

Clinical and Radiographic Comparison Between Patients With Achilles Midsubstance Ruptures and Achilles Sleeve Avulsions

Christopher L. Shultz, MD; Mathew G. Wharton, MD; Katherine J. Gavin, MD^a; Richard A. Miller, MD

Department of Orthopaedics & Rehabilitation, The University of New Mexico Health Sciences Center, Albuquerque, New Mexico

Changed Affiliation

^aDepartment of Orthopedic Surgery, Rush University Medical Center, Chicago, Illinois

Corresponding Author Richard A. Miller. Department of Orthopaedics & Rehabilitation, MSC 10 5600, 1 University of New Mexico, Albuquerque, NM 87131 (email: rmiller@salud.unm.edu).

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ABSTRACT

Background: The diagnosis and treatment of acute midsubstance ruptures to the Achilles tendon has been well described; however, information is lacking about ruptures that occur at the bone-tendon interface known as Achilles sleeve avulsions. The aim of this study was to review the clinical and radiographic features that distinguish midsubstance ruptures from sleeve avulsions.

Methods: Medical records of patients with Achilles tendon ruptures (n = 41) and Achilles sleeve avulsions (n = 8) treated by the senior author (RM) between January 2011 and January 2017 were reviewed. Exclusion criteria were patients with non-midsubstance ruptures (n = 8) or ruptures treated nonoperatively (n = 4). Patients were also excluded who took oral steroid medication, had recent fluoroquinolone use, or received a steroid injection near the tendon (n = 0). Ultimately, patients with midsubstance ruptures (n = 29) were compared to those with sleeve avulsions (n = 8). Radiographic findings were evaluated for posterior heel abnormalities.

Results: Radiographic findings of a posterior calcaneal osteophyte, superior calcaneal prominence, or ossific fragments about the posterior ankle were seen in all patients with sleeve avulsion injuries (n = 8) and not in any with midsubstance ruptures. Faint radiodense specks at the distal aspect of the avulsed tendon were observed in half of the patients (n = 4) with an Achilles sleeve avulsion.

Conclusions: Achilles sleeve avulsions occur mostly in older patients and are less often associated with sports injuries than midsubstance ruptures. The faint radiodense specks seen during the study were termed the "Pleiades sign" owing to their similar appearance to that well-known star cluster, which may be used to assist future diagnosis of Achilles sleeve avulsions.

Keywords: Achilles Tendon, Avulsion Fracture, Ruptures, Radiographic Film, Retrospective Study

INTRODUCTION

Acute rupture of the Achilles tendon is a common injury, in which a midsubstance rupture typically occurs. Both operative and nonoperative treatment have been effective in restoring function after these ruptures. A variation of an Achilles tendon rupture is the insertional Achilles sleeve avulsion, described as an avulsion of the Achilles tendon from its insertion, which leaves few or no fibers on the calcaneus. Patients with Achilles sleeve avulsions present with similar medical history and physical examination findings as those with midsubstance ruptures; however, treatment differs. Only 64% of sleeve avulsions were recognized preoperatively in a series published by Huh et al.¹

Although findings of magnetic resonance imaging (MRI) scans can distinguish between midsubstance ruptures and insertional sleeve avulsions, this test is expensive and thus not routinely obtained (Figure 1). Operative repair of Achilles sleeve avulsions often involves reattaching the tendon to the posterior calcaneus using suture anchors. Additionally, transcalcaneal suture techniques have been described if there is an insufficient amount of distal tendon to reattach the ruptured segment.² The response of Achilles sleeve avulsions to nonoperative treatment is unknown. For these reasons, it is important to distinguish a midsubstance Achilles rupture from an insertional sleeve avulsion.

In the current study, we retrospectively examined patients with insertional Achilles sleeve avulsions and midsubstance ruptures. We compared clinical and radiographic findings between groups to help distinguish particular features of sleeve avulsions, which can be used to decide proper treatment methods.

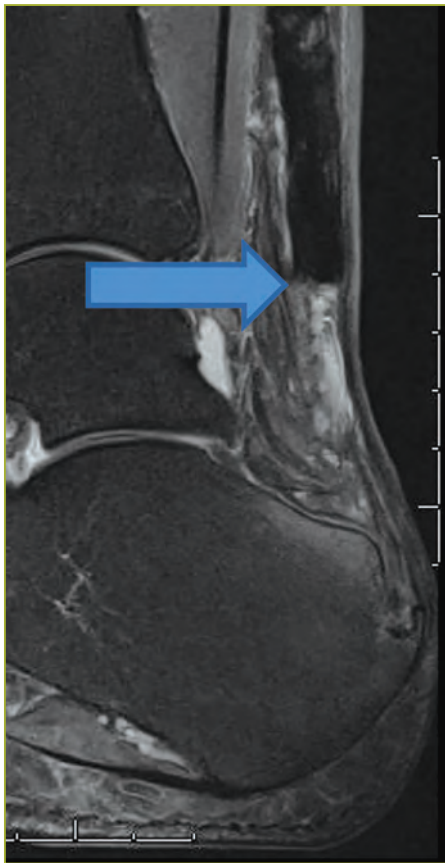


Figure 1. Magnetic resonance imaging (MRI) scan showing the end of an Achilles tendon (arrow), which was avulsed from the calcaneus without the distal tendon present for suture repair. MRI scans were obtained in 13 of the 37 (35%) patients included.

METHODS

After obtaining approval from our Human Research Review Committee (HRRC # 17-341), we reviewed medical records and radiographs of patients with acute Achilles tendon ruptures ($n = 41$) and Achilles sleeve avulsions ($n = 8$) treated by the senior author between January 2011 and January 2017. Of the 41 patients, exclusion criteria were non-midsubstance ruptures ($n = 8$) or ruptures treated nonoperatively ($n = 4$). Furthermore, patients who took oral steroid medication, had recently used fluoroquinolone, or had received a steroid injection near the tendon were excluded in both groups; however, no patient fit into these categories. Ultimately, 29 and 8 patients were included in the midsubstance rupture group and sleeve avulsion group, respectively. The location of all ruptures was confirmed by intraoperative findings. We noted patient age, associated medical conditions, side of injury, and mechanism of injury.

Because we could not obtain the medical record numbers of patients with midsubstance tears treated nonoperatively ($n = 4$), these were excluded. The patients were recalled by the senior author (RM) as follows: a morbidly obese man in his 30s, a male

athlete in his 40s, a 74-year-old man with ruptures of both Achilles tendons, and a man (unknown age) with one rupture caused by lunging during pickleball and a second occurring spontaneously 3 weeks later. The one patient with an Achilles sleeve avulsion treated nonoperatively had been seen recently by the senior author (RM); subsequently, the associated medical record number was obtained and the patient was included in the study.

Radiographs were evaluated for posterior heel abnormalities such as osteophytes (Figure 2), calcaneal tuberosity prominence known as Haglund's deformity

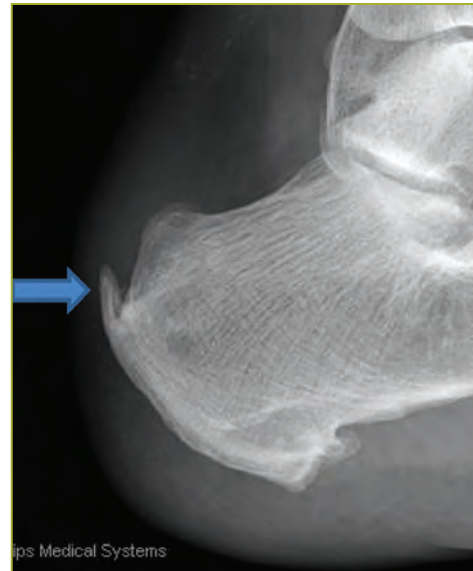


Figure 2. Radiograph showing posterior calcaneal osteophyte (arrow), seen in seven of the eight patients with sleeve avulsion injuries.

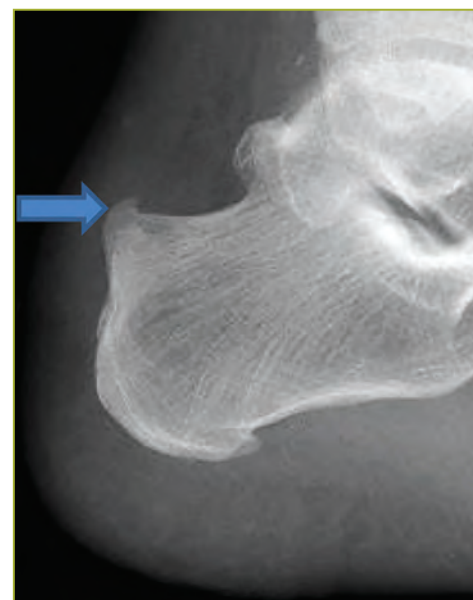


Figure 3. Radiograph showing superior calcaneal tuberosity prominence (arrow), seen in two of the eight patients with sleeve avulsion injuries.



Figure 4. Radiograph showing radiodense fragments proximal to the Achilles insertion, seen in four of eight patients with sleeve avulsion injuries. Additionally, a large posterior calcaneal osteophyte is visible (arrow).

(Figure 3), and small ossific bodies in the posterior ankle region at the distal end of the avulsed tendon (Figure 4). A clear prominence or osteophyte sticking up from the calcaneal tuberosity was defined as a Haglund’s deformity. The presence or absence of radiodense specks, noted as the “Pleiades sign” owing to the similar formation, was also noted on radiographs. This is an undescribed radiographic appearance of faint radiodense bodies seen at the distal end of the avulsed

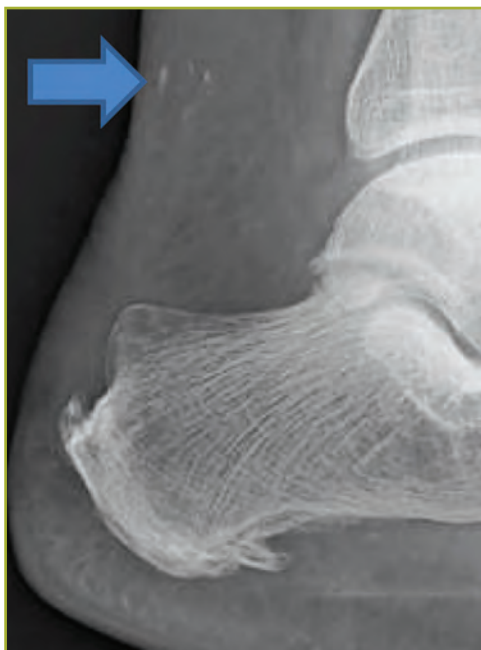


Figure 5. Radiograph showing faint radiodense specks (arrow; the “Pleiades sign”), seen in four of the eight patients with sleeve avulsion.



Figure 6. The Pleiades star cluster in the constellation of Taurus. Reprinted with permission from Trevor Jones at www.astrobackyard.com.

Achilles tendon, which resemble the faint pinpoint lights of the Pleiades star cluster (Figures 5 and 6). These radiodense specks likely represent small fragments of bone avulsed with the tendon.

Preinjury symptoms, return to employment, and return to sports were noted when data were available. However, we were unable to report clinical results of treatment owing to the limited follow-up time and incomplete documentation of these variables.

RESULTS

Demographics

Table 1 shows the distribution of men and women in the midsubstance rupture group (29) and sleeve avulsion group (n = 8) and injury laterality. Overall, 28 men and

Table 1. Information on included patients (n = 37) in the midsubstance rupture group and sleeve avulsion group

Patient variable	Midsubstance rupture group (n = 29)	Sleeve avulsion group (n = 8)
Male	23	5
Female	6	3
Left foot injury	22	6
Right foot injury	7	2

9 women with Achilles ruptures. The left and right sides were ruptured in 29 and 8 patients, respectively.

The average patient age for the midsubstance and avulsion groups were 37.8 and 57.6 years, respectively. Twenty-six of the 29 patients (90%) with midsubstance ruptures were aged < 50 years. Of the eight patients with sleeve avulsions, three (38%) were aged < 50 years and none were aged < 40 years. The oldest patient (66 years) in the midsubstance group presented with ossification at the site of tendon rupture, suggesting tendinopathy before his injury. MRI and operative findings of this patient confirmed a midsubstance rupture. In our study, Achilles sleeve avulsions most commonly occurred in the fifth and sixth decades of life whereas midsubstance ruptures most commonly occurred in the fourth and fifth decades of life (Table 2).

Table 2. Age and distribution of included patients (n = 37) in the midsubstance rupture group and sleeve avulsion group

<i>Age, y</i>	<i>Midsubstance rupture group No. patients (n = 29)</i>	<i>Sleeve avulsion group No. patients (n = 8)</i>
Average age (range)	37.8 (24-66)	57.6 (46-82)
Age 20-29	8	0
Age 30-39	9	0
Age 40-49	9	3
Age 50-59	2	3
Age 60-69	1	0
Age 70-79	0	1
Age 80-89	0	1

Table 3. Mechanism of injury of included patients (n = 37) in the midsubstance rupture group and sleeve avulsion group

<i>Mechanism of injury</i>	<i>Midsubstance rupture group No. patients (n = 29)</i>	<i>Sleeve avulsion group No. patients (n = 8)</i>
Basketball	7	1
Soccer	4	0
Volleyball	2	0
Softball	2	1
American football	1	0
Gymnastics	1	0
Running	2	0
Pushing car	2	0
Kicked	1	0
Fall from ladder	1	0
Hop, twist, misstep, trip	6	4
Stepping up or down from height	0	2

Table 3 depicts the mechanism of injury for each group. Two of the eight patients (25%) with sleeve avulsions were playing sports at the time of injury, whereas 19 of the 29 patients (66%) with midsubstance ruptures were playing sports or running at the time of injury. No patient in either group had rheumatoid arthritis or used steroid medication, steroid injection, and fluoroquinolone. Two patients (25%) in the sleeve avulsion group had type 2 diabetes mellitus. There were no patients with diabetes mellitus in the midsubstance rupture group.

RADIOGRAPHIC FEATURES

There were distinct radiographic differences between the midsubstance and sleeve avulsion groups. Radiographs of all eight patients in the sleeve avulsion group had at least one of the following features:

- Posterior calcaneal osteophyte measuring ≥ 8 mm (seven patients; Figure 2)
- Superior calcaneal tuberosity prominence or Haglund's deformity (two patients; Figure 3)
- Ossific fragments above the insertion of the Achilles tendon (four patients; Figure 4)
- Pleiades sign (four patients; Figure 5)

The Pleiades sign was seen on radiographs of four patients (50%) with sleeve avulsion injuries. This sign has not been described. It appears as faint ossific specks above the insertion of the Achilles tendon, similar in form to the Pleiades star cluster.³ These radiodense specks are smaller than the ossific bodies in Figure 4, and they likely represent small ossific fragments that were avulsed at the distal end of the tendon. In the midsubstance rupture group, four people (14%) had a much smaller calcaneal osteophyte measuring ≤ 2 mm in size as observed in the radiographs. No Haglund's deformity or Pleiades sign were observed in the radiographs. In one radiograph, ossification at the rupture site was observed.

TREATMENT OUTCOMES OF PATIENTS WITH SLEEVE AVULSIONS

Of the eight patients with sleeve avulsions, seven underwent surgical reattachment of the tendon to the calcaneus using one or two suture anchors. The injury was confirmed by findings of MRI scans in the one patient treated nonoperatively. Of the seven patients who underwent surgical treatment, three had the injury confirmed by findings of preoperative MRI scans. In the remaining four patients, the diagnosis was suspected preoperatively and confirmed by intraoperative findings. All eight patients healed clinically. Six returned to work and one was retired. One patient was involved in a workers' compensation claim and had not returned to work after 9 months.

DISCUSSION

In 2003, Bibbo et al² reported on using transcalcaneal suture technique for treating six patients with Achilles sleeve avulsion injuries. They reported no statistically significant difference in the American Orthopaedic Foot and Ankle Society (AOFAS) ankle-hindfoot score or peak strength between the operatively and nonoperatively treated feet. After that report, most studies have focused on the technique used for tendon repair.⁴⁻⁸ Transcalcaneal sutures or suture anchors have been used. Our study is the first to compare demographic and radiographic findings between patients with midsubstance ruptures and sleeve avulsions of the Achilles tendon.

Huh et al¹ reported a 7.6% incidence of Achilles sleeve avulsions amongst operatively treated Achilles tendon ruptures at their institution. During a 6.5-year period, eleven patients had sleeve avulsions. We found a higher incidence in the current study, although our patients only represented the experience of one surgeon and not the entire institution. We do not know why our incidence was higher; it may be related to referral patterns to the foot-and-ankle subspecialist. Huh et al¹ found 72.7% of patients had preexisting symptoms at the insertion of the Achilles before avulsion, and 90.9% were sustained during recreational athletic activity. The average patient age was 44 years (range, 24-63 years). Their patients had improved clinical results after surgical treatment, in which 10 of the 11 reported AOFAS ankle-hindfoot scores of 90 to 100. We had insufficient data to report preoperative symptoms or results of treatment.

Similar to that of our study, Huh et al¹ commonly observed radiographic signs in patients with Achilles sleeve avulsions. In that study, ten of the eleven patients had a Haglund's deformity and eight had radiodensities of 0.4 to 2.5 cm in size proximal to the Achilles insertion. Radiographs of all eight patients in our study had one or more noted signs. Also, four of our eight patients had radiographs with faint radiodense specks proximal to the Achilles insertion. Each of these patients also had a prominent posterior calcaneal osteophyte or a Haglund's deformity noted on the radiographs. We termed this radiographic finding the Pleiades sign because its appearance was similar to the Pleiades star cluster, which can only be faintly seen with the naked eye. This star cluster was used by sailors for navigation and is referenced in the *Iliad* by Homer.^{9,10}

We found Achilles sleeve avulsions more common than midsubstance ruptures in patients who were older, less likely to be injured during sporting activities, and had radiographic findings about the posterior heel. In this demographic of patients, healthcare professionals should consider the possibility that an Achilles sleeve avulsion exists instead of a midsubstance rupture to help decide appropriate surgical treatment.

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