Rehabilitation of the Surgically Repaired Achilles Tendon Using a Dorsal Functional Orthosis: A Preliminary Report

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The efficacy of the nonoperative and operative approaches to Achilles tendon rupture has been debated in the literature. In addition, there is little consensus regarding postoperative immobilization with regard to immobilization type, casting position, cast time, and weight-bearing progression. The rehabilitation of the surgically repaired Achilles tendon has not been well described in the literature. The epidemiology and biomechanics of Achilles tendon rupture as well as splint fabrication and rehabilitation protocol for the surgically repaired Achilles tendon in two patients will be presented.

Achilles tendon rupture has achieved notoriety recently as prominent professional athletes have suffered this disabling injury. It is a relatively common injury in two age groups: well-conditioned athletes in their 20s and recreational athletes, the so-called weekend warriors, in their 30s and 40s. The mechanism of injury generally involves active, forceful, frequently unexpected plantar flexion, or sudden acceleration. Abrupt, repetitive jumping and sprinting, common to sports including basketball, volleyball, and racquet sports, have been implicated as etiologic factors (10, 16).

The Achilles tendon is maximally loaded at approximately 75% of the stance phase and during push-off in running and jumping. The moment arm of the Achilles tendon is 1/5 the ground reaction force exerted on it; therefore, forces equal to 5 times body weight are necessary to equilibrate forces at the ankle during walking, increasing to 8–12 times body weight during running (11). Not all plantar flexion force production comes from the gastrocnemius–soleus complex: Approximately 15–30% of the plantar force comes from the peronei (longus and brevis), tibialis posterior, flexor hallucis longus, and flexor digitorum longus muscles.

The pathogenesis of Achilles tendon rupture has been postulated to stem from chronic tendon degeneration (as demonstrated by areas of chronic degeneration 2–6 cm above the os calcis) or as the result of failure of the inhibitory mechanism of the muscle–tendon unit (2, 3). Although not well substantiated in the literature as an etiologic factor in Achilles tendon rupture, excessive pronation during the stance phase of the gait cycle leading to "whipping" or bowstringing action of the Achilles tendon at the calcaneus (7) may be a factor in chronic Achilles tendon irritation, which may or may not lead to rupture by contributing to microtears in the tendon. This may be particularly true of individuals with rearfoot and/or forefoot varus who overpronate during walking and running. During running, pronation is accompanied by tibial internal rotation. During preparation for takeoff, the foot begins to supinate and the tibia to externally rotate. Individuals who demonstrate prolonged pronation during midstance continue to internally rotate at the tibia, conflicting with the external tibial rotation that should be occurring. This combination of pronation during knee extension may cause vascular impairment and degenerative changes in the Achilles tendon 2–6 cm above the os calcis, similar to the "wringing" effect occurring at the rotator cuff (7).

Other factors contributing to Achilles tendon degeneration likely include training errors, biomechanical alignment, strength and flexibility deficits of the gastrocnemius–soleus, and improper footwear. In the younger group of athletes who demonstrate Achilles tendon rupture, the normal inhibitory mechanism preventing tendon failure (due to excessive force imparted by the muscle contraction or uncoordinated muscle action) may malfunction, often after a period of inactivity, fatigue, or poor conditioning (2). Both chronic degeneration and neuromuscular factors probably play a role in Achilles tendon rupture.

Diagnosis of Achilles tendon rupture is generally made on the basis of a positive Thompson test and a palpable defect at the rupture site. Frequently there are no antecedent symptoms (although 10–20% of patients note symptoms including a history of Achilles tendinitis or an insidious onset of posterior calf pain associated with activity prior to the injury), and the athlete feels "a sudden pop or snap" accompanied by immediate, but quickly resolving, pain if struck on the back of the leg (2). In addition, plantar flexor strength, as reflected by a 20-repetition heel raise test, is generally reduced (12). Because of the contribution by the secondary plantar flexor muscles, everyday function may not be impaired, leading the patient to delay seeking medical attention.

Although nonoperative treatment is recommended for nonathletes and older individuals, residual plantar flexion weakness and rupture rates of 10–35% have been reported (16). In contrast, surgical treatment, recommended for athletes, generally carries a rupture rate of less than 2% (except for the percutaneous repair, for which rupture rates of 12% have been reported) and minimal postsurgical complications. The goal of surgical treatment is to restore the functional length of the muscle–tendon unit.

While the literature has suggested that operative and nonoperative treatments yield similar results (16), others (3) have advocated open repair for high-caliber athletes who can't risk the chance of rupture. During the 1980s major complication rates of 3% (persistent infection, skin and tendon necrosis, and nerve damage) and minor incision complication rates of 13% were reported (12). Postsurgical management varies from plaster immobilization in 20° equinus for 6–8 weeks (often due to concerns for overloading the repair) or neutral casting, followed by the application of a heel lift for 2 weeks and progressive

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weight bearing (1, 6, 14), to the use of a dorsal resting splint at postoperative Day 5 limiting ankle movement at neutral (4) or 20° equinus (6) while allowing unlimited plantar flexion with toe-touch weight bearing for 6–8 weeks. There is little consensus regarding progression of weight bearing in the literature. The approaches range from no weight bearing for 6–8 weeks while in the cast followed by the use of a heel lift and progressive weight bearing over the next 4–6 weeks (6) to immediate toe-touch weight bearing as patient comfort and tolerance dictate (4).

We have modified the functional dorsal orthosis as described by Carter et al. (4), fabricating a functional orthosis at the available range of motion of dorsiflexion allowing for weekly sequential adjustment over a period of 6 weeks from a position of equinus to neutral dorsiflexion; progressive weight bearing starts with toe-touch weight bearing and increases weekly by 15–20% as patient comfort, swelling, and tolerance allow. Theoretically, the use of the functional orthosis allows earlier controlled movement of the foot and ankle, controlled loading of the Achilles tendon, and an earlier return to normal function.

The use of a functional dorsal splint may be hypothesized to mitigate the deleterious effects of immobilization, including muscle atrophy, fibrofatty connective tissue proliferation, joint stiffness, disuse osteoporosis, scar tissue orientation, and tendon adhesions. In addition, use of the splint promotes a quicker return to normal mobility and strength, leading to a more rapid return to preinjury functional levels. Although the literature describes the use of isokinetics and a dynamic test of muscle fatigue (9) in evaluating the rehabilitation of the surgically repaired Achilles tendon, the rehabilitation accompanying the use of the dorsal orthosis has not been described. The purpose of this presentation is to describe the fabrication of the dorsal orthosis and the accelerated rehabilitation progression following surgical repair of the Achilles tendon, illustrated by two case presentations.

### Splint Fabrication Procedure

The purpose of the dorsal functional orthosis is to allow free dorsiflexion to neutral. Because controlled movement is allowed, the rehabilitation may be accelerated without the deleterious effects of immobilization. This approach differs from others (4, 5) in that it calls for frequently adjusting the dorsiflexion block to match the patient’s available dorsiflexion range of motion rather than fabricating the splint at neutral dorsiflexion or in plantar flexion from the outset.

Materials required for the splint fabrication procedure include perforated 1/8-in. (3.2-mm) thermoplastic material, tubigrip stockinet sized for the patient’s leg, compressible foam, 1-in. and 2-in. Velcro straps, and 1-in. Velcro loops with adhesive backing. To fabricate the splint, first cover the patient’s affected lower extremity with an appropriate size of tubigrip stockinet from metatarsal heads to the tibial tubercle. Next, fashion conforming foam pieces to cover bony prominences of foot and ankle and apply over stockinet (Figure 1). To estimate the size of splinting material required, measure leg length from tibial tubercle to metatarsal heads and measure approximately 2/3 of the circumference of the calf. Heat the thermoplast until malleable, mold over the stockinet and foam pieces,
and trim edges and size while the material is still warm (Figure 2). Ice bags may be applied over the splint to speed the cooling process.

After removing the splint from the patient, smooth the edges with a heat gun. Moleskin may be added around rough areas if necessary. Glue conforming foam pads in the impressions in the splint. Attach one adhesive Velcro loop strap at the proximal end of the splint at the metatarsal head area and two straps at approximately the midcalf area. (Velcro will stick better if adhesive is heated by a heat gun before application to the splint.) Add Velcro straps with a single 2-in. strap at the proximal end of the splint, a 1-in. strap around the metatarsal heads, and a split 2-in. strap around the midcalf section (Figure 3). Finally, fit the patient with an orthopedic walking shoe and instruct in toe-touch weight bearing. Note any slippage or areas of friction and adjust accordingly. Adjust the splint weekly or semiweekly over 6–8 weeks by reshaping the splint to match the active dorsiflexion range of motion.

Patient Profiles

Two individuals were treated with a dorsal orthosis: a 34-year-old female (Ms. K.), who sustained a transverse rupture of the Achilles tendon 5 cm from its calcaneal attachment, and a 43-year-old male (Mr. H.), who had a similar rupture 6 cm from the calcaneal attachment. Ms. K. sustained her injury while stair running in an exercise class; she had experienced antecedent symptoms of calf pain for 2 months prior to her injury. Mr. H. was injured while jogging and had no prior history of calf pain. Etiologic factors as well as range of motion (ROM) and objective functional measures are presented in Table 1.

Figure 1 — Stockinet and foam pads are applied to protect the malleoli and tibialis anterior tendon.
Table 1  Comparison of Objective Findings Between Subjects

<table>
<thead>
<tr>
<th>Age</th>
<th>Ms. K</th>
<th>Mr. H.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>F</td>
<td>M</td>
</tr>
<tr>
<td>Injury mechanism</td>
<td>Stair running</td>
<td>Jogging</td>
</tr>
<tr>
<td>ROM Initial</td>
<td>-30° DF to 39° PF</td>
<td>-21° DF to 45° PF</td>
</tr>
<tr>
<td>Week 2</td>
<td>-19° DF to 39° PF</td>
<td>0° DF to 45° PF</td>
</tr>
<tr>
<td>Week 3</td>
<td>-14° DF to 39° PF</td>
<td>0° DF to 45° PF</td>
</tr>
<tr>
<td>Week 4</td>
<td>-7° DF to 39° PF</td>
<td>0° DF to 45° PF</td>
</tr>
<tr>
<td>Week 5</td>
<td>0° DF to 39° PF</td>
<td>0° DF to 45° PF</td>
</tr>
<tr>
<td>At discharge</td>
<td>5° DF to 42° PF</td>
<td>15° DF to 50° PF</td>
</tr>
<tr>
<td>Heel raises at discharge</td>
<td>1/5</td>
<td>5/5 (90% ROM)</td>
</tr>
<tr>
<td>Isokinetic PF work deficit at discharge (60°/s)</td>
<td>60%</td>
<td>37%</td>
</tr>
<tr>
<td>Functional level at discharge</td>
<td>Pain-free ADL</td>
<td>5-min interval walk/jog</td>
</tr>
<tr>
<td>Number of weeks postop at discharge</td>
<td>14</td>
<td>12</td>
</tr>
</tbody>
</table>

Note. DF = dorsiflexion; PF = plantar flexion; ADL = activities of daily living.

Both individuals underwent open repair of the Achilles tendon, with the Kessler procedure, within 5 days of the injury and were placed in a posterior plaster splint in gravity equinus for 1 week. After 7 days, a perforated thermoplastic functional dorsal orthosis was fabricated at the maximum available passive dorsiflexion obtained by goniometric measurement.

Following the surgical repair, the rehabilitation sequence was divided into three phases, as shown in the following list. Physical therapy was started on the 7th postoperative day for splint fabrication, instruction in toe-touch weight bearing, active ankle ROM (ankle pumps, circles, toe curls, alphabet, and gentle towel stretches), straight-leg raises, and rest-ice-elevation-compression (RICE).

Phase I Activities
- splint fabrication and weekly adjustment
- RICE
- gradual progression of weight bearing
- scar management and edema control
- passive ROM, active ROM
- flexibility exercises
- theraband exercises
- seated proprioceptive exercise
- progressive weight-bearing exercise (heel raise, toe raise, BAPS board)
- stationary cycling for ROM
- cardiovascular conditioning

Figure 2 — Molding the splint over the stockinet and foam pads.

Figure 3 — Placement of Velcro straps on the completed splint.
Phase II Activities
- scar management and edema control
- treadmill/video to normalize gait
- flexibility
- trampoline, balance beam
- sport cord activities
- step training progression (2-, 4-, 6-in. steps)
- Total Gym partial squats, heel raises (increase incline, add weights)
- ankle and knee passive-resistive exercises (multiaxial ankle exerciser, N/K table)
- proprioceptive neuromuscular facilitation exercise
- isokinetic progression
- StairMaster
- aquatic workouts
- cardiovascular conditioning

Phase III Activities
- progressive walk/jog program
- carioca, slide board
- incline walking progression
- agility drills
- sport cord activities
- plyometric activities
- sport-specific activities

Phase I (splint phase) goals included wound healing and scar management, returning dorsi flexion ROM to neutral, and 100% pain-free weight bearing. The exercise sequence included tubing exercises, active and passive ROM, aquatic exercise, heel raises at given percentages of body weight (BW), cycling, toe curls, and seated heel and toe raises. Initial weight-bearing status was partial weight bearing (10% body weight), which was gradually increased (in 15-20% increments) according to patient tolerance (i.e., no swelling or pain during normal gait) until full weight bearing with crutches was achieved at 6 weeks postsurgery. Ultrasound was used over the scar to increase scar pliability and blood flow to the surgical site. The splint was adjusted weekly to the available passive range of motion until neutral dorsi flexion was achieved. (The splint is to be worn for 6 to 8 weeks regardless of when neutral dorsi flexion was achieved.)

By 4 weeks weight-bearing status increased to 50% BW, and exercises including partial weight bearing heel raises and partial squats at 30% BW utilizing the Total Gym, tubing exercise, and gentle flexibility were introduced. The Total Gym apparatus allows controlled weight bearing from 18% to 74% BW by increasing the incline at which the closed kinetic chain exercises are performed. (Additional resistance is obtained by the application of external weights.) By 6 weeks postop, Mr. H. was ambulating at full weight bearing without crutches, and by the 8th week use of the splint was discontinued. Unlike previously described treatment approaches, a heel lift was not applied during the course of treatment.

Phase II goals were to normalize gait, achieve normal ROM, improve proprioception, introduce controlled tensile loading of the Achilles tendon, and restore muscle control, muscle timing, and muscular performance. The focus of the rehabilitation program in this phase turned to closed chain and proprioceptive activities. Isokinetic exercise was added by 9 weeks; it began with passive exercise as well as passive–resistive eccentric and concentric exercise and progressed to velocity spectrum isokinetics (starting at angular velocities greater than 120º/s and progressing to slower velocities). Identification and correction of biomechanical foot faults, analysis of technique (during gait, running, and sport-specific activities), proper footwear, and proper training are other factors to be examined as the athlete progresses through the rehabilitation process.

Phase III (return to sport) focused on improving speed, power, and sport-specific skills. Activities included plyometrics, lateral movements (side slides, carioca), graded treadmill walking, and return to a running program.

At the time of discharge (14 weeks postoperatively) Ms. K. had met her goals of resuming everyday activities and ambulating without pain or dysfunction. She was able to raise the injured foot once, and she demonstrated isokinetic plantar flexion work deficits of 60% at 60º/s. Mr. H., whose goal was to return to recreational athletics including jogging, was highly motivated throughout rehabilitation. At discharge (12 weeks postop) he demonstrated isokinetic plantar flexion work deficits of 37% at 60º/s, was able to perform five heel raises through 90% of his available ROM, and was participating in a 5-min walk/jog interval program for 20- to 30-min sessions. A summary of objective findings over the course of the rehabilitation program is presented in Table 1.

Both patients returned for a 1-year follow-up evaluation of postoperative complications, range of motion measurements, circumferential measurements, functional muscular strength tests, and video gait (walking and running) analysis. A summary of the 1-year objective findings is presented in Table 2. The maximum amount of sick days was 7 days. Both patients demonstrated normal gait, jog, and ankle movements and had resumed their preinjury functional activity levels.

Table 2 Summary of Objective Findings at One-Year Follow-Up Evaluation

<table>
<thead>
<tr>
<th></th>
<th>Ms. K.</th>
<th>Mr. H.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>F</td>
<td>M</td>
</tr>
<tr>
<td>Number of sick days</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Complications</td>
<td>Minimal pain with rest</td>
<td>Slight morning stiffness</td>
</tr>
<tr>
<td>ROM</td>
<td>5º DF to 38º PF</td>
<td>10º DF to 40º PF</td>
</tr>
<tr>
<td>Midcalf circumference</td>
<td>–1.0 cm</td>
<td>–4.0 cm</td>
</tr>
<tr>
<td>Number of heel raises in 15 s</td>
<td>I = 6; NI = 15</td>
<td>I = 20; NI = 23</td>
</tr>
<tr>
<td>Abnormal gait</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Abnormal toe stand</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Abnormal jog (4.0 mph)</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Abnormal ankle movement</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Abnormal atrophy</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Functional status</td>
<td>Full return to aerobics, jogging</td>
<td>Full return to jogging, biking</td>
</tr>
</tbody>
</table>

Note. DF = dorsiflexion; PF = plantar flexion; I = involved; NI = noninvolved.
Discussion

Our initial results with two patients who participated in the rehabilitation of the surgically repaired Achilles tendon using the dorsal orthosis are encouraging. The patients demonstrated no postsurgical complications and tolerated an early rehabilitation program well. Both experienced little pain, returned to work within 3 weeks of injury, and were satisfied with the rehabilitation progression and outcome. At the follow-up visit, both patients expressed their delight with the use of the removable dorsal splint as opposed to the use of a plaster cast for 6 weeks.

Although the initial splint position ranged from 20° to 30° equinus at the time of splint fabrication, one patient achieved neutral by the 2nd week of splint use (12 days postoperatively) and the second achieved neutral by 5 weeks postoperatively. These range of motion measurements were achieved earlier than those reported in the literature for patients who were casted for 8 weeks. Beskin et al. (2) reported dorsiflexion to -4° at cast removal (8.1 weeks) for a group who underwent direct repair followed by neutral casting 7 days postoperatively.

Our serial splinting approach combined with early rehabilitation was started at 7 days postoperatively. Others using the splint postoperatively applied it at neutral (4) or in plantar flexion (6) for 6 weeks prior to starting rehabilitation. Alternatively, neutral casting started between 7 and 21 days postoperatively with time to cast removal ranging from 6 to 8 weeks (2, 9). The use of a heel lift as reported in the literature ranged from not at all to 12 weeks after cast removal (3, 4). Thus, there is little consensus in the literature regarding the type of immobilization, length of immobilization, progression of weight-bearing status, and use of a heel lift; in addition, rehabilitation progression has not been clearly described in the literature. Our rehabilitation program was started at 1 week postsurgery, 5 weeks earlier than reported in the literature, and continued for 11–12 weeks. By the time the splint was removed at 6–7 weeks, patients had nearly achieved a normal gait pattern and were participating in a low-level rehabilitation program.

One concern with the accelerated approach may be for excessive loading of the Achilles tendon during the healing process. There is little consensus in the literature (2, 6) regarding the optimal progression of weight-bearing status. In our patients we increased weight bearing gradually and sequentially in 15–20% increments as patient tolerance allowed (i.e., pain-free, no swelling). Although clinical studies of the strain on the Achilles tendon in a walking cast are difficult to carry out, the strain on the sutured Achilles tendon was calculated to be equal during normal walking with full weight bearing, walking with partial weight bearing, and non-weight-bearing ambulation with crutches (1). However, external rotation of the lower leg during full weight bearing was found to place more strain on the Achilles tendon. These findings suggest that progressive weight bearing by 2 weeks postsurgery does not place undue strain on the Achilles tendon, provided the patient is able to maintain a pain-free, normal gait pattern. Further investigation into the effects of the dorsal splint and weight-bearing status on the strain imposed on the healing Achilles tendon is merited.

Early return to activity and rehabilitation may mitigate the effects of immobilization on muscle and tendon. Haggmark et al. (9) demonstrated a 23% decrease in calf muscle cross-sectional area after 6 weeks of immobilization. In addition, Type I fibers were particularly susceptible to atrophy due to the lack of tension on the immobilized muscle–tendon unit. This accelerated approach combining early active motion and progressive tensile loading may reduce the amount of muscular atrophy found after 6 weeks of immobilization.

Common measures of muscular performance include a dynamic test of muscle fatigue (single-leg heel raise at 40 heel raises per minute to fatigue) and isokinetic measurement of plantar flexor torque. Although isokinetic testing was cited by a number of authors (2, 4, 15) to document return of muscle performance, clinical application of the data is limited due to the lack of consistency in isokinetic test protocols. Achilles tendon ruptures may result in a speed-specific pattern of muscle weakness due to either decreases in contractile material or neural activation. Isokinetic testing at angular velocities less than 90°/s demonstrated greatest impairment of muscular function (15). Further research is indicated to determine the degree of muscular atrophy and the recovery of muscle function with the use of the functional orthosis and accelerated rehabilitation program.

During the remodeling phase, beginning at 17–28 days postinjury, the collagen content begins to stabilize and tensile strength begins to increase (8). During the maturation phase of tendon healing, starting at approximately 6–8 weeks after tendon injury, passive mobilization and controlled loading improve tendon and ligament healing (13). Due to collagen and revascularization characteristics, the healing tendon is weakest at postoperative Weeks 7–8. Both the rehabilitation professional and the athlete should take this into consideration; in our program patient tolerance to activity was carefully monitored for pain, swelling, and motor control. In addition, during Weeks 7–8, eccentric loading of the tendon was limited to no more than 30% body weight (using the Total Gym). The graded exercise program, beginning at Week 4, is designed to facilitate tendon healing, reduce swelling, and gradually introduce controlled tensile loading. Tension in the tendon resulting from passive stretch and eccentric exercise improves collagen fiber orientation and tendon strength. The tensile demands on the Achilles tendon are greatest during push-off during running or jumping, requiring forces nearly 12 times body weight to offset the ground reaction forces (11). Jogging and running are permitted by Weeks 12–16, and a return to sports is permitted by 6 months postinjury (12). Prior to the athlete’s return to competition, careful attention must be given to factors including the correction of biomechanical foot faults, footwear, and the conditioning program. To date, no long-term prospective studies have examined the functional outcome or tensile response following an accelerated rehabilitation program using the dorsal splint. Although neither patient was a high-caliber athlete, both had achieved their stated rehabilitation goals at the time of discharge from physical therapy.

One-year follow-up results of this accelerated approach with two patients were good, with each demonstrating an earlier return to normal activities of daily living and recreational activity than previously documented. Although findings are limited by our small sample size, the most striking finding was the number of work days missed: Ms. K. missed 1 day, while Mr. H. missed 7 days and returned to work with crutches, compared to a mean sick leave time of 6.2 weeks (6). The progressive increase in weight-bearing status and dorsiflexion range of motion for these two individuals—as opposed to 6 weeks of non-weight-bearing status with the leg fixed in plantar flexion, in Cetti’s group (6)—may be responsible for the reduction in sick days.
At the 1-year follow-up visit neither patient demonstrated abnormal treadmill gait (walking and jogging) or abnormal ankle movement, compared to 5.4% (walking), 12.5% (jogging), and 17.9% (ankle movement) reported by Cetti et al. (6) in a follow-up of 56 individuals who had undergone surgical repair of ruptured Achilles tendons. Mr. H. was able to return to jogging 12 weeks postoperatively compared to 18 weeks previously reported (6). Both patients reported full return to previous activity levels with minor complaints of occasional pain at rest (Ms. K.) and occasional morning stiffness (Mr. H.). A functional test of plantar flexor strength consisting of the number of heel raises completed in 15 s revealed 13% and 40% deficits (injured/noninjured) for Mr. H. and Ms. K., respectively.

Circumferential measurements revealed a 4.0-cm calf circumference reduction for Mr. H. (although he demonstrated no functional deficits) and a 1.0-cm circumference reduction for Ms. K. This compared to a mean 1.5-cm reduction in circumference measures in 39% of the operative patients in Cetti's study (6).

The accelerated approach merits further investigation in other settings where an athlete is seeking to return to full optimum athletic performance at its highest level rather than the functional level achieved by the patients whose progress we have described. Further investigations might focus on comparing treatment outcomes between this approach and other postoperative approaches. In conclusion, the splint combined with the rehabilitation approach described here markedly reduced sick leave days and accelerated the return to functional and recreational athletic activities. This approach deserves further investigation in the high-level athletic population.

References