

Early Motion of the Ankle After Operative Treatment of a Rupture of the Achilles Tendon

A PROSPECTIVE, RANDOMIZED CLINICAL AND RADIOGRAPHIC STUDY*

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Abstract

Background: Different regimens of early motion of the ankle after operative treatment of a ruptured Achilles tendon have been suggested since the late 1980s. However, as far as we know, no controlled studies comparing these regimens with conventional immobilization in a cast have been reported.

Methods: In a prospective study, seventy-one patients who had an acute rupture of the Achilles tendon were randomized to either conventional postoperative management with a cast for eight weeks or early restricted motion of the ankle in a below-the-knee brace for six weeks. The brace was modified with an elastic band on the posterior surface, in a manner similar to the principle of Kleinert traction. Metal markers were placed in the tendon, and the separation between them was measured on serial radiographs during the first twelve weeks postoperatively. The patients were assessed clinically when the cast or brace was removed, at twelve weeks postoperatively, and at a median of sixteen months postoperatively.

Results: The separation between the markers at twelve weeks postoperatively was nearly identical in the two groups, with a median separation of 11.5 millimeters (range, zero to thirty-three millimeters) in the patients managed with early motion of the ankle and nine millimeters (range, one to forty-one millimeters) in the patients managed with a cast. The separation was primarily correlated with the initial tautness of the repair ($r[S] = 0.45$). No patient had excessive lengthening of the tendon. The patients managed with early motion had a smaller initial loss in the range of motion, and they returned to work and sports activities sooner than those managed with a cast. Furthermore, there were fewer visible adhesions between the repaired tendon and the skin in the patients managed with early motion, and these patients were subjectively more satisfied with the overall result. The patients in both groups recovered a median of 89 percent of strength of plantar flexion compared with that of

the noninjured limb, as measured with an isometric strain-gauge at 15 degrees of dorsiflexion. The heel-rise index was similar for both groups: 0.88 for the patients managed with early motion and 0.89 for those managed with a cast.

Conclusions: Early restricted motion appears to shorten the time needed for rehabilitation. There were no complications related to early motion in these patients. However, early unloaded exercises did not prevent muscle atrophy.

Rigid immobilization in a plaster cast for four to nine weeks has been the treatment of choice of most physicians after operative repair of a rupture of the Achilles tendon²⁰. However, in an effort to minimize the risk of complications, such as joint stiffness, muscle atrophy, tendocutaneous adhesion, and deep venous thrombosis due to prolonged immobilization, different concepts of early motion after operative treatment have been suggested since the 1980s^{1,5,8,11,13,16,17,19}. The results reported in all of those studies were good, and they support the advantages of early motion in the treatment of a ruptured Achilles tendon. However, those studies did not include a control group, so the possible advantages of early motion have not been documented sufficiently.

The advantages and risks associated with early motion have been well documented in experimental studies. In one such study, Mason and Allen¹² showed that restricted motion could be started safely at the end phase of fibroplasia. Later experimental studies^{6,21} showed that early restricted motion of sutured tendons accelerated the return of tensile strength to the repair; however, there was a risk of an increased gap between the ends of the tendons, resulting in elongation or breakdown of the repair. Early motion, in the form of active extension exercises against a rubber band, was shown by Kleinert et al.⁸ to be useful after repair of flexor tendons in humans. This technique allows early motion of the flexor tendon inside the tendon sheath in order to minimize adhesions. The Achilles tendon, however, does not have a narrow fibrous or true synovial tendon sheath. Therefore, the problems associated with repair of flexor tendons are different from those associated with repair of the Achilles tendon, and the results of the former cannot be directly applied to the latter.

The aim of our prospective, randomized clinical investigation was to compare two postoperative regimens

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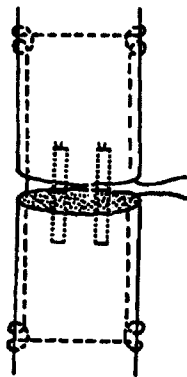


FIG. 1

Illustration of the modified Kessler suture technique for repair of the Achilles tendon.

after operative repair of a ruptured Achilles tendon. Early motion was compared with our former standard protocol, which included eight weeks of rigid immobilization in a below-the-knee plaster cast.

Materials and Methods

Eighty-eight patients were managed for an acute, complete rupture of the Achilles tendon at the Department of Orthopaedics at Odense University Hospital between January 1991 and December 1992. In seven patients, the rupture was treated nonoperatively because the skin was in such poor condition. Of the eighty-one patients who were managed operatively, three were excluded from the study because the rupture had occurred more than forty-eight hours before the patient was seen, two were excluded because they lived outside the county, two were excluded because they had been managed with corticosteroids within six months before the rupture, one was excluded because she was pregnant, and one was excluded because of noncompliance with the protocol. One patient did not want to be included in the study. Thus, the present study consisted of seventy-one patients. All patients gave informed consent, according to the Declaration of Helsinki II, and the study was approved by the local ethical committee.

The rupture of the Achilles tendon was diagnosed by clinical examination, by palpation of a defect, and on the basis of a positive Thompson test¹⁸. The Thompson test is performed with the patient prone and the knee in 90 degrees of flexion. Squeezing the triceps surae muscle results in plantar flexion of the ankle if the Achilles tendon is intact; the test is positive if no plantar flexion occurs.

Sixty-five patients (92 percent) sustained the rupture during a sports-related activity. The most frequent activities were badminton (thirty-three patients; 46 percent), soccer (twelve; 17 percent), handball (seven; 10 percent), and gymnastics (five; 7 percent).

The seventy-one patients were randomized with use of computer-generated random numbers to a postoper-

ative regimen of either immobilization in a below-the-knee plaster cast (thirty-five patients) or early motion (thirty-six patients). Ten patients in each group were women. The median age was thirty-nine years (range, twenty-four to sixty-three years) for the patients managed with a cast and thirty-five years (range, twenty to seventy-three years) for those managed with early motion. The median time between the rupture and the operation was four hours (range, one to twenty-four hours) for the patients managed with a cast and five hours (range, one to thirty-five hours) for those managed with early motion. These basic data were statistically comparable.

The largest circumference of the calf was measured preoperatively, with a tape measure. All patients were managed with the same operation, which was performed with the patient prone and under local anesthesia (1 percent lidocaine with noradrenaline), without a tourniquet. A ten-centimeter-long longitudinal medial skin incision was made, and the fascia and the paratenon were divided in the midline. The tendon was repaired with the modified Kessler suture technique (Fig. 1) with absorbable PDS (polydioxanone) 0-gauge sutures (Ethicon, Somerville, New Jersey) and smaller apposition sutures with Vicryl (polyglactin) sutures (Ethicon). With the patient prone and with both feet over the edge of the operating table, the PDS sutures were tightened so that the ankle joint demonstrated an equinus position that was comparable with that of the noninjured ankle. After the repair was done, a marker was placed outside

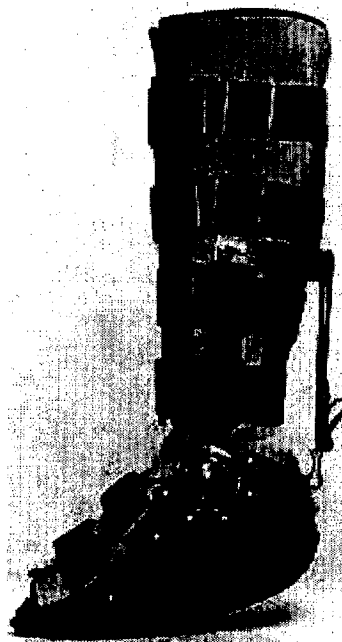


FIG. 2

Photograph of the modified DonJoy ROM-Walker brace. An elastic band pulls the ankle into 30 degrees of plantar flexion but allows active dorsiflexion to neutral.

each frayed end of the tendon with a 5.0 steel suture tied to the tendon. The paratenon and the fascia were carefully resutured with Vicryl sutures, and the skin was closed with Ethilon (nylon) sutures (Ethicon).

The patients who were randomized to early motion of the ankle had a below-the-knee dorsal plaster splint applied with the ankle in the spontaneous equinus position that resulted when the patient was prone and the knee was flexed 90 degrees. This splint was kept in place for two weeks to allow the skin to heal. It then was changed to a modified DonJoy ROM-Walker brace (Smith and Nephew, Vista, California) (Fig. 2). This brace holds the ankle in 30 degrees of plantar flexion by means of an elastic band on the posterior surface of the brace; active dorsiflexion to neutral is possible. The patients were instructed to do a small series of dorsiflexion exercises several times a day. Four weeks postoperatively, the brace was fixed in the neutral position and the patients were allowed to bear weight as tolerated. At that time, the patients were instructed to take the brace off several times a day and to do active, but unloaded, range-of-motion exercises for a few minutes. Six weeks postoperatively, the brace was removed and the patients were allowed to walk normally. The brace was worn for only six weeks because studies^{6,12,21} have shown that early motion accelerates the return of strength to the tendon.

The patients who were randomized to immobilization in a cast had a below-the-knee plaster cast applied postoperatively with the ankle in the spontaneous equinus position described earlier. Six weeks postoperatively, the cast was changed to a below-the-knee weight-bearing cast applied with the ankle in neutral. Eight weeks postoperatively, the cast was removed and the patients were allowed to bear weight as tolerated.

The range of motion of the ankle and the circumference of the calf were measured immediately after removal of the cast or brace in both groups. Atrophy of the calf muscles was calculated as the difference between the preoperative circumference and the circumference after removal of the cast or brace.

We advised the patients in both groups to use a one-centimeter heel-lift in both shoes during the first month after the cast or brace was removed. Standard instructions concerning rehabilitation were given, but no organized physical-therapy program was imposed. The standard instructions for rehabilitation started with range-of-motion exercises for the ankle and the use of an exercise bicycle as well as swimming if possible. Daily walks were recommended, with a gradual increase in the intensity of the training. The goal was a return to sports after six months.

Standardized radiographs were made for the two groups on the first day postoperatively and at six and twelve weeks postoperatively. Radiographic follow-up was discontinued after twelve weeks. The distance between the x-ray source and the film plate was fixed at 100

centimeters, and all of the radiographs were focused on the medial malleolus. The exact postoperative equinus position was calculated as the difference between the tibiocalcaneal angle on the radiograph made one day postoperatively and that on the radiograph made twelve weeks postoperatively with the ankle in neutral.

All of the patients were seen twelve weeks postoperatively, at the time that the final radiograph was made, and were questioned about pain and tenderness, stiffness, and the ability to walk. Any difference between the range of motion of the injured ankle and that of the noninjured ankle was recorded. The circumference of the calf was also measured.

The most recent clinical examination was performed at a median of sixteen months postoperatively. The patients were interviewed concerning pain and tenderness, stiffness, the ability to run, the number of days of sick leave before they returned to work (a parameter normally used in Denmark to measure rehabilitation), whether they had had physical therapy, and when sports activities had been resumed. Finally, the patients were asked to categorize their overall subjective opinion of the most recent result as excellent, satisfied, or not satisfied, without additional description. A clinical examination was performed after the interview. The circumference of the calf was measured and was compared with the preoperative circumference. The ranges of active dorsiflexion and plantar flexion were measured with a goniometer. A dorsal shift in the pattern of movement, indicating an elongated Achilles tendon, was defined as increased dorsiflexion and decreased plantar flexion. A plantar shift was defined as decreased dorsiflexion and increased plantar flexion. The sensibility of the sural nerve was tested by asking the patient if he or she had normal feeling to gentle touch on the skin of the lateral border of the foot. The ability to walk on tiptoe was tested, and the outer thickness of the Achilles tendon was measured with a slide gauge. The ankle was examined for visible adhesions of the scar to the repaired tendon. Grade 0 was assigned when there was no adherence; grade 1, when there was minor adherence that was visible only when the ankle was moved; and grade 2, when there was visible deformity of the scar without movement of the ankle, which denoted adherence of the scar to the tendon. The adherence was confirmed by moving the ankle.

At the most recent clinical examination, strength of plantar flexion was tested with an isometric strain-gauge and dynamic function of the calf muscles was tested with a specially constructed heel-rise device⁷. After the patient was familiarized with the instrumentation, strength was measured with the patient supine, the hip and knee flexed 90 degrees, and the ankle in 15 degrees of dorsiflexion and then in 15 degrees of plantar flexion. All of the tests were repeated ten times, and the highest score was used to calculate the difference between the injured and the noninjured limb,

which was considered to be the strength index. For the heel-rise test, the patient was asked to stand on one limb and to raise the heel five centimeters at a rate of twenty times per minute. The pace was set by a metronome. A bulb in front of the patient lit when the heel was raised the correct distance. Only heel-rises that activated the bulb were recorded. Both limbs were tested, always starting with the noninjured limb, and the patient was asked to continue until he or she was exhausted. The difference between the injured and the noninjured limb was calculated, and the value was used for the heel-rise index.

Statistical Analysis

The statistical analysis was performed with Statistica 4.5A for Windows (Statsoft, Tulsa, Oklahoma). Spearman's nonparametric rank correlation was used to estimate correlation between variables, the Mann-Whitney unpaired rank-sum test was used to compare groups of patients, and Fisher's exact test was used to compare the binomial scale parameters between the two groups. A two-tailed p value of less than 0.05 was considered significant.

Results

At the twelve-week follow-up examination, seven patients (19 percent) who had been managed with early motion and fourteen (40 percent) who had been managed with a cast stated that they were still not able to walk as far as they could before the injury (p = 0.06). With the numbers available for study, we could not detect a significant difference between the two groups with regard to pain and tenderness or stiffness at twelve weeks.

Thirty-one (86 percent) of the patients managed with early motion were examined at a median of six-

TABLE I
DATA ON THE PATIENTS SIXTEEN MONTHS AFTER OPERATIVE TREATMENT OF A RUPTURED ACHILLES TENDON

	Postoperative Regimen		P Value
	Early Motion (N = 31)	Cast (N = 30)	
Sick leave* (days)	43 (1-103)	68 (2-285)	<0.05
Had physical therapy (no. of patients)	3 (10%)	7 (23%)	0.29
Subjective result (no. of patients)			<0.05
Excellent	26 (84%)	19 (63%)	
Satisfied	4 (13%)	10 (33%)	
Not satisfied	1 (3%)	1 (3%)	
Sports activity†			
Returned to sports (no. of patients)	22 (73%)	22 (76%)	1.00
Time until sports resumed* (mos.)	4 (2-13)	7.5 (3-22)	<0.001
Reached preinjury level (no. of patients)	17 (57%)	16 (55%)	1.00
Time until preinjury level reached* (mos.)	6 (2.5-13)	9 (6-14)	<0.001

*The values are given as the median, with the range in parentheses.
†One patient in each group did not participate in any sports activity before the injury. The percentages are based on thirty patients managed with early motion and twenty-nine managed with a cast.

teen months (range, twelve to twenty-four months) postoperatively, and thirty (86 percent) of the patients managed with a cast were examined at a median of sixteen months (range, twelve to twenty-one months) postoperatively. An equal number of patients from both groups were not seen at the most recent follow-up interval, and these patients did not differ from the rest of the patients with regard to gender or age. Twenty-eight patients managed with a cast and twenty-nine managed with early motion had used the one-

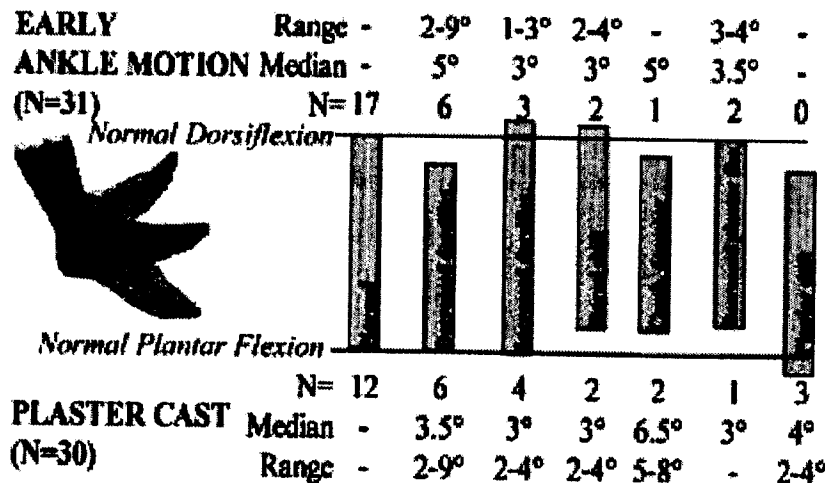


FIG. 3

Qualitative analysis of the change in the pattern of movement at the ankle joint. The upper rows are the results for the patients managed with early motion. The lower rows are the results for the patients managed with a plaster cast.

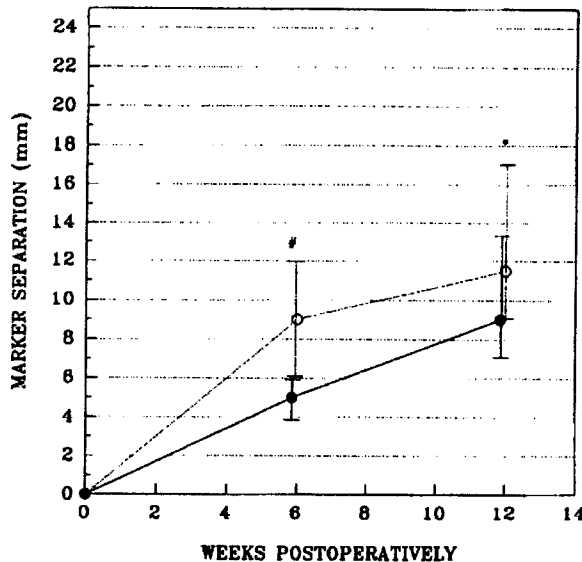


FIG. 4

Graph of the median separation (and 95 percent confidence limits) between the intratendinous metal markers as measured on the radiographs made the first day postoperatively and at six and twelve weeks postoperatively. Solid circles = patients managed with a cast, empty circles = patients managed with early motion, # = $p < 0.001$, and * = not significant ($p = 0.20$).

centimeter heel-lift for at least two weeks.

The prevalence of pain and tenderness in the area of the Achilles tendon was similar between the two groups. One patient in each group had constant tenderness, and four who had been managed with early motion and five who had been managed with a cast had intermittent symptoms, typically slight pain when they began to walk. One patient in each group had constant stiffness in the ankle, and six managed with early motion and eight managed with a cast had periodic stiffness, typically when they began to walk. One patient in each group had not tried to run after the repair. All patients had returned to their preinjury occupation, but the patients managed with early motion returned after significantly fewer sick days ($p < 0.05$) than those managed with a cast (Table I). The subjective assessments of the most recent result favored the early-motion regimen. With the numbers available for study, we found no significant difference between the groups with regard to the number of patients who had returned to sports or who had reached their preinjury level of participation (Table I). Thirteen patients in each group had not returned to the preinjury level of participation, but only one in each group stated that the reason was physical sequelae. Most patients stated that they were afraid of another rupture.

At the most recent follow-up examination, all patients, except one managed with a cast, were able to walk on tiptoe. The thickness of the Achilles tendon in the injured limb was similar in both groups; typically, it was 45 to 50 percent thicker than that in the noninjured

limb, but the patients managed with early motion had fewer and less severe adhesions between the tendon and the scar than those managed with a cast. Nineteen patients managed with early motion had grade-0 (no) adhesions, ten had grade-1, and two had grade-2, compared with nine, fifteen, and six patients managed with a cast ($p < 0.01$).

The atrophy of the calf muscles was nearly identical in the two groups. At the time that the cast or brace was removed, the median loss in the circumference of the calf for both groups was 2.5 centimeters (range, zero to five centimeters). At twelve weeks postoperatively, the median loss was 1.5 centimeters (range, zero to four centimeters). At the most recent follow-up examination, the patients managed with early motion had a median loss of 1.0 centimeter (range, zero to three centimeters) and those managed with a cast had a median loss of 1.25 centimeters (range, zero to five centimeters). The difference was not found to be significant, with the numbers available for study.

At the time that the cast or brace was removed, the patients managed with early motion had a median decrease in the range of motion of 20 degrees (range, 0 to 45 degrees), which was significantly less than the median decrease of 30 degrees (range, 0 to 85 degrees) for the patients managed with a cast ($p < 0.001$). At twelve weeks postoperatively, the median decrease was 10 degrees (range, -5 to 45 degrees) for the patients managed with early motion and 15 degrees (range, 0 to 45 de-

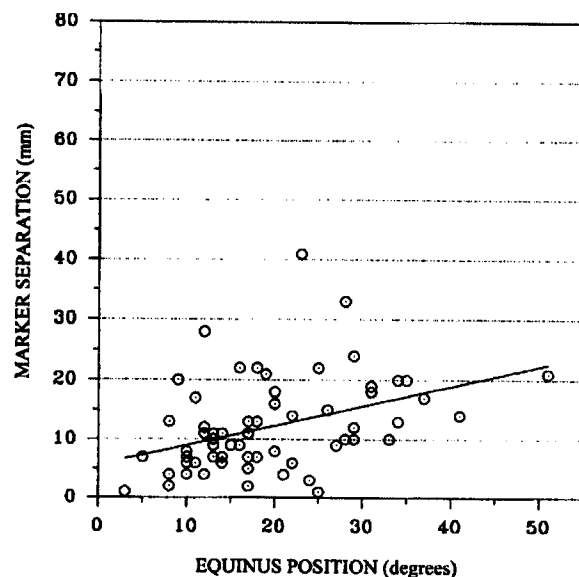


FIG. 5

Graph of the correlation between the separation between the markers at twelve weeks postoperatively and the postoperative equinus position, which was calculated as the difference between the tibio-calcaneal angle, measured with the ankle in the equinus position, on the radiograph made one day postoperatively and the tibio-calcaneal angle, measured with the ankle in neutral, on the radiograph made twelve weeks postoperatively. $R(S) = 0.45$; $p < 0.001$.

TABLE II
STRENGTH AND HEEL-RISE INDICES BETWEEN THE INJURED
AND NONINJURED LIMBS SIXTEEN MONTHS POSTOPERATIVELY*

Postoperative Regimen	Strength Index		Heel-Rise Index
	In 15 Degrees of Dorsiflexion	In 15 Degrees of Plantar Flexion	
Early motion	0.89 (0.82-0.98)	0.75 (0.62-0.86)	0.88 (0.71-1.00)
Cast	0.89 (0.75-0.98)	0.72 (0.50-0.78)	0.89 (0.75-0.96)

*The values are given as the median, with the 95 percent confidence interval in parentheses.

degrees) for those managed with a cast ($p < 0.05$). However, at the most recent follow-up examination, the median decrease in each group was 0 degrees because more than half of the patients in each group had a normal or increased range of motion. The median difference in dorsiflexion and the median difference in plantar flexion were both 0 degrees as well; however, fourteen patients managed with early motion and eighteen managed with a cast had a minor change in the pattern of movement (Fig. 3). Of the patients managed with early motion, seventeen had a normal range of motion, six had decreased dorsiflexion (median, 5 degrees; range, 2 to 9 degrees), three had increased dorsiflexion (median, 3 degrees; 1, 3, and 3 degrees), two had a dorsal shift (2 and 4 degrees), one had a combined decrease in dorsiflexion and plantar flexion (5 degrees), and two had decreased plantar flexion (3 and 4 degrees). None had a plantar shift. Of the patients managed with a cast, twelve had a normal range of motion, six had decreased dorsiflexion (median, 3.5 degrees; range, 2 to 9 degrees), four had increased dorsiflexion (median, 3 degrees; range, 2 to 4 degrees), two had a dorsal shift (2 and 4 degrees), two had a combined decrease in dorsiflexion and plantar flexion (5 and 8 degrees), one had decreased plantar flexion (3 degrees), and three had a plantar shift (median, 4 degrees; 2, 4, and 4 degrees). Despite the fact that more patients managed with early motion had a normal pattern of movement, no significant difference between the groups could be detected, with the numbers available.

At six weeks postoperatively, the median separation between the intratendinous markers was nine millimeters (range, zero to twenty-six millimeters) in the patients managed with early motion compared with five millimeters (range, one to thirty-four millimeters) in those managed with a cast ($p < 0.001$) (Fig. 4). However, at twelve weeks postoperatively, the median separation was 11.5 millimeters (range, zero to thirty-three millimeters) in the patients managed with early motion and nine millimeters (range, one to forty-one millimeters) in those managed with a cast ($p = 0.20$). With the numbers available, we could not detect a correlation between the median separation at twelve weeks and the most recent range of motion ($r[S] = 0.02$; $p =$

0.97) or any specific pattern of movement of the ankle ($r[S] = -0.08$; $p = 0.52$ for the change in dorsiflexion, and $r[S] = 0.09$; $p = 0.62$ for the change in plantar flexion). Eleven patients had increased dorsiflexion or a dorsal shift, indicating elongation of the Achilles tendon; however, these patients had a median separation of only eight millimeters at twelve weeks postoperatively. With the numbers available, we could not detect a correlation between the separation of the markers and the results of strength tests performed with the isometric strain-gauge ($r[S] = 0.12$; $p = 0.38$) or dynamic muscle function tested with the heel-rise device ($r[S] = 0.03$; $p = 0.82$).

However, we did find a significant correlation between the separation at twelve weeks and the calculated equinus position at twelve weeks ($r[S] = 0.45$; $p < 0.001$) (Fig. 5). This equinus position, as determined on the radiographs, was a median of 18 degrees (range, 8 to 41 degrees) in the patients managed with early motion and 16 degrees (range, 3 to 51 degrees) in those managed with a cast. No significant difference between the groups could be detected, with the numbers available.

We also could not detect a significant difference between the groups with regard to the median strength of plantar flexion measured with the ankle in 15 degrees of dorsiflexion (strength index, 0.89 for each group) and that with the ankle in 15 degrees of plantar flexion (strength index, 0.75 for the patients managed with early motion and 0.72 for those managed with a cast) or in the median work capacity of the calf muscles measured with the heel-rise test (heel-rise index, 0.88 for the patients managed with early motion and 0.89 for those managed with a cast) (Table II). The strength indices measured isometrically at 15 degrees of dorsiflexion ($r[S] = 0.34$; $p = 0.02$) and 15 degrees of plantar flexion ($r[S] = 0.30$; $p = 0.02$) both were weakly correlated with atrophy of the calf muscles. With the numbers available for study, we could not detect a significant correlation between atrophy of the calf muscles and the heel-rise index ($r[S] = 0.24$; $p = 0.07$).

During the first six weeks after the cast or brace was removed, the repair failed in one patient managed with early motion and in two managed with a cast. In addition, a seventy-three-year-old man managed with early motion had a deep infection. No patient had a superficial infection, symptoms of deep venous thrombosis, or injury of the sural nerve.

Discussion

A regimen for functional treatment after repair of the Achilles tendon was first described by Marti and Weber¹⁰ in 1974. Those authors removed the plaster cast four, five, or six days postoperatively and instructed the patients in active range-of-motion exercises for the ankle and knee. After motion of the ankle had almost returned to normal, a below-the-knee plaster cast was worn for six to eight weeks and the patient was allowed

progressive weight-bearing. Since the late 1980s, some new regimens involving early motion have been reported^{1,5,9,11,13,16,17,19}. All of these regimens had satisfactory results without an increase in the rate of failure or a substantial elongation of the tendon. However, because those studies did not include a control group, the effects of early motion have not been evaluated critically.

Our standard treatment for rupture of the Achilles tendon before this study was operative repair followed by immobilization for eight weeks in a below-the-knee plaster cast. Because Mason and Allen¹² found that restricted early motion accelerated the return of strength to the repair, we decided to incorporate a shorter period of immobilization (six weeks) in a brace into the regimen. We are aware that there are problems associated with evaluation of our early results at six and eight weeks postoperatively and, to some extent, with evaluation at twelve weeks postoperatively.

In the present prospective, randomized study, we made a special effort to evaluate the possibility of elongation of the tendon because several authors^{3,17} have reported a mean dorsal shift of 1 to 2 degrees in studies that included different kinds of early unloaded exercises for the ankle. If elongation occurred because of early motion, one would expect more patients to have increased dorsiflexion or a dorsal shift in the range of motion than any other abnormality; however, this was not the case in the present study (Fig. 3).

Another tool that we used to demonstrate elongation of the tendon was intratendinous markers. We chose twelve weeks as the time for the final radiographic evaluation because earlier studies have shown that there is no noticeable increase in separation after this time^{14,15}. Because the ends of a ruptured tendon are markedly frayed, it is difficult to know during the operation if the tendon has been repaired in an elongated or shortened position; however, as previously mentioned, we applied the cast with the foot in the spontaneous position of plantar flexion that occurred when the knee was flexed 90 degrees. Therefore, we believe that this equinus position reflects the length of the tendon after

the repair. The significant correlation between the postoperative equinus position and the separation of the markers ($r[S] = 0.45$; $p < 0.001$) (Fig. 5) indicates that increased tautness of the repair resulted in increased separation postoperatively.

Early unloaded motion of the ankle did not prevent atrophy of the calf muscles. The decrease in the circumference of the calf reported in other studies has ranged from 0.75 to two centimeters^{3,5,11,17}. Therefore, unloaded exercises do not seem to be enough to protect against atrophy of the calf muscles.

Häggmark et al.⁷, in a study of operatively and non-operatively treated ruptures of the Achilles tendon, found that the heel-rise test was superior to isokinetic testing of muscle torque with a Cybex-II dynamometer with regard to discrimination of muscle function after repair of the Achilles tendon. We did not find a correlation between the results of the heel-rise test and atrophy of the calf muscles as measured with a tape measure. We believe that the major problem with the heel-rise test is the difficulty of determining the end point, when the calf muscles are so fatigued that the patient does not think that he or she can raise the heel off the ground.

Despite different treatment periods, our data favor early motion. Moreover, we did not find any adverse effects associated with early motion. The advantages were primarily evident in the early postoperative period. However, because we did not examine our patients between twelve weeks postoperatively and a median of sixteen months postoperatively, we do not know how long the patients managed with early motion had a better range of motion than those managed with a cast. We believe that more frequent follow-up examinations should be incorporated into the rehabilitation protocol of future studies.

Early restricted motion appeared to shorten the period of rehabilitation in our relatively small series of patients. There were no complications related to early motion. However, early unloaded exercises did not prevent muscle atrophy.

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