Triangular Fibrocartilage Injuries 36

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DEFINITION

The triangular fibrocartilage complex (TFCC) is the primary stabilizer of the ulnar aspect of the wrist, including both radiocarpal and ulnocarpal relationships. The complex functions as both a load-bearing spacer and a ligament, and the treatment for a pathological lesion of the complex is based on the particular function affected.

ANATOMY

The TFCC is composed of the triangular fibrocartilage and the ulnocarpal ligaments. The triangular fibrocartilage arises from the superior aspect of the radial side of the distal radial-ulnar joint (sigmoid notch) and attaches to the ulna at the fovea at the base of the ulnar styloid. The portions originating at the volar and dorsal aspect of the radius and attaching to the fovea are ligamentous in structure and form stabilizing ligaments for the radioulnar joint. These portions are vascularized and are capable of healing if repaired. The central portion is composed of fibrocartilage and transmits compressive loads from the carpus to the ulnar head. This area is avascular and is not capable of healing if injured.

The ulnocarpal ligaments arise from the fovea of the distal ulna, with the triangular fibrocartilage, and insert on the volar surface of the ulnar carpus; they help stabilize the ulnar side of the carpus. The inner sheath of the extensor carpi ulnaris (ECU) is attached to the dorsal portion of the triangular fibrocartilage and further stabilizes the dorsal portion of the complex (Fig. 36-1).

CLASSIFICATION OF INJURIES

Palmer[1] classified injuries of the TFCC in two main categories based on etiology. The traumatic type occurs with isolated trauma, usually a rotation torque of the distal radioulnar joint. The degenerative type occurs from

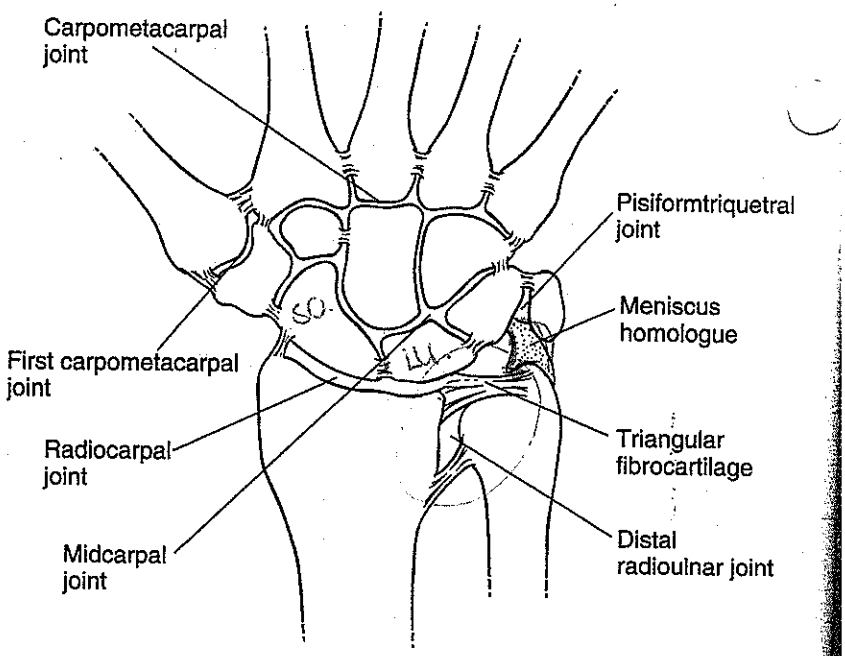

FIG. 36-1 Normal anatomy of the triangular fibrocartilage complex (TFCC). (From Cooney WP, Linscheid RL, Dobyns JH, et al.: The Wrist: Diagnosis and Operative Treatment. Mosby, St. Louis, 1998.)

repetitive compressive forces on the central portion from proximal migration of the lunate toward the ulna with forceful use of the hand. This causes progressive destruction of the central, avascular portion of the cartilage and degenerative changes on either side of the joint.

Traumatic (Type 1) Injuries (Fig. 36-2)

Involved structures may include the following:

I. Horizontal tear in the disc adjacent to the sigmoid notch of the radius
II. TFCC avulsion from the ulna
III. Avulsions of the ulnocarpal ligaments from the carpus
IV. TFCC avulsions from the sigmoid notch of the radius

Degenerative (Type 2) Injuries (Fig. 36-3)

Sequence of degenerative changes:[1]

I. Thinning of the TFCC
II. Thinning of the TFCC with chondromalacia of the ulna and lunate
III. Perforation of the TFCC with chondromalacia of the ulna and lunate
IV. Perforation of the TFCC with chondromalacia of the ulna and lunate and a lunotriquetral ligament tear
V. Perforation of the TFCC with arthritis of the ulna and lunate and a lunotriquetral ligament tear

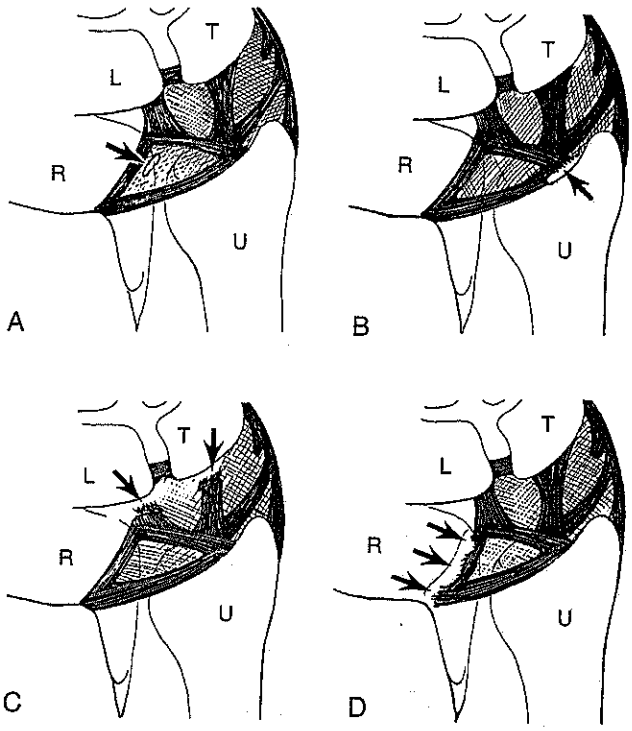

FIG. 36-2 Diagrammatic drawing of traumatic, or class I, abnormalities of the triangular fibrocartilage complex. **A,** Class IA, central perforation *(arrow)*. **B,** Class IB, ulnar avulsion *(arrow)*, with or without distal ulnar fracture. **C,** Class IC, distal avulsion *(arrows)*. **D,** Class ID, radial avulsion *(arrows)*, with or without sigmoid notch fracture. *L,* Lunate; *R,* radius; *T,* triquetrum; *U,* ulna. (Redrawn from Palmer AK: J Hand Surg Am 14:594-606, 1989 with permission from The American Society for Surgery of the Hand.)

TREATMENT INDICATIONS/TECHNIQUE

The indications for treatment of abnormalities of the TFCC are pain and/or instability. The pain may arise from instability of either the ulnocarpal or the radioulnar joints (traumatic injuries), or from the lunotriquetral joint (degenerative injuries), or from progressive degenerative changes between the ulna and lunate.

Traumatic Injuries[2]

I. The horizontal tear is in the avascular portion of the TFCC and does not involve the ligamentous portions. It is treated by arthroscopic debridement to a stable rim *(debridement treatment program)*.

II. An avulsion of the ligamentous portion of the TFCC off the ulna destabilizes the distal radioulnar joint. The ligament retracts and loses it natural tension when observed arthroscopically (the trampoline effect). It is treated by either direct repair of the ligaments to the ulna or reconstruction of the ligaments with tendon graft *(reconstruction treatment program)*.

III. Although the ulnocarpal ligaments help stabilize the ulnar side of the carpus, injuries to this complex are usually treated by

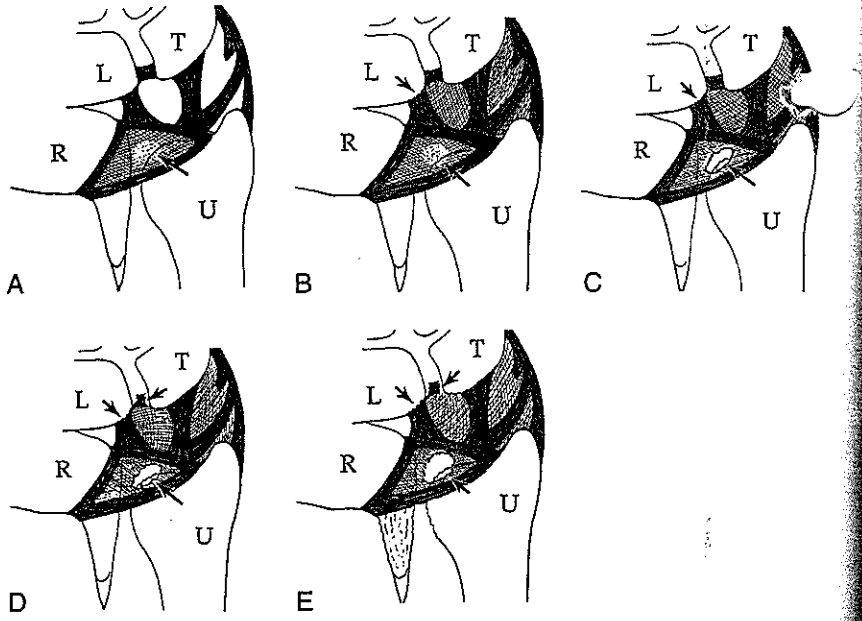

FIG. **36-3** Diagrammatic drawing of degenerative, or class 2, abnormalities of the triangular fibrocartilage complex (TFCC). **A,** Class 2A, TFCC wear *(arrow)*. **B,** Class 2B, TFCC wear with lunate *(small arrow)* and/or ulnar *(large arrow)* chondromalacia. **C,** Class 2C, TFCC perforation with lunate *(small arrow)* and/or ulnar (large arrow) chondromalacia. **D,** Class 2D, TFCC perforation with lunate *(arrow)* and/or ulnar *(large arrow)* chondromalacia and lunotriquetral ligament perforation *(small arrow)*. **E,** Class 2E, TFCC perforation with lunate *(arrow)* and/or ulnar *(large arrow)* chondromalacia, lunotriquetral ligament perforation *(small arrow)*, and ulnocarpal arthritis. *L,* lunate; *R,* radius; *T,* triquetrum; *U,* ulna. (Redrawn from Palmer AK: J Hand Surg Am 14:594-606, 1989 with permission form The American Society f Surgery of the Hand.)

arthroscopic debridement for pain *(conservative treatment program with wrist gauntlet)*.

IV. Avulsions of the TFCC off the sigmoid notch are often seen in conjunction with distal radius fractures, and they are usually initially treated with immobilization *(conservative treatment program with wrist gauntlet splint)*. The primary treatment focus should be on the distal radius fracture.

Degenerative Injuries[2]

I. Thinning of the TFCC from repetitive compressive loads does not require treatment *(conservative treatment program)*.
II. Once the compressive loads are sufficient to cause chondromalacia of the opposing joint surfaces, localized pain develops and can be treated by debridement *(conservative treatment program)*.
III. A central perforation of the TFCC leaves flaps of cartilage that mechanically impinge between the lunate and ulna, making the early degenerative changes of both surfaces more symptomatic. It is treated by debridement of the tears as well as the chondromalacia *(debridement treatment program)*.

IV. A degenerative tear of the lunotriquetral ligament adds to the localized pain. Initial treatment consists of debridement of the remaining injured structures *(debridement treatment program)*.
V. If this is insufficient, either lunotriquetral fusion[3] *(reconstruction treatment program)* or ulnar shortening[4] *(debridement treatment program)* may be considered.
VI. Advanced changes are treated with arthroscopic or open ulnar wafer procedure (removal of the distal surface of the ulna down to subchondral bone, typically 3 mm) or ulnar shortening[5] *(debridement treatment program)*.

NONOPERATIVE MANAGEMENT

TFCC injuries to the central avascular articular disk that are confirmed by magnetic resonance imaging often are not amenable to primary repair. Therefore, initial management is aimed at resting the distal radioulnar joint (DRUJ), the ECU, and the TFCC. This is accomplished with a long arm splint or cast to stop forearm rotation and weight-bearing, to facilitate rest. Activity modification and gradual exposure to activities of daily living (ADLs) risk factors is conducted in a controlled manner.

NONOPERATIVE MANAGEMENT TIMELINE[2,6,7]

I. 0 to 6 weeks: Splint is worn 18 hours/day, with no physical activity outside the splint
   A. Long arm cast or long arm splint is fitted with elbow at 70 to 90 degrees flexion, forearm and wrist in neutral[6,8] (Fig. 36-4)
   B. The splint is worn for 6 weeks to rest the TFCC.
   C. Patient education on risk factors with ADL tasks, pathology, and healing timelines

FIG. 36-4 Long arm splint.

D. ADL adaptation is explored, with patient's goals and social roles the major considerations
E. Edema control measures are started with overhead fisting, Coban wraps, and tendon gliding every hour

II. 6 weeks: The focus of rehabilitation in this phase is to restore active range of motion (AROM) of the flexor and extensor compartments and diminish joint stiffness while avoiding an increase in pain.[6]
A. AROM and active-assisted range of motion (AAROM) exercises are performed for the wrist and forearm every hour for 5 to 10 minutes.
B. AROM is conducted for the wrist (linear motion), forearm (in neutral), hand, and digits.
1. Patients can conduct the following:
a. Tendon gliding to restore muscle balance
(1) Basic four hand postures
(2) Joint blocks
(3) Flexor digitorum superficialis (FDS) individual tendon glides
b. Neural gliding to diminish the pain reflex and restore muscle balance
(1) Ulnar nerve gliding
(2) Median nerve gliding (distal)
2. Passive range of motion (PROM) may start with pronation and supination if kept below a pain reflex.
3. ADL training enhances motor control with fine motor and gross motor dexterity tasks (e.g., lacing, buttoning).
a. Basic ADL tasks work well to decrease the pain reflex and restore confidence with basic self-care.
b. *NOTE: Keep wrist in neutral with all tasks.
C. A wrist gauntlet splint (Fig. 36-5) may be appropriate to use after removal of the long arm splint, to increase the patient's tolerance to basic ADL tasks and to rest the wrist complex when not conducting the home exercise program. The splint helps control co-contraction of muscle from joint pain.[8]

III. 8 weeks: Progressive strengthening may be initiated, assuming that there is no increase in pain or discomfort and the patient is totally asymptomatic.

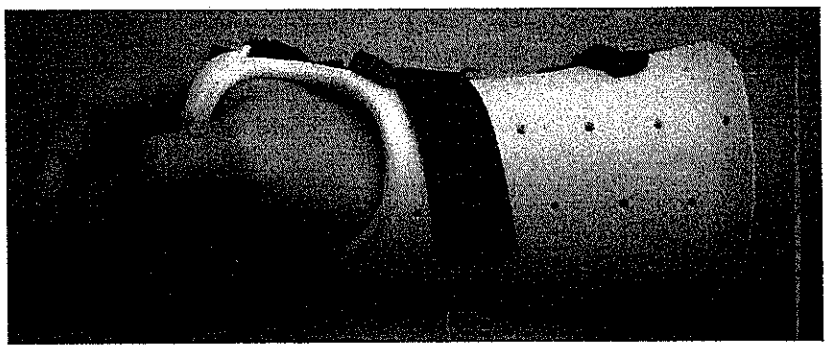

FIG. 36-5 Wrist gauntlet splint.

A. All strengthening is conducted in linear motion patterns while maintaining a neutral forearm position.
   1. Isometric strengthening with grip and hold
   2. Isotonic strengthening with putty
   3. Isotonic wrist flexion and extension with weight
B. Overhead, pronation, supination, torquing and weight-bearing activities are avoided until the patient is asymptomatic with linear-motion, forearm-neutral strengthening tasks.

IV. 10 to 12 weeks: Overhead, torquing, and weight-bearing activities may be initiated if the patient is asymptomatic. These types of tasks place direct biomechanical impingement, soft tissue torsion, and impaction stress on the TFCC. Exposure to these risk factors must be done on a gradual and guarded basis.[9]
A. The Baltimore Therapeutic Equipment (BTE) Work Simulator is recommended as an excellent tool to introduce the risk factors of radial and ulnar deviation, pronation, and supination in a safe and graded manner.
   1. First, introduce the torque motion patterns of ulnar and radial deviation, followed by pronation and supination. Progress slowly until no residual pain is noted the next treatment session. Torque motion with gradual increase in load.
   2. Final stage is torque motion with load and pace.
B. Start gradual exposure to risk factors of overhead activities, torquing tasks, and torquing tasks with load. These tasks have the highest potential for reinjury.
   1. Isometric strengthening with grip and hold (work at 10% or less of maximum voluntary effort [MVE]).
   2. Isotonic strengthening with putty (focus on complete excursion of flexor digitorum profundus [FDP]).
   3. Isotonic wrist flexion and extension with weight
C. Once the patient is asymptomatic with isometric grasp and linear isotonic wrist flexion and extension, exposure to low-load repetitive grasping may be attempted.

V. The patient may consider surgery if the pain continues with torque and weight-bearing tasks.

VI. *NOTE: Conservative management is not always considered if the problem is greater than 6 months in duration.

OPERATIVE INDICATIONS[2,7]

I. Failure of recovery of function with conservative treatment
II. Lunotriquetral ligament injury
III. Distal radioulnar joint instability

DEBRIDEMENT OF THE TFCC

Evaluation and Treatment Timeline

I. Postoperatively in 3 to 5 days[6]
A. Postoperative dressing is removed, and incision site is inspected for signs and symptoms of infection.

B. Edema control measures are taken with overhead fisting, Coban wraps or edema glove, and tendon gliding every hour.
C. A wrist gauntlet splint is appropriate to use after removal of t dressing to increase the patient's tolerance to basic ADL tasks and to rest the wrist complex when not conducting the home exercise program. The splint helps control co-contraction of muscle from joint pain[8] (see Fig. 36-5).
D. Gentle AROM exercises are initiated at the wrist (linear motion), forearm (in neutral), hand, and digits every hour for 5 to 10 minutes.
1. Tendon gliding to restore muscle balance
2. Joint blocking exercises for individual joints
3. Neural gliding to diminish the pain reflex and restore muscle balance
a. Ulnar nerve glides
b. Median nerve glides (distal)
4. ADL training to enhance motor control with fine motor and gross motor dexterity tasks (e.g., lacing, buttoning)
a. Basic ADL tasks work well to decrease the pain reflex and restore confidence with basic self-care.
b. *NOTE: Keep wrist in neutral with all tasks.

II. 7 to 10 days
A. Sutures are removed, and incision site is inspected for signs and symptoms of infection
B. Scar management
1. Silicone or elastomer applied directly to the scar 1 day after removal of sutures.
2. Scar pad is worn half of the day and all night to diminish scar pain.
C. Wrist gauntlet is worn part-time for support and comfort as needed for 10 days to 4 weeks.
D. The patient continues to focus on AROM exercises for the digits, hand, and wrist, to create proper muscle lengths to facilitate normal function with ADL tasks.
E. The patient continues self-care ADL tasks to restore motor control.

III. 4 to 6 weeks
A. AAROM and PROM may begin below pain reflex.
B. The patient may start gentle isotonic strengthening with light putty with forearm in neutral position.
C. Treatment focuses on end-range motion below pain reflex to restore full ROM and diminish adaptive shortening of muscles.
D. Patient should continue prior AROM recommendations.

IV. Week 6
A. PROM and static progressive splinting may be considered, assuming that the patient does not have pain with progressive exercises, the scar is mature, and the major limiting factor is extrinsic extensor tightness or joint stiffness.
1. Static progressive wrist flexion/extension or pronation/supination splinting should be applied with the load tolerable to wear a minimum of 2 hours.
2. Patient education is critical, with the focus on stretch

versus pain. Directional forces are alternated throughout the day in the exercise program.

3. Emphasis can be placed in a specific direction, but always seek establishment of wrist extension before flexion—this facilitates the grasp reflex, increases function, and diminishes impairment.

B. Progressive strengthening may be initiated.
   1. Isotonic strengthening with putty
   2. Isotonic wrist flexion and extension with weight
   3. Isometric strengthening with grip and hold
      a. Normally, start with a 10-lb gripper—hold 30 seconds, rest 1 minute; do 5 repetitions twice per day. This is increased to hold 1 minute, rest 1 minute with 10-lb gripper 5 times twice per day.
      b. *NOTE: All strengthening is conducted in linear motion patterns while maintaining a neutral forearm position.

C. Overhead tasks, torquing tasks, and weight-bearing tasks are initiated if the patient is asymptomatic with linear-motion, forearm-neutral strengthening tasks. These types of tasks place direct biomechanical impingement, soft tissue torsion, and impaction stress on the TFCC. Exposure to these risk factors must be done on a gradual and guarded basis.[9-11]
   1. First, introduce the torque motion patterns of ulnar and radial deviation; gradual increase in time, with the patient working at his or her own pace.
   2. Ulnar and radial deviation torque motion with load and pace.
   3. Pronation and supination torque motion; gradual increase in time, with the patient working at his or her own pace.
   4. Pronation and supination torque motion with load and pace.

V. The patient may consider vocational change if the pain continues with torque and weight-bearing tasks.

VI. Other treatment considerations
   A. Use of minivibrator (padded) for scar pain and adhesions at the incision site
   B. Use of transcutaneous electrical nerve stimulation (TENS) unit to diminish pain while conducting exercises after surgery
   C. Static progressive splinting (see earlier description) should be used with caution, because it can increase pain and discomfort.
      1. The patient is instructed to set the tension level of the static progressive splint at a point at which the splint can be worn for a minimum of 1 hour without pain; the patient should feel a stretch, but no pain, while using the splint.
      2. The goal is to increase splint wear to 2 hours on, 1 hour off per day. The splint is used until the desired motion is met.

VII. Patient education key points
   A. Conduct AROM in a pain-free fashion while not wearing the splint.
   B. Avoid overhead activity, torquing tasks (pronation, supination, and radial/ulnar deviation), and weight-bearing tasks.
   C. Conduct basic ADL tasks such as laundry, groceries, and meal preparation below pain level with splint until clearance by physician or therapist.

Postoperative Complications with Central Lesion Repair[2,7]

I. Failure of recovery of function
II. Painful neuroma, which can lead to complex regional pain syndrome (CRPS)
III. Infection
IV. Hypersensitive scar
V. DRUJ instability
VI. Extensor tendon injury
VII. Nerve injury

PRIMARY REPAIR OF TFCC PERIPHERAL TEAR

Surgical Indications

Injury to the peripheral TFCC can result in instability of the DRUJ and chronic ulnar carpal pain. Tears to the well-vascularized peripheral area are considered eligible for direct repair. The radial side has poor vascularity but can also be repaired to improve function.[2]

Evaluation and Treatment Timeline[2,6,7]

I. 0 to 10 or 14 days
   A. Immobilization in postoperative splint or cast
II. 7 or 10 days to 8 weeks
   A. The postoperative dressing is removed, and the patient is fitted with a long arm cast or long arm splint with elbow at 90 degrees flexion, forearm in neutral, and wrist in neutral[8] (see Fig. 36-4), or a Muenster-type splint to allow elbow flexion/extension while preventing forearm rotation.
   B. If DRUJ pinned, the patient will conduct pin care with 50% peroxide and 50% sterile water and change of dressings daily or according to the surgeon's preference.
   C. Patient is educated on signs and symptoms of infection with skin care.
   D. AROM exercises are initiated for digits (to prevent or diminish edema, intrinsic tightness, extrinsic tightness, and joint capsule stiffness)
      1. Overhead fisting for edema control
      2. Basic-4 hand postures
      3. Joint blocks for metacarpophalangeal, proximal interphalangeal, and distal interphalangeal joints
III. Weeks 3 to 4
   A. DRUJ pin usually is removed, and gentle wrist flexion and extension is initiated.
   B. PROM with supination to 45 to 60 degrees, depending on the tear, the repair, and the surgeon's preference.
IV. Weeks 6 to 8+
   A. Full AROM for flexion, extension, pronation, and supination should be the treatment goal.
   B. Terminal passive motion to pain tolerance.

V. 8 weeks
   A. AROM/PROM and AAROM are initiated to the forearm, wrist, and hand every hour for 5 to 10 minutes.
   B. PROM (rarely needed) and static progressive wrist splinting may be applied, assuming that the patient does not have pain with progressive exercises.
      1. Static progressive wrist splinting should be applied with the load tolerable to wear a minimum of 2 hours.
      2. Patient education is critical, with the focus on stretch versus pain. Directional forces are alternated throughout the day in the exercise program.
      3. Emphasis can be placed in a specific direction, but always seek to establish wrist extension before flexion; this facilitates the grasp reflex, increases function, and diminishes impairment.
      4. The patient wears a wrist gauntlet to protect the surgical repair while conducting ADL tasks. The splint diminishes pain and allows the wrist joint and muscles to rest while not conducting exercises. ADL training is initiated to restore motor control for self-care, grooming, and fine motor grasp and dexterity (see Fig. 36-5).

VI. 8 to 12 weeks
   A. The patient begins isotonic strengthening with putty, progressing to isometric grip and isotonic wrist flexion and extension.
      1. All strengthening is conducted in linear motion patterns while maintaining a neutral forearm position.
      2. Isometric strengthening with grip and hold (work at 10% or less of MVE)
      3. Isotonic strengthening with putty (focus on complete excursion of FDP)
      4. Isotonic wrist flexion and extension with weight
      5. Focus on speed and control of movement to maximize motor recruitment.
      6. Disallow recruitment of extensor digitorum communis (EDC) for wrist extension, because this will impair the natural grasp reflex.

VII. 12+ weeks
   A. Overhead activities, pronation, and supination torquing tasks and weight-bearing tasks are avoided until the patient is asymptomatic with linear-motion, forearm-neutral strengthening tasks.
   B. Start gradual exposure to overhead activities, torquing tasks, and torquing tasks with load.
      1. Isometric strengthening with grip and hold (work at 10% or less of MVE)
      2. Isotonic strengthening with putty (focus on complete excursion of FDP)
      3. Isotonic wrist flexion and extension with weight
   C. Once the patient is asymptomatic with isometric grasp and linear isotonic wrist flexion and extension, exposure to low-load repetitive grasping may be attempted.

D. If the patient is asymptomatic with repetitive grasping, then progress to overhead, pronation, supination, ulnar and radial deviation, and weight-bearing tasks. These types of tasks place direct biomechanical impingement, soft tissue torsion, and impaction stress on the TFCC. Exposure to these risk factors must be done on a gradual and guarded basis.
    a. First, introduce the torque motion patterns of ulnar and radial deviation, progressing to pronation, and supination. *NOTE: Supination is initiated before pronation, to avoid loading of the TFCC.
    b. Torque motion with gradual increase in load
    c. Final stage is torque motion with load and pace
    d. *NOTE: This progression is critical for predicting a safe return to activity level.

VIII. Other treatment considerations
A. All treatment programs, including splints, should avoid pain reflex and increase in pain, particularly to the ulnar side of the wrist.
B. All exercises, equipment, and strengthening should be performed in a forearm-neutral position, avoiding pronation and supination.
C. These exercises can be gradually progressed to supinated and then pronated postures while strengthening.
D. TENS units may be used and may be found helpful to diminish postoperative joint capsule pain, muscle guarding, and autonomic flare response from the surgical repair.
E. The patient may have to wear a wrist gauntlet splint for heavy instrumental activities of daily living (IADL) tasks such as yard work and manual labor for up to 6 months after surgery to support the TFCC repair.

POSTOPERATIVE COMPLICATIONS WITH PERIPHERAL LESION REPAIR

I. Failure of recovery of function
II. Painful neuroma
III. Infection
IV. Hypersensitive scar
V. Nerve injury (dorsal branch ulnar sensory can lead to CRPS)
VI. Failure to relieve symptoms

OUTCOMES

A radial nerve lesion can be devastating to a patient with the loss of functional dexterity. The functional outcome of radial nerve lesions is dependent on the severity index, location of the injury, age of the patient, and skill levels of the hand surgeon and the hand therapist. The majority of radial nerve lesions when managed by a hand surgeon realize functional recovery and independence with ADL tasks.

The therapist can enhance the functional outcome with detailed evaluations, which will provide the patient with the appropriate custom splints, a graded rehabilitation program, and recommendations on ADL adaptations.