approach.

Axillary block complications

Local anesthetic toxicity
Intravascular injection
Inadequate block
Persistent paresthesia
Axillary hematoma
Axillary artery thrombosis

Minimal doses of local anesthetic can cause CNS toxicity during an accidental intravascular injection. Sz should be treated with STP or midazolam titrated to effect, accompanied by airway control. If there is any question of a full stomach, intubation should be accomplished rapidly. Axillary thrombosis is very rare.

Proper exsanguination and tourniquet function is critical. Tourniquet should remain inflated a minimum of 25 min. Systemic toxic reaction to the local anesthetic may occur as a result of tourniquet leak or inadvertent premature (< 20 min) tourniquet release. Treatment is supportive. Sz are controlled with STP or midazolam, with appropriate airway protection. Even with a functioning tourniquet, it is possible to overcome tourniquet pressure by injecting too vigorously. Care must be taken when switching from proximal to distal tourniquet; never deflate proximal tourniquet until verifying that distal tourniquet is working.

Bier block complications

Local anesthetic toxicity
Inadequate block
Thrombophlebitis

(Print pagebreak 923)

Postoperative

Pain management

Oral analgesics are usually sufficient.

The lingering analgesia of the brachial plexus block is often sufficient for pain relief in the recovery room; oral analgesic therapy can be instituted prior to discharging patient to home.

Tests

None routinely indicated.

Suggested Readings

1. Brockway MS, Wildsmith JA: Axillary brachial plexus block: method of choice? *Br J Anaesth* 1990; 64(2):224–31.
2. Chan VW, Perlas A, Rawson R, et al: Ultrasound guided supraclavicular brachial plexus block. *Anesth Analg* 2003; 97 (5):1514–7.
3. Gerancher JC: Upper extremity nerve blocks. *Anes Clin North Am* 2000; 18(2):1–16.



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6. Ramamurthy S, Anderson D: Anesthesia. In *Operative Hand Surgery*, 5th edition. Green DP, Hotchkiss RN, Pederson WC, et al, eds. Elsevier, New York: 2005, 25–54.
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8. Salazar CH: Infraclavicular brachial plexus block. *Reg Anesth Pain Med* 1999; 24(5):411–6.
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(Print pagebreak 924)
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11. Wilson JL: Infraclavicular brachial plexus block: parasagittal anatomy important to the coracoid technique. *Anesth Analg* 1998; 87(4):870–3.

Wrist Arthroscopy/Repair of Triangular Fibrocartilage Complex Tears

Surgical Considerations

Description: Wrist arthroscopy may be performed for either diagnostic or therapeutic indications. A smaller diameter version of the standard arthroscope is used for visualizing the wrist joint. All of the entry portals are on the dorsum of the wrist and course between the extensor compartments. Irrigation is used during the procedure and a cannula is routinely placed ulnar to the extensor carpi ulnaris tendon. Unlike the knee joint, where visualization is obtained by distention of the joint, in-the-wrist visualization is obtained by distraction. The digits are placed in finger traps and up to 10 lb of traction can be placed on the wrist. Specialized instrumentation is available to resect and débride intraarticular structures and to place sutures to repair torn ligaments. The **triangular fibrocartilage complex** is a source of ulnar- sided wrist pain. It is a term given to the soft tissues spanning the distal radio-ulnar joint. It is composed of the articular disk, radio-ulnar ligaments, ulnocarpal ligaments, extensor carpi ulnaris tendon sheath, and meniscus homologue. Advances in both imaging and arthroscopic techniques in the recent past have led to our ability to better treat patients with injuries to the triangular fibrocartilage complex (TFCC). The classification of these injuries credited to Palmer involves both traumatic and degenerative tears, which are associated with ulnar positive variance and ulnar impaction or impingement syndrome. If an open procedure, such as repair of an intercarpal ligament or an ulnar shortening procedure is contemplated following diagnostic arthroscopy, either GA or regional block is preferred.

Variant procedure or approaches: The standard approach is to suspend the forearm vertically in traction. The forearm also can be placed horizontally on the hand table in traction.

Usual preop diagnosis: Internal derangement of the wrist of unknown etiology; tears of the triangular fibrocartilage complex; intercarpal instability due to intercarpal ligament tears; scapholunate dissociation; luno-triquetal dissociation; fracture of distal radius; ulnar impingement syndrome.

Summary of Procedures

Position

Supine, with arm extended on hand-surgery table
Small incisions are made on the dorsum of the wrist for

Incision

Special instrumentation

Unique considerations

Antibiotics

Surgical time

Tourniquet

Closing considerations

EBL

Postop care

Mortality

Morbidity

Pain score

instrument insertion.

2.7-mm diameter arthroscope, 0 or 30° field of view; light source and video camera; television monitor; surgical power shaver; joint irrigation system; traction device for forearm; pneumatic tourniquet

Patient is often awake and observes surgery on monitor.

Cefazolin 1 g iv

30 min–2 h

150 mmHg above SBP; max time = 120 min

Arthroscopic portals are each closed with a single skin suture.

Minimal; procedure performed with tourniquet control.

PACU → home

None associated with procedure.

Infection: < 1%

Swelling (2° to irrigation fluid): Common

Nerve and artery damage: Uncommon

1–3

(Print pagebreak 925)

Patient Population Characteristics

Age range

Adults

Male:Female

1:1

Incidence

Least common form of arthroscopy

Etiology

See Usual preop diagnosis, above.

Associated conditions

Antecedent trauma

Anesthetic Considerations

See [Anesthetic Considerations following Carpal Tunnel Release, p. 927](#).

Suggested Reading

1. Green DP, Hotchkiss RN, Pederson WC, et al, eds: *Operative Hand Surgery*, 5th edition. Elsevier, New York: 2005.

Carpal Tunnel Release

Surgical Considerations

Description: This is the most commonly performed procedure in hand surgery. It consists of the transection of the transverse carpal ligament through either an open-palmar or an endoscopic approach ([Fig. 10.1-4](#)). In patients (Print pagebreak 926) with severe synovitis, as in rheumatoid arthritis, a synovectomy should be performed at the same time. If there is advanced thenar atrophy and weakness of thumb opposition, a tendon transfer may be done at that time. The most common transfer is the **Camitz opponensplasty**, in which the palmaris longus tendon is prolonged with palmar fascia and transferred to the thumb. Transfers of the extensor indicis proprius and superficial flexor tendons also can be performed. Surgeons differ in their approach to anesthesia for this procedure: some prefer local infiltration, whereas others prefer regional as there is less fluid edema.

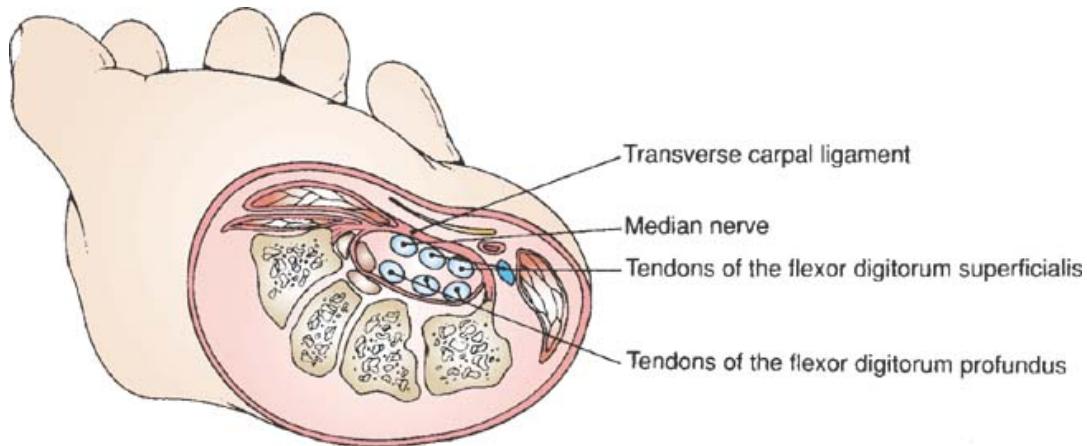


Figure 10.1-4. 4. Exposure of the carpal tunnel. (Reproduced with permission from Scott-Conner CEH, Dawson DL: *Operative Anatomy*, 2nd edition. Lippincott Williams & Wilkins, 2003.)

Usual preop diagnosis: Carpal tunnel syndrome (CTS); median nerve compression at the wrist

Summary of Procedures

Position	Open Carpal Tunnel Release	Endoscopic Carpal Tunnel Release
Incision	Supine Longitudinal incision in palm; may extend to forearm.	2 cm transverse at proximal flexion crease of wrist; some use a distal palmar incision also
Special instrumentation	Pneumatic tourniquet	Endoscopic carpal tunnel release system: endoscope, sheath and trocar, special cutting tools
Unique considerations	Although rare, damage to neurovascular structures	Danger of intraop injury to digital nerves, median nerve, tendons, superficial vascular arch
Antibiotics	Cefazolin 1 g iv	
Surgical time	30–90 min	30 min
Tourniquet	150 mmHg above SBP; max time = 120 min	
Closing considerations	Simple skin closure, some surgeons will splint	
EBL	Minimal; performed under tourniquet control.	Minimal
Postop care	PACU → home	PACU→ home
Mortality	None associated with procedure	
Morbidity	Overall complication rate: 4% Reflex sympathetic dystrophy (RSD): < 5% Hematoma: Rare Infection: Uncommon	Rare Complications of ulnar nerve palsy < 5% Tendon and nerve laceration: Rare (< 1%) Vascular injury: Less common than nerve injury
Pain score	1–2	1–2

Patient Population Characteristics



Age range	20–80 yr; 50% are 40–60 yr
Male:Female	1:2
Incidence	Common
Etiology	Compression of the median nerve within the carpal tunnel by synovitis; mass effect 2° tumor or fracture fragments, peripheral neuropathy, gout, anomalous structures, thrombosis of a persistent median artery, and idiopathic; repetitive trauma (e.g., computer use)
Associated conditions	Rheumatoid arthritis; thyroid imbalance; diabetes; amyloidosis; multiple myeloma; alcoholism; hemophilia; pregnancy; menopause; gout; fractures of the distal radius; Kienböck's disease

(Print pagebreak 927)

Anesthetic Considerations

(Procedures covered: tendolysis of flexor or extensor tendon; wrist arthroscopy; carpal tunnel release)

Preoperative

In general, there are two patient populations involved: (a) healthy patients with Hx of wrist trauma, and (b) rheumatoid patients. (See [Anesthetic Considerations for Wrist Procedures, p. 914](#), for discussion of preop concerns in the rheumatoid patient.)

Laboratory

Hb/Hct (healthy patients); otherwise, as indicated from H&P.

Premedication

Mild-to-moderate premedication (e.g., in adults, midazolam 1–2 mg iv, fentanyl 50–100 mcg iv, titrated to effect) is often desirable before placement of a regional block.

Intraoperative

Anesthetic technique: Intravenous regional anesthesia is an excellent technique for procedures that are < 1 h. For longer procedures, an axillary or infraclavicular brachial plexus block is a good alternative. Both of these techniques are especially appropriate for outpatients.

The Bier block (intravenous regional anesthesia) is an excellent technique for short (< 60 min), superficial wrist and hand surgeries. 40–50 mL of 0.5% lidocaine is commonly used. A very brief operative procedure may be an indication to reduce the dose of iv anesthetic agent by, for example, having the surgeon use a forearm tourniquet instead of an upper-arm tourniquet. The OR staff should be alerted that iv regional anesthesia is being used, so that all are ready to proceed after the tourniquet is inflated (i.e., surgical prep ready to be performed; surgeons scrubbed, gowned, and gloved). Tourniquet pain and postop pain are reduced by adding ketorolac (20 mg) or clonidine (1 mcg/kg) to the lidocaine solution.

Minimal blood loss

IV: 18 ga × 1

NS/LR @ 1.5–2 mL/kg/h

Standard monitors ([p. B-1](#))

and pad pressure points.
eyes.

An 18-ga iv catheter placed in the nonoperative upper extremity should be adequate.

Intravenous regional block

Blood and fluid requirements

Monitoring

Positioning

Proper exsanguination and tourniquet function are critical. A tourniquet should remain inflated a minimum of 25 min. Systemic toxic reaction to the local anesthetic may occur as a result of tourniquet leak or inadvertent premature (<

Intravenous regional block complications

Local anesthetic toxicity
Inadequate block
Thrombophlebitis

20 min) tourniquet release. Treatment is supportive. Sz are controlled with STP or midazolam, with appropriate airway protection. Even with a functioning tourniquet, it is possible to overcome tourniquet pressure by injecting too vigorously. Care must be taken when switching from proximal to distal tourniquet; never deflate proximal tourniquet until verifying that distal tourniquet is working.

Postoperative

Pain management

Oral analgesics usually sufficient

Residual analgesia with iv regional anesthesia is minimal unless ketorolac or clonidine is used. Some iv opioid may be necessary until the patient is tolerating fluids in the recovery room.

Tests

None routinely indicated.

(Print pagebreak 928)

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Fixation of Fractures and Dislocations of the Wrist and Hand

Surgical Considerations

Description: Patients with fractures of the distal radius, distal ulna, carpus, metacarpals and phalanges that cannot be treated adequately with closed methods, require fixation. Difficult fractures may require a combination of techniques such as percutaneous

pinning or external fixation in addition to **open reduction and internal fixation** (ORIF). The criteria for adequate treatment include anatomic reduction of the fracture fragments with focus on articular congruity and stable fixation for maintenance of this reduction. Cast/splint treatment or fixation of any kind is an effort to decrease motion at the fracture site and allow the body to produce a bony union with acceptable length, alignment and rotation. Patients with carpal/wrist fractures or dislocations may have signs of neurologic compromise, specifically the median nerve. Often a closed reduction will improve these symptoms, but if not urgent operative treatment is indicated. Most dislocations within the hand are reducible in the emergency room setting with adequate anesthesia; there are irreducible varieties that warrant immediate operative treatment. Vascular compromise of the hand associated with these injuries is rare, usually occurring in patients with severe crush or high-energy injuries. The devascularized hand is a surgical emergency, and revascularization must be carried out as soon as possible. High-energy injuries such as gunshot wounds may have significant soft-tissue components that must be treated. The possibility of a coexisting compartment syndrome should be considered; and a fasciotomy may be needed at the time of surgery. Open fractures are, by definition, contaminated and should be irrigated and débrided within 8 h of the injury. Surgical approaches depend on the nature and location of the fracture, but typically are longitudinal. Some fractures of the articular surface of the distal radius are amenable to percutaneous pin fixation using fluoroscopy and possibly arthroscopic assistance. Screw fixation of the scaphoid also can be accomplished via percutaneous methods using image guidance. This injury may be associated with a picture of perilunar instability. Damage to intercarpal ligaments may require open repair or reduction and percutaneous pinning. Intraoperative fluoroscopy often is utilized, as are standard portable radiographs to monitor and assess the quality of the reduction of the fracture.

Soft-tissue coverage of these injuries may be problematic, and **local flaps** or **free microvascular tissue transfers** may be indicated. Rarely are these procedures done with the initial operative debridement; an antibiotic bead pouch or wound vac may be used to temporize open wounds. Free transfers can come from the same limb (radial forearm flap, based on the radial artery; lateral upper arm flap, based on the posterior radial collateral artery) or a remote site (latissimus dorsi muscle, based on the thoracodorsal artery; or scapular skin flap, based on the circumflex scapular artery). Remote flaps require special patient positioning and draping. Microsurgical tissue transfers also may need special pharmacological considerations, such as the administration of heparin or dextran to prevent thrombosis of the anastomosis. These procedures also significantly increase operative time and equipment needs.

(Print pagebreak 929)

Usual preop diagnosis: Fractures of the distal radius (Colles', Barton's, Smith's are common eponyms); wrist dislocations (perilunate, lunate); fractures of the carpus, metacarpals, or phalanges; GSW; crush injuries; blast injuries

Summary of Procedures

Position	Supine, with arm extended on hand-surgery table.
Incision	Usually volar, longitudinal for distal radius; longitudinal either midaxial, midlateral or dorsal for phalanges; dorsal for metacarpals and carpal fractures; if symptoms of acute carpal tunnel syndrome, which warrants a volar incision
Special instrumentation	Fluoroscopy; internal and external fixation devices and power tools; pneumatic tourniquet,
Unique considerations	Associated injuries and soft-tissue problems in high-energy fractures
Antibiotics	Cephalosporin prophylaxis is indicated for the treatment of closed fractures. Open fractures may require the addition of an aminoglycoside or penicillin depending on the amount and type of contamination.
Surgical time	30 min–3 h.
Tourniquet	150 mmHg above SBP; max time = 120 min
Closing considerations	Some injuries require local flaps or free microsurgical tissue transfers for closure. Fasciotomy wounds may be left open. Splint applied at surgery.
EBL	Minimal for fracture treatment, as tourniquet control is used.
Postop care	PACU → home unless significant soft tissue injuries requiring additional procedures
Mortality	Usually 2° associated injuries
Morbidity	Loss of reduction, requiring repair Nonunion (requires additional surgical procedure)

Pain score

Infection

3–9 (Great variation, probably depending on degree of median, ulnar, or dorsal radial sensory nerve involvement. Postop pain management is often problematic. Early use of stellate ganglion blocks may be beneficial in preventing the development of sympathetic mediated pain syndromes.)

Patient Population Characteristics

Age range	All ages. More conservative approaches are used with elderly patients.
Male:Female	1:1
Incidence	Very common
Etiology	Trauma
Associated conditions	Traumatic injuries

■ Anesthetic Considerations

▲ Preoperative

The majority of patients presenting for these procedures are relatively young and healthy. Most present for elective repair of a traumatic injury, and preop workup is routine. Replantation and some injuries, such as irreducible dislocations or open fracture, require immediate attention and necessitate emergency surgery and full-stomach considerations (see [p. B-4](#)).

(Print pagebreak 930)

Neurologic

If regional anesthesia is contemplated, pre-existing sensory or motor defects should be documented carefully preop.

Laboratory

Hb/Hct (healthy patients); otherwise, as indicated from H&P.

Premedication

Mild-to-moderate premedication (e.g., in adults, midazolam 1–2 mg iv, fentanyl 50–100 mcg iv, titrated to effect) is often desirable before placement of a regional block.

◆ Intraoperative

Anesthetic technique: GETA, regional anesthesia, or a combination is commonly used. A brachial plexus block is excellent for short (1–2 h) procedures on the wrist and hand. Ultrasound guided block may be performed with a supraclavicular or axillary approach. Using a nerve stimulator, infraclavicular or axillary approaches are usual. Regional anesthesia alone is a means of avoiding the risk of aspiration pneumonitis associated with GA in the patient with a full stomach whose operation must be done emergently (see [Rapid-Sequence Induction of Anesthesia, p. B-4](#)). A combination of regional and general anesthesia is appropriate for prolonged cases and those that require the use of bone grafts harvested from the iliac crest or a free-tissue transfer.

General anesthesia:

Induction

Standard induction ([p. B-2](#))

Maintenance

Standard maintenance ([p. B-2](#))

Emergence

Skin closure is frequently followed by application of a splint; patient should remain anesthetized during splinting procedure.

Regional anesthesia: 1.5% mepivacaine (40 mL) for routine superficial cases; 0.5% bupivacaine or 0.5% ropivacaine, 40 mL for procedures > 2.5 h or if extended analgesia is desired. Epinephrine (2.5–5 mcg/mL) should be added whenever possible to decrease peak plasma concentrations of local anesthetics.

Ultrasound guided supraclavicular block

Using ultrasound guidance the brachial plexus can be blocked at the supraclavicular level. Direct visualization of the plexus and surrounding structures reduces the risk of pneumothorax with this approach. This block provides adequate anesthesia for procedures distal to mid-humerus.

Infraclavicular block

The coracoid approach makes this a safe and effective regional technique. A single injection will provide anesthesia distal to the mid-humerus. No additional injections are necessary, and the patient's arm does not need to be abducted for block placement. If intraop sedation is necessary, propofol (50–100 mcg/kg/min) by continuous infusion or intermittent bolus injection of opioid/benzodiazepine are good choices.

The medial aspect of the upper arm is innervated by the intercostobrachial nerve (T2) and requires a separate subcutaneous field block in the axilla, especially when a tourniquet is used. The lateral cutaneous nerve of the forearm, a sensory branch of the musculocutaneous nerve supplying sensation to the lateral forearm, is frequently missed by the axillary approach to the brachial plexus. Thus, a block of this nerve at the elbow or within the proximal body of the coracobrachialis muscle is sometimes necessary. This block may also be performed under ultrasound guidance. Using this technique the musculocutaneous nerve is easily identified and blocked at the same time as the other nerves.

If intraop sedation is needed, propofol (50 mcg/kg/min) by continuous infusion or intermittent bolus injection of opioid/benzodiazepine (e.g., midazolam 0.5–1.0 mg iv q 5 min and alfentanil 5–10 mcg/kg iv q min titrated to effect) are good choices.

Minimal-to-moderate blood loss

IV: 18 ga × 1

NS/LR @ 1.5–3 mL/kg/h

Standard monitors ([p. B-1](#))

and pad pressure points.
eyes.

An 18-ga iv catheter placed in the nonoperative upper extremity should be adequate.

Local anesthetic toxicity

Inadequate block

Intravascular injection

Pneumothorax

Persistent paresthesia

Pneumothorax is very rare with the lateral coracoid approach.

Inadequate block

Intravascular injection

Persistent paresthesia

Axillary hematoma

Axillary artery thrombosis

Minimal doses of local anesthetic can cause CNS toxicity during an accidental intravascular injection. Sz should be treated with propofol or midazolam titrated to effect, accompanied by airway control. If there is any question of a full stomach, then intubation should be accomplished rapidly. Axillary thrombosis is extremely rare.

(Print pagebreak 931)

Postoperative

Pain management

Continuous nerve block can be considered in appropriate cases. PCA ([p. C-3](#)), in combination with regional block

Regional or combined regional-general anesthetic techniques are excellent for wrist procedures, especially with respect to postop pain management.

Tests

None routinely indicated.

Suggested Readings

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Digit and Hand Replantation

Surgical Considerations

Description: Patients with traumatic amputations of digits and the hand are candidates for emergency microsurgical replantation of these parts. In children, replantation is attempted for essentially all amputations. In the adult, replantation is carried out for amputations of the thumb, multiple digits, and amputations through the palm or proximal. In general, amputations of a single digit are not candidates for replantation, because of the minimal loss of function in relation to the long rehabilitation period and expected outcome. Certainly, a single digit amputated (*Print pagebreak 932*) proximal to the insertion of the flexor digitorum superficialis (FDS) tendon (Zone II) ([Fig. 10.1-3](#)) should not be replanted. The condition of the amputated part plays an important role in the decision to proceed with replantation. A severely crushed, contaminated, or burned part cannot be expected to survive and function. In addition to the condition of the amputated part, the method of preservation and the time from initial injury play a role in deciding on whether or not replantation is attempted. The patients also may have associated traumatic injuries (i.e., intraabdominal bleeding with a positive peritoneal lavage, chest injuries), which will take preference over replantation. The patient's overall health status must be assessed and may play a role in deciding whether or not to proceed with replantation.

There are a variety of reasons that people suffer amputations. Some studies of these patients have shown an increased incidence of psychopathology, such as alcohol or substance abuse. More often than not these injuries occur in industrial accidents, or in a population of people using power tools at home. Rarely children will gain access to dangerous objects and self-inflicted injuries can occur. Because these procedures are emergent, patients often arrive at the hospital with full stomachs. Although regional anesthesia techniques provide peripheral vasodilation through their sympatholytic effect, surgeons prefer GA because of the unpredictable length of the procedures. While the patient is being readied for induction, the surgeon prepares the amputated part in the OR. At this time, the structures to be repaired are tagged, which saves a great deal of anesthetic time. When the patient is prepped and draped, the hand is irrigated and débrided, and the corresponding structures are tagged in similar manner. The amputated part is brought to the field and the actual replantation is performed. Once arterial blood flow is reestablished, the patient must be kept warm to prevent vasospasm. As with other microsurgical procedures, pharmacologic intervention is indicated to prevent thrombosis; iv heparin and dextran are normally administered. Skin grafts for soft-tissue coverage and vein grafts to replace segmental vascular defects are commonly used. Vein grafts can be obtained from the ipsilateral upper extremity or from the lower extremity, especially the dorsum of the foot. Either the lateral thigh or abdomen is an excellent donor site for split-thickness skin grafts. Rarely is an immediate microsurgical free-tissue transfer indicated for soft-tissue coverage.

Usual preop diagnosis: Traumatic amputation of the digits or hand

Summary of Procedures

Position	Supine, with arm extended on hand-surgery table
Incision	Incisions extend both proximal and distal to traumatic amputation to explore neurovascular structures as well as define the zone of injury. Lower extremity prepped and draped as donor site for vein grafts from dorsum of foot, split-thickness skin graft from the thigh.
Special instrumentation	Operating microscope; microsurgical instrumentation
Unique considerations	Emergency procedure
Antibiotics	Cefazolin 1 g iv
Surgical time	3–12 h
Tourniquet	150 mmHg above systolic; max time = 120 min
Closing considerations	Routine volar hand splint
EBL	< 500 mL
Postop care	ICU → requires monitoring in intensive nursing environment. Should be kept pain-free for extended period postop to minimize vessel spasm. Patients will benefit from postop sedation.
Mortality	Minimal for digit and hand. Mortality becomes an important issue when large amounts of muscle are part of the reattachment.
Morbidity	Loss of replanted part (vessel thrombosis): 10% Infection: Rare
Pain score	3–5

(Print pagebreak 933)

Patient Population Characteristics

Age range	All ages, typically adults of working age
Male:Female	1:1
Incidence	Uncommon
Etiology	Trauma
Associated conditions	Substance abuse; alcoholism

Anesthetic Considerations

Preoperative

In general, there are two patient populations for hand replantation: (a) isolated hand injury patients (common), and (b) multiple trauma victims (rare).

Respiratory

As suggested by coexisting disease or acute trauma injuries. Evidence of occult chest injury, including pneumothorax and pulmonary contusion, should be sought.

Tests: Consider CXR, ABGs in victims of significant trauma.

As suggested by coexisting disease or acute trauma injuries. for evidence of occult cardiac or mediastinal injuries, such as myocardial contusion or great vessel rupture.

Tests: Consider CXR (with NG tube in place to assess mediastinal widening), and ECG in victims of significant trauma.

Cardiovascular

Neurological

As suggested by coexisting disease or acute trauma injuries. The possibility of closed head injury should be addressed in multiple-trauma victims. Verify integrity of C-spine.

Tests: Consider head CT prior to beginning a long procedure under GA in a patient with evidence of head trauma; C-spine x-ray.

Gastrointestinal

All patients should be considered to have a full stomach and to be at risk for aspiration pneumonitis. In general, they should receive preop medication to reduce stomach volume and acidity (e.g., metoclopramide 10 mg iv and ranitidine 50 mg iv).

Multiple-trauma victims are likely to suffer from acute blood loss. Although blood loss from these procedures is generally modest, a preop T&C for several U PRBCs is wise for trauma patients.

Tests: CBC

50% of trauma victims are intoxicated. Anesthesia-related implications of ethanol intoxication include decreased anesthetic requirements, diuresis, vasodilation, and hypothermia.

As suggested by coexisting disease or acute trauma injuries. In general, most victims of significant trauma are best served by obtaining a wide variety of baseline lab studies to screen for unrecognized injury. These studies normally include: ABGs; UA; renal function tests; LFTs; serum amylase; tox screen.

Metabolic

Full-stomach precautions: Na citrate 0.3 M 30 mL, metoclopramide 10-20 mg iv; H₂blocker

Laboratory

Premedication

Intraoperative

Anesthetic technique: GETA, after rapid-sequence induction (see [p. B-4](#)). Because of the unpredictable length of these procedures and the possible need for bone and/or vessel grafts, regional anesthesia is not feasible as the primary technique. A concurrent, continuing brachial plexus block, however, will provide sympathetic blockade, as well as postop analgesia, and catheter placement should be considered before inducing GA. The hand injury repair may be done concurrently with other procedures in multiple-trauma victims.

(Print pagebreak 934)

Induction

Rapid-sequence induction ([p. B-4](#)) is mandatory in emergency cases, unless awake intubation is performed. C-spine fracture patients and those with facial injuries may require awake fiber optic intubation ([p. B-5](#)). Hemodynamically unstable, acute-trauma patients may be induced more safely with etomidate or ketamine.

Standard maintenance ([p. B-2](#)) for stable patients. Hemodynamically unstable, acute-trauma victims undergoing emergency surgery may be better served by using a combination of medications designed to have minimal hemodynamic consequences (e.g., fentanyl for analgesia, vecuronium for muscle relaxation, and scopolamine or midazolam for amnesia). NQ is best avoided in the trauma patient.

Difficult airway or full-stomach cases require awake extubation. Trauma victims who have undergone a prolonged procedure or who have significant associated cardiopulmonary injuries should remain intubated for postop mechanical ventilation.

Significant blood loss

A 16-ga iv catheter in nonoperative upper extremity should be adequate in

IV: 16 ga × 1

NS/LR @ 1.5–3 mL/kg/h + replacement of blood loss

hemodynamically stable patients. Acute-trauma victims who are unstable require a minimum of two large-bore iv catheters or large-bore central lines.

Fluid/blood warmers, heating blanket, warmed circuit humidifier

Invasive hemodynamic monitoring and TEE should be considered in acute, multiple-trauma victims.

Emergency

Blood and fluid requirements

Standard monitors ([p. B-1](#))

and pad pressure points.

Monitoring

Positioning

eyes.

Complications

Hemodynamic instability

Previously unrecognized injuries (e.g., pneumothorax, cardiac tamponade, intracranial bleeding) should be considered as a cause of unexplained intraop hemodynamic instability in all acute-trauma victims.

Postoperative

Complications

Sepsis

ARDS

Pain management

PCA ([p. C-3](#))

Tests

None routinely indicated.

Suggested Readings

1. Cullings HM, Hendee WR: Radiation risks in the orthopaedic operating room. *Contemp Orthop* 1984; 8:48–52.
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