

Immobilization or Early Mobilization After an Acute Soft-Tissue Injury?

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In Brief: Experimental and clinical studies demonstrate that early, controlled mobilization is superior to immobilization for primary treatment of acute musculoskeletal soft-tissue injuries and postoperative management. Optimal treatment and rehabilitation follow four steps that address response to trauma. First is treating the damaged area with PRICES: protection, rest, ice, compression, elevation, and support. Second, during the first 1 to 3 weeks after the injury, immobilization of the injured tissue areas allows healing without extensive scarring. Third, when soft-tissue regeneration begins, controlled mobilization and stretching of muscle and tendons stimulate healing. Fourth, at 6 to 8 weeks postinjury, the rehabilitative goal is full return to preinjury level of activity.

Acute soft-tissue injuries such as muscle-tendon strains, ligament sprains, and ligament or tendon ruptures occur frequently in sports and exercise. Without correct diagnosis and proper treatment, they may result in long-term breaks in training and competition. Far too often, injuries become chronic and end careers of competitive athletes or force recreational athletes to abandon their favorite activity. For these reasons, an increased focus has been on finding ways to ensure optimal healing. In this regard, the question has centered on immobilization or early mobilization in treatment.

Soft-Tissue Response to Trauma

Musculoskeletal soft tissue responds to trauma in three phases: the acute inflammatory phase (0 to 7 days), the proliferative phase (about 7 to 21 days), and the maturation and remodeling phase (21 days and thereafter; table 1). (1)

TABLE 1. Phases of Healing After an Acute Soft-Tissue Injury

Phase	Approximate Days After Injury
Inflammation	0-7
Proliferation	7-21

Acute inflammatory phase. In this phase, ischemia, metabolic disturbance, and cell membrane damage lead to inflammation, which, in turn, is characterized by infiltration of inflammatory cells, tissue edema, fibrin exudation, capillary wall thickening, capillary occlusions, and plasma leakage. Clinically, inflammation manifests as swelling, erythema, increased temperature, pain, and loss of function. The process is time dependent and mediated by vascular, cellular, and chemical events culminating in tissue repair and sometimes scar (adhesion) formation.

Proliferative phase. These changes include fibrin clotting and a proliferation of fibroblasts, synovial cells, and capillaries. The inflammatory cells eliminate the damaged tissue fragments by phagocytosis, and fibroblasts extensively and markedly elevate production of collagen (initially, the weaker, type 3 collagen, later type 1) and other extracellular matrix components.

Maturation and remodeling phase. In this phase, the proteoglycan-water content of the healing tissue decreases and type 1 collagen fibers start to assume a normal orientation. Approximately 6 to 8 weeks postinjury, the new collagen fibers can withstand near-normal stress, although final maturation of tendon and ligament tissue may take as long as 6 to 12 months.

Injury and Four-Step Treatment

After an injury, the ideal treatment and rehabilitation program should include four steps.

PRICES. Immediately after injury, the damaged area should be treated with PRICES: protection, rest, ice (cold), compression, elevation, and support (table 2) (1,2). The aim is to minimize hemorrhage, swelling, inflammation, cellular metabolism, and pain, and to provide optimal conditions for healing (2). Since prolonged inflammation may lead to excessive scarring, early, effective treatment seeks to prevent it. On the other hand, one must remember that inflammation is not only the body's response to insult, but also the initial step in healing.

TABLE 2. Basic Treatment Plan for Acute Musculoskeletal Injury ('PRICES' Mnemonic)

- P** = Protection from further damage
- R** = Rest to avoid prolonging irritation
- I** = Ice (cold) for controlling pain, bleeding, and edema
- C** = Compression for support and controlling swelling
- E** = Elevation for decreasing bleeding and edema

S = Support for stabilizing the injured part

Immobilization and protection. The second step is immobilization and protection of the injured tissue area during the first 1 to 3 weeks. In the early phase of healing, immobilization allows undisturbed fibroblast invasion of the injured area that leads to unrestricted cell proliferation and collagen fiber production. Premature and intensive mobilization at this time leads to enhanced type 3 collagen production and weaker tissue than that produced during an optimal immobilization period (2). Protection (such as with a cast or brace) prevents secondary injuries and early distension and lengthening of injured collagenous structures such as a torn anterior cruciate ligament (ACL) (3).

Maturation. About 3 weeks after injury, collagen maturation and final scar tissue formation begins (1,2,4). In this phase, injured soft tissues need *controlled mobilization*. Less injured portions of the tissue or joint, however, can be mobilized earlier, sometimes even during the proliferative phase. Prolonged immobilization, though, must be avoided to prevent atrophy of cartilage, bone, muscle, tendons, and ligaments (5-12). Controlled muscle stretching and joint movement enhance new collagen fiber orientation parallel to the stress lines of the normal collagen fibers; these activities also serve to prevent tissue atrophy from immobilization. Treatment can be supported with physical therapy to improve local circulation and proprioception, inhibit pain, and strengthen muscle-tendon units.

Resumption of activity. Approximately 6 to 8 weeks after the injury, new collagen fibers can withstand near-normal stress, and the goal for rehabilitation is rapid and full recovery to activity. If the previous steps were followed, protection is no longer needed, and each component of the damaged soft tissue is ready for a progressive mobilization and rehabilitation program (2).

Soft-Tissue Healing: Experimental Studies

The current literature on experimental acute soft-tissue injury speaks strongly for the use of early, controlled mobilization rather than immobilization for optimal healing.

Knee joint. Studies by Woo and colleagues (reviewed in Woo and Hildebrand [13]) have shown that an experimentally induced tear of the medial collateral ligament (MCL) in animals heals much better with early, controlled mobilization than with immobilization. Early mobilization influenced healing even more than did surgical repair performed on the rupture. Exercise had an adverse effect on ligament healing and knee stability only when the animals' joints had been rendered unstable by transection of both the ACL and the MCL. These results probably reflect the poor regeneration potential of the ACL after rupture or transection (3,13).

Muscle. Much of the experimental data about the effects of early mobilization versus immobilization on muscle injury repair have come from studies in Tampere and Turku, Finland, and have been reviewed in Järvinen and Lehto (2). In experimentally injured rat

gastrocnemius muscle, fiber regeneration is often inhibited by dense scar-tissue formation. Immobilization immediately after injury limits the size of the connective tissue area formed within the injury site. Penetration of muscle fibers into the connective tissue is prominent, but their orientation is complex and fibers are not parallel to the uninjured muscle fibers. In addition, immobilization for longer than 1 week resulted in marked atrophy of the injured gastrocnemius. Mobilization instituted immediately after injury resulted in dense scar formation and interfered with muscle regeneration.

In the rat model, the best results were achieved when mobilization was started after 3 to 5 days of immobilization. In the gastrocnemius, muscle fiber penetration through the immature connective tissue appeared optimal, and orientation of regenerated muscle fibers aligned with the uninjured muscle fibers. The gain in strength and capacity for energy absorption has been similar and as good as that of muscles treated by early immediate mobilization alone (2).

Tendons. Using a rat model, Enwemeka et al (14) demonstrated a significant increase in Achilles tendon strength after repair and early mobilization compared with repair and immobilization. In divided, unrepaired rat Achilles tendons, Murrell et al (15,16) obtained similar results. Gelberman et al (17) reported that mobilization of an animal extremity enhanced the orientation and organization of tendon collagen. Thus, after the inflammatory phase, a controlled stretching and strengthening of the regenerating, repaired tendon is likely to increase the final tensile properties of the tendon. However, suspicion remains that even with optimal therapy after repair, the collagen fibers in the tendon may be deficient in content, quality, and orientation (10). If so, this deficiency may present increased risk of inflammatory reaction, tendon degeneration, and tendon reruptures during later activities.

Soft-Tissue Healing: Clinical Trials

Early controlled mobilization. Controlled clinical trials of acute soft-tissue injuries support the results of experimental studies and have shown that early controlled mobilization is superior to immobilization, not only in primary treatment, but also in postoperative management. The superiority of early controlled mobilization has been especially clear in terms of quicker recovery and return to full activity without jeopardizing the subjective or objective long-term outcome. Evidence has been systematic and convincing for many injuries (table 3): acute ankle ligament rupture (18-20); after surgery for ankle ligament rupture (21); after surgery for chronic ankle ligament instability (22); knee ligament injury (6,23); articular cartilage injury (24); minimally displaced distal radius fracture (25); and complete Achilles tendon rupture (26-28). In addition, in many other injuries such as elbow or shoulder dislocation and many nondisplaced fractures, early mobilization yielded good results, although not all studies used a control group (10,29).

TABLE 3. Soft-Tissue Injuries That Have Been Shown to Have Better Outcomes With Early Mobilization Than With

Immobilization

Acute ankle ligament tears

Postsurgery acute or chronic ankle ligament tears

Knee ligament injuries

Complete Achilles tendon ruptures

Randomized studies. The importance of results from prospective, randomized trials cannot be overemphasized; they may dramatically change our thinking and conventional treatment protocols. For example, 2-year results from a prospective, randomized study (27) from Hannover, Germany, (conservative functional treatment alone vs surgery plus similar functional treatment) support the use of early functional rehabilitation alone in complete Achilles tear. This finding is supported by an experimental observation in rats that surgical repair of a surgically divided Achilles tendon did not improve the outcome obtained by functional treatment (free-cage activity) alone (30).

Other examples come from investigations of patellar dislocation: Two randomized studies (31,32) from Finland indicate that after a 2-year follow-up, conservative treatment of acute patellar dislocation gives results at least as good as surgical treatment followed by similar conservative treatment. Comparable observations have been made in acute, complete rupture of the ankle ligaments: Early controlled mobilization alone gives results at least as good as surgery plus early controlled mobilization (18,21,33).

Practical Applications

Avoiding atrophy. Obviously, the best method for preventing immobilization atrophy is usage. Complete immobilization should be minimal and often is not needed at all. During the last 10 to 15 years, many postoperative protocols, especially those involving knee and ankle ligament injuries, have undergone a major change from long, complete immobilization to early, controlled mobilization using elastic or other bandages, rehabilitative braces, continuous passive devices, or a combination immediately after the trauma. Also, active joint motion and weight bearing is allowed earlier than before, and training during immobilization is becoming more and more effective (10). Even modern fracture treatment has considerably reduced the degree and duration of cast immobilization (10,25).

Early mobilization. Early mobilization is the best method to avoid joint contracture and its harmful consequences on articular cartilage. The technique also serves to maintain and return joint proprioception, which, in turn, may be important in preventing reinjury and in hastening recovery to full fitness. In addition, Frank et al (34) have suggested that joint

motion may help reduce postinjury and postoperative pain, swelling, and thromboembolic complications.

The efficacy of early motion in preventing immobilization atrophy depends on how well it controls pain, inflammation, and swelling. Inflammation and pain result in voluntary inhibition of muscle activity across the affected joint. Spencer et al (35) have even reported that pain is not required to cause muscle inhibition; swelling alone is sufficient (so-called reflex inhibition). Therefore, primary treatment should control all three factors using early controlled motion in combination with other treatment modalities such as cold, anti-inflammatory analgesics, and transcutaneous neural stimulation.

Rehabilitation programs. For each joint and each type of injury, rehabilitation programs must be individualized, taking into account the injured structures that should be protected from premature and intensive mobilization, as well as the uninjured structures that should be mobilized as soon as possible. To prevent muscle dysfunction when immobilization must be used, diverse stimuli are needed throughout the entire period; these include strength, power, and endurance exercises. The modern operational principle in the treatment of acute soft-tissue injuries and during immobilization is that "within the limits of pain, everything that is not explicitly forbidden is allowed." (10) This, of course, requires good cooperation between the patient and the attending physician and physical therapist.

Take-Home Message

Controlled experimental and clinical trials have yielded convincing evidence that early, controlled mobilization is superior to immobilization for musculoskeletal soft-tissue injuries. This holds true not only in primary treatment of acute injuries, but also in their postoperative management. The superiority of early controlled mobilization is especially apparent in terms of producing quicker recovery and return to full activity, without jeopardizing the long-term rehabilitative outcome. Therefore, the technique can be recommended as the method of choice for acute soft-tissue injury.

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