

Potential Risk of Rerupture in Primary Achilles Tendon Repair in Athletes Younger Than 30 Years of Age

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Background: Complete Achilles tendon ruptures are found more often in athletes who participate in sports involving explosive acceleration or maximal effort. In most studies, the consensus for athletes is surgery. This form of treatment has been shown to exhibit the best functional performance with a lower rerupture rate.

Hypothesis: Achilles tendon ruptures in a young population (<30 years) have a higher rerupture rate than similar injuries in an older age group (31-50 years), in which the injury is more common.

Study Design: Cohort study; Level of evidence, 4.

Methods: Retrospective study was carried out by chart review. Magnetic resonance images were obtained comparing appearance of repair in young and old patients at 8 to 12 weeks after operation.

Results: There were a total of 4 reruptures in the 89 Achilles tendon repairs. This was an overall rerupture rate of 4.5%, which was consistent with the literature. When the reruptures were critically analyzed, it was noted that the 4 reruptures of the repaired tendon occurred in a young population. Of the 89, there was a subgroup of athletes ($n = 24$) who were 30 years of age or younger at the time of injury. The incidence of rerupture for these individuals was 16.6%. In the remaining athletes ($n = 65$) older than 30 years, the incidence of rerupture was zero. There were no significant differences ($P \leq .05$) in all parameters measured (average days in a boot, average days to active range of motion, average time to full weight-bearing, average days to bike or use a stair climbing machine, average return to sports) between age groups except in the time from injury to surgery (7.1 days, for athletes ≤ 30 years vs 2.65 days for athletes >31 years).

Conclusions: The results of Achilles tendon repair with an early weightbearing and an early range of motion rehabilitation program are good. However, caution may need to be taken in the younger athlete (≤ 30 years) during rehabilitation.

Clinical Relevance: Although the authors recommend aggressive rehabilitation for Achilles tendon repairs, caution should be observed in the younger athlete.

Keywords: athletic injury; Achilles tendon rupture; repair; rerupture

Patients with a traumatic spontaneous rupture of the Achilles tendon can be divided into 2 groups: (1) injuries sustained by weekend athletes in their late 30s and 40s and (2) injuries occurring in active, well-conditioned athletes in their 20s.³ It is known that between 6.5% and 18% of running injuries involve the Achilles tendon.² Complete

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Achilles tendon ruptures are found more frequently in athletes who participate in sports involving explosive acceleration or maximal effort, such as basketball, tennis, baseball, and softball. Alternatives of treatment of Achilles tendon rupture include cast immobilization and repair with either an open or percutaneous technique.⁹ In most studies, the consensus for athletes is surgery.^{3,8} This form of treatment has been shown to exhibit the best functional performance with a lower rerupture rate.^{3,8}

Mandelbaum et al⁵ have described a suture technique for Achilles tendon repair that allows early range of motion (ROM) and weightbearing with a postoperative orthosis. Soma and Mandelbaum⁷ have reported a superior return to function with early range of motion compared with traditional postoperative casting. Reports describing

TABLE 1
Number of Achilles Ruptures by Sport

Sport	n	%
Group 1		
Basketball	15	63
Volleyball	2	8
Football	3	13
Other	4	17
Group 2		
Basketball	29	45
Tennis	10	15
Volleyball	4	6
Racquetball	6	9
Running	2	3
Other	14	22

the results of this aggressive functional rehabilitation do not make a distinction in the outcome between the younger athlete and the more typical older athlete who sustains an Achilles tendon rupture.⁷

The purpose of this study was to document possible variables, such as age, sport, and gender, that would explain the higher rate of reruptures in a younger population of athletes after Achilles tendon repair.

MATERIALS AND METHODS

Between 1987 to 1994, 89 consecutive patients with a traumatic, spontaneous rupture of the Achilles tendon were treated with surgical repair by 5 surgeons. Patients' data were evaluated retrospectively to determine the response to the surgery and a supervised, functional rehabilitation program that focused on early ROM and early weightbearing.

The clinic and physical therapy records were reviewed for each patient. We reviewed each patient's record for the sport the patient was involved in at the time of injury, age, gender, average days from injury to surgery, complications, time of immobilization, time to active ROM, time to full weightbearing in the orthosis, and time to return to sports.

There were 6 female and 83 male patients. The mean age was 36 years (range, 19-63 years). The most common sports in which patients ruptured their tendons were basketball and tennis (Table 1). The mean time to surgery was 10 days.

All patients were treated with a surgical repair of their tendon rupture using an open, end-to-end reapproximation of the tendon with a nonabsorbable suture in a modified Kessler fashion without augmentation. All 5 surgeons practiced the same surgical technique and postoperative protocols in treating the patients in this review. After surgery, patients were immobilized in a cast or cast boot until adequate wound healing was achieved, approximately 10 days after surgery. After initial wound healing, patients were placed in a rigid orthosis (CAM Walker or Aircast-type boot, Aircast Inc, Summit, NJ) with 1 or 2 heel wedges in place. Active and passive dorsiflexion, inversion, and eversion were encouraged to progress to 100% weight-

TABLE 2
Reruptures by Age and Time From Initial Repair

Patient	Age at First Rupture	Time From Initial Surgery to Retear, wk	Activity During Which Retear Occurred
1	29	7.0	Walking up an incline
2	24	6.6	Walking down stairs
3	23	7.5	Car door shut on leg
4	30	10.0	Walking down stairs

bearing as tolerated during the first 4 weeks. As weight-bearing increased, the heel lift height was reduced until the ankle was in a neutral position. At approximately 6 weeks after surgery, patients were allowed to wear shoes of various types (cowboy boots or flats), depending on their ROM, for the next 4 to 6 weeks. All patients were allowed to return to sports when ROM, strength, and endurance reached levels similar to their normal leg, as measured by isokinetic strength tests or a functional progression skill performance test (see the appendix).

A linear regression analysis was used to analyze the relationship between the rerupture rate and other variables. Based on the results from statistical analysis, we divided the groups into 2 subsets. The first subset (group 1) consisted of patients who ruptured their Achilles tendon and were 30 years of age or younger (Table 1). The second group consisted of those athletes 31 years of age and older (group 2). Results from the younger subset are discussed and compared to those of the older group of athletes.

RESULTS

In group 1, there were 24 patients who were 30 years of age or younger (3 women, 21 men). The mean age of these patients was 26.2 years (range, 19-30 years). The mean time to return to sports was 22.3 weeks (range, 12-28 weeks) (Table 3).

Group 2 consisted of 65 athletes (3 women, 62 men), all older than 30 years. The mean age was 40.8 years (range, 31-63 years). The mean time to return to sports was 25.5 weeks (range, 12-80 weeks) (Table 3).

The mean follow-up time for both groups was 168.82 days (range, 31.5-531 days). All subjects were able to return to their previous level of activity. On postoperative examination, all the subjects had a negative Thompson sign and full ROM. Cybex scores were not documented, and subjective questionnaires were not completed during the study.

Four reruptures occurred in the younger group of athletes (group 1) between 7 and 10 weeks after their primary repair (Table 2). Of the 4 patients with reruptures, 3 had their primary repair performed by the same surgeon. All 4 reruptures occurred in male patients with similar athletic body types. The incidence of rerupture for this group was 17%. No reruptures occurred in the second, older group (group 2). Age was the only statistically significant difference found in the rerupture rate of patients younger than 30 when

TABLE 3
Data Reviewed

	30 Years of Age or Younger	Range	30 Years of Age or Older	Range
Average age	26.2	19-30	40.8	31-63
Average days from injury to surgery	7.1	1-48	2.7	1-7
Average days in boot	45.7	23-90	48.6	21-105
Average days to active ROM	22.5	14-35	25.4	6-50
Average time to full weightbearing	34.8	21-56	37.0	12-90
Average days to bike or Stairmaster	54.5	21-120	58.6	21-150
Average weeks to return to sports ^a	22.3	12-28	25.5	12-80

^aAll subjects returned to their previous level of activity.

TABLE 4
Significance of Age and Sex on Rerupture Rate
After Achilles Tendon Repair

Variable	<i>t</i>	<i>Pr</i> > <i>t</i>
Age	-2.29	.0242
Sex	-0.89	.3750

compared to patients older than 30 ($P = .008$, Fisher exact test). Other variables such as sex (Table 4) or the rehabilitation protocols (Table 5) did not show any significance.

The average number of days from injury to surgery was 7.1 for group 1 versus 2.65 for group 2. However, of the 4 reruptures in group 1, the number of days from injury to surgery was 2 to 3 days (Table 3). Other than age, this was the only measured parameter that showed statistical significance.

CASE REPORT

A 29-year-old male subject, playing in a 3-on-3 basketball tournament, reported that he felt a pop in his lower posterior calf while walking down the court and was unable to continue to play. He had no history of previous lower extremity difficulties. Three days after the injury, he was evaluated at our clinic. He had significant swelling, a palpable defect in the Achilles tendon, and a positive Thompson test. He was taken to the operating room, and end-to-end repair of his Achilles tendon was performed. His lower extremity from knee to toe was placed in a bulky cast after surgery.

Postoperative Course

At 10 days after surgery, the subject's staples were removed. At 17 days, he was placed in a rigid orthosis with 2 heel wedges (9/16 in). He then began physical therapy following the protocol listed in the appendix. At 45 days after surgery, after obtaining near full ROM, he was placed in an athletic shoe with a heel lift. At 10.5 weeks, the patient was doing well, swimming, walking normally, using the bike and stair climbing machine, and working on

TABLE 5
Significance of Rehabilitation Protocols in Relation
to Rerupture Rate After Achilles Tendon Repair

Variable	<i>t</i>	<i>Pr</i> > <i>t</i>	Mean
Boot, d	0.57	.5969	48.18
Full weightbearing, d	0.58	.5627	36.47
Bike or Stairmaster, d	0.42	.6741	56.35
Active range of motion, d	0.59	.5577	24.77
Normal gait, d	0.85	.4024	63.42
Plantar flexion, d	0.39	.6999	33.85
Full range of motion, d	-1.00	.3211	92.16
Return to sport, wk	1.36	.1803	24.97

his strength. He was walking up an incline when he felt a pop posteriorly in his recently operated lower extremity and had severe pain and swelling.

The examination after reinjury was consistent with a retear of the subject's Achilles tendon. During his second surgery, he was found to have complete failure of the tendon inferior to the previous tear. He was the only one of the 4 subjects with a rerupture to have a rerupture distal to his initial rupture. His postoperative course after this second surgery consisted of 6 weeks of casting and 8 weeks in an orthosis. At 8 months after the second repair, his Cybex test showed equal strength (left vs right), and he began sports participation. At 2 years after his rerepair, he had full ankle ROM, his tendon was intact, and he was asymptomatic with return to full sports.

DISCUSSION

Achilles tendon ruptures are prevalent in the athletic population. They are much more common in the aging athlete. The exact cause has not been conclusively ascertained. The prevailing theories are the following: (1) hypovascularity in the distal tendon (vascularity has been shown to decrease after the third decade) coupled with a decreased metabolic rate leading to slow healing,⁴ (2) repetitive microtrauma, (3) corticosteroid use (locally infiltrated or systemic), and (4) tendon degeneration.⁴⁻⁵

A histopathologic study of spontaneous tendon rupture by Kannus and Jozsa⁴ showed that a healthy state was not seen in any ruptured tendon. The majority of the pathologic findings were degenerative changes. They found that 65% of age-matched, control autopsy specimens had normal tendons, and every ruptured tendon had obvious pre-existing histopathologic alterations. The authors concluded that a spontaneous rupture of a tendon is preceded by degenerative changes.⁴

The most appropriate treatment of Achilles tendon rupture remains uncertain when all patients are considered. Traditional treatment of an Achilles tendon rupture involves cast immobilization for a minimum of 6 to 8 weeks. Multiple studies have shown that after prolonged immobilization, a minimum of 10% deficit in strength exists in the gastrosoleus complex compared to the normal leg after rehabilitation.^{5,7}

In a prospective, randomized study comparing the results of operative and nonoperative treatment of Achilles tendon ruptures, Nistor⁶ found similar results regarding strength and return to normal activities, although there was an 8.3% rerupture rate with cast treatment versus 4.4% in the operative group. In a review of the literature comparing surgical with nonsurgical treatment of ruptures, Wills et al⁸ reported a 17.7% (40 of 226) rerupture rate in nonsurgically treated patients versus a 1.54% rerupture rate (12 of 777) in surgically treated patients.

For the majority of young active people, operative treatment seems to be the treatment of choice.³ After surgery, immobilization leads to muscle atrophy, contributes to a prolonged rehabilitation time, and leads to weaker tendon healing (random orientation of collagen) and a delay of normal tensile properties.^{1,5,7} Early mobilization leads to decreased adhesions, stimulates the intrinsic tendon healing response (increased organization of collagen fiber orientation), and promotes fibro-polymerization of collagen, leading to stronger tendon healing and limited muscle atrophy.^{1,3,5,7}

Early mobilization for an Achilles tendon rupture, when prospectively compared to patients immobilized in the traditional fashion, led to an earlier return to sports, fewer patients with calf atrophy, better plantar-flexion strength, and shorter sick leave.¹ Mandelbaum et al⁵ concluded that early mobilization led to a return of 94% of preinjury functional level by 6 months, an acceptable complication rate, no cast-related morbidity, and the rapid obtainment of athletic goals with minimal deficits.

Our study showed results similar to those in the literature. However, we identified a possibly difficult patient population. Patients younger than 30 years of age had a significantly higher rate of rerupture; this has not been reported in the literature to our knowledge.

In this study, we were unable to find a cause for the increased rerupture rate in this younger patient group. All 4 reruptures occurred during normal daily activities (Table 2).

The aggressive athletic nature of the younger patients could cause excessive, abnormal stress to the repaired tendon instead of the desired beneficial stress needed to promote improved tendon healing. It is possible that the older group was composed of a less aggressive athletic patient population that could appropriately stress their healing tendon to allow for healing.

Another possibility for the greater failure rate is a property inherent to the tendon itself. In our case report, minimal trauma was involved in the initial injury, indicating the presence of a less than normal tendon. When a random sample of 3 MRIs was used to examine these tendons at 12 weeks after injury, there were no differences found in the tendinous structure of the Achilles tendon of younger patients when compared with the older population of athletes who did not rerupture their Achilles tendon. The time of rerupture for this population (7-10 weeks) demonstrates a problem with early healing. Biopsy specimens for histologic evaluation were not obtained in this series; however, this may have been helpful to evaluate the differences between the 2 populations.

This study raised some questions that need to be addressed in the future. Has a tendon that fails at such a young age been subjected to significant stresses that affect its ability to heal in a timely fashion? Is there an intrinsic property of the tendon that allows early failure, which then hinders appropriate healing after rupture? Is there some change that needs to be instituted for repairs of Achilles tendons in patients younger than 30 years of age? Further research into the biology of tendon injury and healing is needed. The results will be confirmed with a prospective study in the future.

CONCLUSION

We reported the results of primary repair of Achilles tendon ruptures combined with a supervised early ROM and early weightbearing rehabilitation program. We identified a subset of patients 30 years of age or younger as potentially at a higher risk for rerupture. We continue to recommend this rehabilitation protocol in athletes with an Achilles tendon rupture but recommend caution, especially during the 7 to 10 weeks after surgery in athletes younger than 30 years of age.

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APPENDIX

Achilles Tendon Repair Rehabilitation Program

Phase 1 Weeks 0-3

Goals: wound healing, control swelling

Weeks 0 and 1

1. Postoperative dressing care
2. Elevate ankle
3. Crutches, nonweightbearing

Weeks 1 and 2

1. Postoperative dressing replaced with rigid orthosis walking boot (CAM walker or Aircast-type boot)
2. Postoperative walking boot with heel wedges—3 wedges, 9/16 inch each
3. Crutches, nonweightbearing
4. Elevate
5. Out of splint 3 times daily for icing of wound

Weeks 2 and 3

1. Same as week 2
2. Start active range of motion (ROM)—0 dorsiflexion

Phase 2 Weeks 3-6

Goals: progress to full weightbearing, active ROM to at least neutral, early strengthening

Weeks 3 and 4

1. One heel wedge removed from walking boot
2. Active ROM—0 dorsiflexion
3. Bike with walking boot
4. Cryo-cuff icing

Weeks 4-6

1. Progress to full weightbearing with walking boot
2. Remove remaining heel wedges in walking boot to neutral
3. Active ROM—0 dorsiflexion
4. Biking
5. Cryo-cuff icing

Week 6

1. Discontinue walking boot
2. One quarter inch to 3/8-inch heel lift in shoe
3. Biking
4. Light workout on stair-climbing machine
5. Wall, chair, seated toe raise

Phase 3 Weeks 7 and 8

Goal: normal gait

1. Full range of motion
2. Foot flat bilateral eccentric heel raise, unilateral toe raise
3. Continue with stretching
4. Heel lift in tennis/dress shoe
5. Leg press for quadriceps
6. Cryo-cuff icing

Phase 4 Weeks 8-12

1. Discontinue heel lift
2. Strength exercises; bilateral concentric heel raise, unilateral concentric toe raise

Phase 5 Months 3-6

1. Walk or jog progression
2. Sport-specific agility skills
3. Continue with strength exercises
4. Swede-O brace

Functional progression—full activity
