Hand Therapy Modalities for Proximal Interphalangeal Joint Stiffness

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Learning Objectives

- Discuss the pathogenesis of the proximal interphalangeal joint contracture.
- Detail the different phases of proximal interphalangeal joint tissue healing.
- Describe the specific therapeutic modalities for each phase of joint contracture.
- Illustrate methods of prevention of proximal interphalangeal joint contracture.
- Feature therapeutic modalities outcomes of proximal interphalangeal joint contracture.

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Stiffness of the proximal interphalangeal (PIP) joint may lead to substantial disability but, fortunately, may be successfully treated with focused hand therapy in the majority of cases.[1] Proximal interphalangeal joint stiffness may be the result of both traumatic and atraumatic conditions, such as Dupuytren disease, infection, and neurological injury.[1,2]

The PIP joint has unique anatomy that predisposes it to stiffness. Unlike the metacarpophalangeal (MCP) joint, the PIP is a simple hinge joint that allows for motion in the flexion-extension axis only.[2] In full extension, joint stability is maintained by the highly congruent bony architecture; whereas, in flexion, the capsuloligamentous structures that envelope the joint maintain stability. These structures include the dorsal capsule, volar plate, and collateral ligaments, which, unlike the MCP joint, are essentially isometric throughout the arc of motion.

The pathogenesis of the PIP joint contracture is attributed to a cycle of edema, immobilization, and tissue adherence of the capsuloligamentous structures.[3] This may be compounded by concurrent tendon adhesions and

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TABLE 1. Phases of Tissue Healing and Modalities Utilized

	Timing	Tissue Response to Insult	Goals	Modalities
Inflammatory phase	< 1 wk	Increased blood flow and influx of WBCs	Edema control Pain control	Cryotherapy Elevation Retrograde massage ± Immobilization
Fibroblastic phase	Wks 1–3	Influx of fibroblasts and initiation of collagen synthesis	Edema control Incorporate ROM exercises	Active motion exercises Blocking orthoses Static and dynamic orthoses
Remodeling phase	Beyond wk 3	Continued collagen synthesis, remodeling, and scar maturation	Continued ROM exercises Increased emphasis on passive ROM	Active motion exercises Blocking orthoses Static and dynamic orthoses

ROM, range of motion; WBCs, white blood cells.

complex deformities, such as swan neck or boutonniere deformities.

Preventing PIP joint stiffness from developing following an insult to the joint is of primary importance. Prevention is focused on interrupting the cycle described previously with edema control, pain control, and limiting length of immobilization. When prolonged immobilization is necessary, it is vitally important to place the hand in the position of safety. This position places the wrist in 30° of extension, the MCP joints in 70° to 90° of flexion, and the interphalangeal joints in full extension. In this position, the collaterals of the MCP joint and the volar plate of the PIP joint are placed on stretch.[4]

The modalities employed by the hand therapist vary depending upon the stages of tissue healing. These stages are divided into the inflammatory phase, the fibroblastic phase, and the maturation phase and correspond to the tissue response to injury (Table 1).[3]

INFLAMMATORY PHASE

The inflammatory phase lasts roughly 1 week following an inciting injury and may be managed with judicious immobilization, edema control, and pain control modalities. Working on range of motion is incorporated as early as possible but is typically delayed while the inflammatory phase is resolving.

Specific modalities that are employed in these time periods include cryotherapy, pulsed ultrasound, elevation, retrograde massage, contrast baths, and various electrical stimulation protocols to reduce pain and inflammation. We primarily utilize cryotherapy with ice packs or ice massage for short durations (typically < 15 minutes), retrograde massage, and elevation with prefabricated pillows and ergonomic adjustments for edema control.[3] Although patient anecdotes support the use of contrast baths, its impact on edema control and functional benefit remains questionable.[5]

FIGURE 1: Thermoplastic casting tape orthosis utilized for nighttime wear or as a serial cast.

FIBROBLASTIC PHASE

The fibroblastic phase is characterized by an influx of fibroblasts and collagen production at the injury site beginning the process of tissue remodeling. This period typically lasts from the end of the inflammatory phase to around 3 weeks postinjury.[6] The goal of treatment is to incorporate active motion and gentle passive motion into the patient's regimen. Differential tendon gliding activities, active motion exercises incorporating joint blocking, and static and dynamic orthosis fabrication may be utilized.

Differential tendon gliding activities utilize a single tendon's isolated active range of motion in relation to another to limit adhesion formation. A prime example of this is the flexor digitorum profundus tendon gliding past

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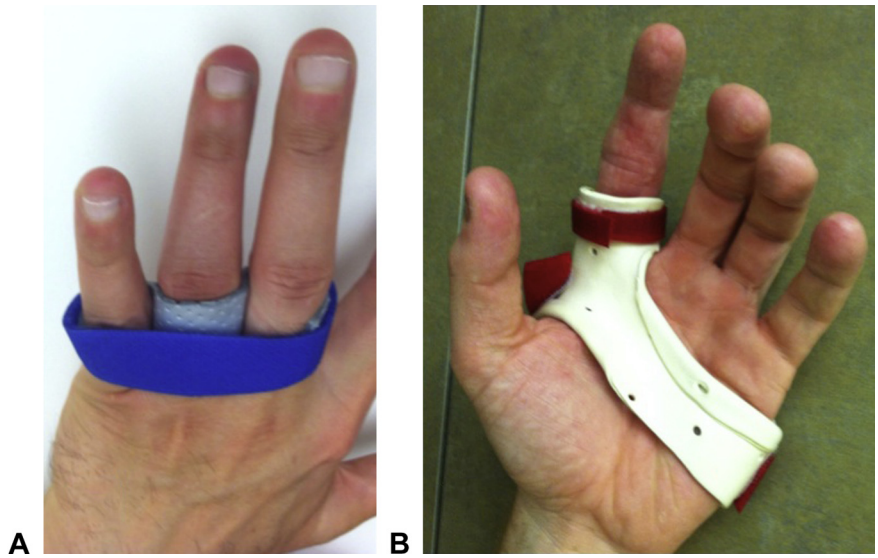

FIGURE 2: **A** Metacarpophalangeal joint extension-blocking orthosis. **B** Metacarpophalangeal joint flexion-blocking orthosis.

the flexor digitorum superficialis tendon while the PIP joint is held in extension. It has been suggested that as little as 3 mm of intrasynovial tendon excursion is enough to prevent adhesion formation.[7] Several tendon gliding exercise regimens have been described.[8] We favor a sequence of active differential tendon glide exercises in the following positions: hook fist, flat fist, full fist, full digital extension, and individual fingertips to palm.

The use of orthoses is an invaluable tool for treating stiffness. Orthosis fabrication works by holding tissue in a higher than resting tension, which incites tissue remodeling.[9] Factors that are associated with improved outcomes with orthotics include a lower degree of initial contracture, shorter time since injury, flexion more so than extension deficit, and more hours per day spent in the orthosis.[10,11] Both static and dynamic orthosis fabrication techniques are efficacious. Glasgow et al[12] followed a prospective cohort of 41 patients with PIP joint stiffness treated with dynamic orthosis fabrication and noted that flexion deficits improved quicker than extension deficits with maximal gains seen at 12 weeks in the flexion-deficit group. The extension-deficit group continued to show improvement at a slower rate, with continuing improvement past the 17-week study end point.

Although numerous designs are available, we typically recommend custom static orthoses for wear at night and dynamic orthoses (custom or prefabricated) during the day. We recently incorporated the use of thermoplastic casting tape into our practice (Fig. 1). This material allows for rapid fabrication and a low profile that we have found useful as nighttime orthoses and serial casts.

In select cases, blocking orthoses may be useful. These orthoses work by immobilizing the joints proximal to the stiff PIP joint, thereby preventing force transmission through the more mobile joints. For example, we use an MCP joint block orthosis placed dorsally to promote active PIP joint extension (Fig. 2).

REMODELING PHASE

The remodeling phase of healing is characterized by continued collagen synthesis, remodeling, and maturation of the tissue.[3] During this time, increased emphasis on passive motion is usually indicated given the increasing strength of the involved tissues.[9] Modalities such as heated ultrasound, paraffin baths, and moist heat complement manual joint mobilization, scar massage, and continued active range of motion exercises.[3] An important consideration is avoidance of overstretching the central slip with overzealous passive stretch.[13,14] This is especially important when mobilizing a digit with a PIP joint extension contracture, which may lead to an extensor lag. As such, we take care to maintain active extension while working on passively correcting flexion deficits.

Should a patient have a persistent deficit in functional motion once the contracture has matured, surgical treatment in the form of tenolysis, capsulotomy, or dynamic external fixation may be indicated.[3]

In summary, stiffness of the PIP joint is a challenging problem that may be successfully treated under the guidance of a hand therapist. Although many modalities exist to treat stiffness, it is imperative to start therapy as early as possible and position the hand correctly at the first encounter.

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JOURNAL CME QUESTIONS

Hand Therapy Modalities for Proximal Interphalangeal Joint Stiffness

Which of the following modalities are best employed for phases of proximal interphalangeal joint contracture?

a. Cryotherapy, pulsed ultrasound, and elevation for the inflammatory phase.
b. Retrograde massage, contrast baths, and various electrical stimulation protocol for the remodeling phase.
c. Mobilization with active and passive motion for the inflammatory phase.
d. Differential tendon gliding joint blocking and retrograde massage for the remodeling phase.
e. Immobilization and scar massage for the fibroblastic phase.

Which of the following statements describes the duration and tissue response for phases of proximal interphalangeal joint contracture?

a. Inflammatory phase duration is 1-3 weeks and has increased blood flow.
b. Inflammatory phase duration is less than one week and has fibroblast influx.
c. Fibroblastic phase duration is 1-3 weeks and has collagen synthesis.
d. Fibroblastic phase duration is less than one week and has remodeling and scar maturation.
e. Remodeling phase duration is beyond 3 weeks and has white blood cell influx.

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