Early Motion for Achilles Tendon Ruptures: Is Surgery Important?

A Randomized, Prospective Study

Bruce C. Twaddle,*† FRACS, and Peter Poon,‡ FRACS
From the †Department of Orthopaedics, Auckland City Hospital, Auckland, New Zealand, and ‡North Shore Hospital, Takapuna, Auckland, New Zealand

Background: Comparisons of surgically and nonsurgically treated Achilles tendon ruptures have demonstrated that those treated with surgery allow earlier motion and tend to show superior results. However, early motion enhances tendon healing with or without surgery and may be the important factor in optimizing outcomes in patients with Achilles tendon rupture.

Hypothesis: There is no difference in the outcome of acute Achilles tendon rupture treated nonoperatively or operatively if controlled early motion is allowed as part of the rehabilitation program.

Study Design: Randomized, controlled clinical trial; Level of evidence, 1.

Methods: Patients with acute rupture of the Achilles tendon were randomized to surgery or no surgery, with both groups receiving early motion controlled in a removable orthosis, progressing to full weightbearing at 8 weeks from treatment. Both groups were followed prospectively for 12 months with measurements of range of motion, calf circumference, and the Musculoskeletal Functional Assessment Instrument (MFAI) outcome score; any reruptures and any complications were noted.

Results: Both groups were comparable for age and sex. There were no significant differences between the 2 groups in plantar flexion, dorsiflexion, calf circumference, or the MFAI scores measured at 2, 8, 12, 26, or 52 weeks. One patient in each group was noncompliant and required surgical rerepair of the tendon. There were no differences in complications and a similar low number of reruptures in both groups.

Conclusion: This study supports early motion as an acceptable form of rehabilitation in both surgically and nonsurgically treated patients with comparable functional results and a low rerupture rate. There appears to be no difference between the 2 groups, suggesting that controlled early motion is the important part of treatment of ruptured Achilles tendon.

Keywords: Achilles tendon rupture; surgical treatment; rehabilitation; nonsurgical management

Achilles tendon rupture occurs relatively commonly in the adult population and can be a major disruptive injury. Despite the considerable inconvenience to patients from this injury, there is no universally agreed treatment regimen. Scientifically supported guidelines as to whether surgical or nonsurgical management is the ideal option for the patient are not available.

Studies comparing surgically and nonsurgically treated Achilles tendon ruptures have shown that those treated with surgery have earlier motion and tended to show superior results.[2,10,16] Previous studies in which both groups of patients have been treated in casts for up to 3 months have not been clearly supportive of surgery,[12] and all studies accept that a deep infection as a complication of Achilles tendon surgery can be a devastating event.

In animal studies, and in human in vitro experience with hand tendons in particular, it has been shown that early motion enhances tendon healing and that immobilization of joints delays remodeling of newly formed collagen bundles.[3,8] The ability of tendons to reform with tendon-like material comparable with the repair tissue of surgically repaired tendons has been highlighted by the "lizard tail" phenomenon after harvesting of the semitendinosus tendon for anterior cruciate ligament reconstruction.[4] The material that forms appears to be inferior to the original tendon with poorer biomechanical properties. This is presumably similar to the healing response of an Achilles tendon. The key feature of neglected Achilles tendon ruptures is the "calcaneus" deformity with increased length of the

*Address correspondence to Bruce C. Twaddle, FRACS, Department of Orthopaedics, Auckland City Hospital, Private Bag 92-024, Auckland 1, New Zealand (e-mail: brucet@adhb.govt.nz).

No potential conflict of interest declared.

The American Journal of Sports Medicine, Vol. 35, No. 12
DOI: 10.1177/0363546507307503

material that has healed in the gap. Achilles tendon ruptures treated with surgery and early motion but restricting excessive dorsiflexion have been shown to have superior outcomes to patients treated without surgery with cast immobilization, with increased strength and a low rerupture rate.[2] It is possible that controlled early motion is the important factor in optimizing outcomes in patients with Achilles tendon rupture[14] and that surgery makes no difference to the outcome apart from increasing the risk of local infection.

This study was designed to prospectively compare a group of patients with Achilles tendon ruptures treated with surgery and controlled early motion with a group of patients with Achilles tendon ruptures treated with the same controlled early motion without surgery.

MATERIALS AND METHODS

Between December 1997 and February 2002, patients who were referred to the acute orthopaedic service at Auckland Hospital with a rupture of the Achilles tendon who agreed to take part in this study were randomized to surgical or nonsurgical management. Patients were included if they presented within 10 days of injury.

Approximately 60% of patients who were approached agreed to be involved in the study. The numbers are not absolutely accurate as some patients who presented were not informed that being part of the study was an option for them by the receiving registrar and therefore were not noted to have been approached. The extent to which this occurred was difficult to determine. Almost all the patients who elected not to be involved in the study did so because they preferred to have surgical treatment or were advised by their referring practitioner that surgery was preferable.

Patients had to be between 18 and 50 years of age at the time of injury, have a normal noninjured leg, be nonsmokers, and have no other significant medical problems or be on any medication that may impair tendon healing. Most of the injuries were sustained from sporting activities. The patient population group was from a broad cross-section of the community, but the majority of elite athletes would not seek treatment for Achilles tendon ruptures at this institution but would be managed by their own team's support medical staff.

Prior approval for the study had been obtained from the Auckland Regional Ethics Committee. Fifty patients agreed to participate in the study after reading the study information sheet provided as part of the consent process.

Randomization was determined by tossing a coin 50 consecutive times and recording the heads or the tails in sequence. "Heads" received operative treatment, and "tails" received nonoperative treatment. This sequence was then used to allocate the sequence of envelopes that were uncovered when the patient signed the informed consent to be part of the study.

Patients randomized to the nonsurgical group were placed in a hanging equinus plaster of Paris cast for 10 days. Patients randomized to the surgical group were admitted and operated on within 48 hours by the senior author (B.C.T.). Surgical treatment involved a posteromedial incision and careful reflection of the damaged paratenon. A Krackow-type whip suture using nonabsorbable size 2 suture was placed in either end of the damaged tendon and sutured together to reappose the tendon ends at the normal resting length of the tendon using the noninjured side as a guide. This was reinforced with several size 2 absorbable sutures as needed. The paratenon was carefully repaired over the top and the skin closed with interrupted nylon sutures. The leg was then placed in a hanging equinus plaster of Paris cast for 10 days. Both groups then received the same rehabilitation instructions. All patients remained nonweightbearing with crutches for a total of 6 weeks.

At 10 days from commencement of treatment, the cast was removed, and the patient's limb was placed in a removable below-knee orthosis with the ankle at 20° of plantar flexion. Patients were instructed to remove the orthosis for 5 minutes of every hour and, while sitting with the injured leg hanging, practice active ankle dorsiflexion and passive plantar flexion, letting the foot fall down as far as was comfortable. Particular emphasis was made of the importance of not dorsiflexing the ankle beyond the neutral position and remaining nonweightbearing.

At 4 weeks from commencement of treatment, the removable orthosis was brought to neutral, and the same exercise instructions were again reinforced to the patient. At 6 weeks from beginning treatment, the patients were allowed to bear weight as tolerated with crutches in the orthosis and to remove the orthosis at night.

At 8 weeks from commencement of treatment, the patients had the orthosis removed and were encouraged to wean themselves off crutches and begin toe-raising exercises using the good leg to support the injured leg. When they could initiate toe raising on the injured leg alone, they were allowed to begin stretching and strengthening exercises with physiotherapy supervision.

Patients were reviewed at 10 days, 8 weeks, 6 months, 3 months, and 12 months from injury. Measurements were made of ankle dorsiflexion, plantar flexion, calf circumference, and squeeze test reactivity from 8 weeks on. The Musculoskeletal Functional Assessment Index (MFAI), a 100-question validated outcome score for musculoskeletal injuries,[15] was measured at all follow-up visits.

Plantar flexion was measured with a goniometer by asking the patient to forcibly plantarflex the freely hanging foot and ankle with the knee flexed at 90° over the side of an examination table. Dorsiflexion was measured with the foot planted on the ground and the patient asked to bend the knee and dorsiflex the ankle, keeping the foot and heel on the floor. All measurements were performed at least twice until 2 reproducible measurements within 1° of each other could be achieved.

Any wound complications, deep infections, or reruptures were recorded. Lack of compliance with secondary disruption of the healing tendon before 8 weeks was also recorded.

Power calculations vary somewhat on the basis of the agreed rerupture rate comparing surgery with no surgery. The numbers required for an 80% power therefore vary between 50 (25 in each group) and 62 (31 in each group) patients. We originally enrolled 50 patients but had 8 patients who did not complete the study. Because of changes required in processing the patients enrolled in this study when the department was moved to a new

TABLE 1
Characteristics of Operative and Nonoperative Patients

	Operative	Nonoperative
Number	20	22
Side	10 right, 10 left	10 right, 12 left
Male:female	14:6	14:8
Average age (y)	41.8	40.3

hospital and ethics committee requirements, we elected to stop the study once 50 patients had been recruited.

Statistical analysis was performed using the Mann-Whitney *U* test to compare the difference between the injured and the noninjured side in all parameters measured at all points of assessment.

RESULTS

Fifty patients were prospectively enrolled in the study. Eight patients were excluded from the study for a variety of reasons, leaving 20 patients in the operative group and 22 patients in the nonoperative group. Both groups were comparable for age and sex (Table 1).

Eight patients were excluded during the course of the study. One patient in each group was noncompliant and required surgical rerepair of the tendon before 8 weeks after removing the orthosis and mobilizing without any splintage. Both patients had surgical repair of the reinjured tendon. One patient who had surgery moved overseas 3 months after being included in the study. One patient drove to another city and sought surgical treatment after being randomized to the nonsurgical group. One patient was misdiagnosed and, when examined at the 2-week point for surgery, was thought to clinically have had a tear of the medial head of gastrocnemius muscle. He went on to make an uneventful recovery without further restriction on weightbearing. Three patients had a rerupture of the tendon beyond the 8-week follow-up mark; 2 were in the operatively treated group and 1 in the nonoperatively treated group. In the operatively treated patients, 1 patient fell down some stairs at 10 weeks after injury, and 1 patient was thrown from the hood of a car traveling at 40 km/h when trying to stop a robbery from his place of work. The rerupture patient in the nonoperatively treated group slipped off a bank at 16 weeks after injury. All patients with reruptures were treated with surgical repair (Figure 1).

When we measured plantar flexion, there were no significant differences between the operatively and nonoperatively treated patients for differences between the injured and noninjured sides at 8 weeks, 12 weeks, 6 months, or 1 year follow-up (Table 2). The noninjured side on average had a greater range of plantar flexion at all collection intervals (Figure 2).

When we measured dorsiflexion, there were no significant differences between the operatively and nonoperatively treated patients for differences between the injured and noninjured sides at 8 weeks, 12 weeks, 6 months, or 1 year follow-up (Table 2). The noninjured side on average had a greater range of dorsiflexion at all collection intervals (Figure 3).

The MFAI produces a score out of 100. The greater the score, the more disabled the patients perceive themselves as being. There were no significant differences between the operatively and nonoperatively treated patients at 2 weeks, 8 weeks, 12 weeks, 6 months, or 1 year follow-up (Table 2 and Figure 4).

There were no significant differences between the operatively and nonoperatively treated patients for differences in calf circumference at 8 weeks, 12 weeks, 6 months, or 1 year follow-up (Table 2 and Figure 5).

TABLE 2
Comparison of Operative and Nonoperative Limbs[a]

Variable	Operative Mean	Operative Range	Nonoperative Mean	Nonoperative Range	*P* Value[b]
MFAI 2 weeks	42.4	27 to 57	43.0	32 to 63	.67
MFAI 8 weeks	23.7	10 to 39	27.6	12 to 60	.37
MFAI 12 weeks	15.2	5 to 23	17.0	7 to 35	.85
MFAI 24 weeks	7.8	0 to 18	10.4	4 to 24	.60
MFAI 52 weeks	3.4	0 to 12	4.2	1 to 13	.64
Dorsiflexion 8 weeks	–12.9	–3 to –31	–13.8	–2 to –35	1.00
Dorsiflexion 12 weeks	–8.2	0 to –23	–8.0	0 to –22	.80
Dorsiflexion 24 weeks	–2.3	1 to –10	–2.4	1 to –15	.84
Dorsiflexion 52 weeks	–1	2 to –6	–0.2	1 to –5	.061
Plantar flexion 8 weeks	–14.1	–4 to –22	–11.1	0 to –28	.16
Plantar flexion 12 weeks	–8.2	0 to –14	–6.0	0 to –21	.072
Plantar flexion 24 weeks	–2.3	0 to –10	–2.7	3 to –15	.25
Plantar flexion 52 weeks	–0.6	0 to –8	–0.2	3 to –12	.37
Calf circumference 8 weeks	–1.3	–4 to 1	–2.0	–5 to –0.5	.094
Calf circumference 12 weeks	–0.9	–3 to 0	–1.4	–3.5 to 0	.23
Calf circumference 24 weeks	–0.7	–1.6 to 0	–0.7	–2.1 to 0	.90
Calf circumference 52 weeks	–0.5	–1.6 to 0	–0.2	–1.3 to 0	.24

[a]MFAI, Musculoskeletal Functional Assessment Index.
[b]Statistical *P* values for Mann-Whitney *U* test.

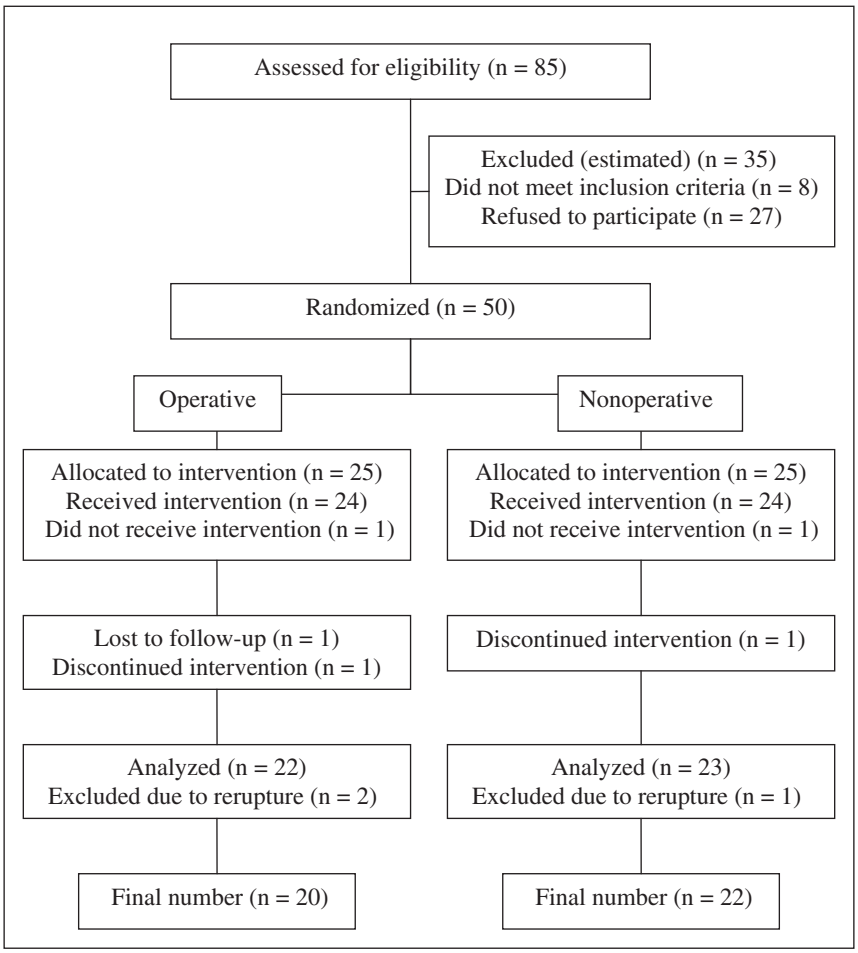

Figure 1. Consort diagram of Achilles tendon rupture study patients.

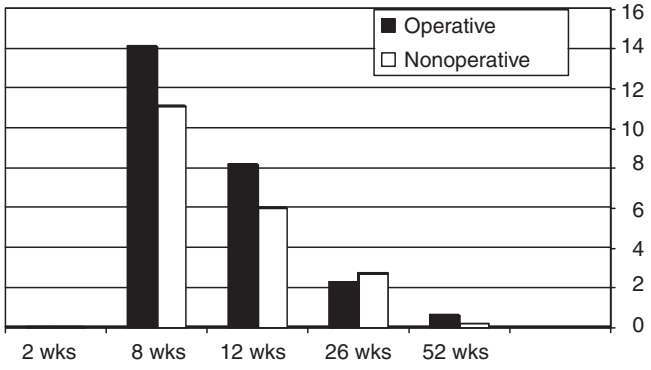

Figure 2. Differences in plantar flexion (degrees) between injured and noninjured sides for operated and nonoperated groups.

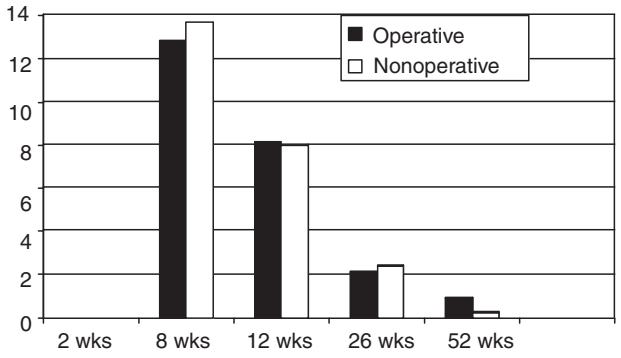

Figure 3. Differences in dorsiflexion (degrees) between injured and noninjured sides for the operated and nonoperated groups.

DISCUSSION

Despite rupture of the Achilles tendon being a relatively common injury, there continues to be discussion and argument about whether surgical or nonsurgical treatment is the best way to manage these patients. Nistor[12] was the first to undertake a randomized, prospective study of this injury with both groups receiving prolonged immobilization in a cast. He demonstrated a greater rerupture rate in the nonoperatively treated patients but 2 deep infections in the surgically treated patients. He favored nonoperative treatment at the conclusion of this study. More recent randomized studies comparing operative and nonoperative treatment of Achilles tendon rupture have suggested improved outcome and superior strength in the operatively treated patients, but in all these studies, the nonoperatively

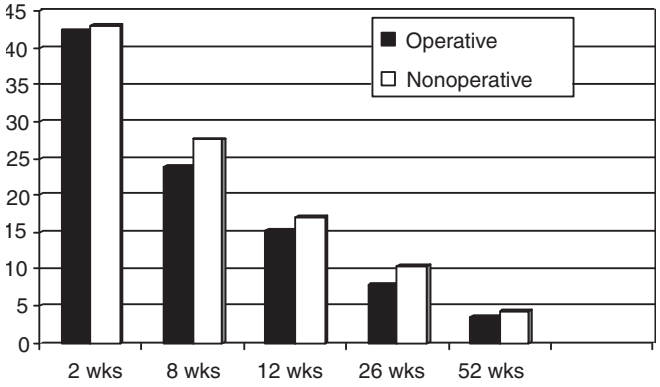

Figure 4. Differences in the Musculoskeletal Function Assessment Index score between operative and nonoperative patients.

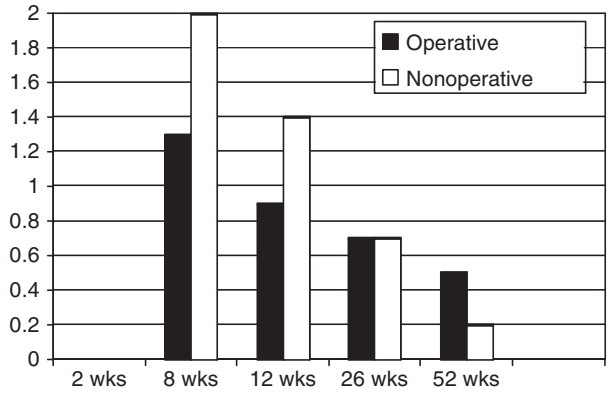

Figure 5. Differences in calf circumference (cm) between injured and noninjured sides for the operative and nonoperative groups.

treated patients have been immobilized for a much greater period of time, and the surgically treated patients have been allowed controlled early motion and weightbearing.[2,5,10,11] In all these studies and in comprehensive review or meta-analysis papers in the literature,[1,6,7,9,13,17] there has been a greater rerupture rate in the nonoperatively treated patients but a higher rate of moderate and major complications in those treated surgically, with deep infection being the most difficult complication to manage.

Early motion has been shown to be beneficial for tendon healing and function in both animal models and in human studies, particularly in the hand. It has been known for many years that tendons that rupture outside synovial sheaths or joints usually undergo spontaneous repair. Recent documentation of the "lizard tail" phenomenon for the regeneration of hamstring tendons harvested for anterior cruciate ligament reconstruction demonstrates the potential reparative properties of tendons.[4] This tissue has many of the characteristics of normal tendon but appears inferior to the original unit. In 1992, Saleh et al[14] reported a randomized, prospective study of treatment of rupture of the "calcaneal" tendon in which both groups received nonoperative treatment, but 1 group was allowed early, controlled motion. The early motion group regained motion and returned to normal activity sooner. More recently, with early weightbearing in both groups, Weber et al[16] showed no difference in patient satisfaction, return to sports, or ultimate strength between operatively or nonoperatively treated Achilles tendon ruptures. The rerupture rate was higher in the nonoperatively treated patients, but the nonoperatively treated patients were placed in an equinus position in their rehabilitation and the surgical group in neutral.

In the present study, there was no difference in any of the measured parameters for operatively and nonoperatively treated patients as long as both groups received early, controlled motion as part of their rehabilitation. Compliance can be an issue when patients are able to remove their own splint; this created 1 reinjury in each group in this study. No patient who remained compliant in either group appeared to have a measured or functionally lengthened tendon.

The lack of wound complications in surgically treated patients in this study is not in keeping with results from other studies published with surgical treatment of Achilles tendon rupture. All procedures were performed by the senior author. Attention to detail in closing the paratenon injury is thought to reduce wound complications to a minimum, but rarely problems have been experienced with this technique in patients not involved in this study; the numbers in this study may be too few to accurately capture the rate of this significant complication.

This study supports early motion as an acceptable form of rehabilitation in both surgically and nonsurgically treated patients with comparable functional results and a low rerupture rate. Previous randomized studies that have suggested a particular surgical approach combined with early motion is superior to nonoperatively treated patients have immobilized the nonoperative patients for a longer period of time. There appears to be no difference between the 2 groups in this study when both received the same rehabilitation protocol, suggesting that controlled early motion is the most important part of treatment of ruptured Achilles tendon.

REFERENCES

1. Bhandari M, Guyatt GH, Siddiqui F, et al. Treatment of acute Achilles tendon ruptures: a systematic review and meta analysis. *Clin Orthop Relat Res.* 2002;400:190-200.
2. Cetti R, Christensen SE, Ejsted R, Jensen NM, Jorgensen U. Operative versus nonoperative treatment of Achilles tendon rupture: a prospective randomised study and review of the literature. *Am J Sports Med.* 1993;21:791-799.
3. Gelberman RH, Woo SL, Amiel D, Horibe S, Lee D. Influences of flexor sheath continuity and early motion on tendon healing in dogs. *J Hand Surg [Am].* 1990;15:69-77.
4. Gill SS, Turner MA, Battaglia TC, Leis HT, Balian G, Miller MD. Semitendinosus regrowth: biochemical, ultrastructural, and physiological characterization of the regenerate tendon. *Am J Sports Med.* 2004;32:1173-1181.
5. Kangas J, Pajala A, Siira P, Hämäläinen M, Leppilahti J. Early functional treatment versus early immobilization of the musculotendinous unit after Achilles rupture repair: a prospective, randomized, clinical study. *J Trauma.* 2003;54:1171-1180.
6. Khan RJ, Fick D, Brammar TJ, Crawford J, Parker MJ. Interventions for treating acute Achilles tendon ruptures. *Cochrane Database Syst Rev.* 2004;3:CD003674.

7. Khan RJ, Fick D, Keogh A, Crawford J, Brammar T, Parker M. Treatment of acute Achilles tendon ruptures: a meta-analysis of randomised, controlled trials. *J Bone Joint Surg Am.* 2005;87:2202-2210.
8. Lipscomb PR, Wakim KG. Regeneration of severed tendons: an experimental study. *Proc Staff Meet Mayo Clin*. 1961;36:271-276.
9. Lo IK, Kirkley A, Nonweiler B, Kumbhare DA. Operative vs non operative treatment of acute Achilles tendon ruptures: a quantitative review. *Clin J Sport Med.* 1997;7:207-211.
10. Moller M, Movin T, Granhed H, Lind K, Faxen E, Karlsson J. Acute rupture of tendon Achilles: a prospective randomized study of comparison between surgical and non-surgical treatment. *J Bone Joint Surg Br.* 2001;83:843-848.
11. Mortensen NHM, Skov O, Jensen PE. Early motion of the ankle after operative treatment of a rupture of the Achilles tendon: a prospective, randomized, clinical and radiographic study. *J Bone Joint Surg Am.* 1999;81:983-990.
12. Nistor L. Surgical and non-surgical treatment of Achilles tendon rupture: a prospective randomised study. *J Bone Joint Surg Am.* 1981;63:394-399.
13. Rajasekar K, Gholve P, Faraj AA, Kosygan KP. A subjective outcome analysis of tendo-Achilles rupture. *J Foot Ankle Surg.* 2005;44:32-36.
14. Saleh M, Marshall PD, Senior R, MacFarlane A. The Sheffield splint for controlled early mobilization after rupture of the calcaneal tendon: a prospective, randomised comparison with plaster treatment. *J Bone Joint Surg Br.* 1992;74:206-209.
15. Swiontkowski MF, Engelberg R, Martin DP, Agel J. Short musculoskeletal function assessment questionnaire: validity, reliability, and responsiveness. *J Bone Joint Surg Am.* 1999;81:1245-1260.
16. Weber M, Niemann M, Lanz R, Müller T. Nonoperative treatment of acute rupture of the Achilles tendon: results of a new protocol and comparison with operative treatment. *Am J Sports Med.* 2003;31:685-691.
17. Wong J, Barrass V, Maffulli N. Quantitative review of operative and non operative management of Achilles tendon ruptures. *Am J Sports Med.* 2002;30:565-575.