جَامعة
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MANARA UNIVERSITY

Hand Impairments

HAND THERAPY CONCEPTS:

1. Tissue Healing
2. Antideformity Positioning
3. The Myth of No Pain, No Gain
4. Passive Range of Motion Can Be Injurious
5. Isolated Exercise, Purposeful Activity, and Therapeutic Occupation

1. Tissue Healing

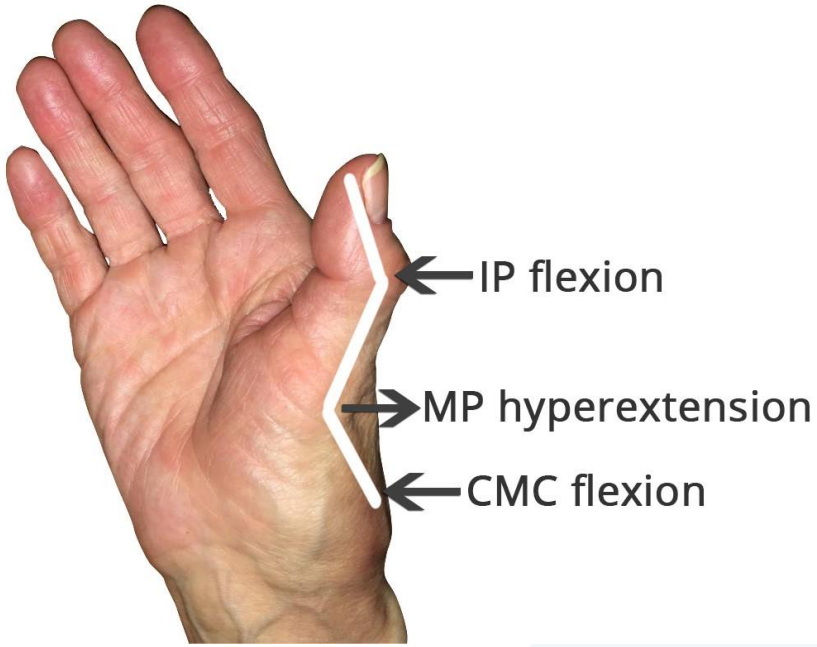
- Tissue heals in phases as follows: inflammation, fibroplasia, and maturation or remodelling.
- The inflammation phase lasts several days. It includes vasoconstriction followed by vasodilation, with white blood cell migration to promote phagocytic removal of foreign bodies and dead tissue. Depending on the diagnosis, immobilization to provide rest is often advised during the inflammation phase.

- The fibroplasia phase starts at approximately day 4 and continues for 2–6 weeks. In this phase, fibroblasts synthesize scar tissue.
- The wound's tensile strength increases gradually with the increase in collagen fibres.
- At this time, active range of motion (AROM) and orthotics may be appropriate to protect healing tissues and promote balance in the hand.

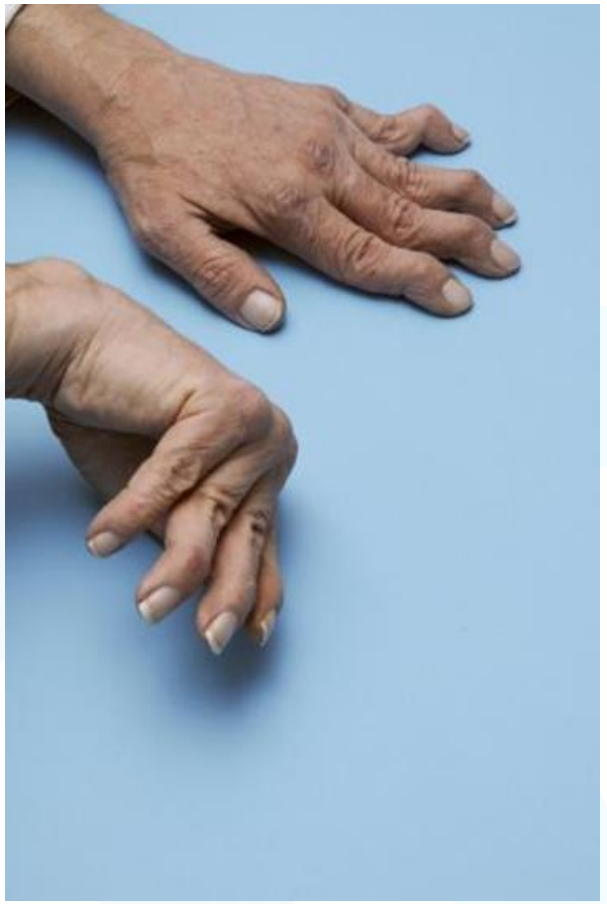
- The maturation, or remodelling, phase may last for years, but tissue is usually more responsive early rather than late in this period. The remodelling phase reflects the changing architecture and improved organization of collagen fibres and the associated increased tensile strength.
- Gentle resistive activity may be appropriate during maturation, but it may also generate inflammatory responses, which should be avoided. Gentle application of corrective dynamic or static orthoses may also be appropriate.
- Tolerance of tissues to controlled stress requires monitoring throughout all phases of intervention. As tissue continues to heal, the wound contracts, and the scar shrinks. Collagen continues to remodel, as it is constantly doing in uninjured tissue.

2. Antideformity Positioning

- Upper extremity injury and disuse are associated with predictable deforming hand positions. Oedema, which typically accompanies injury, creates tension on extrinsic extensor structures. This leads to a zigzag collapse with a resulting deformity position of flexed wrist, hyperextended metaphalangeals (MPs), flexed (IP) or (hyperextended proximal interphalangeals (PIPs) and flexed distal interphalangeals (DIPs)), and adducted thumb.



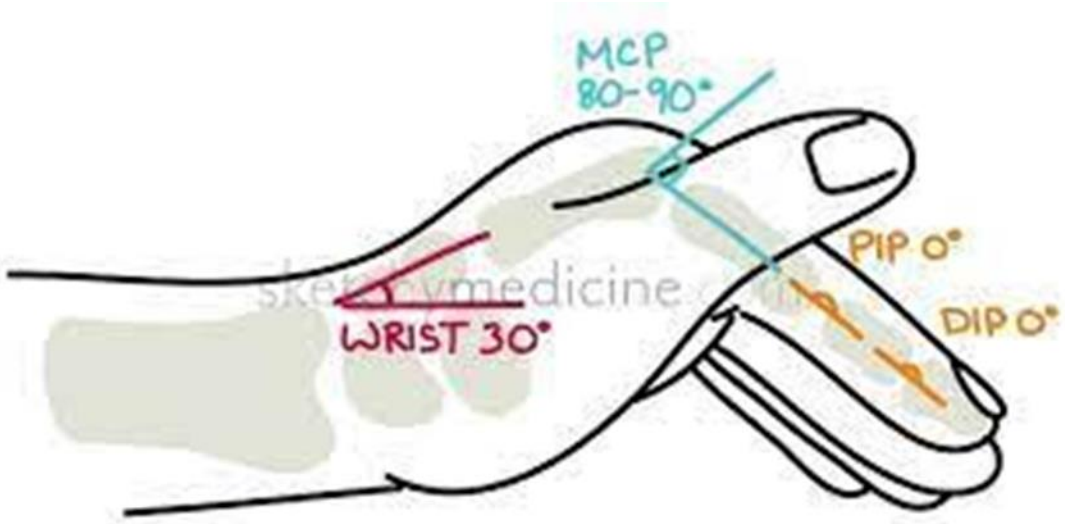
Zig Zag Deformity of the Thumb



- Hand joints are anatomically destined to stiffen in predictable positions. Specifically, the MP joint is prone to stiffen in extension. This is because the protruding or cam shape of the metacarpal head causes the collateral ligament to be slack in MP extension and taut in MP flexion. Conversely, the interphalangeal (IP) joints are prone to become stiff in flexion because of shortening of the volar plate and collateral ligaments.

- When prolonged or constant immobilization is necessary and range of motion (ROM) is at risk, it is usually best to splint the patient's hand in the antideformity position , also called the intrinsic-plus position.
- This position places the wrist in neutral or extension, the MPs in flexion, the IPs in extension, and the thumb in abduction and opposition. The antideformity position allows the collateral ligaments at the MP joints and the volar plate at the IP joints to maintain their length, which counteracts the forces that promote zigzag collapse.

- Certain diagnoses, such as flexor or extensor tendon repair, are not compatible with antideformity positioning. The physician can assist in this determination.



3. The Myth of No Pain, No Gain

- Regarding tissue tolerances, the myth of “no pain, no gain” must be dispelled in hand therapy. A better mindset would be no pain, more gain. Well-intentioned therapists and overzealous family members of patients have too often caused irreversible damage by applying passive range of motion (PROM) forces beyond the tissues’ tolerances. Pain induced by therapy can also cause complex regional pain syndrome (CRPS).

- People with upper extremity problems often arrive at therapy prepared for painful intervention. Some patients do not tell the therapist when intervention hurts. It is essential to educate patients about this. In addition, watch the patient's body language and face for signs of pain.
- Wincing and withdrawing the upper extremity are obvious signals. Proximal guarding is another revealing response. Change the intervention accordingly, and if necessary, try a hands-off approach wherein the therapist coaches and instructs while the patient self-treats.

4. Passive Range of Motion Can Be Injurious

- PROM can be injurious to the delicate tissues of the hand. Specifically, PROM can disturb healing tissues and incite further inflammatory reactions, resulting in increased scar production. PROM can damage articular structures and can even trigger CRPS. A tissue's timeline for remodelling is maximized by non inflaming intervention and is cut short by intervention that is inflaming or provoking.
- For all of these reasons, if PROM is clinically appropriate, be sure it is done gently and in a pain-free manner. Low load, long-duration splinting is a safer and more effective method for remodelling tissue and increasing PROM

- The potential for harm may be compounded if PROM is performed following external application of heat. External application of heat, such as a hot pack, is a popular way to prepare tissues for stretching. Unfortunately, the clinical concerns of externally applied heat have received less attention than they deserve. Heat increases oedema, which acts like glue. Heat may degrade collagen and contribute to microscopic tears. Heat may also incur a rebound effect, with stiffening following its use.

- Safety Message: Do not use heat on patients who have oedema or sensory loss or whose limb appears inflamed. Overall, it is safer to use aerobic exercise to warm up the tissues of people with hand impairments. If external application of heat is used, elevate the upper extremity, be gentle with exercise, and promote active movement in conjunction with the heat. Continue to monitor for immediate and subsequent signs of inflammation.

5. Isolated Exercise, Purposeful Activity, and Therapeutic Occupation

- Technically, it is necessary to treat hand impairments with a structure-specific approach to isolate and care for the discrete components that are involved.
- Although some hand therapists do incorporate purposeful activity into intervention, more support is needed for an alternative approach to hand therapy that leads with concepts of therapeutic occupation. One way to achieve this is to integrate patient-directed goals and activities of daily living (ADL) into hand therapy intervention planning and implementation. Whenever possible, encourage upper extremity use in ordinary daily activities as appropriate to the diagnosis. Explore the capabilities in the clinic, and then teach patients to do activities at home. For example, folding socks and underwear can be upgraded to folding heavy towels and jeans, which require greater strength and endurance.

- Occupation elicits adaptive responses that do not occur with exercise alone. Compared to isolated exercise, purposeful activity or occupation promotes more coordination and better movement quality. An example of isolated hand therapy exercise to increase grip strength is gross grasp with therapy putty or exercise grippers. An example of purposeful activity to increase strength would be putting away groceries, starting with light items and progressing to heavier objects.
- The examples cited earlier become therapeutic occupation with the use of activity that is meaningful to the particular person to accomplish the therapeutic goal. If the patient enjoys baking, then rolling dough with a rolling pin would be a therapeutic occupation to promote grip function.

EVALUATION

- **History:**

History taking as part of the occupational profile offers an excellent opportunity to establish therapeutic rapport.

Assess deficits in the areas of occupation by asking what the patient cannot do that he or she wants to do, needs to do, or is expected to do. Also discuss the case with the physician.

For trauma, learn the date of injury, dates of any surgery, where and how injury occurred, mechanism of injury, posture of the hand when it was injured, and any previous intervention.

For nontraumatic problems, learn the date of onset, whether the symptoms are worsening, sequence of onset of symptoms, functional effects, and what worsens and/or lessens the symptoms

- **Pain**

Pain may be acute or chronic. Acute pain has a sudden and recent onset, usually has a limited course with an identifiable cause, and can last a few minutes to 6 months. Acute pain serves a physiological purpose, signalling the need to protect tissue from further damage. Chronic pain lasts months or years longer than expected and may not serve a physiological purpose. Myofascial pain, which may be chronic or acute, stems from local irritation in fascia, muscle, tendon, or ligament. It has specific reproducible pain patterns and associated autonomic symptoms.

Evaluation of pain may include a graphic representation of pain, in which the patient marks painful areas on a drawing of the human body; analog pain rating scales, joint or muscle palpation to identify areas of local pain or qualitative changes in soft tissue; and trigger point sensitivity

- **Physical Examination**

It is helpful to observe the positioning and use of the patient's upper extremity in the waiting area before the meeting. On examination, look at the entire unclothed upper extremity for posture, guarding and gesturing, atrophy, and oedema.

Because distal symptoms are often caused by proximal problems, it is important to perform a cervical screening , which is a proximal screening assessment of the neck and shoulder, to identify additional areas requiring intervention

- **Wounds**

Evaluate wound size in terms of length, width, and depth. Wound drainage (exudate) is bloody (sanguinous), serous (clear or yellow), purulent (pus), or deep or dark red (hematoma). Wound odour is absent or foul.

The three-color concept (red, yellow, or black) dictates wound care. Wounds can be one of or a combination of these three colours. A red wound is healing, uninfected, and composed of revascularization and granulation tissue. A yellow wound has an exudate that requires cleansing and debridement. A black wound is necrotic and requires debridement. The goal of wound care is to convert yellow and black wounds to red wounds

- **Scar Assessment**

Observe scar location, length, width, and height. Hypertrophic scars stay confined to theKeloids area of the original wound and usually resolve within a year. proliferate outside the area of the original wound and do not usually become smaller or less pigmented with time. Note any scar tethering or adherence of skin and tendon causing restricted movement. Any wound or scar crossing a joint may form a contracture , which restricts passive motion. An immature scar has a red or purplish colour imparted by its vascularity. It blanches to touch. A mature scar is flatter and softer. It has a neutral color and does not blanch to touch

- **Vascular Assessment**

Cyanosis, erythema, pallor, gangrene colour indicates vascular compromise. To test digital capillary refill, apply pressure to the fingernail or distal pad of the involved digit. Colour should return within 2 seconds of release of pressure. Compare the refill time to that of uninvolved digits


Gangrene of the tip of ring finger
Early ischemic changes

- **Oedema**

Circumferential measurement is quick to perform and provides a good alternative when it is not possible to use a volumeter. Be consistent with measuring tape placement and tension. Volumetric measurement is contraindicated for open wounds, percutaneous pinning such as Kirschner wires, plaster casts, or vasomotor instability.

- **Range of Motion**

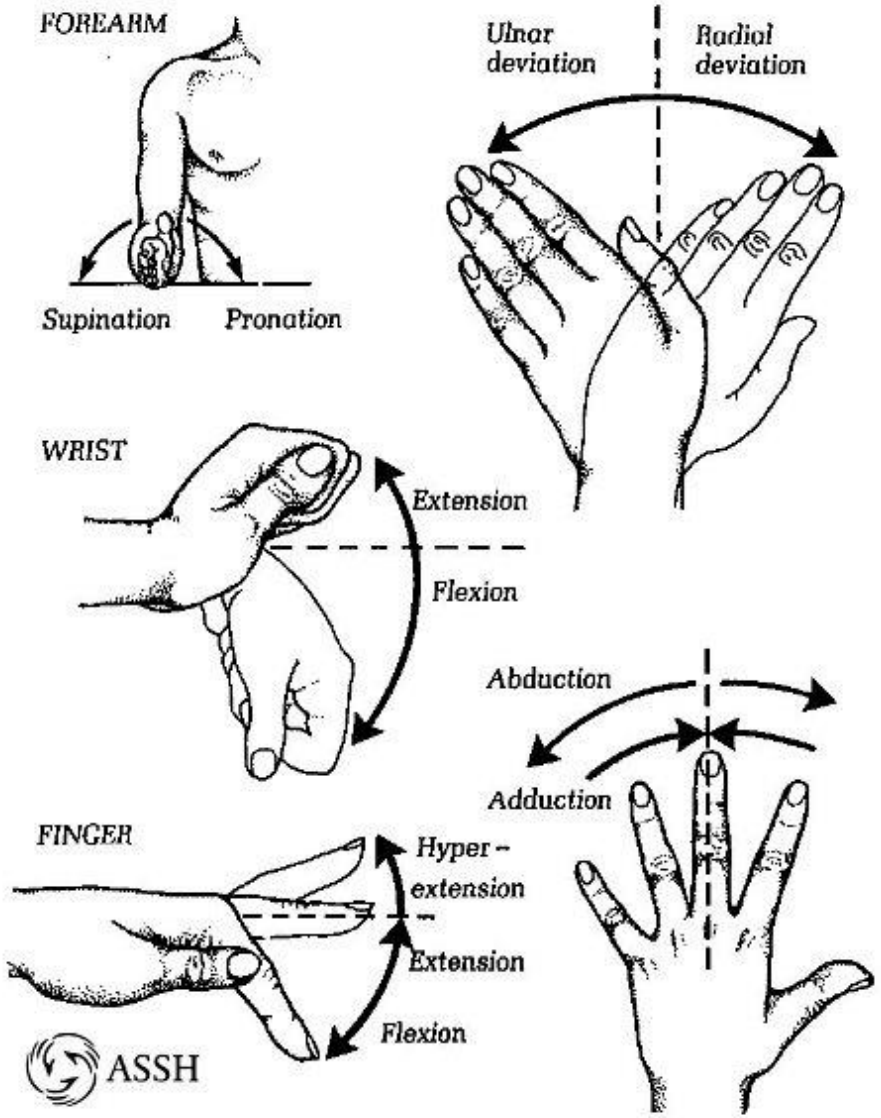
In hand therapy, both AROM and PROM should be evaluated and compared to the uninjured extremity. Facilities usually have their own guidelines for measuring ROM. As expected, consistency of retesting is important.

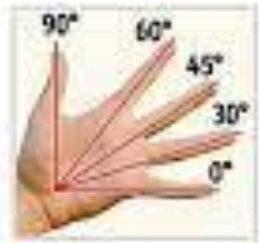
Total active motion (TAM) or total passive motion (TPM) measures the sum of composite digital flexion and extension. This measurement is used in some studies.

Normal TAM and TPM are 270°

Total Active Motion (TAM) and Total Passive Motion (TPM)

- Add the measurements for flexion of the MP, PIP, and DIP joints.
- Subtract the combined deficits in extension for those joints.
- For example, if the digital AROM is MP: 10–50, PIP: 20–70, DIP: 0–40, the total active motion (TAM) would be 160 (flexion total) minus 30 (extension deficits total) = 130 TAM.


FOREARM
Supination
Pronation
Ulnar deviation
Radial deviation
WRIST
Extension
Flexion
Abduction
Adduction
FINGER
Hyper – extension
Extension
Flexion
ASSH

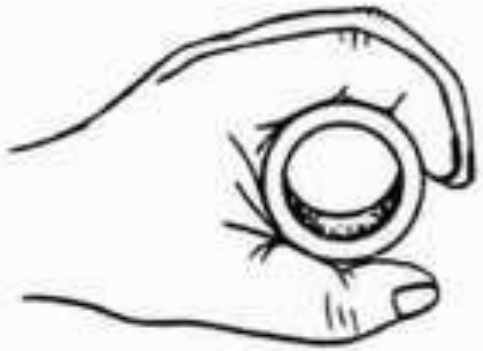

90°
60°
45°
30°
0°

- **Grip and Pinch**

When properly calibrated, the Jamar dynamometer is one of the best instruments to assess grip strength because of its reliability, face validity, and accuracy.

Hand therapy authorities recommend comparing scores with those of the contralateral extremity rather than using norms. Goals for grip and pinch strength depend on occupational factors and dominance. There ma be approximately 10%–15% difference in strength between dominant and nondominant hands, with dominant hand usually being stronger. It is routine to measure three pinch patterns: lateral, three-jaw chuck, and tip. As with grip, compare pinch scores with those of the contralateral extremity.

Types of Prehension



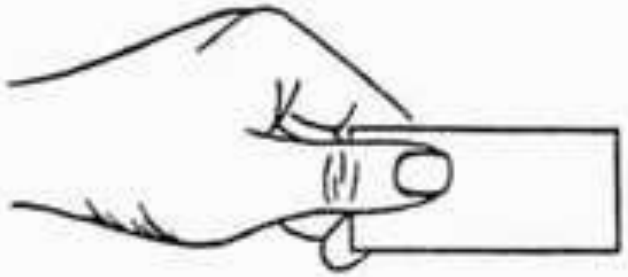
Cylindrical Grasp

Tip

Hook or Snap

3 Jaw Chuck

Spherical Grasp



Lateral

3-Jaw Chuck Grasp

Tripod Grasp

No linear relationship exists between improvement in grip and pinch strength and improvement in function. Rice, Leonard, and Carter (1998) noted that even debilitated, deformed hands could be surprisingly functional. These authors found only weak relationships between grip and pinch strength and the forces required to open six containers used commonly in the home. Thus, grip and pinch testing are not substitutes for ADL assessment with contextual relevance (Liepert, 2010). To promote occupational functioning of people with hand impairments, it is far better to have intervention and goals reflect personally meaningful ADL than grip or pinch strength measures.

- **Manual Muscle Testing**
- Manual muscle testing is particularly useful for monitoring progress following peripheral nerve lesions. Facilities usually have their preferred method of grading, which may be numerical or descriptive.

- **Sensibility**
- Inspect the patient's hand for dryness, moistness, and calluses. Blisters may be an alert to injurious hand use because of sensory loss. "Wear marks" illustrate where and how the hand is used and which parts of the hand avoid use, indicating sensory impairment.
- The Semmes-Weinstein Monofilament Test and the Two-Point Discrimination (2PD) test are most commonly used in hand therapy. The Semmes-Weinstein Monofilament Test assesses pressure threshold, and the 2PD assesses density of receptors. The Moberg Pickup Test is a functional test appropriate for use on patients with median or median and ulnar nerve lesions.

- **Sensory Examination**

Exam in this order

  - Superficial (Exteroceptive) sensation
  - Proprioceptive(deep) sensation
  - Combined cortical sensations.

- If the superficial sensation is impaired then some impairment is also seen in deep and combined sensations.
- Sensory tests are done from the distal to the proximal direction.

Superficial Sensation	Deep Sensation	Combined Cortical Sensation
1. Pain Perception 2. Temperature Awareness 3. Touch Awareness 4. Pressure Perception	1. Kinesthesia Awareness 2. Vibration Perception	1. Stereognosis Perception 2. Tactile Localization 3. Two-Point Discrimination 4. Double Simultaneous Stimulation 5. Graphesthesia 6. Recognition of Texture 7. Barognosis

- Pain Perception

- It is also known as sharp/dull discrimination. To test this sensation, the sharp and dull end of any objects like a safety pin, a reshaped paperclip, or neurological pin is used. The sharp and dull end is randomly applied perpendicular to the skin, should not be applied too close to each other or in a too rapid manner to avoid the summation of impulses. The patient is asked verbally to indicate sharp/dull when a stimulus is felt. All areas of the body should be tested. After testing the instrument should be sterilized or disposed.

- Temperature Awareness

- Two test tubes with stoppers are required for this examination; one should be filled with the cold water (between 5°C to 10°C) and warm water(40°C to 45°C). It should be taken care that the temperature should remain within this range for accuracy. The test tubes are randomly placed in contact with the skin area to be tested. All skin surfaces should be tested. The patient is asked to respond hot and cold after each stimulus application.

- Touch Awareness

- A piece of cotton, camel-hair brush, or tissue is used to perceive the tactile touch input. Light touch or stroke is applied in the area to be tested. The patient is asked to indicate where he/she recognizes that a stimulus has been applied.

- Pressure Perception

- The therapist's fingertip or a double-tipped cotton swab is used to apply a firm pressure on the skin surface. The patient is asked to indicate when an applied stimulus is recognized.

- Kinesthesia Awareness

- Awareness of movement is known as kinesthesia. The Therapist passively moves a joint through a relatively small range of motion and the patient is asked to describe the direction of movement. The patient can also respond by simultaneously duplicating the movement with the opposite extremity.

- Proprioception Awareness

- Proprioception includes position sense and awareness of joint at rest. The joint is moved through a range of motion and held in static position by the therapist, the patient is asked to describe the position either verbally or by demonstrating on another limb.

- Vibration Perception

- The perception of a vibratory stimulus is tested by placing the base of the vibrating tuning fork on the bony prominence(sternum, elbow, ankle). Generally, the tuning fork should be of 128Hz. If there is impairment patient will be unable to distinguish between a vibrating and nonvibrating tuning fork. Therefore, there should be a random application of vibrating and nonvibrating stimuli.

- Stereognosis Perception

- Tactile object recognition is determined in this test. A familiar object of different shape and size are required like keys, coins, combs, safety pins, pencils). A single object is placed in a hand and the patient manipulates it to identify the object and say it verbally. For speech impairment patients sensory testing shield can be used.

- Tactile Localization

- The test checks the ability to localize touch sensation on the skin. This test is not performed in isolated manner rather it is done in combination with pressure perception or touch awareness.

- Two-Point Discrimination

- It determines the ability to perceive two points applied to the skin simultaneously. Aesthesiometer or the circular two-point discriminator are the devices to test. The two tips of the instrument are applied to the skin simultaneously with the tip spread apart. With each successive application, the two tips are gradually brought closer together until the stimuli are perceived as one. The smallest distance between the stimuli that is still perceived as two distinct points is measured.

- Double Simultaneous Stimulation(DSS)

- DSS examines the ability to perceive a simultaneous touch stimulus on opposite sides of the body; proximally and distally on a single extremity; or proximally and distally on one side of the body.

- Graphesthesia(Traced Figure Identification)

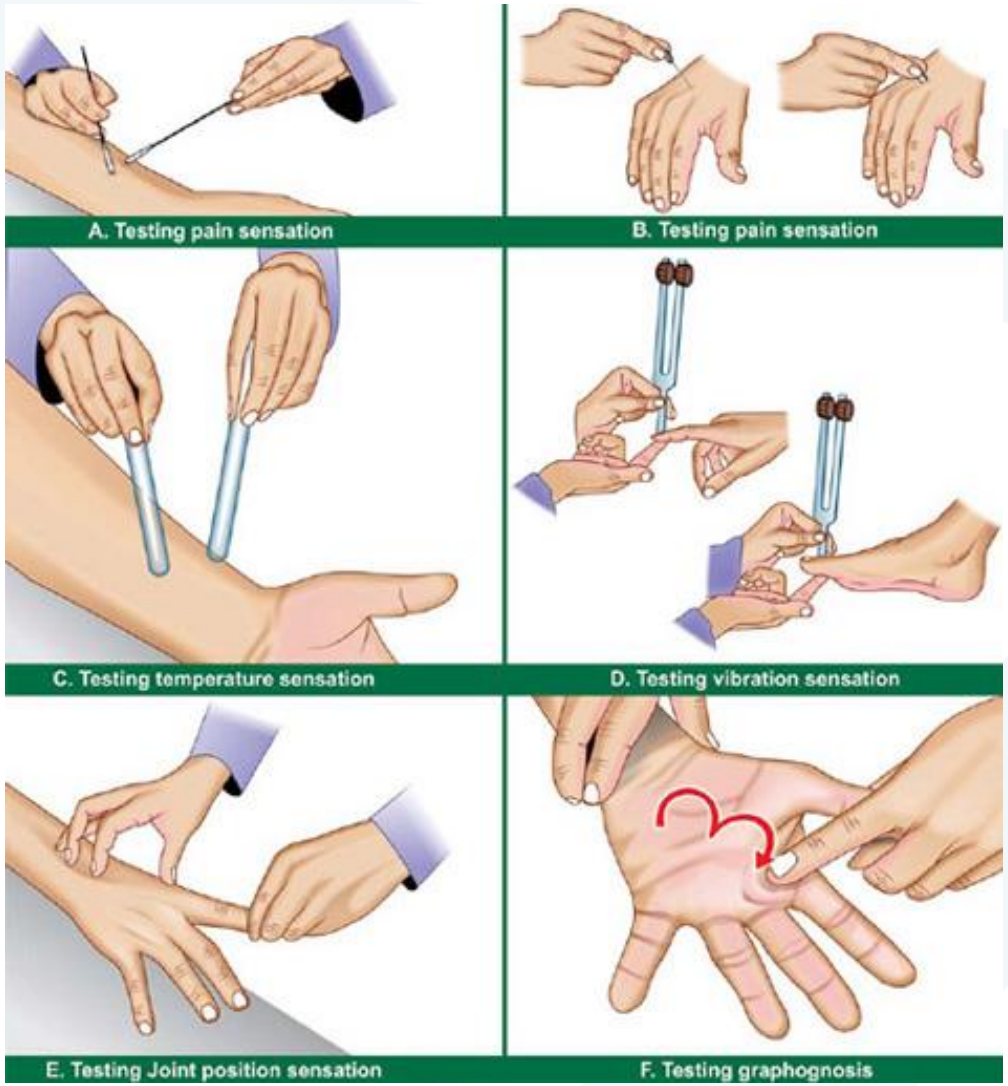
- The ability to recognize letters, numbers, or designs traced on the skin is examined using fingertip or the eraser end of the pencil. the patient is asked verbally the figures drawn on the skin.

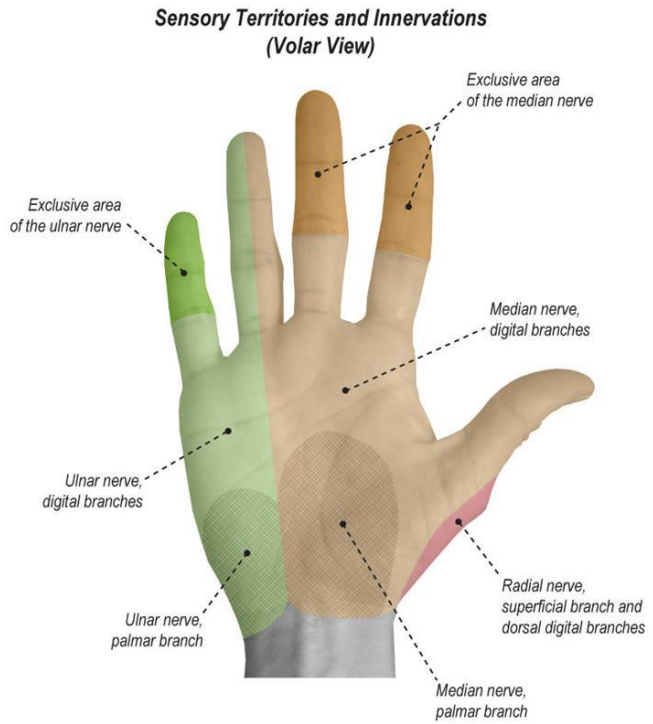
- Recognition of Texture

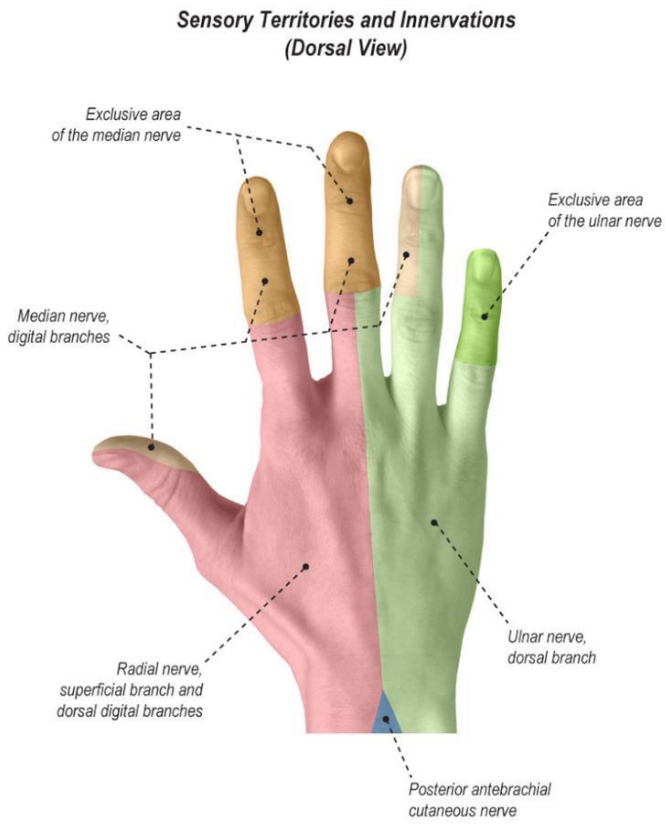
- The test examine the ability to differentiate among various textures like cotton, wool, or silk.

- Barognosis(Recognition of weight)

- For the test different weights are used. the therapist may choose to place a series of different weights in the same hand one at a time, place a different weight in each hand simultaneously.


A. Testing pain sensation
B. Testing pain sensation
C. Testing temperature sensation
D. Testing vibration sensation
E. Testing Joint position sensation
F. Testing graphognosis


Sensory Territories and Innervations
(Volar View)
Exclusive area of the median nerve
Exclusive area of the ulnar nerve
Median nerve, digital branches
Ulnar nerve, digital branches
Radial nerve, superficial branch and dorsal digital branches
Ulnar nerve, palmar branch
Median nerve, palmar branch

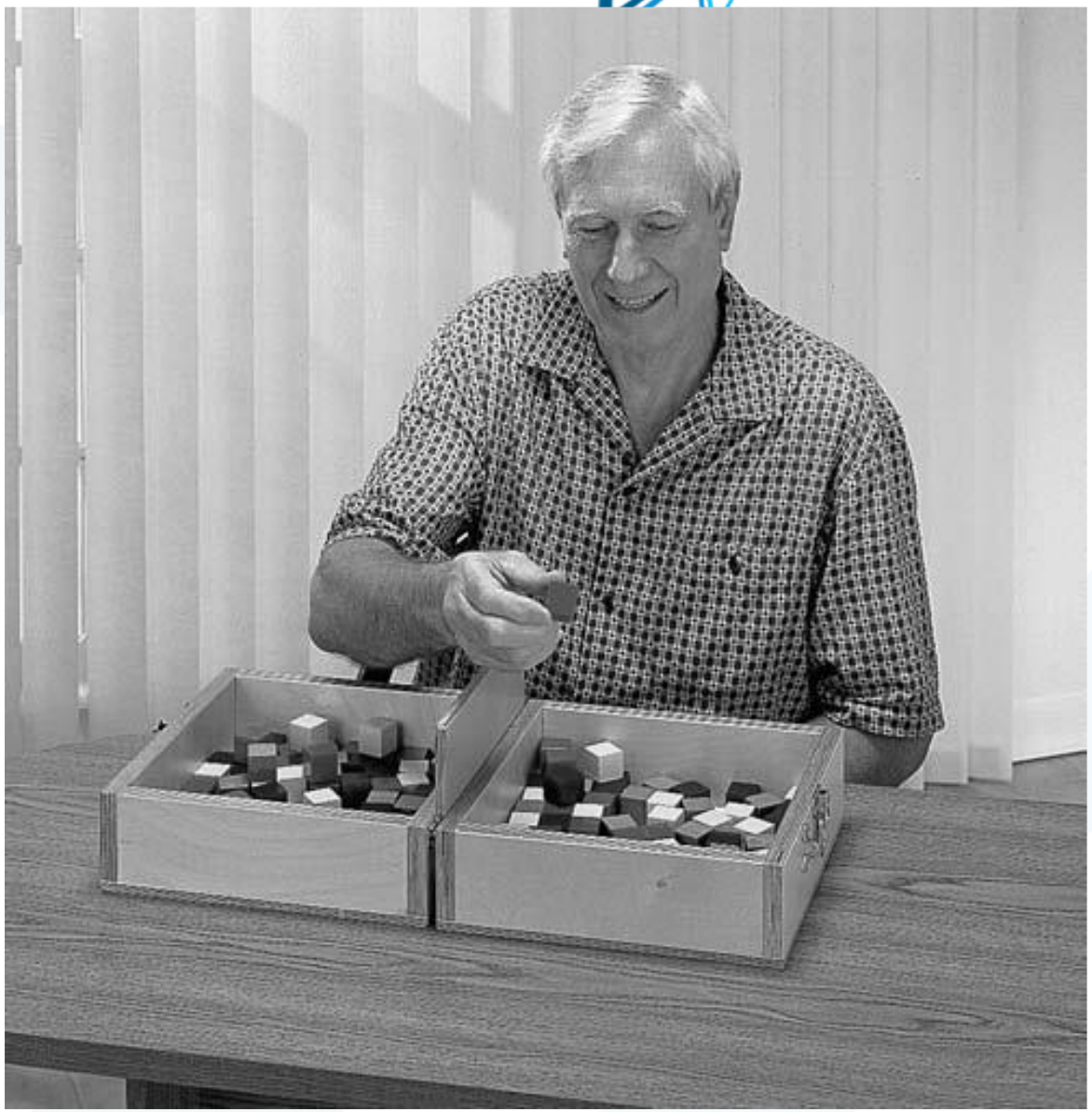

Sensory Territories and Innervations
(Dorsal View)
Exclusive area of the median nerve
Exclusive area of the ulnar nerve
Median nerve, digital branches
Ulnar nerve, dorsal branch
Radial nerve, superficial branch and dorsal digital branches
Posterior antebrachial cutaneous nerve

- **Dexterity and Hand Function**

No one evaluation covers all features of hand function

Box and Block Test

The Box and Block Test measures gross manual dexterity. It was developed to test people with severe problems affecting Coordination. The subject transfers 1-inch blocks from one side of the box to the other. The score is the number of blocks transferred in 1 minute for each hand.



Administration Procedures for the Box and Block Test (Mathiowetz et al., 1985)

- Place the test box lengthwise along the edge of a standard-height table (Fig. 37-2).
- The 150 cubes are in the compartment of the test box to the dominant side of the patient.
- Sit facing the patient to monitor the blocks being transported.
- Give these instructions: "*I want to see how quickly you can pick up one block at a time with your right [left] hand [the therapist points to the dominant hand]. Carry the block to the other side of the box and drop it. Make sure your fingertips cross the partition. Watch me while I show you how.*"
- Transport three cubes over the partition in the same direction the patient is to move them. After the demonstration, say, "*If you pick up two blocks at a time, they will count as one. If you drop one on the floor or table after you have carried it across, it will still be counted, so do not waste time picking it up. If you toss the blocks without your fingertips crossing the partition, they will not be counted. Before you start, you will have a chance to practice for 15 seconds. Do you have any questions? Place your hands on the sides of the box. When it is time to start, I will say 'Ready' and then 'Go.'*"
- Start the stopwatch at the word *go*. After 15 seconds, say "*Stop*."
- If the patient makes mistakes during the practice period, correct them before beginning the actual testing.
- On completion of the practice period, return the transported cubes to the compartment.
- Mix the cubes to ensure random distribution, and then say, "*This will be the actual test. The instructions are the same. Work as quickly as you can. Ready; go. [After 1 minute:] Stop.*"
- Count the blocks transported across the partition. This is the patient's score for the dominant hand.
- If the patient transports two or more blocks at the same time, subtract the number of extra blocks from the total.
- After counting, return the blocks to the original compartment and mix randomly.
- Turn the test around so that the blocks are on the nondominant side.
- Administer the test to the nondominant hand using the same procedures as for the dominant hand, including the 15-second practice.

From Mathiowetz, V., Volland, G., Kashman, N, & Weber, K. (1985). Adult norms for the box and block test of manual dexterity. *American Journal of Occupational Therapy, 39*, 386–391.

Table 37-1 Average Performance of 628 Normal Subjects on the Box and Block Test[a]

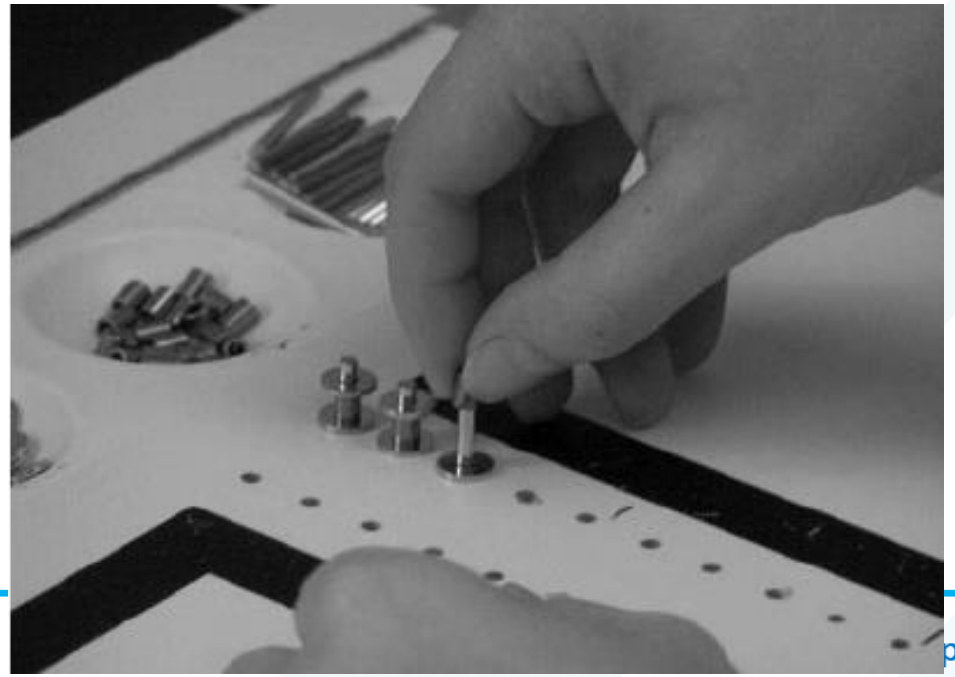
Age (Years)	Males		Females		Age (Years)	Males		Females	
	Mean	*SD*	*Mean*	*SD*		*Mean*	*SD*	*Mean*	*SD*
20–24					50–54				
Right hand	88.2	8.8	88.0	8.3	Right hand	79.0	9.7	77.7	10.7
Left hand	86.4	8.5	83.4	7.9	Left hand	77.0	9.2	74.3	9.9
25–29					55–59				
Right hand	85.0	7.5	86.0	7.4	Right hand	75.2	11.9	74.7	8.9
Left hand	84.1	7.1	80.9	6.4	Left hand	73.8	10.5	73.6	7.8
30–34					60–64				
Right hand	81.9	9.0	85.2	7.4	Right hand	71.3	8.8	76.1	6.9
Left hand	81.3	8.1	80.2	5.6	Left hand	70.5	8.1	73.6	6.4
35–39					65–69				
Right hand	81.9	9.5	84.8	6.1	Right hand	68.4	7.1	72.0	6.2
Left hand	79.8	9.7	83.5	6.1	Left hand	67.4	7.8	71.3	7.7
40–44					70–74				
Right hand	83.0	8.1	81.1	8.2	Right hand	66.3	9.2	68.6	7.0
Left hand	80.0	8.8	79.7	8.8	Left hand	64.3	9.8	68.3	7.0
45–49					75+				
Right hand	76.9	9.2	82.1	7.5	Right hand	63.0	7.1	65.0	7.1
Left hand	75.8	7.8	78.3	7.6	Left hand	61.3	8.4	63.6	7.4

- **Purdue Pegboard Test**

The Purdue Pegboard Test of finger dexterity assesses picking up, manipulating, and placing little pegs into holes with speed and accuracy. It tests finger or fine motor dexterity.

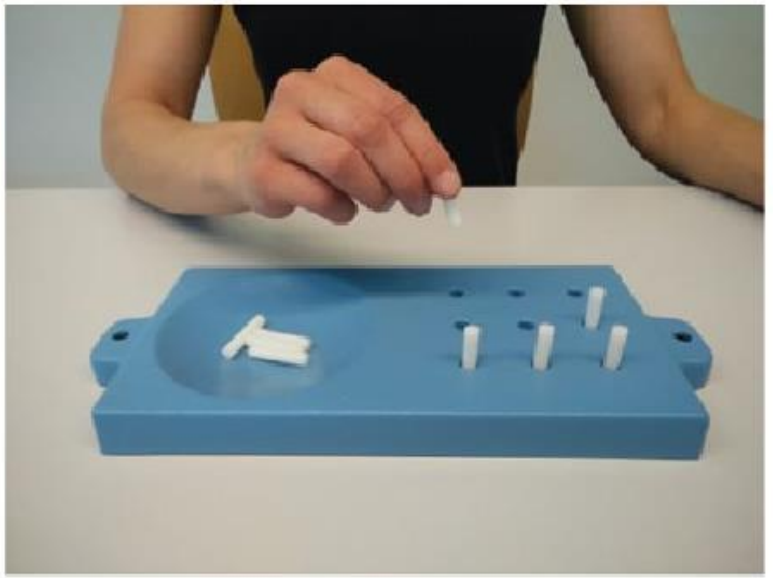
It has a wooden board with two rows of tiny holes plus reservoirs for holding pins, collars, and washers. The four subtests are performed with the subject seated. To begin, there is a brief practice. The subtests for preferred, nonpreferred, and both hands require the patient to place the pins in the holes as quickly as possible, with the score being the number of pins placed in 30 seconds.

- The subtests for preferred, nonpreferred, and both hands require the patient to place the pins in the holes as quickly as possible, with the score being the number of pins placed in 30 seconds. The subtest for assembly requires the patient to insert a pin and then put a washer, collar, and another washer on the pin, with the score being the number of pieces assembled in 1 minute. The Purdue Pegboard Test manual provides normative data using percentile tables for adults and different categories of jobs and for children 5–15 years of age by age and sex.



- **Nine-Hole Peg Test**

The Nine-Hole Peg Test measures finger dexterity among patients of all ages. Test administration is brief, involving the time it takes to place nine pegs (7 mm diameter, 32 mm length) in holes in a 5-inch square board and then remove them.



- Scoring:

- The number of seconds it takes for the patient to complete the test.
- Alternative scoring - the number of pegs placed in 50 or 100 seconds can be recorded. In this case, results are expressed as the number of pegs placed per second.

- **TEMPA**
- TEMPA is an acronym from the French for Upper Extremity Performance Test for the Elderly. It consists of nine tasks, five bilateral and four unilateral, reflecting daily activity. Each task is measured by the three sub scores of speed, functional rating, and task analysis.
- The nine tasks are 1.to pick up and move a jar, 2. open a jar and take a spoonful of coffee, 3. pour water from a pitcher into a glass, 4. unlock a lock, 5. take the top off a pillbox, 6. write on an envelope and affix a postage stamp, 7. put a scarf around one's neck, 8. shuffle and deal cards, use coins, and 9. pick up and move small objects.

- The test takes about 15–20 minutes for an unimpaired elderly subject and about 30–40 minutes for an impaired elderly subject. Advantages of the TEMPA are clinical use, especially with hand patients older than 60 years of age.

CLINICAL REASONING AND INTERVENTION

- **Questions to Ask**
- General categories of questions may include the physician's expectations for functional recovery; tendon status, such as fraying or vascular compromise; whether the patient is medically cleared for AROM only or AROM and/or PROM; and whether the patient is medically cleared for low-load, long-duration dynamic splinting.
- **Activities of Daily Living and Occupational Role Implications**
- The functional use of the upper extremity and the patient's ability to perform in the areas of occupation are what really matter.

- **Goal Setting:**
- Express hand therapy goals or projected outcomes in terms that reflect the patient's occupational functioning. Ultimately, the number of degrees achieved in ROM is less important than whether the patient can open a door, get dressed, or return to work. One way to integrate concrete and functional outcomes is to measure the movement needed to accomplish an appropriate patient-specific functional task and incorporate that measurement into the stated goal.
- For example, if a patient wants to be able to splash water on his or her face but lacks forearm supination to do so, have the patient perform the activity with the opposite upper extremity. Measure the supination needed to perform the task. In this instance, the goal could be stated as "sufficient forearm supination (60°) for ability to wash the face."

- **Quality of Movement**
- Poor quality of movement (called dys-coordinate co-contraction) may result from co-contraction of antagonist muscles. The cause may be habit, fear of pain, guarding, or excessive effort. Poor quality of movement looks awkward and unpleasant. It is important to identify dys-coordinate co-contraction early and to work on retraining a smooth, comfortable, effective quality of motion. Pain-free occupation is the best way to promote good quality of motion.
- Oscillations are rhythmic therapeutic movements that may be helpful, but they must be pain free. Imagery, such as pretending to move the extremity through water or gelatin, may also help (Cooper, 2007). Biofeedback may aid in muscle reeducation as well.

What Structures Are Restricted, and Does Passive Range of Motion Exceed Active Range of Motion?

- It is not adequate to identify a general problem, such as decreased ROM. Rather, it is important to understand and treat the specific structures causing the restriction. Limited PROM may be due to pericapsular structures, such as adhered or shortened ligaments, or actual joint limitations, such as mechanical block or adhesions.

- PROM that exceeds AROM may be due to disruption of the musculotendinous unit, adhesions restricting excursion of the tendon, or weakness.
- When PROM exceeds AROM, promote active movement and function of the restricted structures with differential tendon gliding exercises, blocking exercises, place-and-hold exercises, and functional orthoses.
- When PROM equals AROM, discern whether the restriction is joint or musculotendinous or both and promote both passive and active flexibility.

- **Joint versus Musculotendinous Tightness**
- With joint tightness, the PROM of the particular joint does not change with repositioning of the joints proximal and/or distal to it. With musculotendinous tightness, the PROM of the particular joint does vary with repositioning of joints crossed by that multiarticulate structure.
- Treat joint tightness with dynamic splinting, static progressive splinting, or serial casting, followed by AROM. Treat musculotendinous tightness the same as extrinsic tightness

- **Lag versus Contracture**
- A lag is a limitation of active motion in a joint that has passive motion available. A joint contracture is a passive limitation of the joint. A patient with a PIP extensor lag cannot actively extend the PIP joint even though passive extension is available. A patient with a PIP joint flexion contracture lacks passive extension of that joint.


Over-advancement of the FDP
during tendon repair
Flexion Lag
of Adjacent
Fingers
Quadrigia Effect
Normal

- Treat lags by facilitating motion of the restricted structure with scar management, blocking exercises in mechanically advantageous positions, place-and-hold exercises, static splinting to promote normal length of the involved structure, and functional splints. Treat contractures the same as for joint tightness.
- An advantageous position to test or treat extensor lag at the PIP level is to maintain MP flexion while trying to extend actively at the PIP. An advantageous position to test or treat extensor lag at the DIP level is to maintain MP and PIP flexion while trying to extend actively at the DIP. This is contraindicated if the diagnosis is acute mallet finger.

A

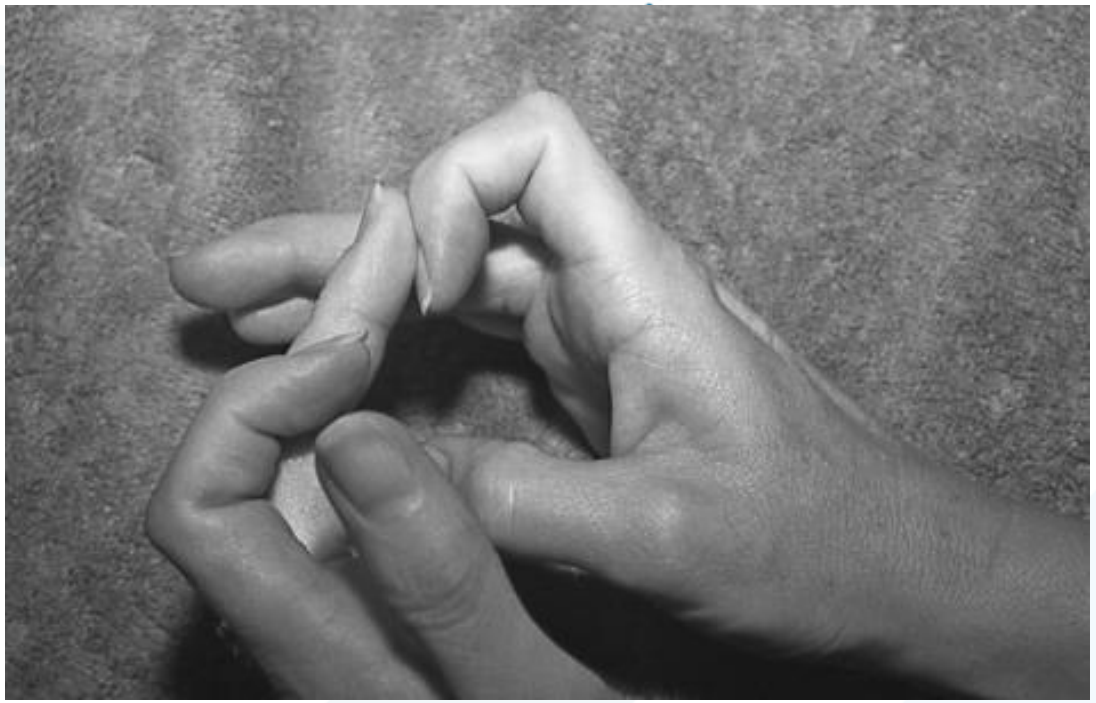
B

C

Intrinsic or Extrinsic Extensor Muscle Tightness

- Intrinsic muscles are the small muscles in the hand. Extrinsic muscles are longer musculotendinous units that originate proximal to the hand.
- Intrinsic tightness and extrinsic extensor tightness are tested by putting these muscles on stretch. This is accomplished by comparing the PROM of digital PIP and DIP flexion when the MP joint is passively extended and then passively flexed.
- With interosseous muscle tightness, passive PIP and DIP flexion is limited when the MP joint is passively extended or hyperextended. With extrinsic extensor tightness, PIP and DIP flexion is limited when the MP joint is passively flexed.

- To treat intrinsic tightness, perform PIP and DIP flexion with MP hyperextension. Functional orthotics are very helpful for isolating specific exercise to restore length to the intrinsics while performing daily activities. In other words, promote IP flexion with MPs hyperextended.
- To treat extrinsic extensor tightness, promote composite motions (that is, combined flexion motions of the wrist, MPs and IPs) with orthotics, gentle stretch, and exercise. Instruct the client that performing these exercises with the wrist in a variety of positions is helpful.



Interosseous muscle tightness.Proximal interphalangeal (PIP) and distal interphalangeal (DIP) flexion is passively limited when the metacarpophalangeal (MP) joint is passively extended or hyperextended.

Extrinsic extensor tightness.PIP and DIP flexion is passively limited when the MP joint is passively flexed.

Figure 6

A B

Clinical photographs of the intrinsic tightness test. **A,** The metacarpophalangeal (MCP) joint is held extended while the degree of proximal interphalangeal (PIP) joint motion is measured (arrow). **B,** The MCP joint is flexed, and the degree of PIP motion is again examined (arrow). With intrinsic contracture, PIP joint motion is restricted while the MCP joint is extended and is improved when the MCP joint is flexed.

- **Tightness of Extrinsic Extensors or Extrinsic Flexors**
- With extrinsic extensor tightness, there is less passive composite digital flexion available with the wrist in flexion than with the wrist in extension. In contrast, with extrinsic flexor tightness, there is less passive composite digital extension available with the wrist in extension than with the wrist in flexion. Treat extrinsic flexor or extensor tightness with place-and-hold exercises, static splinting comfortably at end range (especially useful at night), dynamic or static progressive splinting during the day, and functional splinting.

BASIC INTERVENTIONS
Edema Control

- Elevation, active exercise, and compression have been the mainstays of edema control. Treatment of upper extremity edema has also historically included retrograde massage, string wrapping, compression garments, and modalities such as an intermittent pressure pump.
- a new approach to the treatment of upper extremity edema, called manual edema mobilization (Artzberger, 2007), a technique for stimulating the lymphatic system to remove the excess large plasma proteins that cause sustained edema leading to fibrotic tissue and stiffness.

Manual Edema Mobilization Concepts

- The basic MEM technique consists of diaphragmatic breathing, light skin-traction massage, exercise, pump point stimulation, and a self-management program.
- All MEM sessions begin with deep, diaphragmatic breathing. This "belly" breathing involves breathing in deeply through the nose, causing the abdomen to expand, and then slowly exhaling through "pursed" lips. Feeling or seeing the rise and fall of the abdomen can help the therapist ensure that the patient is correctly performing the technique.
- Respiration changes tissue pressure, and thus lymphatic absorption is stimulated.

- A light skin-traction massage is a massage so light that no blanching or indentation of the skin occurs yet it is firm enough to move the skin, thereby preventing the hand from sliding on the skin. The light skin-traction massage technique involves a rhythmical massage that forms U shapes on the skin, with the opening of each U in the direction of lymphatic flow proximally to an uninvolved or previously decongested area. The massage technique should remain light and should follow lymphatic pathways.

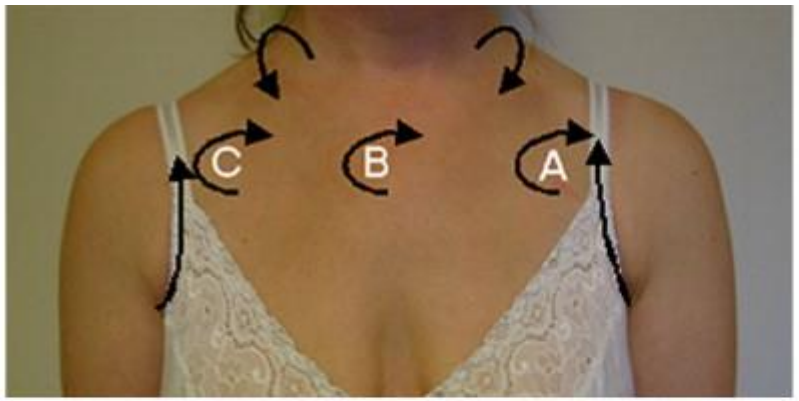
- Clearing U Massage
- Initially, the therapist performs the MEM massage technique (the U technique) in one segment of the body, starting proximally (or centrally) and moving distally down the segment. This proximal- (or central-) to-distal massage technique is referred to as the "clearing U s," and its purpose is to clear the lymphatic system within that segment. The clearing U s technique consists of performing five consecutive U massages in the most proximal (or central) location within that segment, then performing another five U massages just distal to the previous five, and continuing in this manner down to the distal portion of that segment. For example, if edema is in the right hand, the clearing U s would start with five U s at the left shoulder region, then five at the left clavicle, five over the sternum, five over the right clavicle, five at the right shoulder region, and so on down the arm until the therapist reached the hand.

- Immediately after performing the clearing U massage technique in each section (trunk, upper arm, elbow, forearm, hand), active and/or passive exercises that move the joints and muscles associated with the recently cleared body segment are performed. In the example given, active and/or passive shoulder flexion, shoulder abduction, elbow flexion/extension, wrist flexion/extension, and fisting exercises would be performed after the clearing U massage.
- Once the clearing U massages have been performed throughout the entire segment and the active and/or passive exercises have been performed, that segment is then considered cleared. The purpose of clearing a segment is to open and clear out the lymphatic pathways to allow the flow of lymph into the central structures.

- Flowing U Massage
- After a segment has been cleared, the therapist changes the direction of the massage technique to promote the flow of lymph through the recently cleared segment. During the flow portion, the U massage is performed distally to proximally (or centrally) within the newly cleared segment. This distal-to-proximal (or -central) massage technique is referred to as “flowing U s,” and it consists of performing one U massage in a distal location within the cleared segment, then performing another U massage just proximal to the previous one, and continuing up to the most proximal portion of the segment. At this point, the sequence is repeated until five U massages have “flowed” up the cleared segment.
- In the previous example, after the right arm had been cleared, the therapist would perform one U massage over the dorsum of the right hand, then over the right volar wrist, the right volar forearm, the right cubital tunnel, the right volar upper arm, the right shoulder, the right clavicle, the sternum, the left clavicle, and then finally the left axilla.

- Differences Between Clearing U Massage and Flowing U Massage
- Although the clearing U massage and the flowing U massage are performed in the same segmental area, they differ from each other in two ways. First, the clearing U massage is performed in a proximal- (or central-) to-distal fashion, whereas the flowing U massage is performed in a distal-to-proximal (or -central) fashion. Second, the clearing U massage consists of performing five U massages in each location before moving distally, whereas the flowing U massage consists of performing only one U massage distally within a segment, and then moving sequentially up the segment until the proximal (or central) portion of that segment is reached. The flowing U massage sequence is then repeated a total of five times

a



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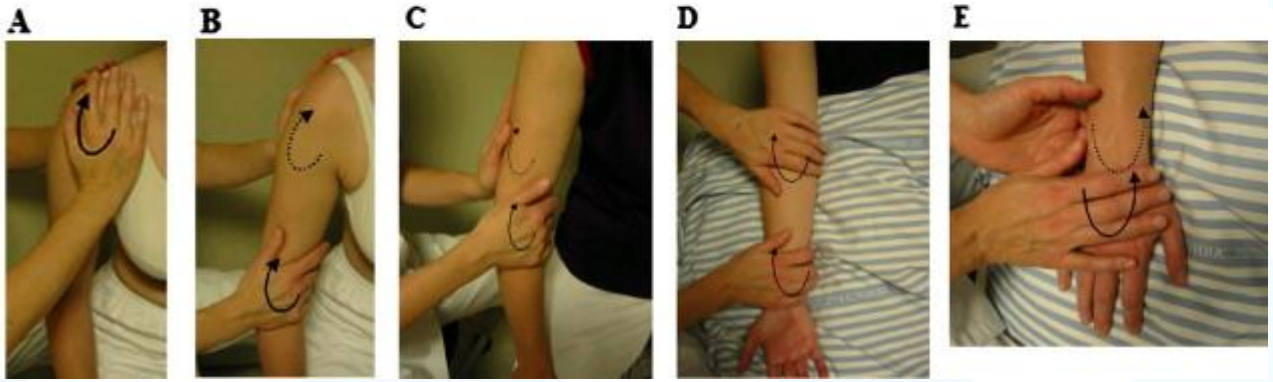


Contraindications

- **When Not to Perform Manual Edema Mobilization (MEM)**
- If infection is present because there is the potential to spread the infection
- Over areas of inflammation because of the potential of increasing the inflammation and pain (Do MEM proximal to the inflammation to decrease congested fluid.)
- If there is a blood clot or hematoma in the area because there is the opportunity to activate (move) the clot
- If there is active cancer (A controversial theory notes the potential to spread cancer. Absolutely never do MEM if the cancer is not being medically treated. Always seek a physician's advice.)
- If the patient has congestive heart failure, severe cardiac problems, or pulmonary problems because there is the potential to overload the cardiac and pulmonary systems
- In the inflammation stage of acute wound healing because theoretically there is the possibility to disrupt the "clean-up" process and the invasion of fibroblasts
- If renal failure or severe kidney disease problems exist (This is not a high-protein edema. There is the potential for overloading the renal system and/or moving the fluid elsewhere.)
- If the patient has primary lymphedema or postmastectomy lymphedema

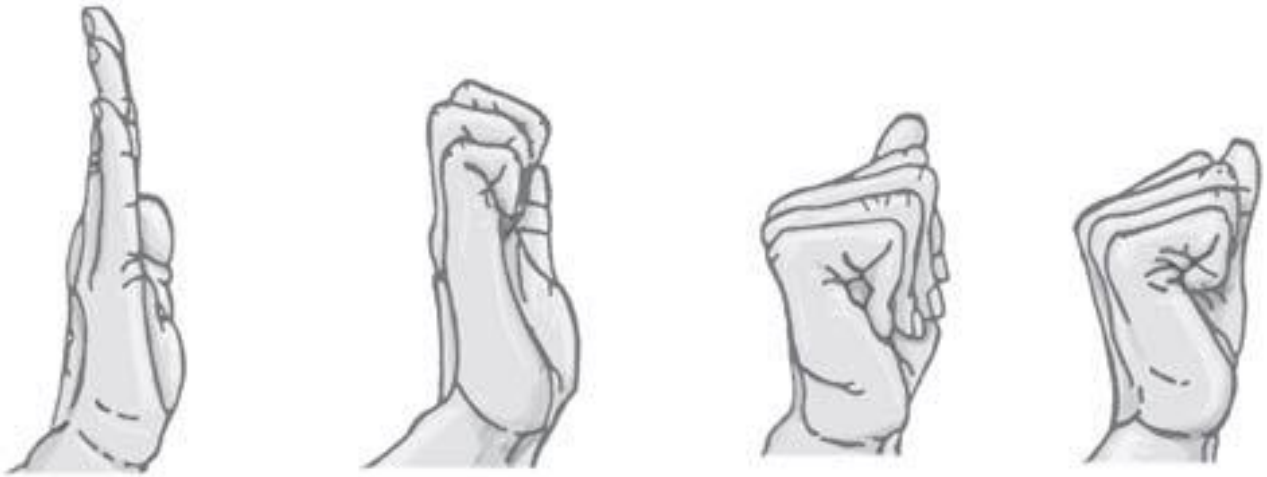
Scar Management

- Compression (e.g., Isotoner™ gloves, Tubigrip™, or Coban™ wrap) and desensitization are traditionally used to promote scar softening and maturation. Silicone gel applied over the scar helps promote scar maturation, presumably through neutral warmth. Other inserted materials such as padding, otoform, or elastomer can also be used.
- Application of micropore tape over incision scars is gaining popularity. It has been shown to be very effective and is much more affordable than the other options

- Although friction massage has typically been advocated for scar softening, legitimate questions have been raised as to whether this more aggressive technique may in fact cause inflammation, resulting in deposition of even more scar tissue. Manual edema mobilization may be a more effective alternative. Research is needed in this area.

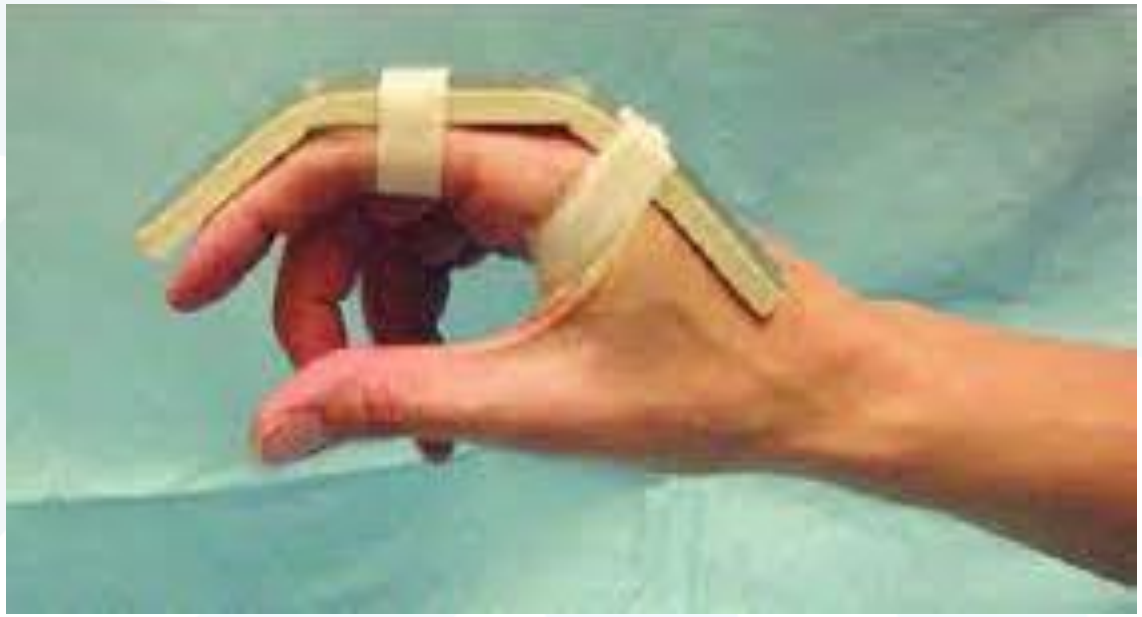
Differential Digital Tendon Gliding Exercises

- Tendon gliding exercises maximize total gliding and differential gliding of digital flexor tendons at the wrist. Because tendon gliding exercises promote digital and joint motions, they are a mainstay of most home exercise programs.
- The four positions: straight, hook, straight fist, and full fist.

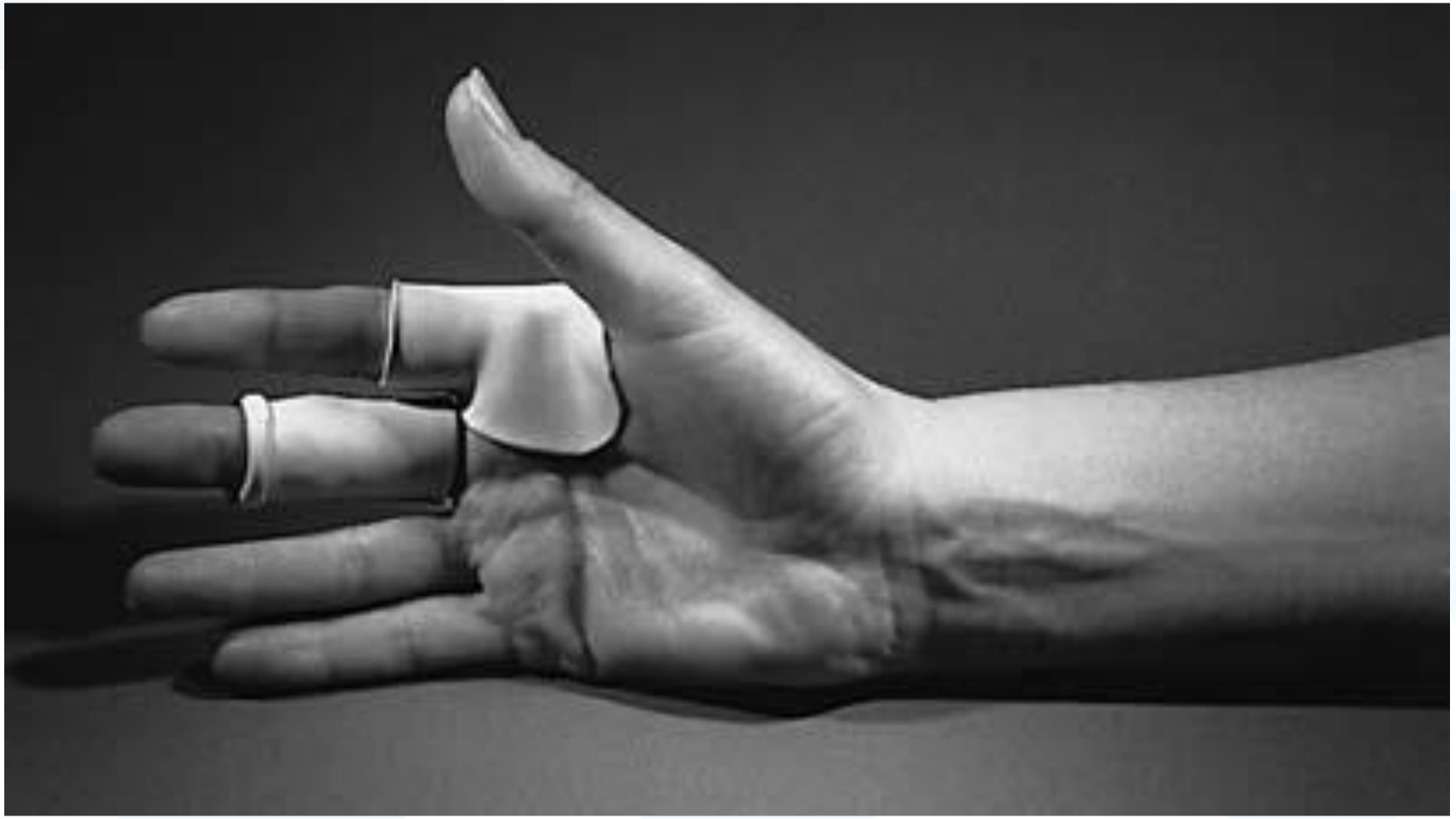


Blocking Exercises

- Digital cylinders blocking the IPs help to isolate and exercise MP flexion and extension. A blocking splint with the MPs extended promotes intrinsic stretch as well as IP flexion. A blocking splint with the MPs flexed promotes extrinsic extensor stretch and recovery of composite fisting [flexion at all finger joints of the hand simultaneously].
- A PIP cylindrical block encourages DIP isolated flexion and flexor digitorum profundus (FDP) excursion at the DIP. A DIP cap facilitates PIP flexion and flexor tendon excursion at the PIP.
- Instruct patients who do blocking exercises to exercise comfortably into the end range to remodel the tissue. Teach them to do the exercises frequently and slowly, holding at the comfortable end range for 3–5 seconds.



Blocking splints. MP splint blocks MP motion, promoting PIP and DIP motion. Digital splint blocks PIP motion, promoting MP, and/or DIP motion.



Place-and-Hold Exercises

- Place-and-hold exercises are effective for achieving increased ROM when PROM exceeds AROM.
- To perform them, use comfortable PROM to position the hand (e.g., composite fisting). Then release the assisting hand while the patient tries to sustain the position in a pain-free way.
- Place-and-hold exercises can be effective in combination with blocking exercises.

Mirror Box

- Growing interest in neuroplasticity has provided fascinating additions to the traditional repertoire of hand therapists. The use of a mirror box (also called mirror visual feedback or mirror training) is based on research on neural responses to intentional visual confusion, with stimulation of neurons called mirror neurons. Mirror training is used for pain, sensory, and motor problems and can be used in conjunction with laterality and graded imagery interventions. It has been used with clients who have had a cerebral vascular accident (CVA) and is being used more recently with clients with peripheral and orthopedic problems of the upper extremities

- In mirror therapy (MT), a mirror is used to create a reflective illusion of an affected limb in order to trick the brain into thinking movement has occurred without pain, or to create positive visual feedback of a limb movement.
- This approach exploits the brain's preference to prioritise visual feedback over somatosensory/proprioceptive feedback concerning limb position. In conditions such as phantom limb pain (PLP), stroke, or Complex Regional Pain Syndrome Type 1 (CRPS1) where neuropathic processes cause issues with pain, related or unrelated to movement, this approach is thought to offer potential relief.


reflex


reflex

End Feel and Splinting

- If there is a soft end feel (a favorable spongy quality at end range indicative of potential to remodel), it is reasonable to try low-load, long-duration dynamic splinting for a medically cleared patient. Dynamic splint forces must be prolonged and gentle for tissue to remodel. Forceful splinting is contraindicated because it causes pain and injury, hence inflammation and scarring. Follow dynamic orthotic use with activity that challenges and incorporates the limited motion. For a firmer or hard end feel (an unyielding quality at end range), try increasing the time in the orthosis and decreasing the force. If there is a hard end feel, dynamic splinting may not be effective, and serial casting or static progressive splinting may be more useful.

Splints (Orthotics)

- Functional splints (or orthotics) can be used in ordinary daily activity to promote mobility of restricted structures. For example, if the index finger PIP joint lacks flexion and the MP joint moves normally, try a hand-based index finger MP blocking splint, used off and on throughout the day. When the splint is in use, the patient achieves PIP flexion exercise while performing normal grasping activities.

- Buddy straps allow one digit to assist a neighboring digit to achieve greater motion. The offset buddy strap accommodates different phalangeal lengths of adjacent digits. Buddy straps are also useful to retrain keyboard users who habitually maintain the small finger MP in hyperextension or repetitively hyperabduction the small finger when keyboarding.
- A dorsal MP flexion blocking orthosis promotes composite flexion incorporating MP flexion and is particularly helpful when there is extrinsic extensor tightness. If the patient has difficulty incorporating MP flexion into composite fisting and instead extends the MPs while flexing the IPs, a dorsal hood maintaining MP flexion promotes recovery of composite fist incorporating MP flexion.

Offset buddy straps. Interdigital strap accommodates different phalangeal lengths of adjacent digits. Used to allow one digit to assist the next in achieving motion and for protection.

Stiff Hand

- Any upper extremity injury can result in the serious and sometimes irreversible problem of a stiff hand. Even an injury in the proximal upper extremity can cause serious stiffening of the digits. The stiff hand is what hand therapists try to prevent. Edema is the main culprit in the series of events leading to a stiff hand. Edema is a natural response to trauma, occurring in the inflammatory phase. The challenge for hand therapy is to strike a balance between rest and movement.
- Too much rest may increase the edema. Too much movement may increase the inflammation. The right amount of rest in an appropriate position reduces inflammation and promotes healing. Proximal motion plus well-tolerated hand and wrist exercise and functional use, particularly while elevated, help to reduce edema and restore motion.

- Encourage the patient to achieve gentle full arcs of available motion with functional use or exercise instead of performing quick or incomplete arcs of motion that are less effective. Make exercises relevant to occupational functioning or at least goal oriented whenever possible (e.g., grasping and releasing items). If the patient's hand is painful or more swollen after use or exercise, it is imperative to decrease temporarily the amount of exercise being performed

- Avoid aggressive PROM. It is okay to coax tissues to lengthen within their available comfortable range, but always respect the feeling of tissue resistance, and do not exceed it. Gentle passive motion, if indicated, should be accompanied by joint traction to promote gliding of the joint surfaces. Sustained holding of a position is much more effective than fast jerky stretches, which frequently add to the inflammation.

- During the acute inflammatory stage, static splinting is usually most appropriate. After the inflammation has subsided and while the joint displays a soft end feel, dynamic splinting is productive. Inflamed tissue is not as flexible as uninflamed tissue.
- Watch closely for signs of inflammation and return to static splinting as indicated. Later, if there is a hard end feel, serial static or static progressive splinting will most likely be needed. Many patients with hand impairments complain of morning stiffness. Night splinting, which can be very helpful for this problem, also corrects tissue tightness that limits daytime use of the hand.

Tendinitis/Tendinosis

- The pain associated with tendinitis/tendinosis can be severe and can seriously impact performance in all areas of occupation. Symptoms include pain with AROM, with resistance, and with passive stretch of the involved structures.
- Tendons are made up of connective tissues that are not well vascularized. Tendinitis has been treated historically as if it is an inflammatory phenomenon. More recent histological evidence has shown that the pathology of tendinitis includes alterations in tissue with disorganized and degenerated collagen and atypical vascular granulation tissue.

- These findings are described as angiofibroblastic hyperplasia or angiofibroblastic tendinosis. It is now believed that the patients who are diagnosed with tendinitis actually have tendinosis. Because the pathology is not primarily inflammatory, treatment approaches now emphasize interventions that restore nourishment to collagen.
- The question of use of modalities with this diagnosis remains intriguing. Most authorities report that modalities are effective in reducing pain, normalizing the vascular status of the involved tissue, and quieting inflammation if it exists.

- Tendons are vulnerable because they are relatively avascular. Cell damage may become chronic. Biomechanical deficits include muscular weakness, inflexibility, and scar tissue. Early treatment of an acute traumatic case typically has a better prognosis than after the injury has become chronic.

Evaluation

- An overaggressive evaluation that provokes pain can set the treatment timetable back significantly and undermine the trust of and rapport with the patient. Start the evaluation with a cervical screening to look for proximal causes of distal symptoms. Compare both extremities. Assess for pain that may be local or diffuse, swelling, sensory changes, and loss of function.

- Tendinitis typically is accompanied by pain with AROM, with resistance, and with passive stretch of the involved structures. Compare subjective and objective findings, but remember that symptoms are often elusive and may occur dynamically or intermittently. Patients who seem angry or hostile may understandably be depressed over their loss of function.

- It is essential to identify the activity causing the pain. Occupational therapists possess unique skills for ergonomic-related analysis of occupational performance and activity modification. It is best to observe the actual activity. If this is not possible, simulate the activity. Ergonomic risk factors for tendinitis include forceful, rapid, repetitive movements. A movement is considered repetitive if it is performed more than once every 30 seconds or for more than half the total work time. Additional risk factors include a history of soft-tissue problems, pressure and shear forces, stress and muscle tension, and hypermobility.

- **Intervention**
- Treat the acute phase with ice, compression, elevation of the involved structures, and rest if needed to manage pain. Anti-inflammatory physical agent modalities may be useful at this time, but remember that tendinitis/tendinosis is no longer thought to be primarily inflammatory. Splinting is individualized to the patient's and physician's preferences. Orthotic intervention may be most beneficial and least problematic at night. There are also clinical compromises associated with disuse from immobilization. Soft supports may be very helpful. Try to avoid pain, and monitor the clinical responses. Active pain-free motion is the best way to begin revascularizing the involved tissues.

- After the inflammation subsides, upgrade intervention to restore normal function through gradual mobilization balanced with rest. Most importantly, pain must be avoided. Instruct in tendon gliding exercises in a pain-free range appropriate to the particular structures involved. Progress from isometric exercises with gentle contractions of involved structures to isotonic exercises. Gradually introduce low-load, high-repetition strengthening in short arcs of motion. Then increase the arc of motion and modify proximal positions to be more challenging if appropriate for work simulation. Instruct in gentle flexibility exercises in a pain-free range. It is often difficult for patients to learn to perform slow and pain-free passive stretch. Aerobic exercises and proximal conditioning are essential.

- Prevent re-injury through education. Simulation and biofeedback can promote biomechanically efficient upper extremity use. Teach the patient to avoid reaching and gripping with an extended elbow or a flexed or deviated wrist. First, solve the easily recognizable issues, such as obviously poor posture or trunk twisting with reaching and lifting. Instruct in pacing to avoid fatigue that leads to reinflammation.

- Unsupported upper extremity use is taxing, as are nonsymmetrical upper extremity use, non-frontal trunk or upper extremity alignment, and unilateral upper extremity work.
- Many people with distal symptoms recover well by focusing intervention on posture, conditioning, and proximal strengthening. Using handheld tools with ergonomic design can be helpful. Even a small ergonomic adjustment, such as learning to lift bilaterally with proper body mechanics or making use of a telephone headset instead of laterally flexing the neck and elevating the shoulder to hold the receiver, can often lead to dramatic improvement.

Lateral Epicondylitis or Tennis Elbow

- Lateral epicondylitis involves the extrinsic extensors at their origin. The extensor carpi radialis brevis is most commonly involved. Pain is at the lateral epicondyle and extensor wad (the proximal portion of the extensor muscles).
- This diagnosis is differentiated clinically from radial tunnel syndrome, in which tenderness occurs more distally over the radial tuberosity. Test for radial tunnel syndrome with the middle finger test (positive if there is pain secondary to resisting the middle finger proximal phalanx while the patient maintains elbow extension, neutral wrist, and MP extension) or by percussing distally to proximally over the superficial radial nerve. This percussion test is positive if it elicits paresthesia

- Exercises should include proximal conditioning and scapular stabilizing. Instruct the client to use built-up handles. If using an orthosis, support the wrist in extension, especially at night. Splinted wrist position recommendations range from neutral to about 30°. Also try a counterforce strap , which is a strap placed over the extensor wad to prevent full muscle contraction and to reduce the load on the tendon during the day with activity. Safety Message: Avoid applying the counterforce strap too tightly, because this can cause radial tunnel syndrome.

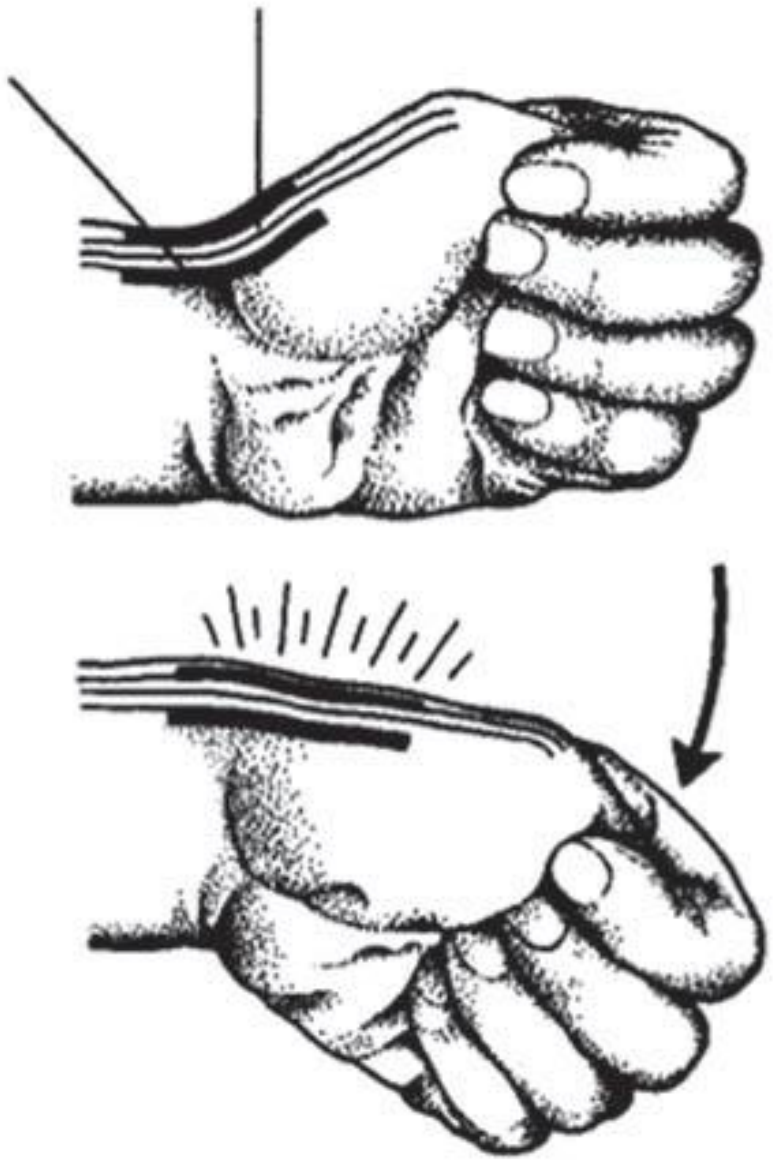
Medial Epicondylitis, or Golfer's Elbow

- Medial epicondylitis involves the extrinsic flexors at their origin. The flexor carpi radialis (FCR) is most commonly involved. Pain is at the medial epicondyle and flexor wad (the proximal portion of the flexor muscles) and worsens with resisted flexion and pronation. Exercise should promote proximal conditioning. Avoid activity that requires force at end ranges. Provide built-up handles. If using an orthosis, maintain the wrist in neutral, and try a counterforce strap over the flexor wad.

De Quervain’s Tenosynovitis

- De Quervain’s tenosynovitis is tendinitis involving the abductor pollicis longus (APL) and extensor pollicis brevis (EPB) tendons at the first dorsal compartment. It is the most common upper extremity tenosynovitis. Finkelstein’s test is positive if there is exquisite pain with passive wrist ulnar deviation while flexing the thumb. This diagnosis occurs frequently among golfers, knitters, and racquet sports players. Thumb posture in sustained hyperabduction at the computer space bar may also be provoking. Differential diagnosis is for carpometacarpal (CMC) arthritis, scaphoid fracture, intersection syndrome, and FCR tendinitis.

- Teach patients to avoid wrist deviation, especially in conjunction with pinching. Provide built-up handles. If splinting, use a forearm-based thumb spica, leaving the IP free. Watch for irritation from the radial splint edge along the first dorsal compartment.



Intersection Syndrome

- Intersection syndrome presents as pain, swelling, and crepitus of the APL and EPB muscle bellies approximately 4 cm proximal to the wrist, where they intersect with the wrist extensor tendons (extensor carpi radialis brevis and extensor carpi radialis longus). This diagnosis is associated with repetitive wrist motion and occurs in weight lifters, rowers, and canoers. Differential diagnosis is for de Quervain's disease, but both diagnoses can occur concomitantly. Teach patients to avoid painful or resisted wrist extension and forceful grip. Orthotic selection is the same as for de Quervain's disease

Extensor Pollicis Longus Tendinopathy

- Also called drummer boy palsy, tendinitis of the extensor pollicis longus (EPL) reveals pain and swelling at Lister's tubercle (a dorsal prominence at the distal radius around which the EPL passes). It is less common than other forms of tendinitis, but if left untreated, it can lead to tendon rupture. EPL tendinitis is associated with activities requiring repetitive use of the thumb and wrist, as seen in drummers. Rupture of the EPL may occur in persons with rheumatoid arthritis (RA) or Colles' fracture.
- Help patients to identify and eliminate provocative activities. Enlarge the girth of utensils. The orthotic choice is a forearm-based thumb spica that includes the IP.

Extensor Carpi Ulnaris Tendinopathy

- Tenosynovitis of the extensor carpi ulnaris (ECU) occurs fairly frequently. It causes pain and swelling distal to the ulnar head and is associated with repetitive ulnar deviation motions. Subluxation of the ECU tendon elicits a painful snap with forearm supination and wrist ulnar deviation. Differential diagnosis includes instability of the distal radioulnar joint and ulnocarpal abutment or tears of the triangular fibrocartilage complex. Teach patients to avoid ulnar deviation with activities. Orthotic intervention consists of a forearm-based ulnar gutter or a wrist cock-up splint.

Flexor Carpi Radialis Tendinopathy

- With tendinitis of the FCR, pain is over the FCR tendon just proximal to the wrist flexor creases. Differential diagnosis is for a volar ganglion or arthritis of the scaphotrapeziotrapezoid joint. Orthotic intervention consists of a wrist cock-up in neutral or a position of comfort.

Flexor Carpi Ulnaris Tendinopathy

- Flexor carpi ulnaris (FCU) tendinitis is more common than FCR tendinitis. It causes pain along the volar–ulnar side of the wrist. Inflammation occurs where the FCU inserts at the pisiform. Differential diagnosis is pisiform fracture and pisotriquetral arthritis or triangular fibrocartilage complex injury. Teach patients to avoid wrist flexion with ulnar deviation. Orthotic intervention consists of a forearm-based ulnar gutter. For comfort, pad the ulnar head if it is prominent, so the splint does not rub or irritate it.

Flexor Tenosynovitis, or Trigger Finger

- Trigger finger is also called stenosing tenosynovitis of the digital flexor. The usual cause is stenosis at the A-1 pulley, which is part of the fi bro-osseous tunnel that prevents bow-stringing of the digital flexors. Tenderness is over the A-1 pulley of the digital flexor along with pain with resisted grip and painful catching or locking of the fi nger in composite flexion.

- The origin of this impairment can be inflammatory or not. It has been strongly associated with diabetes and RA. Medical management often consists of a mixture of steroid and local anesthetic injected into the flexor sheath. The injection may be repeated a few times. Therapy consists of splinting the MP in neutral to prevent composite digital flexion (preventing triggering), while promoting tendon gliding, and place-and-hold fi sting that avoids triggering. Built-up handles, padded gloves, and pacing strategies are helpful. Instruct the patient to avoid triggering, as this reinflames the tissue. If symptoms persist, the surgeon may surgically release the A-1 pulley.

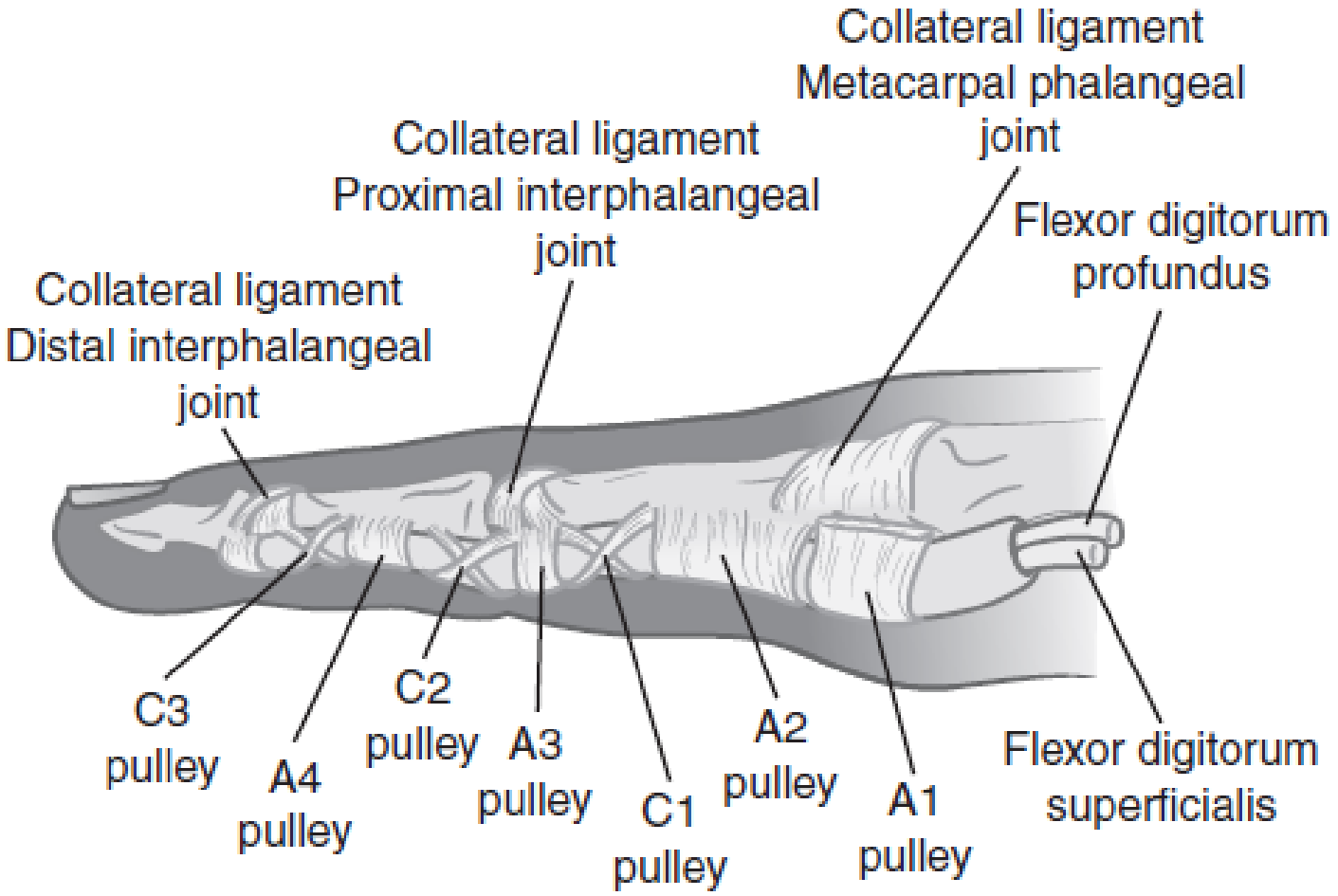


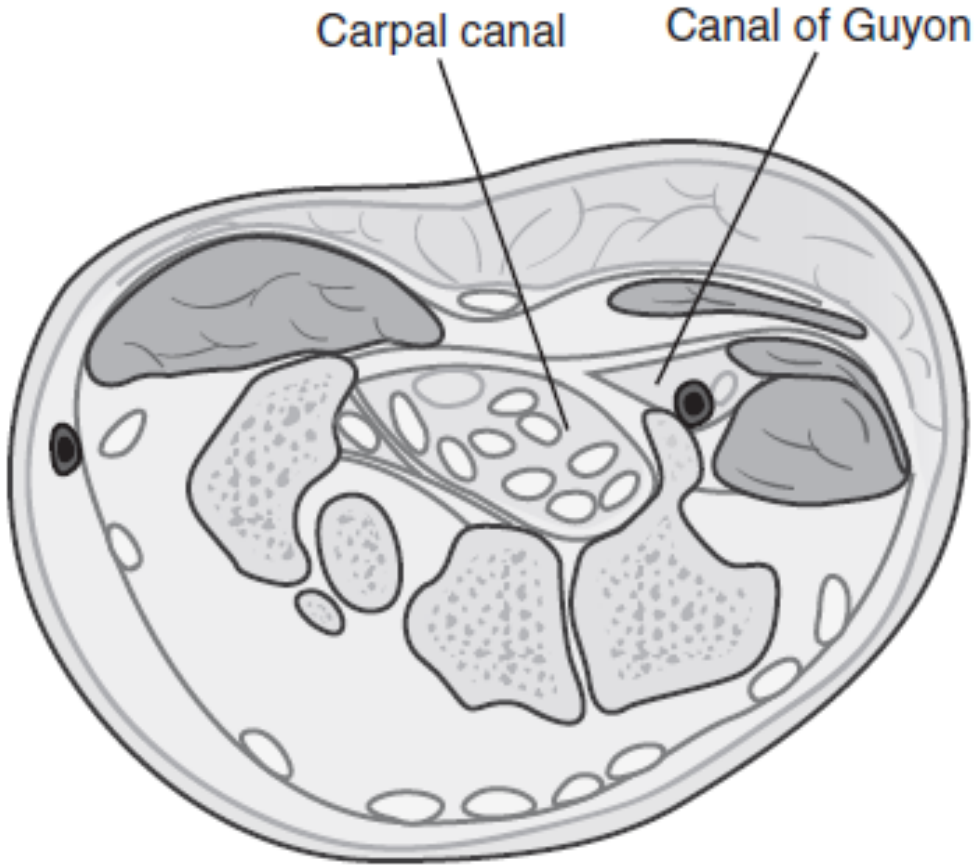
Figure 37-8 Pulley system. (Adapted with permission from Rayan, G., & Akelman, E. [2011]. *The hand: Anatomy, examination, and diagnosis.* Philadelphia: Lippincott Williams & Wilkins.)

Nerve Injury

- When injury or disease occurs to a neural structure in the upper extremity, there is a high likelihood that multiple areas of neural pathology will develop. This phenomenon is known as the double or multiple crush syndrome. Remembering this concept lessens the possibility of missing relevant clinical findings.
- The various mechanisms of nerve injury include acute or chronic compression, stretch ischemia, electrical shock, radiation, injection, and laceration. Compression and laceration, impairments that are commonly seen by hand therapists, are described next.

Nerve Compression

- **Median Nerve Compression at the Wrist, or Carpal Tunnel Syndrome**
  Carpal tunnel syndrome is the most common upper extremity nerve entrapment. It results from compression of the median nerve at the wrist. The carpal bones form the floor of the carpal tunnel. The transverse carpal ligament, also called the flexor retinaculum, forms the roof of the tunnel and acts as a pulley for the flexor tendons during gripping. Inside the carpal canal are nine flexor tendons (four FDP, four flexor digitorum superficialis [FDS], and the flexor pollicis longus) and the median nerve, which is most superficial.


Carpal canal
Canal of Guyon

- Swelling or thickening of the tendons can lead to pressure on the nerve, resulting in sensory symptoms in the distribution of the median nerve.
- Typical complaints include hand numbness, particularly at night or when driving a car, along with pain and paresthesia in the distribution of the median nerve (thumb through radial ring finger pads), and clumsiness or weakness

- Associated diagnoses include RA, Colles' fracture, diabetes, deconditioning, obesity, and thyroid disease. Transient carpal tunnel syndrome is fairly common in pregnancy. Carpal tunnel syndrome may be associated with repetitive use or flexor tenosynovitis caused by increased friction between the tendons and nerve. For these people, focus intervention on resolving the tendinitis.

- **Evaluation.** Perform a cervical screening, and evaluate posture, ROM, grip and pinch, and a manual muscle test looking for independent excursion of FDP and FDS. Also do Tinel's, Phalen's, Semmes-Weinstein Monofilament, and two-point discrimination tests. Tapping at the volar wrist elicits Tinel's sign, which is a sensation of tingling or electric shock if the median nerve is compromised.
- Phalen's test provokes sensory symptoms in the median nerve distribution if positive, created by maintaining the wrist in flexion for 60 seconds.

- Phalen’s test should be done with extended elbows to avoid confusing these findings with a positive elbow flexion test (cubital tunnel syndrome).
- Advanced cases of carpal tunnel syndrome reveal thenar atrophy of the abductor pollicis brevis, which can be functionally debilitating


Carpal Tunnel Syndrome
90°
Positive Phalen's Maneuver
Maintained flexion of the wrist at a 90° degree angle for 30-60 seconds reproduces CTS symptoms of tingling or pain.

Effects of carpal tunnel syndrome on adaptation of multi-digit forces to object weight for whole hand manipulation (research)

- CTS-induced deficits in tactile sensitivity interfere with the formation of accurate sensorimotor memories of previous manipulations. Consequently, CTS patients use compensatory strategies to maximize grasp stability at the expense of exerting consistently larger multidigit forces than controls. These behavioral deficits might be particularly detrimental for tasks that require fine regulation of fingertip forces for manipulating light or fragile objects.

Implications for Practice

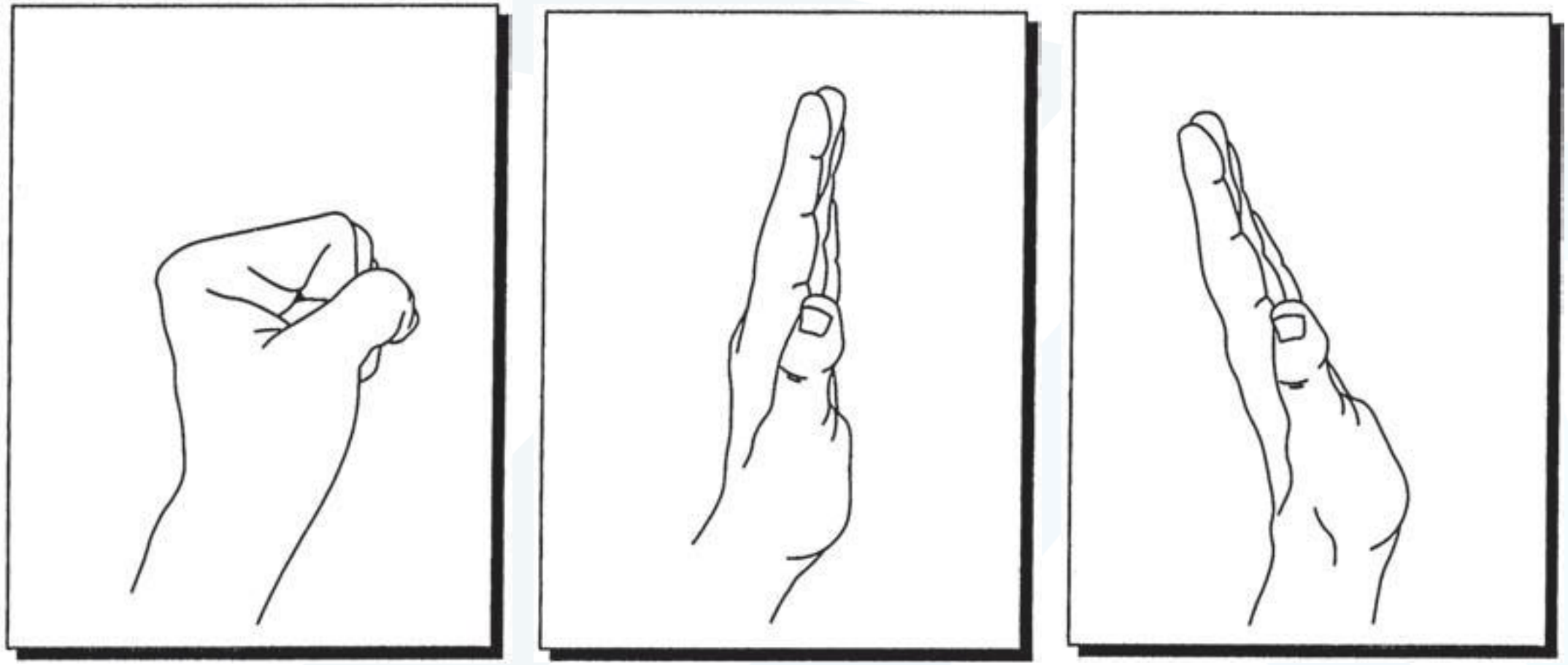
- Clients with CTS have sensory loss that affects hand dexterity and use of the whole hand, not just the fingers with sensory impairment.
- Hand therapy for clients with CTS should address occupational tasks that incorporate use of the whole hand, not just those digits with sensory innervation of the median nerve.

- **Intervention .** Conservative medical management may include steroid injection. Conservative therapy for carpal tunnel syndrome includes night splinting with the wrist in neutral because this position minimizes pressure in the carpal tunnel, exercises for median nerve gliding at the wrist, differential flexor tendon gliding exercises, aerobic exercise, proximal conditioning, ergonomic modification, and postural training.
- Teach patients to avoid extremes of forearm rotation or of wrist motions and to avoid sustained pinch or forceful grip. Provide padded gloves and built-up handles. Thick padded automobile steering wheel covers are helpful.

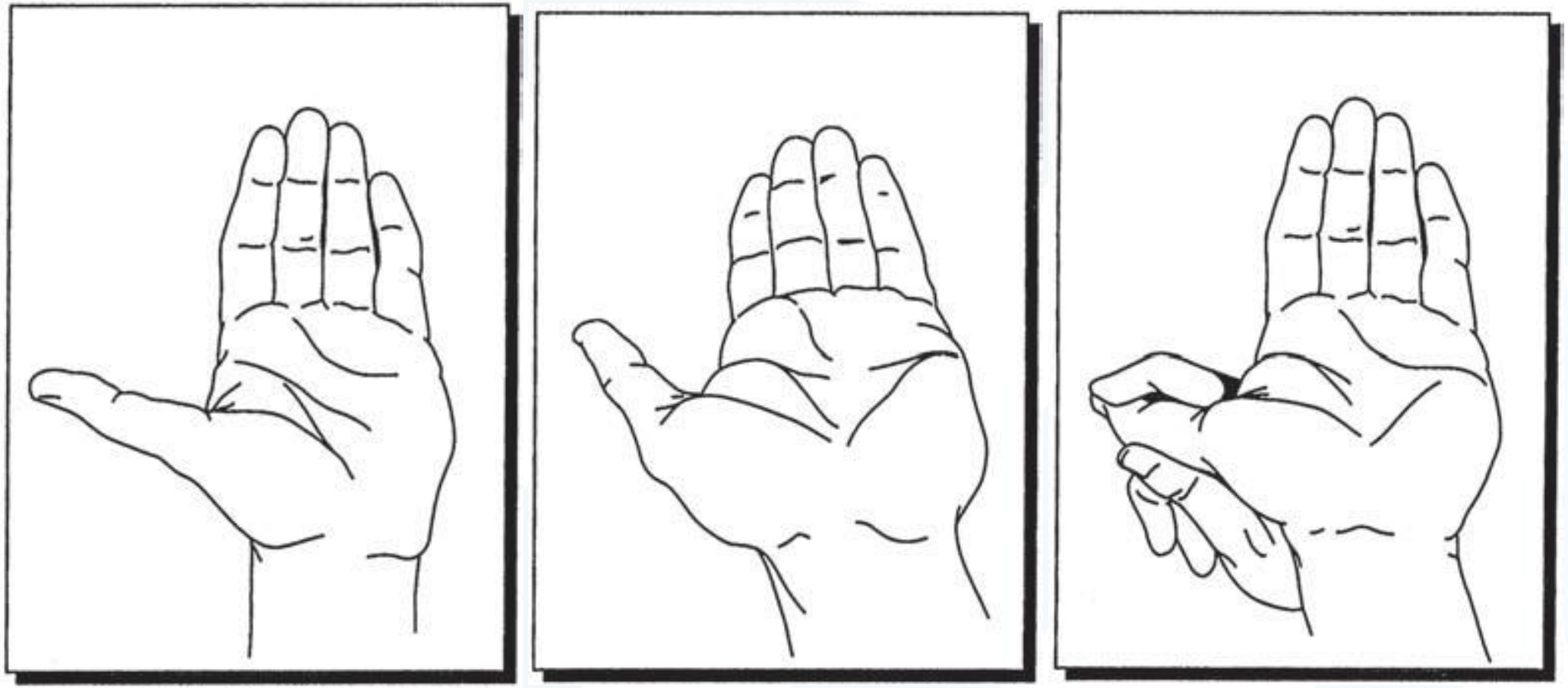
- Surgical intervention consists of decompression of the carpal tunnel by division of the transverse carpal ligament. Carpal tunnel release is one of the 10 most frequent surgeries performed in the United States.
- Postoperative therapy, when necessary, consists of edema control, scar management, desensitization as needed, nerve and tendon gliding exercises, and eventual strengthening. Many therapists postpone strengthening exercises until at least 6 weeks following carpal tunnel release to avoid inflammation. Patients with new and mild symptoms tend to recover best.

Median nerve gliding exercises at the wrist.

Positions: 1.Neutral wrist with finger and thumb flexion. 2. Fingers and thumb extended. 3. Wrist and fingers extended with thumb in neutral.

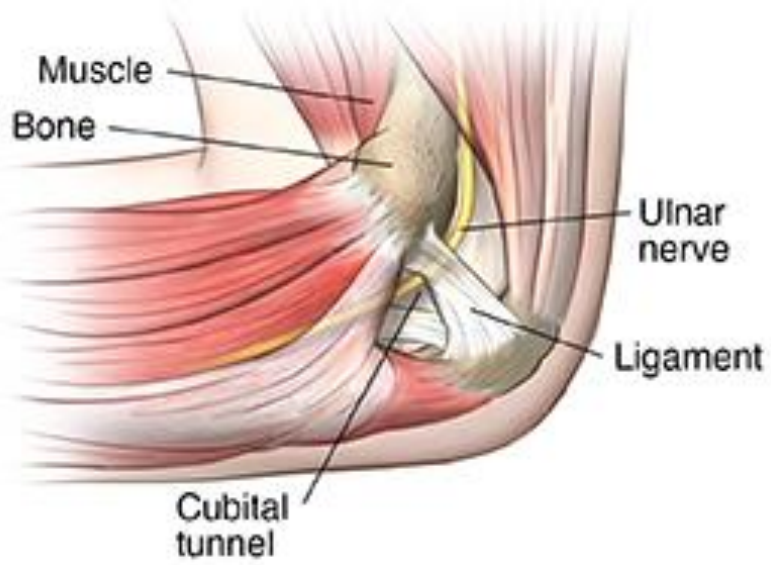


4. Thumb extended. 5. Forearm supinated. 6. Thumb gently stretched into extension.



Ulnar Nerve Compression at the Elbow, or Cubital Tunnel Syndrome.

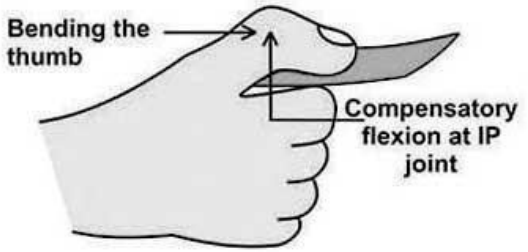
- Cubital tunnel syndrome is the second most common upper extremity nerve entrapment and is the most commonly compressed site of the ulnar nerve, at its location between the medial epicondyle and the olecranon.
- Typical complaints include proximal and medial forearm pain that is aching or sharp; decreased sensation of the dorsal and palmar surfaces of the small finger and the ulnar half of the ring finger; and weakness of interossei, adductor pollicis (AP), FCU, and FDP of the ring and small fingers.


Muscle
Bone
Ulnar nerve
Ligament
Cubital tunnel

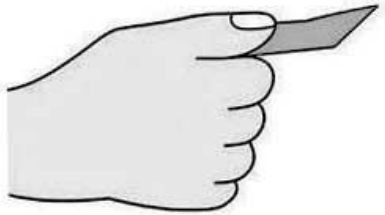

CUBITAL TUNNEL SYNDROME

- Wartenberg’s sign, the inability to adduct the small finger, and Froment’s sign, in which effort at lateral pinch elicits thumb IP flexion because of weakness of the AP, may be seen. Grip and pinch strength are decreased, and patients complain of dropping things. Symptoms are worse when the elbow is flexed repeatedly or is kept in flexion because this position dramatically reduces the volume of the cubital tunnel. Understandably, symptoms may increase at night if the person sleeps with the elbow flexed.

Froment's Sign



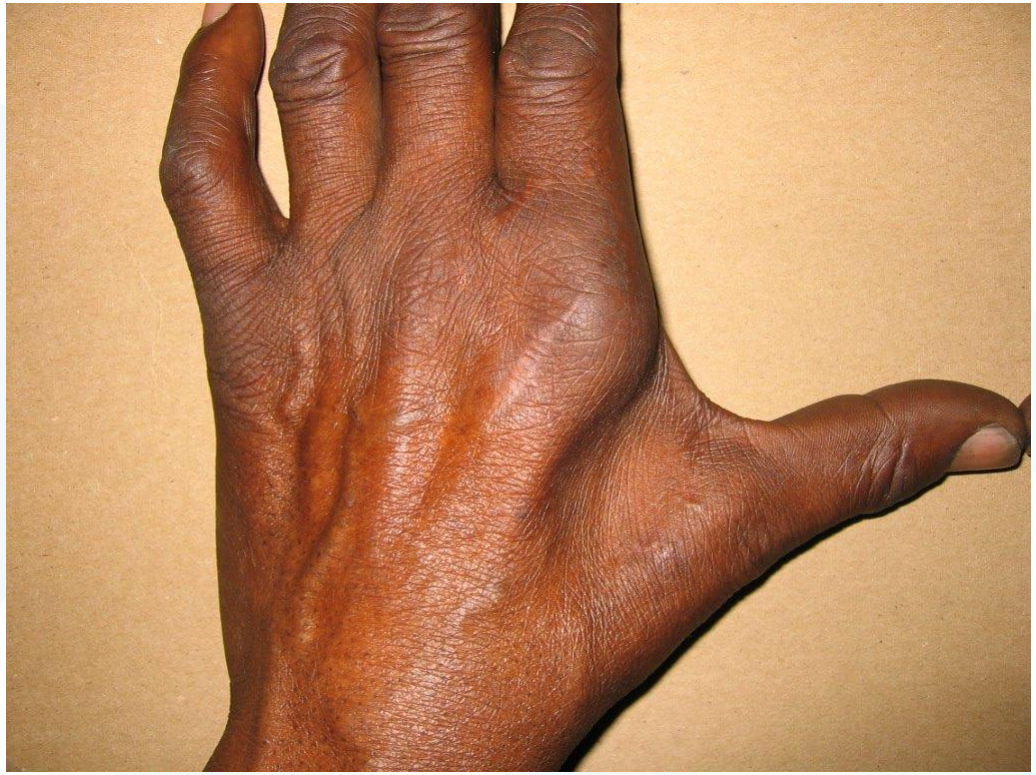
Positive (Ulnar nerve palsy)



Negative (Normal ulnar nerve)

- Cubital tunnel syndrome may result from trauma, such as a blow to the elbow or fracture or dislocation of the supracondylar or medial epicondylar area, or it may be due to chronic mild pressure on the elbow. Associated diagnoses include osteoarthritis (OA), RA, diabetes, and Hansen’s disease.

- Evaluation . Tapping over the cubital tunnel elicits a positive Tinel's sign. However, Tinel's sign may also be positive in 20% of normal people. The elbow flexion test is positive if passively flexing the elbow and holding it flexed for 60 seconds produces sensory symptoms. Keep the wrist neutral while performing the elbow flexion test so as not to confound the findings with Phalen's test.
- Look for digital clawing and for muscle atrophy in the first web space, hypothenar eminence, and medial forearm. Perform grip and pinch testing and manual muscle testing as appropriate, and test sensation.



- Intervention . Conservative therapy for cubital tunnel syndrome includes edema control; splinting or padding the elbow; and positioning guidelines to avoid leaning on the elbow, to avoid elbow-flexed postures, and to avoid elbow-intensive activity. An elbow orthosis helps prevent sleeping with the elbow flexed. Types of orthotics include elbow pads or soft splints, pillows, and anterior or posterior thermoplastic orthoses. The splinted elbow position for sleeping is usually about 30° of flexion. Additional therapy includes proximal conditioning, postural and ergonomic training, and ulnar nerve gliding exercises

Neural mobilization for cubital tunnel syndrome in highly irritable stage.

A. Ipsilateral scapular elevation and cervical side-bending while the wrist, ring, and small fingers are extended with the forearm remaining supinated and the elbow extended.
B. Return the scapula and cervical spine to neutral as the patient brings the wrist, ring, and small fingers into slight flexion.

Perform this in a slow and in rhythmic manner.

- **Radial Nerve Compression, or Posterior Interosseous Nerve Syndrome.**
- Posterior interosseous nerve syndrome is purely motor. It presents two clinical pictures. In one, paralysis affects all muscles innervated by the posterior interosseous nerve, with inability to extend the MP joints of thumb, index, long, ring, or small fingers. Wrist extension occurs only radially because of paralysis of extensor digitorum and ECU. In the other presentation of this syndrome, the person cannot extend the MP joint of one or more digits. Paralysis may spread to other digits if it is not treated on a timely basis

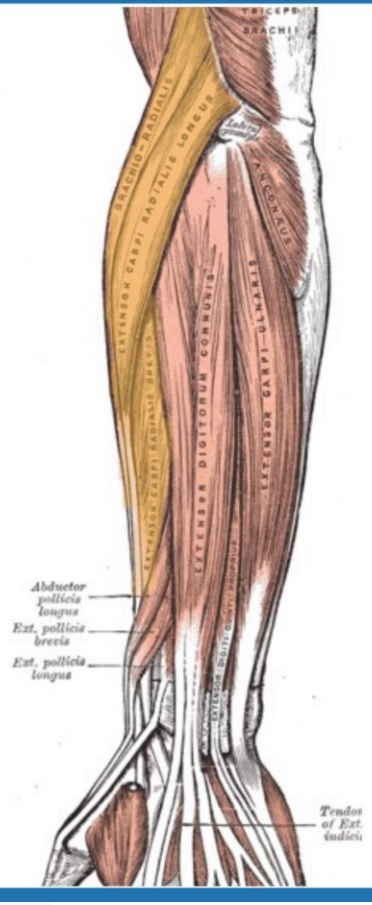
POSTERIOR INTEROSSEOUS NERVE INNVERVATION

THEPLASTICSFELLA.COM

PIN innervates all muscles in the extensor compartment, except those highlighted in yellow:

- Brachioradialis
- ERCL
- ERCB

Go to ThePlasticsFella.com for references and sources



- A common site of entrapment of the posterior interosseous nerve is at the supinator muscle, where it pierces the two heads of this muscle. Other causes include soft tissue tumors, RA with synovial proliferation, and radial head fractures or dislocations. Therapy focuses on maintaining PROM and orthotic selection to prevent deformity and promote function.

Nerve Laceration

- Nerve lacerations are categorized as complete or partial. Stretching and contusion injuries can occur along with the laceration. Nerve reconstruction is termed primary if within 48 hours, early secondary if within 6 weeks, and late secondary after 3 months.
- The advantages associated with primary repair are that nerve stump retraction is limited, and electrical stimulation can be used to identify distal fascicles

- A **neuroma** , a disorganized mass of nerve fibers, can follow nerve injury. Significant nerve pain is elicited by tapping over the neuroma, with hypersensitivity limiting functional use of the hand.
- Desensitization techniques are helpful, along with padding over the painful area to promote functional use.

- Following nerve injury, therapy promotes functional performance in the areas of occupation with ADL training and adaptive equipment and assists in prevention of deformity with orthotics and appropriate PROM.
- Hand therapy provides valuable education to patients about their diagnosis and general recovery sequence and teaches protective guidelines to compensate for sensory loss. Hand therapy monitors changes in sensory and motor function and helps prevent joint contractures and imbalance by re-evaluating ROM, sensation, and muscle status. Orthotic modifications are based on clinical changes over time.

- **Low Median Nerve Lesion** . Median nerve laceration at the wrist results in low median nerve palsy, with denervation of the opponens pollicis and abductor pollicis brevis of the thumb and of the lumbricals to the index and long fingers. Clawing of the index and long fingers does not usually occur because the interossei remain ulnarly innervated.
- Loss of sensation of the radial side of the hand is present. With the absence of thumb abduction and opposition, the thumb rests in adduction, where it may become contracted. Fabricate a hand-based thumb abduction orthosis to maintain balance, to substitute for lost thumb opposition, and to prevent overstretching of denervated muscles.

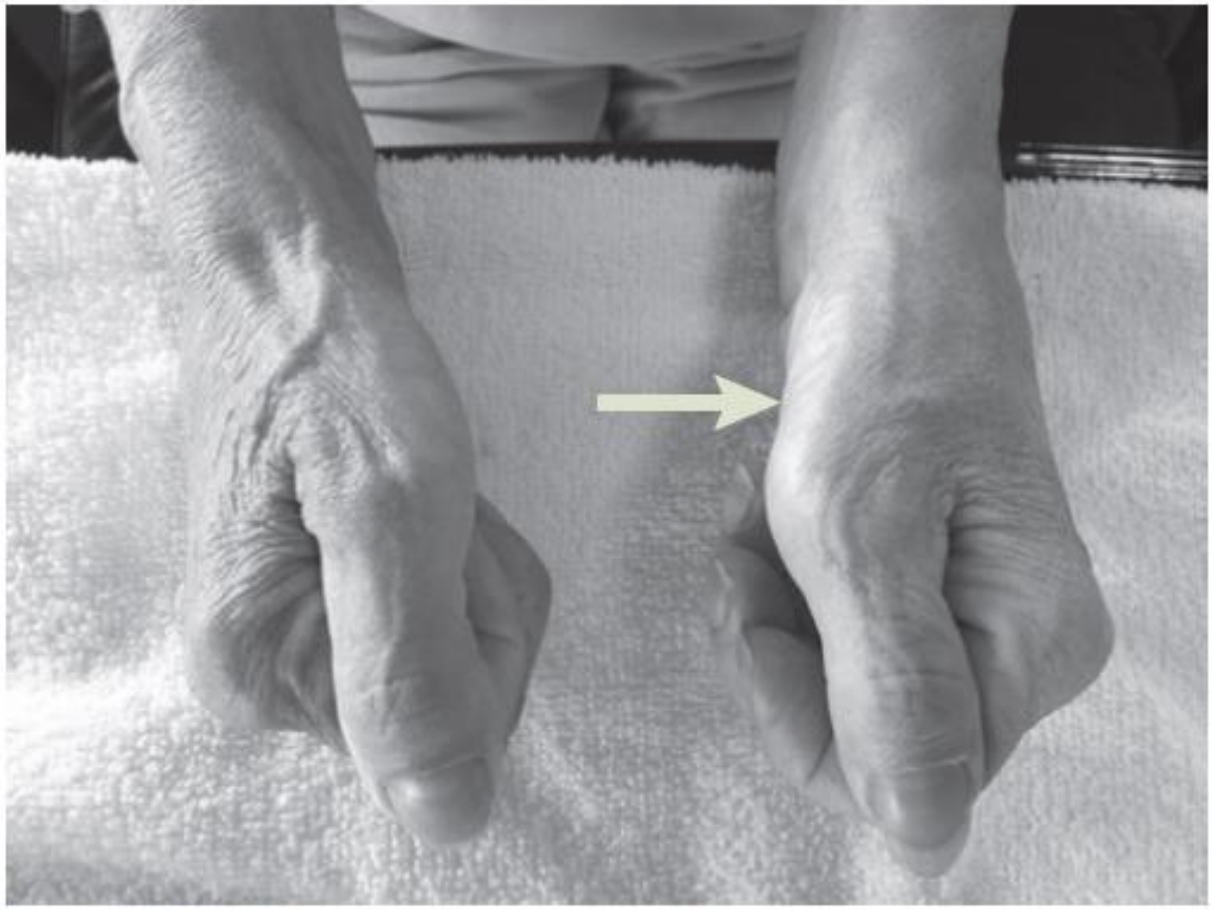


Figure 37-12 Thenar wasting (atrophy of thumb muscles) caused by median nerve problem.

- Median nerve laceration creates serious functional loss of manipulation and sensibility of the thumb, index, and long fingers. Motor recovery usually occurs before sensory recovery. Be sure to teach compensatory strategies to avoid reinjury while sensibility is impaired. Instruct the patient to perform PROM to maintain joint mobility. Fabricate orthotics to sustain thumb abduction and digital MP flexion with IP extension to promote functional hand use and to counteract the deforming forces of the injury.

- **High Median Nerve Lesion** . Injury near or at the elbow is called a high median nerve injury. Along with the motor loss identified earlier, there is denervation of FDP to index and long fingers, FDS to all digits, pronator teres, and pronator quadratus.
- The median nerve is considered the most important sensory nerve, and its loss severely compromises hand function. In therapy, prepare patients for probable tendon transfers by preventing deformity with orthotics and by maintaining PROM of pronation, of digital MPs in flexion, of digital IPs in extension, and of thumb CMC abduction. Visual cues, adaptive devices, and modified handles may help compensate for the functional loss.

- **Low Ulnar Nerve Lesion**. Laceration of the ulnar nerve at the wrist level is called a low ulnar lesion. This injury results in loss of most of the hand intrinsics. Denervation of the abductor digiti minimi, flexor digiti minimi, and opponens digiti minimi results in flattening of the hand with loss of the ulnar transverse metacarpal arch; denervation of thumb AP and deep head of fl exor pollicis brevis results in loss of thumb adduction and MP support; denervation of dorsal and volar interossei results in loss of digital abduction or adduction; and denervation of lumbricals to the ring and small fi ngers results in extrinsic imbalance.
- The ring and small fingers present a claw deformity , a position of MP hyperextension and PIP flexion associated with muscle imbalance in ulnar-innervated structures. Fine manipulation skills are compromised. Sensory loss involves the ulnar digits.

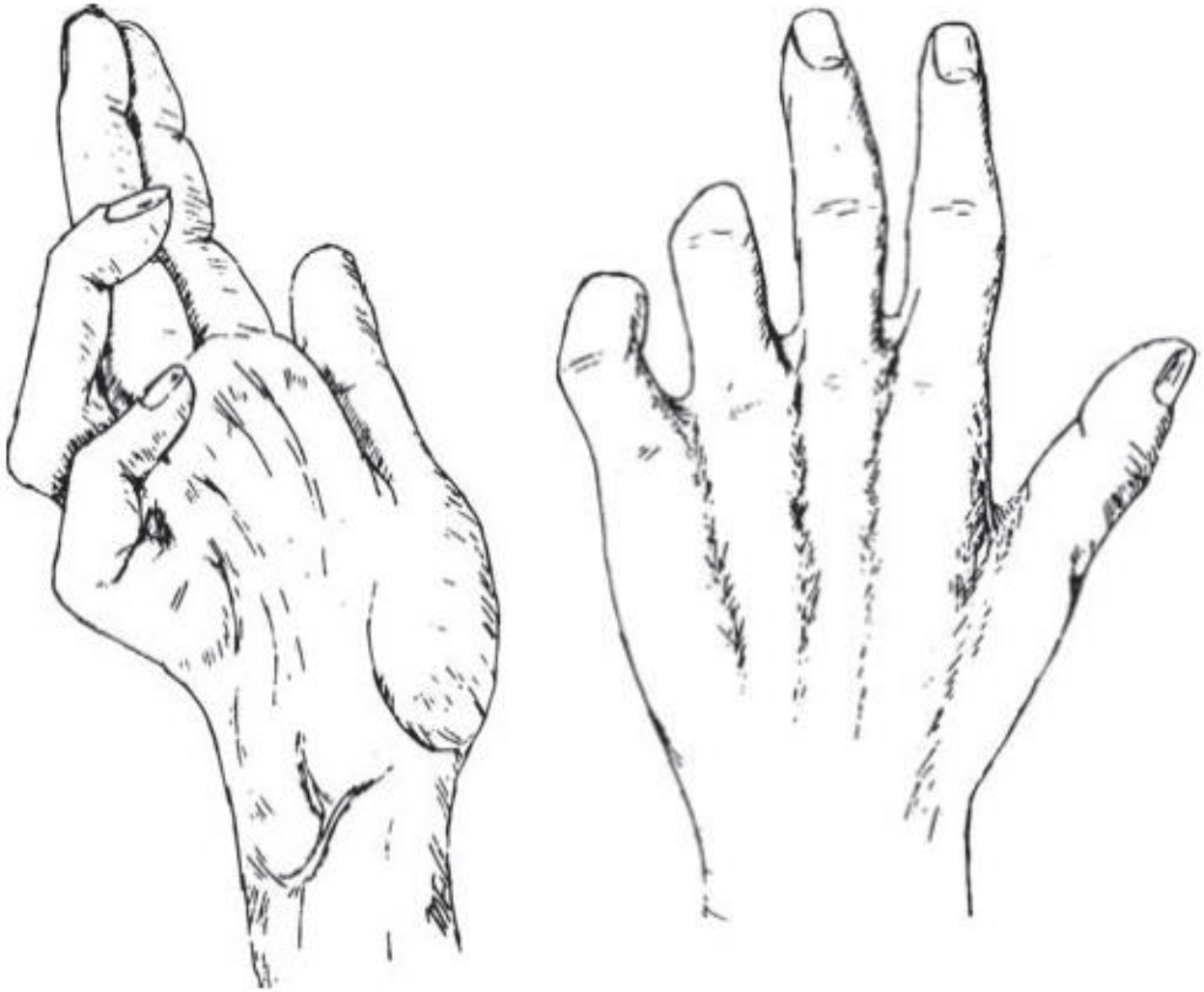


Figure 37-13 Clawing of digits seen with ulnar nerve problems. (From Snell, R. S. [2003]. *Clinical anatomy* [7th ed.]. Baltimore: Lippincott Williams & Wilkins.)

- Orthotic intervention for ulnar nerve palsy aims to prevent overstretching of the denervated ring and small finger intrinsics. An MP blocking orthosis that maintains slight MP flexion and prevents MP extension is recommended. Teach patients to compensate for sensory loss and to maintain passive range of the MPs in flexion and the IPs in extension. It is very important to prevent PIP flexion contractures. Built-up handles in conjunction with the MP blocking orthosis may be helpful.

- **High Ulnar Nerve Lesion** . A high ulnar nerve lesion is often identified with trauma at or proximal to the elbow. There is involvement of the muscles listed earlier and denervation of FDP of ring and small fingers and of FCU.
- Ring and small finger clawing is less apparent with the high lesion but becomes noticeable as the FDP are reinnervated and are unopposed by the still-absent intrinsics. Orthotic intervention and treatment are the same as for a low ulnar nerve lesion. If the FDP is absent, teach the patient to maintain full PROM of the IPs of the ring and small fingers to prevent contractures

- **Low Radial Nerve Lesion** . Low radial nerve injury of the deep motor branch is called posterior interosseous palsy.
- Presentations vary but brachioradialis and extensor carpi radialis longus function is usually present. Efforts to extend the wrist yield strong radial deviation. MP extension is affected.
- Sensation on the dorsal radial hand is affected. Therapy is similar to that described for radial nerve compression, with emphasis on maintaining PROM for wrist, thumb, and digital extension and orthotics to promote tenodesis for functional pinch, grip, and release.

- **High Radial Nerve Lesion** . A high radial nerve injury is seen commonly with humeral fractures because this nerve spirals around the humerus. Wrist and digital extensors are absent. Sensory loss occurs on the dorsal– radial hand, which interferes less with function than does sensory loss on the palmar hand. Triceps function remains, but the supinator and all wrist and finger extensors lose function. Tenodesis is lost.

Figure 37-14 Wrist drop caused by radial nerve problem. (From Snell, R. S. [2003]. *Clinical anatomy* [7th ed.]. Baltimore: Lippincott Williams & Wilkins.)

- Splinting restores tenodesis and may be useful for the many months during the wait for reinnervation, which occurs at approximately 1 inch per month. Various static and dynamic orthoses are available; the dynamic orthotics are most useful functionally. Many patients make good use of both types of orthoses. Compliance tends to be good because of the functional value of these orthoses. It is important to maintain joint suppleness while awaiting reinnervation or reconstructive surgery.

Fractures

- **Distal Radius Fracture**
- Distal radius fractures are among the most common upper extremity fractures. Hand therapists frequently treat patients with this diagnosis. Distal radius fractures should not be confused with fractures of the carpal bones. The main complication associated with distal radius fracture is traumatic arthritis caused by poor articular congruency. Decreased wrist ROM, decreased grip strength, alteration of the carpal alignment, and instability may ensue. Other complications include tendon rupture, compression of the median or ulnar nerve, and complex regional pain syndrome (CRPS)

- Therapy during Immobilization . Appropriate early therapy intervention can make a huge difference in the patient's overall functional recovery. If digits are allowed to become swollen and stiff, the long-term functional results can be devastating.
- These fractures are common among older people with osteoporosis and balance problems. Temporary loss of independence following fracture can trigger an irreversible downward spiral in their occupational functioning.

- Typical medical management of Colles' fracture is cast immobilization, usually above elbow with the elbow in 90° of flexion to prevent forearm rotation during the first 3 weeks. When the patient is put in a short arm cast and the elbow is freed, begin elbow AROM for fl exion and extension, but avoid resisted elbow motion so as not to stress the fracture healing. Do not perform elbow PROM without medical clearance, and be very gentle. Biceps tightness commonly follows elbow immobilization.

- Certain fractures require some form of fixation. Some physicians delay the referral of patients to therapy, but postponing the initiation of therapy can result in significant problems with edema and decreased ROM.
- It is a good idea to communicate with referring physicians and encourage routine early therapy referral for this diagnosis.

- While the patient has percutaneous pins, provide pin site care as the physician prescribes using sterile technique and universal precautions. Teach the patient digital ROM and tendon gliding exercises, and instruct in precautions related to cast wearing. It is critical to monitor for cast tightness because a tight cast can cause CRPS. Call the physician if the cast is too tight. Discourage the use of slings because they promote unnecessary proximal stiffness, guarded posture, and disuse.

- Insidious onset of shoulder restrictions is problematic and best avoided. Physicians most assuredly appreciate therapists' input regarding early signs of this problem.
- To prevent a frozen shoulder, proximal ROM is a high treatment priority. Instruct in shoulder flexion, abduction, internal rotation, and external rotation. Perform as thorough a physical assessment as tolerated and as cast constraints permit. This may have to be done in phases. Early identification of guarding, excessive pain, or autonomic signs can alert the team to the possibility of CRPS.

- Following distal radius fracture, the recovery of function depends on restoration of motion and strength and on maximizing the length-tension relationship of the digital flexors and extensors. Edema can contribute to decreased ROM at uncasted areas. Patients are often surprised that uninjured and uncasted areas can stiffen.
- The goals of early therapy during immobilization are to normalize edema and to achieve as nearly normal AROM of uncasted areas as possible. During this period, intrinsic tightness, extrinsic tightness, and digital joint tightness may occur. The chance of tendon adherence is increased following open reduction and its accompanying incisional scar. Various blocking splints may be used with functional activity and exercise to resolve joint or musculotendinous tightness

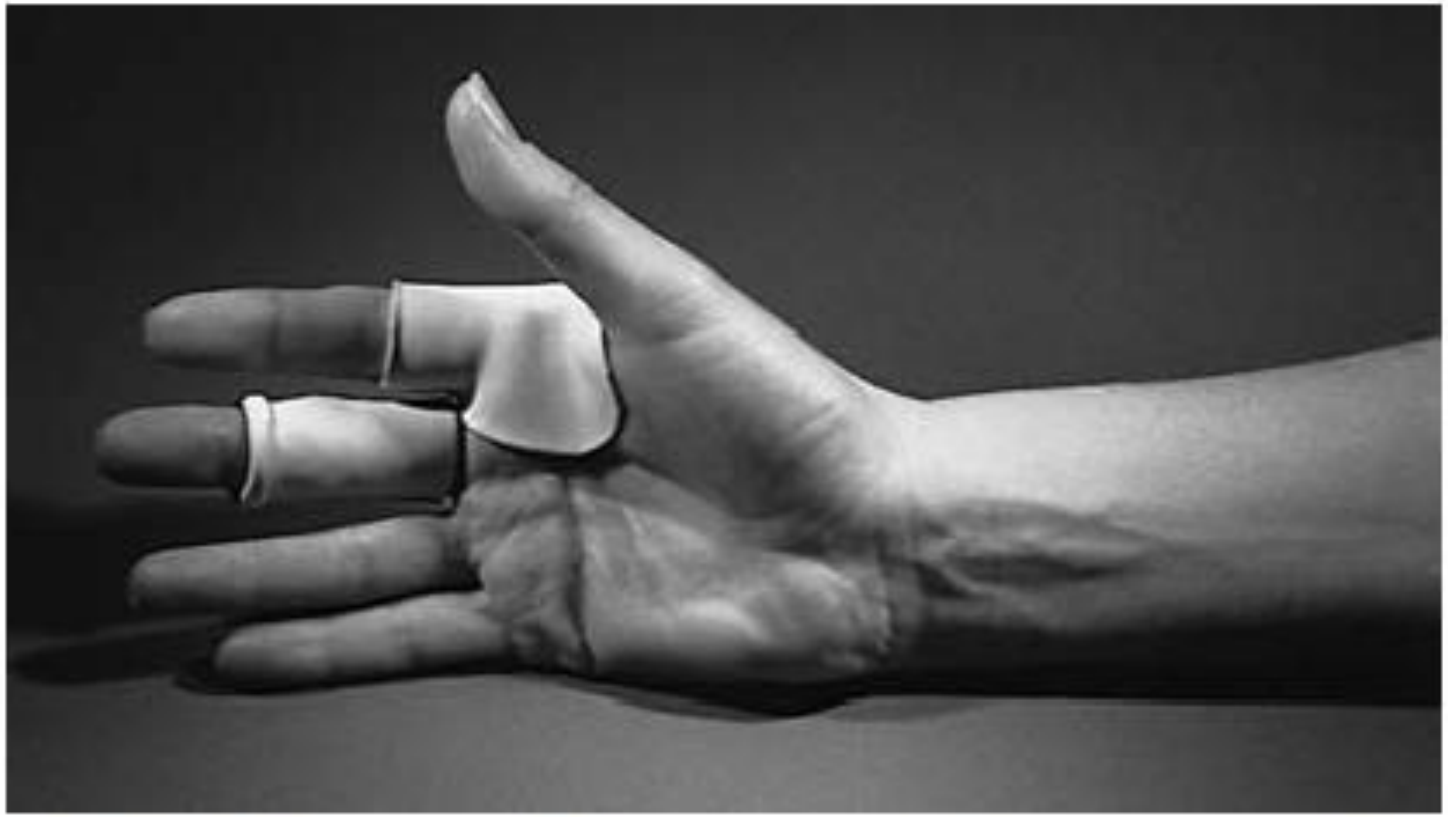


Figure 37-4 Blocking splints. MP splint blocks MP motion, promoting PIP and DIP motion. Digital splint blocks PIP motion, promoting MP, and/or DIP motion.

- Differential tendon gliding exercises are extremely important. Frequent exercise throughout the day is better than a few long sessions. It is generally advised to perform exercises every hour or two, perhaps 5–10 repetitions each, maintaining the end position comfortably for 3–5 seconds. Incorporate exercises into occupation, including ADL, as much as possible.
- If extrinsic musculotendinous tightness persists, it may be appropriate to add night static progressive splinting or low-load, long-duration dynamic splinting in conjunction with exercise to normalize extrinsic length. Consult the physician before making this determination.

- Therapy after Immobilization Stage . When fracture immobilization is discontinued, physicians often recommend a custom-fabricated volar wrist orthosis. This is protective and can be corrective to help restore functional wrist motion (usually extension). This temporary support is particularly helpful if the patient maintains habitual wrist flexion because this “doggy paw” posture leads to development of the undesirable deformity position of MP extension, PIP flexion, and thumb adduction and extension discussed earlier.

- At this stage of therapy, there is usually measurable limitation in ROM, with patients reporting awkwardness and decreased function. Consult the physician for medical clearance and guidelines for forearm and wrist ROM.
- **Safety Message**: Do not initiate PROM of the wrist without medical clearance because this may be injurious.
- Teach the patient to wean off the protective orthosis according to the physician's guidelines, which are individualized. Oedema control continues to be the highest priority until it is resolved. AROM and ADL can help correct the oedema.

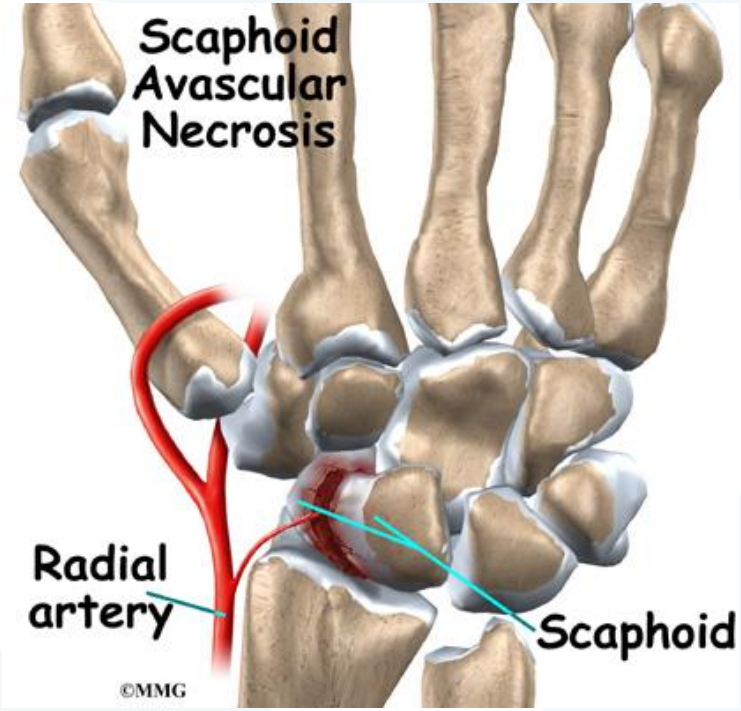
- At any time, but especially in this early stage, overzealous therapy is harmful. Patients and families who think they should be aggressive in their home programs need education and reinforcement to avoid overdoing it. Use written material and illustrations to teach them how to observe tissue responses and monitor inflammation. Temperature elevation or redness over the joints of digits may indicate that intervention is eliciting an inflammatory reaction and should be adjusted accordingly

- It is extremely important to retrain the wrist extensors to function independently of the extensor digitorum. Have the patient practice wrist extension with available composite digital flexion, being especially sure the MPs are flexed. Then have the patient flex the wrist with digits relaxed but extended to isolate the wrist flexors. Because substitution patterns are hard to overcome, early training of biomechanically efficient movement is best. Progressive grasp-and-release activities reinforce this tenodesis training. It is also important to retrain the extensor digitorum to function independently of the intrinsics. Have the patient extend the MPs with the IPs slightly flexed to isolate the extensor digitorum.

- Gradually upgrade therapy with increasingly challenging motions, combined motions, and activities aiming to restore joint suppleness and musculotendinous lengths. Dexterity activities, such as cat's cradle, and games, such as pick-up sticks, promote spontaneous functional movements.
- Sorting drawers and folding small items of clothing are good home activities. Initiate graded functional strengthening with medical clearance, usually after good motion has been achieved. Again, it is easy to be too aggressive with these patients. Upgrade carefully, monitor patient and tissue responses, and adjust the intervention accordingly.

- **Scaphoid Fracture**
- Some 60% of carpal fractures affect the scaphoid (also called the navicular) bone, making scaphoid fractures the most common of all carpal fractures. The mechanism of injury is usually a fall on the outstretched hand (called FOOSH) with wrist radial deviation. Associated ligamentous injury may also be present. Tenderness in the anatomical snuffbox, a depression at the base of the thumb between the EPL and EPB tendons, where snuff used to be placed, is a classic finding. Scaphoid fracture may be difficult to confirm radiographically initially and may not become apparent until 3 weeks following injury because of resorption at the fracture site. Once fracture is confirmed, the thumb is usually included in the cast, with the IP joint free

- Proximal scaphoid fractures may be at risk for developing avascular necrosis because of the pattern of vascular supply. Casting time may be long for this reason. Hand therapy principles are the same as for distal radius fracture.



Non-articular Hand Fracture

- **Distal Phalanx Fracture** . Distal phalanx digital fractures typically result from a crushing injury and occur most often in the thumb and middle finger. Tuft fractures occur at the distal tip. They are extremely painful, in part because there is often a subungual (i.e., beneath the nail) hematoma. Following a distal phalanx fracture, hypersensitivity, pain, and decreased ROM of the DIP joint may occur. Monitor closely for signs of DIP extensor lag or the inability to extend the DIP joint actively despite full available passive extension.

- **Middle Phalanx Fracture** . At the middle phalanx, fractures angulate according to their relation to the FDS insertion. Medical management and early positioning guidelines vary among caregivers. Following middle phalanx fractures, decreased PIP and DIP ROM are common problems. Fractures at this site may require long immobilization time for healing, with resulting stiffness. When the patient is medically cleared for therapy, isolated FDS exercises are very important. Here, too, PIP joint flexion contractures are serious complications that can occur in as little as 2 weeks of immobilization in flexion. Consult with the physician for therapy guidelines based on fracture stability and healing

- **Proximal Phalanx Fracture** . At the proximal phalanx, fractures tend to angulate with a palmar apex. This deforming force is due to the action of the intrinsic muscles on the proximal fragment. With proximal phalanx fractures, a handbased orthosis in intrinsic-plus (antideformity) position is useful at night. A digit-based extension orthosis provides support and protection in the day except during exercise. Again, the physician provides therapy guidelines based on fracture stability and healing. PIP joint fl exion contractures are the most likely and most difficult complication. Watch for these, and catch them early. Better yet, avoid them with appropriate orthotics and structure-specific exercise. PIP extensor lag and fl exor tendon adherence at the fracture site are other serious problems

- **Metacarpal Fracture** . Unless there is associated trauma, metacarpal fractures at the base are frequently stable. Metacarpal fractures at the shaft may be transverse, oblique, or spiral. Metacarpal fractures at the neck are common, occurring most often in the small finger. They may result in muscle imbalance between the intrinsics and extrinsics.
- With metacarpal fractures, dorsal hand oedema is a frequent complication that can contribute to MP joint dorsal capsular tightness. If there is associated soft tissue injury, intrinsic contracture or extensor digitorum adherence may occur. Appropriate early therapy and preventive edema control are important

- Unstable fractures require fixation to achieve stability and allow early ROM. Kirschner wires , a common form of fixation used for hand fractures, may be used alone or in conjunction with additional fixation. Other forms of internal fixation include tension band wires, lag screws, plates, and mini external fixators. Functional recovery relates to anatomical restoration. To maximize functional outcomes, the ideal situation allows for early motion. Preventing stiffness of uninvolved digits is a high priority that can itself be challenging. Prolonged immobilization is associated with oedema and pain. Persistent oedema results in joint and tendon scar and adhesions, atrophy, and osteoporosis.

Collateral Ligament Injury

- **Proximal Interphalangeal Joint Sprain**
- PIP joint sprains often result from sports involving balls. Their severity, which may be underappreciated, is described as grade I through grade III. In grade I, the ligament remains intact, but there is diffuse individual fiber disruption. In grade II, there is complete disruption of one of the joint capsule's major retaining ligaments. In grade III, there is complete disruption of one collateral ligament in addition to injury to dorsal and/or volar capsular structures. Pain, decreased ROM, and risk of flexion contracture are the most common problems associated with grades I and II injuries. Joint instability may occur with grade III injuries

- Therapy focuses on oedema control, joint protection, and ROM. Buddy straps are helpful to protect or to promote movement. They may be offset to improve fit. Orthotic intervention is both protective and corrective. A dorsal extension blocking orthosis is often ordered early on for volar plate injuries associated with dorsal PIP joint dislocation. Persistent thickening about the joint commonly occurs, interfering with recovery of ROM.

Figure 37-6 Offset buddy straps. Interdigital strap accommodates different phalangeal lengths of adjacent digits. Used to allow one digit to assist the next in achieving motion and for protection.

gure 37-15 Dorsal PIP extension–blocking splint. Protective digit-based int maintains slight PIP flexion. Used to prevent full extension to protect ar plate injury.

- **Skier’s Thumb**
- Disruption of the ulnar collateral ligament of the thumb MP joint occurs with acute radial deviation. This diagnosis, which may entail avulsion of bone fragment at the ligamentous insertion, is often seen among people who fall while skiing. Injury to the radial collateral ligament of the thumb MP occurs only one-tenth as often. Following surgical repair, the wrist and thumb are casted. When therapy begins, IP ROM is the priority because full MP flexion may not be achieved, especially among older patients. Avoid resistive exercise until medically cleared. Then begin with lateral pinch but avoid tip pinch until further medical clearance, which may not be for 12 weeks, because tip pinch is strenuous on the injured structures. Use a hand-based spica orthosis for protection. Scar hypersensitivity caused by the underlying radial sensory nerve is common.

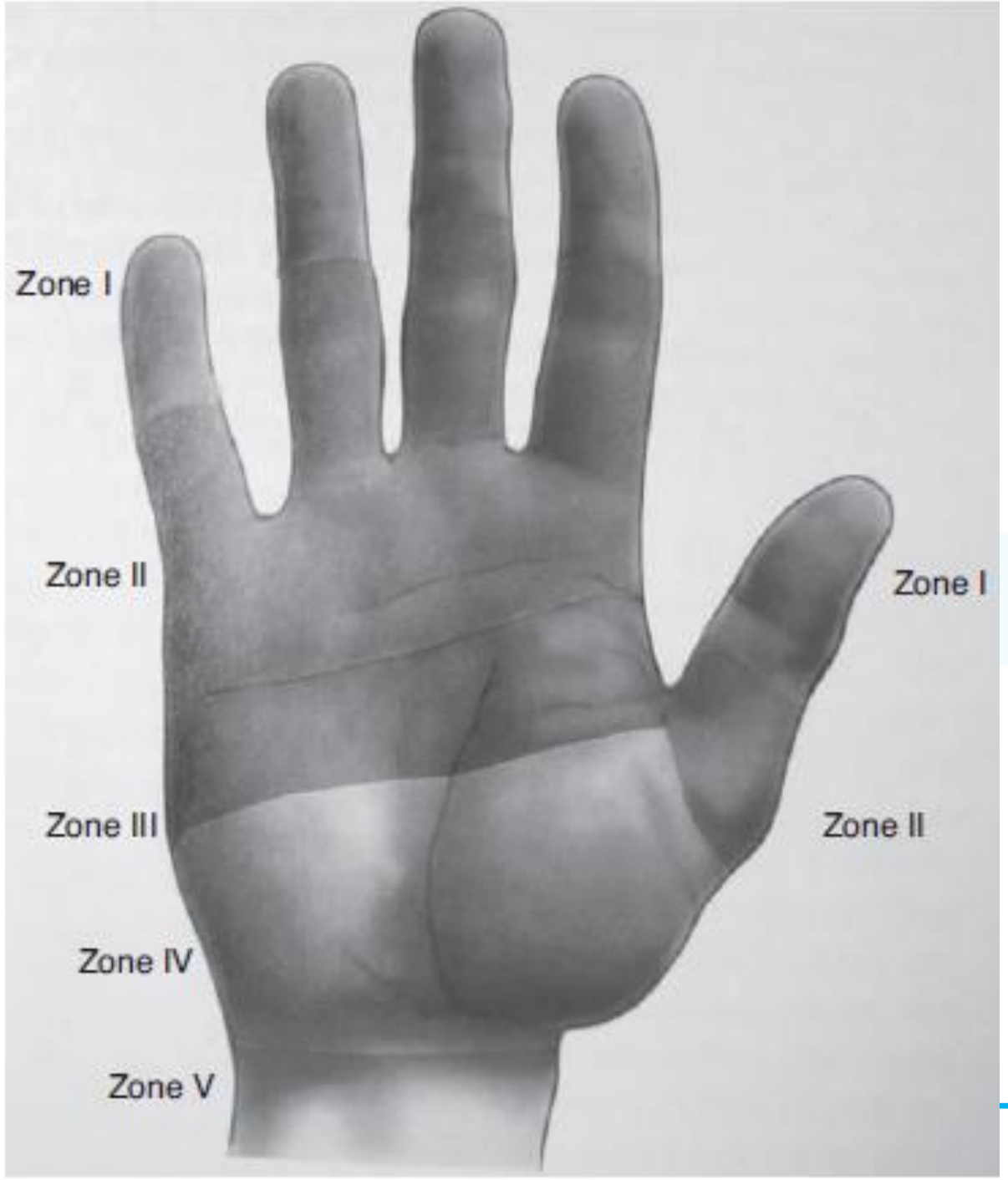
Flexor Tendon Injury

- Surgical repair of flexor tendon injury is a complex undertaking performed by specialists in the fi eld. Like the surgery, hand therapy for these patients is a complicated and specialized area. Therapy can be time consuming, and it entails substantial education of the patient, with subtle but significant changes in splinting and exercise at every session to promote function while protecting fragile repaired structures. Multiple structures are often involved, and there are many precautions and contraindications that vary according to the details of the patient's surgery and the surgeon's specifications and preferences.

- Five anatomical zones describe flexor tendon injury to the index, long, ring, and small digits. Zone I is from the insertion of the FDS to the insertion of the FDP. Zone II is the area where the FDS and FDP both lie within the flexor sheath, from the A-1 pulley to the FDS insertion. This region has memorably been dubbed “no man’s land” to reflect the technical challenge and historically poor prognosis for repair in this area. Zone III describes the area from the distal edge of the carpal tunnel to the A-1 pulley of the flexor sheath, including the lumbrical muscles.

- It is essential to maintain close communication with the patient's surgeon. A therapist experienced in the treatment of these patients should closely supervise their care. Zone IV is where the flexor tendons lie under the transverse carpal ligament in the carpal tunnel. Injuries in this zone may include the median and ulnar nerves. Zone V is the area from the forearm flexor musculotendinous junction to the border of the transverse carpal ligament.

Figure 37-16 The five zones of the hand based on flexor tendon anatomy. Zone I contains flexor digitorum profundus tendon; zone II is the tendon sheath containing flexor digitorum superficialis and flexor digitorum profundus tendons; zone III is the lumbrical muscle zone; zone IV is the carpal tunnel region; and zone V is the forearm area. (From Rayan, G. M., & Akelman, E. [2012]. *The hand: Anatomy, examination, and diagnosis* [Kindle Locations 704–707]. Philadelphia: Lippincott [Wolters Kluwer Health]. Kindle Edition. Used with permission.)



- Physicians usually indicate specific postoperative positioning guidelines to protect repaired structures following fl exor tendon repair. The goals are twofold and contradictory: to minimize adhesion formation and to prevent gap or attenuation of the repaired tendon. These dual goals highlight the complexity of therapy associated with this diagnosis. Various protocols exist for controlled mobilization, using a dorsal orthosis with the wrist in 10°–30° of flexion, MP joints in 40°–60° of flexion, and IP joints ideally in full extension (unless there has also been a digital nerve repair).

- The involved IP joints may have to be in some flexion if a digital nerve has been repaired. The Duran protocol entails passive digital flexion and extension within the protective orthosis to achieve 3–5 mm of differential digital tendon excursion. With this protocol, gentle active motion begins with medical clearance about 4 weeks after surgery.
- The passive flexion–active extension protocol, also called the Kleinert protocol, uses rubber band attachments to the fingernails to provide passive digital flexion within the protective dorsal orthosis.

- The patient performs gentle active digital extension, and the rubber band provides passive digital flexion within the confines of the protective orthosis. Exercises are gradually increased to 10 repetitions comfortably every waking hour. At night, the digits may be strapped carefully and comfortably to the dorsal hood of the orthosis to counteract the tendency to develop PIP or DIP flexion contractures.

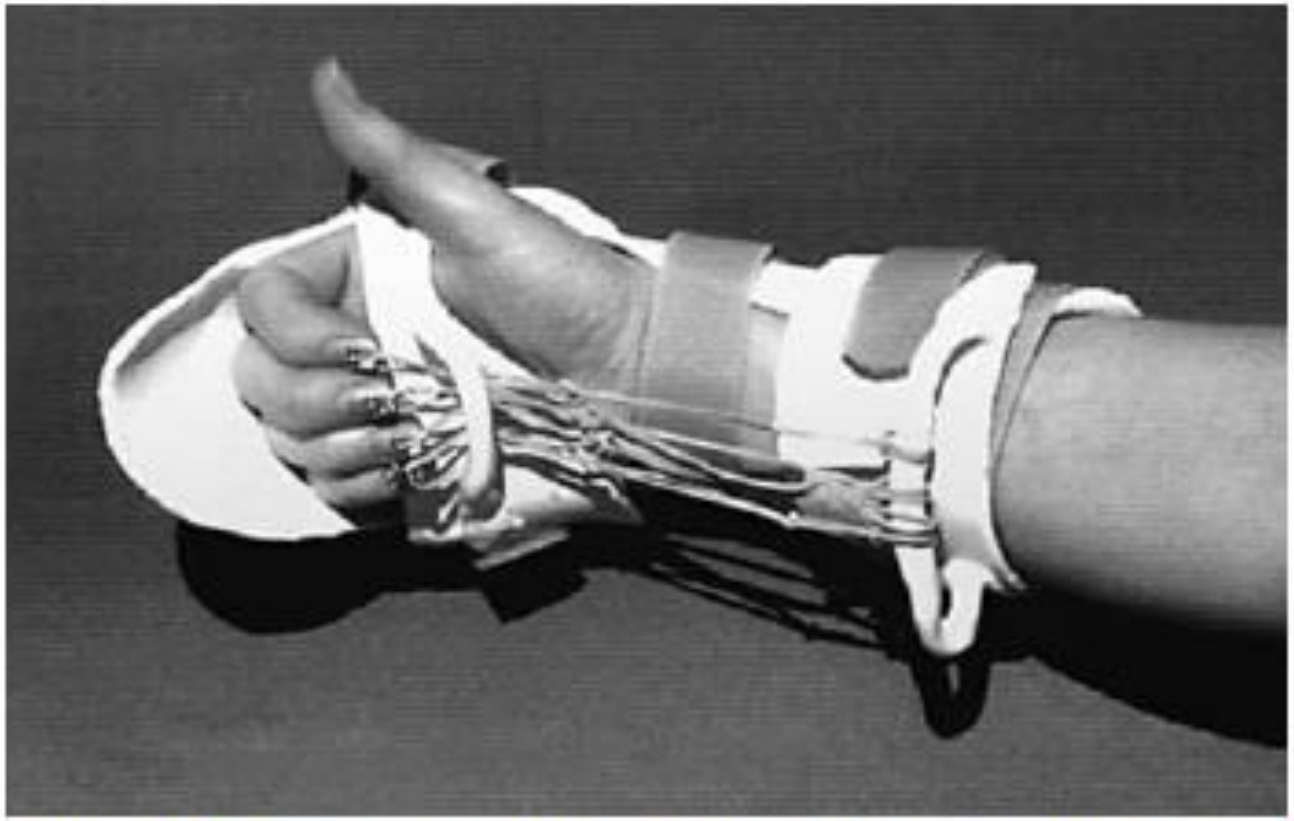


Figure 37-17 Modified Kleinert splint. Dorsal splint maintains the wrist in 30° of flexion, MPs in 70° of flexion, and IPs in extension. Rubber band attachments provide passive digital flexion.

- The Chow protocol uses a combination of the Duran and Kleinert techniques. With advances in suture techniques, flexor tendons protocols are incorporating early active motion in patients who are good candidates.
- When the physician gives medical clearance to discontinue the dorsal protective orthosis, begin a graded program to promote functional movement. Oedema control and scar management remain high clinical priorities. Assess closely and determine tissue-specific limitations that guide the therapy program. Tendon gliding exercises and place-and-hold exercises are typical early techniques. Corrective splinting is useful, along with ADL, graded activity, and upgraded exercise as appropriate.

Staged Flexor Tendon Reconstruction

- Staged flexor tendon reconstruction is a complex two part procedure. It is highly advisable to have an experienced hand therapist supervise the treatment. Staged flexor tendon surgery is chosen when there is significant scarring of the tendon yet potential for eventual function.
- It may be used in cases of flexor tendon rupture or when primary repair is not possible, such as with a complex injury involving bone and multiple tissues. In the first stage, a tendon implant replaces the scarred tendon, capsular contractures are released, and pulleys are reconstructed. The implant, which may be active or passive, stimulates formation of a new biological sheath. In the second stage, after about 3 months, a tendon graft replaces the implant

Extensor Tendon Injury

- Therapy of extensor tendon injuries is complicated and requires supervision by experienced hand therapists. Various protocols are available for immobilization, controlled passive motion, or active short arc of motion following extensor tendon repair.
- Seven zones describe the digital extensors for the index, long, ring, and small fingers, and five zones describe the thumb extensors (Fig. 37-18). Injury in zones I and II leads to a mallet deformity, which follows disruption of the terminal extensor tendon and manifests itself as DIP extensor lag (Fig. 37-19).

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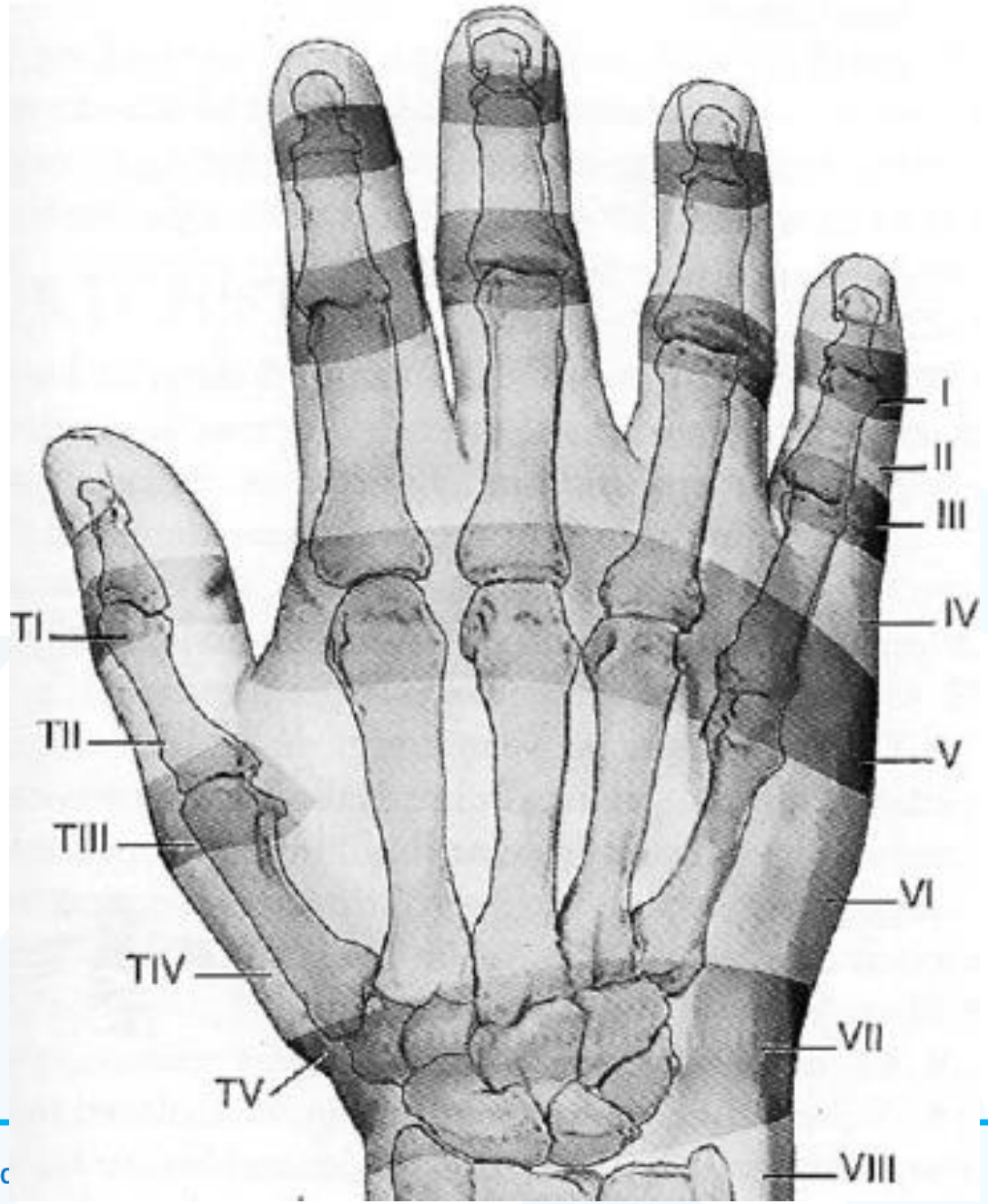

Figure 37-18 The seven zones of the hand based on extensor tendon anatomy. The odd zones I, III, V, and VII belong to distal interphalangeal, proximal interphalangeal, metacarpophalangeal, and wrist joints, respectively. The even zones II, IV, and VI belong to phalanx 2, phalanx 1, and metacarpal. (From Rayan, G. M., & Akelman, E. [2012]. *The hand: Anatomy, examination, and diagnosis* [Kindle Locations 742–744]. Philadelphia: Lippincott [Wolters Kluwer Health]. Kindle Edition. Used with permission.)

Figure 37-19 Mallet finger. (From Anderson, M. K., Parr, G. P., & Hall, S. J. [2009]. *Foundations of athletic training: Prevention, assessment and management* [4th ed.]. Philadelphia: Lippincott Williams & Wilkins. Used with permission).

- Depending on the nature of the problem, in nonoperative cases, therapy may include continuous splinting of the DIP in extension for 6–8 weeks as determined by the physician while the tendon heals. It is essential to maintain normal PIP ROM during immobilization at the DIP. When initiating ROM of the DIP after the terminal tendon has healed, watch closely for recurrence of DIP extensor lag and resume splinting as needed to recover DIP extension. Some physicians recommend continuation of night splinting when DIP AROM is begun.

- Extensor injuries in zones III and IV lead to a boutonniere deformity, an imbalanced digital position of PIP flexion and DIP hyperextension (Fig. 37-20). The deformity is due to volar displacement of the lateral bands secondary to involvement of the central slip. In nonoperative cases, splint the PIP in full extension for 6 weeks, and promote DIP active and passive flexion to prevent stiffness of the oblique retinacular ligament. In operative cases, follow the physician's guidelines, which may vary in timing and technique of mobilization and splinting. When the patient is medically cleared to begin PIP active exercises, watch closely for PIP extensor lag, and modify therapy and splinting accordingly.

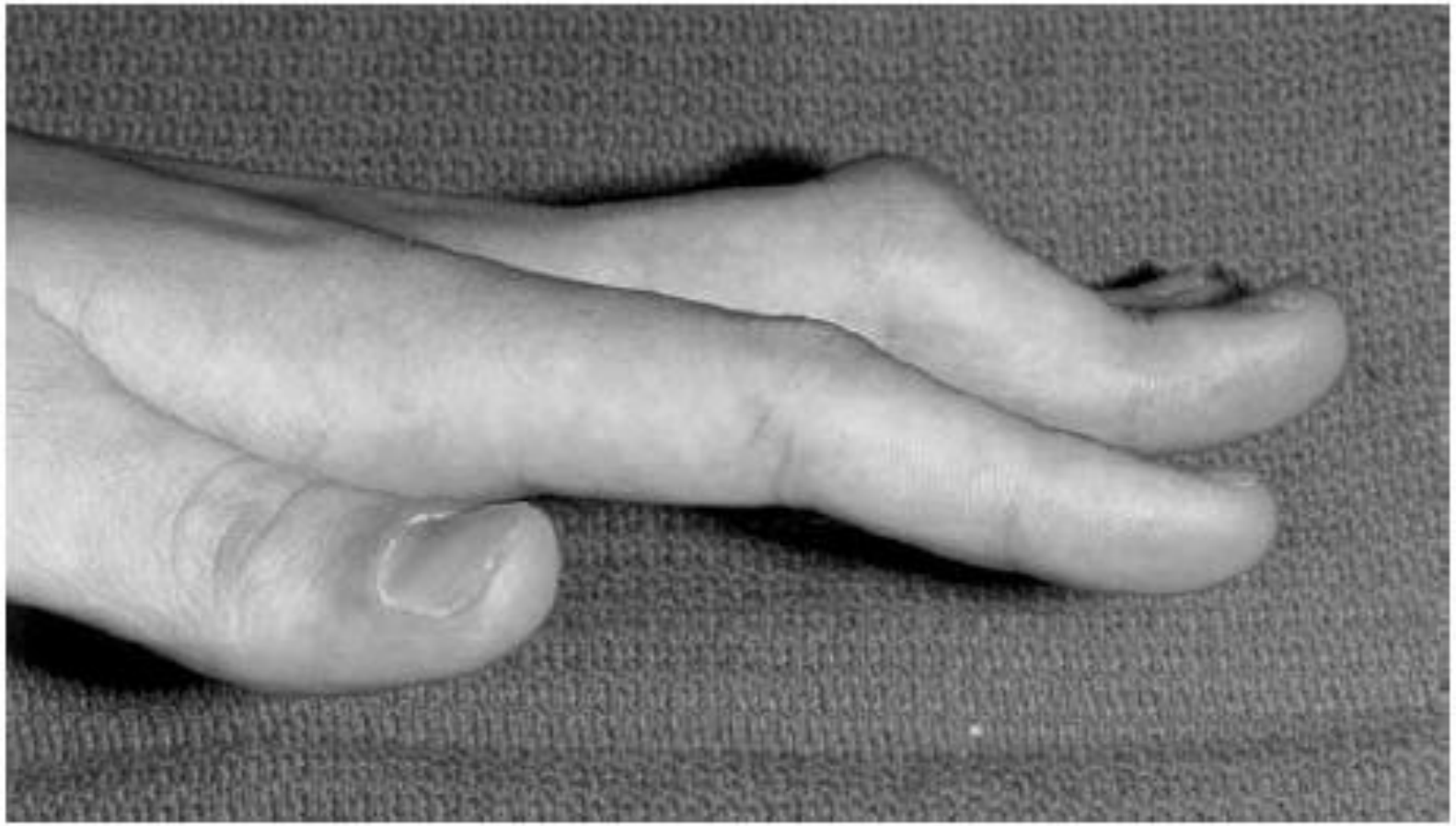

Figure 37-20 Boutonniere deformity. (From Anderson, M. K., Parr, G. P., & Hall, S. J. [2009]. *Foundations of athletic training: Prevention, assessment and management* [4th ed.]. Philadelphia: Lippincott Williams & Wilkins. Used with permission).

- Injury in zones V and VI may be treated by immobilization or by controlled early motion. Specific positioning and motion guidelines vary from surgeon to surgeon and are modified according to each patient's tissue responses. Multiple complex orthotics may be needed to achieve a program that balances rest and motion appropriately.
- Injury in zone VII is likely to result in restrictions because of development of adhesions. Communicate closely with the surgeon for specific positioning and motion guidelines.

Tenolysis

- Tenolysis is a surgical procedure to release tendon adhesions that restrict movement. Physicians do not usually perform this procedure until injured tissues have matured and PROM is maximized, as demonstrated by a plateau in progress during therapy. Therapy following tenolysis may begin as early as a few hours after surgery. The first few days following surgery are considered crucial. The physician's referral should include information on the integrity of the tendon and expected ROM goals based on intraoperative findings. First priorities are oedema control and ROM; observe and respect the tolerances of these fragile tissues.

Complex Regional Pain Syndrome

- Any upper extremity injury, whether as minor as a paper cut or as major as a complex crush injury, has the potential to result in devastating reflex sympathetic dystrophy (RSD), renamed complex regional pain syndrome (CRPS) by the International Association for the Study of Pain. CRPS type I follows a noxious event. Pain that is not limited to the territory of a single peripheral nerve occurs spontaneously and is disproportionate to the inciting noxious event. Oedema is present, with abnormality of skin colour or abnormal sudomotor activity in the painful area since the onset. The diagnosis of CRPS is excluded by other existing conditions that may cause the pain and dysfunction.

- CRPS type II is the same as type I except that it develops after a nerve injury, whereas type I does not involve a nerve injury. CRPS type III refers to a group not otherwise specified and includes patients who do not fulfil the criteria for types I or II.
- Pain that is disproportionate to the injury is the hallmark of CRPS. Constant attention to the patient's pain level and autonomic responses can lead to early medical management, if not prevention, of this challenging problem. The earlier this problem is diagnosed, the more successfully it may resolve.

- The four cardinal symptoms and signs of CRPS are pain, swelling, stiffness, and discoloration. Secondary symptoms and signs include osseous demineralization, sudomotor changes (sweating), temperature changes, trophic changes, vasomotor instability, palmar fasciitis (thickening of palmar fascia), and pilomotor activity (goose pimples or hair standing on end).

- Elegant animal studies have shown that self-protection through immobilization, intended to avoid pain, is itself a risk factor for the diagnosis of CRPS. People with CRPS must learn to use the extremity in ways that are pain free and biomechanically efficient. Normalizing sensory input also helps interrupt the vicious cycle of pain and stiffness.

Therapy for Complex Regional Pain Syndrome

- The most important therapy guideline is no PROM or painful intervention. The fi rst thing is to control the pain. This includes management through medications, sympathetic blocks such as stellate ganglion blocks, and modalities such as TENS as appropriate. Close communication with medical experts specializing in pain management is ideal.

- Provide vasomotor challenge through stress loading (described later), temperature biofeedback, and posture changes during activity. It also helps to reset the sensory thresholds through contrast baths, vibration, and desensitization. Water aerobics and functional activities are excellent ways to provide active movement incorporating reciprocal motion. Use stress loading routinely with patients who are at risk for CRPS. Stress loading is proposed to change sympathetic efferent activity.
- Although the physiological mechanisms of stress loading are not known, it is popular among hand therapists for treating active CRPS, not the sequelae

- The two components of stress loading are “scrubbing the floor” (performed literally on all fours if possible), in brief sessions, three times per day initially, and carrying a weighted briefcase, done with the extremity in extension.
- The weight should be light and tolerable. Be sure it is not too heavy. Scrubbing and carrying achieve compressive loading and distraction of the upper extremity. If actual scrubbing cannot be tolerated, substitute comfortable weight-bearing exercises.

- The frequency and duration of scrub and carry are upgraded as tolerated. If wrist ROM limitations or injury precautions do not allow the patient to assume the scrub position, positions may be adapted to accomplish comfortable weight bearing.
- Also instruct the patient to perform frequent pain-free proximal AROM bilaterally.

- Avoid PROM or other therapy until the pain and swelling begin to subside, and then monitor responses closely. Incorporate traditional hand therapy, including orthotics and other non aggravating modalities, with oedema control, joint ROM, differential tendon gliding, restoration of musculotendinous lengths, strengthening, desensitization, physical agents including transcutaneous electrical nerve stimulation (TENS) and ultrasound as appropriate, and functional activity within tolerance. Manual oedema mobilization is effective with this diagnosis.

- Perhaps with CRPS more than other diagnoses, patient- directed therapy is essential. It is better to perform gentle, pain-free active exercises frequently for short periods than fewer and longer sessions. Light massage and active exercise help to interrupt the pain cycle. Make the exercise program bilateral and include reciprocal upper extremity motions. Allow the progress to be as slow as necessary to prevent worsening of symptoms. This diagnosis can be overwhelming and discouraging. Provide the patient with appropriate encouragement and reassurances that progress can be made over time.

- CRPS typifies the difficult clinical problems that hand therapists are trying to avert or avoid. Intervention programs that are progressing well can be suddenly and unexpectedly derailed by this disorder. For this reason, it is advisable to approach all hand therapy patients supportively and with a very careful eye, regardless of their diagnosis. Early identification of CRPS is a key to resolving it.

Osteoarthritis

- Idiopathic OA is the most common type of OA. In the upper extremity, it often affects the DIP and PIP joints. Osteophytes at the DIP are called Heberden's nodes, and osteophytes at the PIP are called Bouchard's nodes. For painful DIP nodes, small cylindrical splints or a light Coban™ wrap may promote function while decreasing pain.

- Hand therapy for OA focuses on alleviating symptoms through education in principles of joint protection, protective and supportive splinting, and provision of adaptive devices for ADL. For OA of the thumb CMC, a hand-based thumb spica orthosis (Fig. 37-21) is often extremely helpful. Some therapists prefer to use a forearm-based spica orthosis, particularly when there is pan trapezial involvement rather than just CMC joint involvement.

Figure 37-21 Hand-based thumb spica splint. Used to provide pain relief and promote functional pinch.

- Thumb CMC arthroplasty is a common postoperative diagnosis seen by hand therapists. Surgical techniques and timelines for therapy vary among physicians. Patients are often sent to therapy a few weeks after surgery for fabrication of a static forearm-based thumb spica orthosis with the IP free. The physician indicates appropriate guidelines for AROM according to the particular surgical procedures performed. Postoperative therapy goals are to promote pain-free stability and function. ADL modification and joint protection remain a priority.

Rheumatoid Arthritis

- Unlike OA, RA is a systemic disease that primarily affects the synovium. Its debilitating and crippling effects can be severely disabling. RA presents as inflammation of synovial membranes of joints and of tendon sheaths, with redness, swelling, pain, and heat in the areas of involvement.
- Digital involvement at the DIP is less common than at the PIP. If DIP involvement does occur, a mallet finger may result. Involvement at the PIP may result in swan-neck or boutonniere deformities (see the section on extensor tendons for clinical management of mallet and boutonniere deformities).

- A swan-neck deformity presents as MP flexion, PIP hyperextension, and DIP flexion. Fabricate a digital dorsal splint in slight PIP flexion to minimize deforming forces and enhance FDS function. At the level of the MP joints, deformity usually manifests as MP ulnar drift and palmar subluxation. Thumb deformities include boutonniere (primary thumb MP involvement) and swan-neck (primary CMC involvement) deformities. The thumb may also demonstrate stiff, unstable, and painful joints at the levels of the IP, MP, or CMC. RA often affects the wrist. This is significant because the wrist is anatomically critical to proper hand function. Wrist involvement is compounded by concomitant hand deformity. Synovitis at the wrist can lead to fl exor or extensor tendon ruptures

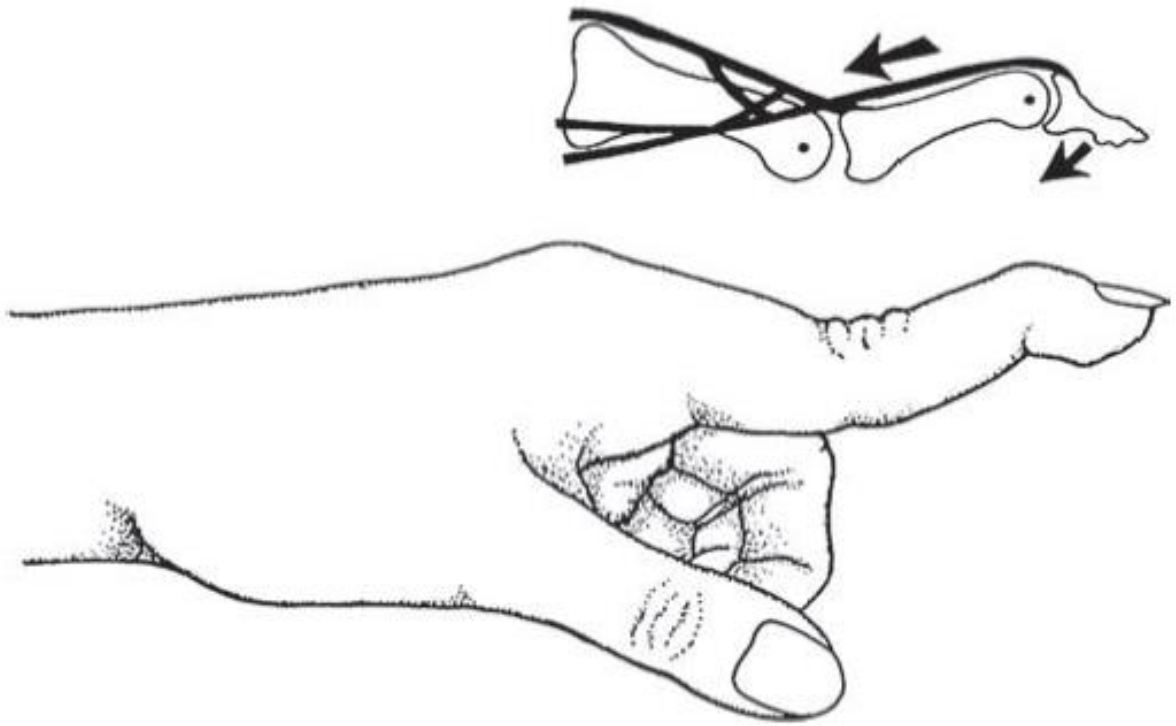

Figure 37-22 Swan-neck deformity: hyperextension of the PIP joint and dorsal migration of the lateral bands. (From Rayan, G. M., & Akelman, E. [2012]. *The hand: Anatomy, examination, and diagnosis* [Kindle Locations 2124–2127]. Philadelphia: Lippincott [Wolters Kluwer Health]. Kindle Edition. Used with permission.)

- In evaluating patients with RA, observe deformities and abnormal posture, any atrophy, and skin condition. Identify crepitus of joint or tendon, palpable nodules, tendon integrity, and joint stability. Ask about morning stiffness, fatigue, and pain. The appearance of the deformity (cosmesis) is also relevant.

- The goals of upper extremity orthotics for RA include reducing inflammation, supporting weak tissues, and minimizing deforming forces. Orthotic intervention also provides functional assistance. Orthotics are used especially in the acute stage, when inflamed structures are at risk for further damage. Forearm-based resting orthoses may support the wrist and entire hand, the wrist and MPs, or only the wrist.

- Determine orthotic design according to the pathomechanics of the disease. Involved MP joints are at risk for volar subluxation. Therefore, splint the wrist in neutral or slight extension, the MP joints in available extension, and the PIP joints in slight flexion. Radial deviation of the wrist encourages ulnar drift of the digits at the MP joints because of the zigzag deformity. An orthosis to correct MP ulnar drift often improves the biomechanics of hand use. Talk with the patient to identify individual preferences and needs in terms of ADL and joint protection. Adapt the straps and practice with patients to be sure they can open and close them. For some people who require bilateral orthotics, it may be easier to use one at a time on alternate nights.

Client-Focused Activity Analysis Case Example

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Thank you