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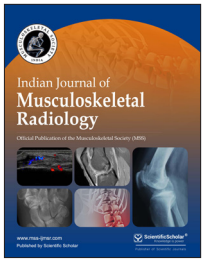

*Original Article*

# "Snake Sign" Secondary Sign of Achilles Tendon Rupture

Aamer Iqbal[1], Hiten Panchal[2], Ramanan Rajakulasingam[1], Amit Shah[3], Vemuri Varaprasad[4], Steven James[1], Rajesh Botchu[1]

[1]Department of Musculoskeletal Radiology, Royal Orthopedic Hospital, Birmingham, West Midlands, England, [2]Department of Radiology, Sanyapixel Diagnostics, Ahmedabad, Gujarat, [3]Department of Musculoskeletal, Radiology, Leicester Royal Infirmary, Leicester, Leicestershire, UK, [4]Department of Radiology, Global Hospital, Vijayawada, Andhra Pradesh, India.

***Corresponding author:**
Rajesh Botchu,
Department of Musculoskeletal radiology, Royal Orthopedic Hospital, Birmingham, West Midlands, England.

drbrajesh@yahoo.com

Received : 28 September 19
Accepted : 22 October 19
Published : 30 December 19

**DOI**
10.25259/IJMSR_32_2019

**Quick Response Code:**

## ABSTRACT

**Objective:** We describe a secondary sign (Snake sign) due to lax plantar fascia in full-thickness rupture of Achilles tendon.

**Materials and Methods:** A 100 consecutive magnetic resonance images with intact Achilles tendon and second group of 17 patients with Achilles tendon rupture (ATR) were analyzed for Snake sign and angle between the achilles tendon and plantar fascia (APA) was calculated.

**Results:** Significant decrease in the APA ($P < 0.0001$) with ATR and Snake sign was present in 8 of the 17 cases in the second cohort.

**Conclusion:** Snake sign and APA are useful secondary signs for ATR.

**Keywords:** Snake, Sign, Achilles, Rupture, Achilles and plantar fascia

## INTRODUCTION

Achilles tendon rupture (ATR) is a common injury. There has been a steady increase in the incidence of ATR, which has been attributed to recreational sports.[1] Clinical history, examination, and imaging (ultrasound [US] and magnetic resonance images [MRI]) are often performed to confirm the diagnosis of ATR. It has been reported that ATR can be missed in up to a quarter of cases, which can result in significant morbidity.[2,3] We describe a secondary sign, which we have termed the "Snake sign" due to laxity of plantar fascia on MRI to aid in the diagnosis of ATR. Snake sign is defined as a lax plantar fascia with or without a tortuous contour [Figure 1].

### Anatomy

Medial and lateral heads of gastrocnemius form the Achilles tendon with an additional contribution from soleus. The distance between the musculotendinous junction of the soleus and the most proximal part of the insertion on the calcaneum can be quite variable.[3,4] The tendon is approximately 15 cm in length and does not have synovial sheath. The blood supply is by the paratenon through vascularized areolar tissues, musculotendinous junction, and osseous insertion. The watershed area of the Achilles tendon is 2–6 cm proximal to its insertion, which makes it most vulnerable to rupture.[5]

## MATERIALS AND METHODS

A retrospective review of 100 consecutive MR of ankles for pain (first cohort) performed at a tertiary hospital was performed. Demographics and pathologies of the Achilles tendon and plantar fascia were documented. A further second cohort of 17 cases of full-thickness rupture of Achilles tendons was also analyzed. On the midsagittal fat-suppressed or non-fat-suppressed images, the angle between the axis of the Achilles plantar fascia angle (APA) was calculated and data were analyses using a *t*-test [Figure 2]. The Achilles line was drawn along the center of the Achilles tendon and the plantar fascia line was the best fit line along the proximal plantar fascia. The presence or absence of the Snake sign was also recorded.

## RESULTS

The average age of the first cohort was 48 years (12–77 years) and there was no sex predominance (46 males and 54 females). The average APA was 86 (76–112) degrees. There were 7 cases of Baxter's neuropathy, 3 with non-insertional Achilles tendinopathy (one with partial thickness tear), 3 had insertional Achilles tendinopathy (one with partial thickness tear), and 9 with plantar fasciitis (7 with partial tears). The rest of the cohort had normal plantar fascia and Achilles tendon. None of this group had the Snake sign or lax plantar fascia.

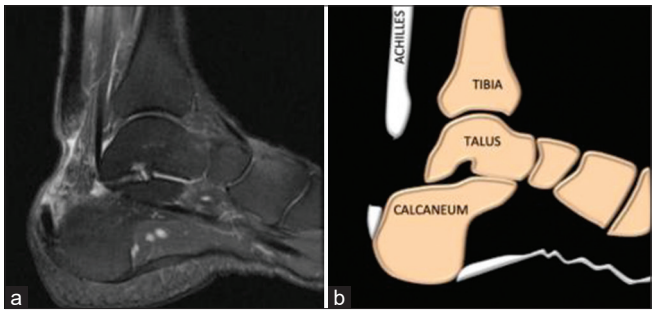


**Figure 1:** Fat-suppressed proton density sagittal image (a) and diagrammatic representation (b) showing full-thickness rupture of Achilles tendon with lax tortuous plantar fascia (Snake sign).

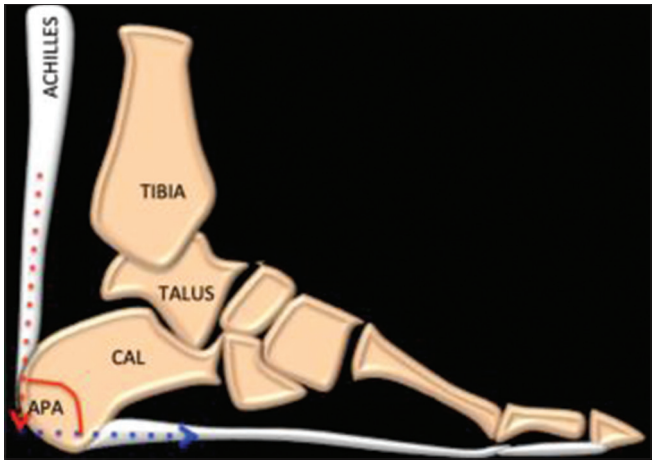


**Figure 2:** Diagrammatic representation showing measurement of the Achilles and plantar fascia (angle between the axis of the Achilles tendon and plantar fascia).

The second cohort of 17 cases had an average age of 52 years (41–70 years) with a male predominance (14 males and 3 females). The APA was decreased with an average of 72° (66–79°). The APA was measured by two readers with moderate interobserver reliability (intraclass correlation of 0.56). All patients had a significant decrease in the APA ($P < 0.0001$) Snake sign with marked tortuosity was present in 8 of the 17 cases in the second cohort. The plantar fascia was lax but less tortuous in the remaining 8 cases. The imaging of ankle in one case did not include the mid and distal part of the plantar fascia hence the contour (laxity or Snake sign) could not be assessed and APA only could be calculated. The site of rupture was non-insertional (4 cm proximal to insertion) in 14 cases and insertional in 3 cases.

## DISCUSSION

ATR is commonly associated with sporting activities, which entail jumping or intermittent spurts of increased activity like sprinting. The increase in the number of people doing strenuous and athletic activity is postulated to cause in the increase in the incidence of ATR. Early diagnosis of ATR and appropriate management is essential as this can have a serious socioeconomic impact. The average incidence of ATR is 18/100,000.[6] There is no sex predominance with a peak incidence in the 4$^{th}$–5$^{th}$ decades and between 60 and 80 years.[6]

The ATR can be diagnosed by clinical history and examination. Weak plantar flexion, palpable gap, and positive Thompson test help to reach a diagnosis.[6-8] Intact plantaris or fibrosis across chronic ATR can result in false negative Thompson test.

US is shown to have a high sensitivity and specificity in evaluation of Achilles tendon pathologies. It aids in confirming the ATR, extent of tear, duration (acute and chronic), and any other underlying pathologies. US enables to assess whether the tendon ends come into apposition on passive plantar flexion, which helps to decide conservative versus surgical treatment. MRI has good specificity and sensitivity for diagnosis of ATR; however, there may be a delay in obtaining one and is expensive. MRI demonstrated 90% of full-thickness tears in the study, with the remaining 10% demonstrating partial-thickness tears or inability to exclude a full-thickness tear.[6]

The plantar fascia has been shown to be continuous with the paratenon of the Achilles tendon through a thin (1–2 mm)

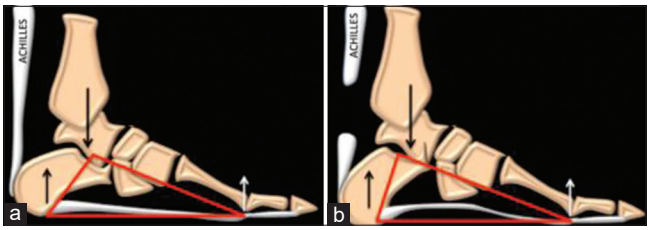


**Figure 3:** Windlass mechanism with forces in intact Achilles tendon (a) and with full-thickness rupture of Achilles tendon (b).

band posterior to the calcaneum. This is better appreciated in children and young adults. With age, the delineation of thin band reduces and the distance between the distal end of the Achilles tendon and proximal part of the plantar fascia increases.[9]

The windlass mechanism described by Hicks is maintained by the plantar fascia, which is a taut band that extends from the calcaneum to the metatarsal heads. The forces from the body weight at the apex and ground reaction forces at the calcaneum and metatarsal heads form the two corners of the base of this.[10,11] The windlass mechanism is maintained with plantar flexion of the foot and big toe in neutral and dorsiflexion.

Any alteration of the forces as in cases of ATR results in disruption of this windlass mechanism producing laxity of the plantar fascia and "Snake" like appearance. This results in increased calcaneal pitch, which contributes to a decrease in the angle between the Achilles tendon and plantar fascia [Figure 3].

The axis of the Achilles tendon is nearly perpendicular to that of the plantar fascia with an average angle of 86°. In our cohort of ATR there was significant decrease in this to an average of 72° with around half of patients having Snake sign with lax plantar fascia and marked tortuosity. In the rest of the cases, though the plantar fascia was lax, the extent of tortuosity was less. The foot was in neutral position in 14 cases, 10° of dorsiflexion in 2 cases, and 30° of plantar flexion in 1 case.

This sign is important where imaging of the foot is performed for pain. The presence of Snake sign should alert the radiologist to evaluate the Achilles tendon if included in the image or recall the patient for further imaging of Achilles tendon. This is more relevant in cases of neglected/chronic ATR. The study has few limitations. This is a retrospectives study. ATRs are diagnosed clinically or on US and MR is rarely performed; hence, the group of ATR is low. This makes it difficult to calculate sensitivity or specificity. The position of the foot was not standardized as it was retrospective study; however, as far as possible, the foot was in neutral position in both the groups.

## CONCLUSION

Snake sign represents a tortuous lax plantar fascia as a consequence of disruption of the windlass mechanism is a useful secondary sign of ATR.

### Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms.

### Financial support and sponsorship

Nil.

### Conflicts of interest

There are no conflicts of interest.

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**How to cite this article:** Iqbal A, Panchal H, Rajakulasingam R, Shah A, Varaprasad V, James S, Botchu R. "Snake Sign" Secondary Sign of Achilles Tendon Rupture. Indian J Musculoskelet Radiol 2019;1(2):79-81.