

Partial mid-portion Achilles tendon ruptures: new sonographic findings helpful for diagnosis

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ABSTRACT

Background Partial Achilles tendon ruptures are not always easy to diagnose. A history including a sudden onset of pain and/or relative weakness in plantar flexion force is an indicator. The most loaded side of the Achilles tendon is the dorsal side (skin side).

Objective The aim of this study was to evaluate the ultrasound (US) and colour Doppler (CD) findings in patients with a suspected partial rupture in the Achilles tendon.

Materials and Methods Seventeen patients (16 men and 1 woman) with a mean age of 36 years (range 23–71 years) were examined clinically and by US+CD because of mid-portion Achilles tendon pain. There was an acute onset in 14 of 17 patients, and all had painful weakness during tendon loading activity.

Results In all patients, the US examination showed a partial Achilles tendon rupture, presented as a disrupted dorsal (skin side) tendon line and an irregular tendon structure mainly located in the dorsal and mid-tendon. The size of the rupture varied from 1/3 to 2/3 of the tendon thickness. In the dorsal part of the tendon, corresponding to the region with disrupted tendon line and irregular structure, CD examination showed high blood flow—most often of a longitudinal character. Six of the patients were surgically treated, and macroscopical examination verified the US findings showing disruption on the dorsal side and a partial rupture in the dorsal and mid-tendon.

Conclusions US and Doppler examination can be helpful tools to diagnose partial mid-portion Achilles tendon ruptures. The characteristic findings of a disrupted dorsal tendon line and high blood flow in the structurally abnormal dorsal tendon indicate a partial rupture.

Achilles tendon ruptures are most often seen among recreational athletes; however, also elite athletes and sedentary individuals sustain ruptures.^{1–3} Because of the functional impairment, total ruptures are often, but not always, diagnosed early after injury.¹ Partial Achilles tendon ruptures renders less functional deficits and can be misdiagnosed. The typical history with a sudden onset of pain and impaired function can sometimes be shaded by other factors such as a high epinephrine drive during a game/match, or alcohol or medicine intake, making diagnosis setting more difficult. If a partial rupture is misdiagnosed to be Achilles tendinosis, these patients can end up being treated with painful eccentric calf-muscle training, possibly resulting in a larger rupture and a lengthening of the tendon. Achilles tendon lengthening is a very difficult condition to treat,⁴ requiring advanced surgery and often 6 to 12 months of rehabilitation.

There are, to the best of our knowledge, no studies showing specific sonographic findings for partial Achilles tendon ruptures. A thickening and an irregular fibre structure in the Achilles mid-portion is commonly given the name partial rupture.⁵ This nomenclature is often based on the surgical findings of a thickened tendon with focal regions of abnormal tendon tissue. Interestingly, these are the same surgical findings you get if you operate patients with the chronic condition tendinosis. Consequently, the ultrasound (US) findings on localised thickening and structural irregularities are seen both for partial ruptures and chronic tendinosis. Kayser *et al*⁶ state that US is not sufficiently reliable to diagnose partial proximal Achilles tendon ruptures and claims that magnetic resonance imaging examination is needed for a reliable diagnosis.

For the chronic painful mid-portion Achilles tendon—Achilles tendinosis—studies using grey-scale US and colour Doppler (CD) have shown typical findings including irregular tendon structure and hypoechoic regions (most often located in the ventral tendon) and high blood flow inside and outside the ventral tendon.^{7,8} Interestingly, the findings in the chronic painful tendinosis tendon have been shown to be located on the ventral, less loaded, side of the tendon, while the most loaded side of the tendon is the dorsal (superficial).^{9,10}

This study aimed to use grey-scale US and CD to examine patients with a history of a sudden onset of pain in the Achilles tendon and/or impaired function and weakness during running or walking.

MATERIAL AND METHODS

Seventeen patients (16 men and 1 woman) with a mean age of 36 years (range 23–71 years) were included. All patients had impaired function and weakness during tendon loading activity, and 14 of 17 had an acute onset of pain symptoms.

Patients were recruited from the Pure Sports Medicine Clinic in London, England, and the Sports Medicine Unit in Umeå, Sweden.

Nine patients were elite athletes, professional football (n=4), professional rugby (n=2), elite level track and field (n=2) and professional ballet (n=1). Six patients were recreational athletes (tennis, 2; triathlon, 2; running, 1; football, 1) and two patients were walkers.

Previous treatment included eccentric training (n=12) and injection therapy (n=10). Injection therapy consisted of cortisone alone, hydrodilatation (cortisone+lidocain+saline) and autologous blood. One patient (elite athlete) had had eight

injection treatments inside and outside the Achilles tendon mid-portion within 10 months.

Clinical examination was done with the patient in prone position and included evaluation of resting tonus and ankle joint range of motion compared with the non-injured side and palpation of the tendon.

All tendons were examined with high-resolution grey-scale US and with CD (CDV), Acuson Segovia-Siemens (Umeå) and Antares-Siemens (London), at inclusion. A linear multi-frequency (8–13 MHz) probe was used. Grey-scale US was used to evaluate tendon thickness and structure, and CD was used to diagnose high blood flow.

Six athletes were operated because of recurrent pain symptoms and plantar flexion weakness, and in 4 of 6 athletes, there were also obvious signs of tendon lengthening (low resting tonus and increased dorsiflexion range of motion compared with the non-injured side).

RESULTS

Clinical examination showed in all patients a tender thickening in the Achilles mid-portion. In 7 of 17 patients, there was clearly a lower plantar flexion tonus (fig. 1) and an increased dorsiflexion range of motion on the injured compared with the non-injured side.

The US and CD examination (fig. 2A, B) showed in all patients the following:

- ▶ There was a thickening of the Achilles tendon mid-portion.
- ▶ The superficial (skin side) tendon line was irregular-wavelike and disrupted.
- ▶ Irregular tendon structure (irregular fibre bundle arrangement) was seen expanding from the dorsal tendon surface into the mid-tendon, indicating a rupture. The size of the rupture varied from approximately 1/3 to 2/3 of the tendon thickness, and there was no full-thickness rupture.
- ▶ There was a high blood flow arranged mainly longitudinally in the region with structural changes in the dorsal (superficial) and mid-tendon.

Six of 17 patients, all professional athletes, were surgically treated. During surgery, a partial rupture in the Achilles mid-portion, corresponding to the localisation found on the US and Doppler examination, was found in all these patients (fig. 3).

DISCUSSION

This study describes new US and CD findings in patients with a history indicating a partial rupture in the Achilles mid-portion. In all patients, US showed an irregular dorsal tendon structure with a wavelike and disrupted superficial tendon line, together with high longitudinal Doppler flow in the region with tendon changes. The findings during surgical treatment of six patients verified the partial rupture and the localisation demonstrated with US and Doppler.

All patients complained of weakness during plantar flexion activities, and in 14 of 17 patients, there was a sudden onset of symptoms. Interestingly, 2 of 3 patients with a gradual onset of symptoms were older than 50 years and had a US picture showing an irregular tendon structure in the Achilles mid-portion together with an irregular dorsal tendon structure and disrupted dorsal tendon line. The remaining patient having had a gradual onset of pain had previously been treated with an autologous blood injection inside the Achilles mid-portion.



Figure 1 Clinical findings before surgery. Lower plantar flexion tonus on the injured compared with the non-injured side, visualised with the patient resting in the prone position.

US and Doppler are well known to be reliable methods to study tendon structure and blood flow.^{11–14} The quality of the US machines plays an important role for the possibility to study the tendon structure. Not all machines have the option to study blood flow using a Doppler system, and the Doppler function needs to be good enough to pick up low flow rates.

An irregular tendon structure is seen in patients with chronic tendon pain, like in Achilles mid-portion tendinosis.⁷ In mid-portion tendinosis, the structural changes are most often seen in the ventral-tendon and mid-tendon, the ventral side of the tendon being the less loaded side of the tendon.^{9,10} Also, in tendinosis, Doppler examination commonly shows a high blood flow outside and inside the ventral tendon, thought to be a neovascularisation.^{7,8} This blood flow most often comes from the ventral fat tissue, going into the tendon. The current findings considering the blood flow in partially ruptured tendons is located inside the tendon and is most often longitudinally orientated, in line with the orientation of the fibre bundles. This blood flow possibly represents high flow in normal blood vessels, in the region of the partial rupture where there, after the rupture, is less intratendinous tension, allowing for a higher blood flow? Or maybe a locally increased blood flow as a part of an ongoing healing? It has been stated that US is not sufficiently reliable for diagnosis of partial Achilles tendon ruptures.⁶ However, the findings in our study indicate that US together with Doppler examination, at least in our relatively small material, reliably diagnosed mid-portion partial ruptures in the six surgically treated cases. Interestingly, from the study by Kayser *et al*,⁶ a figure visualising the partial rupture US findings that show structural changes and hypoechogenicity localised in the dorsal part of the tendon, a location that is similar to the findings in our study that we propose, most likely is characteristic for the mid-portion partial rupture. In our study, we used Doppler examination together with the US, and we believe that the high blood flow we found in the region for the partial rupture is a sign of ongoing intratendinous activity, such as after sustaining a partial rupture. Then it should be recalled that in patients with the chronic condition tendinosis, there is also a high blood flow, but this flow is most often found inside and outside the ventral tendon, in close relation to the structural changes in the ventral tendon. Altogether, it seems that the combination of US and Doppler examination is a helpful tool for trying to identify the partial ruptures that are the ones that

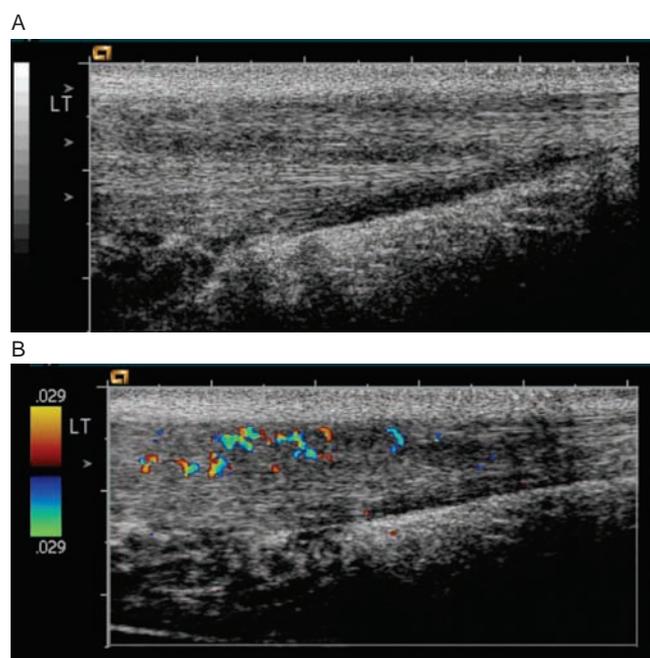


Figure 2 (A) Grey-scale ultrasound showing a slightly thickened Achilles mid-portion with structural changes (irregular fibre bundle structure and hypoechoicity) in the dorsal tendon and irregular dorsal tendon line (superficial-skin side tendon line). (B) Doppler examination showing high blood flow, mainly in a longitudinal pattern, in the region with structural changes in the dorsal tendon.

need specific treatment and cannot be treated with loading regimens such as eccentric training.

It can be argued that because not all patients were operated on, we cannot be certain that all patients had a partial rupture wherein the US and Doppler examinations showed changes indicating a rupture. It would have been ideal to open up and have a look at all these tendons, but because it is from a well-known experience that this injury often heal well when treated conservatively, it would have been ethically incorrect to operate all tendons. Six tendons belonging to elite athletes were operated on because of recurrent symptoms, and in four of these patients, there were also signs of tendon lengthening. In all six tendons, the macroscopic inspection verified the US and Doppler findings, with the partial ruptures being located in the dorsal tendon (skin side) and showing a defect in the superficial (skin side) tendon. It is our experience that lengthening of the Achilles tendon indicates a risk to not be able to regain maximal Achilles tendon function, and these athletes were all involved in sports with high demands on the Achilles tendon. All the other patients were treated conservatively using heel lifts and avoiding loaded dorsiflexion activity in the ankle joint for 3 months.

In this group of patients, we have evaluated resting tonus in the ankle joint and found in 7 of 17 tendons a lower resting tonus on the injured compared with the non-injured side. In the same tendons, we also found a larger dorsiflexion range of motion, compared with the non-injured side. We are aware that evaluation of resting tonus (plantar flexion tonus in resting position) is a non-validated test, and there is no objective measurement. Therefore, we only defined the tendons with an obviously lower plantar flexion tonus on the injured compared with the non-injured side, combined with a larger dorsiflexion range of motion, as having a lower resting tonus. Despite the limitations associated with evaluation of resting tonus, we believe that this evaluation can be useful in clinical practice,



Figure 3 Findings during surgery showing a disruption on the dorsal side (skin side) of the tendon—in the region with ultrasound and Doppler findings.

especially if combined with the evaluation of dorsiflexion range of motion.

Interestingly, 12 of 17 patients had been treated with painful eccentric calf-muscle training. In all these patients, the symptoms had been aggravated from the eccentric training regimen. It cannot be excluded that eccentric training can be responsible for tendon lengthening if instituted on a partial rupture. Therefore, a US examination to exclude a partial rupture is recommended before instituting eccentric training, especially on patients with an acute onset of symptoms, plantar flexion weakness and low resting tonus/increased dorsiflexion range of motion. Also, despite that the material in this study is small, the findings indicate that older patients (2/3) with mid-portion tendinosis and patients (1/3) having had an intratendinous injection can sustain partial ruptures presenting with a gradual onset of pain together with plantar flexion weakness. Altogether, the findings in this study, in which 12/17 patients with a partial rupture had been given eccentric training as treatment, clearly show the importance of having a correct diagnosis before treatment is instituted.

We believe that the findings in the current study provide helpful information on where to look for structural tendon changes and Doppler flow in patients with a suspicion of a partial Achilles tendon rupture. Also, it needs to be remembered that patients with typical chronic Achilles tendinosis findings, structural abnormalities and high blood flow in the ventral and mid-tendon can sustain a partial rupture having additional new US and Doppler findings in the dorsal (superficial) tendon.

In conclusion, this study provides new information about US and Doppler findings in patients with partial ruptures in the Achilles mid-portion. Grey-scale US showing disrupted superficial tendon line and structural abnormalities in the dorsal tendon, together with Doppler examination showing high blood flow (mainly longitudinal) in this region, indicates a partial rupture. The findings are of importance for the treatment strategy.

Competing interests None.

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REFERENCES

1. **Fahlström M**, Björnstig U, Lorentzon R. Acute Achilles tendon rupture in badminton players. *Am J Sports Med* 1998;**26**:467–70.

2. **Kangas J.** Outcome of total Achilles tendon rupture repair, with special reference to suture materials and postoperative treatment. Academic dissertation. Oulu University Hospital, 4 May 2007.
3. **Kvist M.** Achilles tendon injuries in athletes. *Sports Med* 1994;**18**:173–201.
4. **Gabel S,** Manoli A 2nd. Neglected rupture of the Achilles tendon. *Foot Ankle Int* 1994;**15**:512–17.
5. **Kälebo P,** Allenmark C, Peterson L, *et al.* Diagnostic value of ultrasonography in partial ruptures of the Achilles tendon. *Am J Sports Med* 1992;**20**:378–81.
6. **Kayser R,** Mahlfeld K, Heyde CE. Partial rupture of the proximal Achilles tendon: a differential diagnostic problem in ultrasound imaging. *Br J Sports Med* 2005;**39**:838–42; discussion 838–42.
7. **Alfredson H,** Ohberg L. Sclerosing injections to areas of neo-vascularisation reduce pain in chronic Achilles tendinopathy: a double-blind randomised controlled trial. *Knee Surg Sports Traumatol Arthrosc* 2005;**13**:338–44.
8. **Ohberg L,** Lorentzon R, Alfredson H. Neovascularisation in Achilles tendons with painful tendinosis but not in normal tendons: an ultrasonographic investigation. *Knee Surg Sports Traumatol Arthrosc* 2001;**9**:233–8.
9. **Almekinders LC,** Lyman J, Weinhold PS. Strain patterns in the Achilles tendon: implications for tendinopathy. Proceedings of the 10th Congress of the European Society of Sports Traumatology, Knee Surg and Arthroscopy, Rome, 23–27 April 2002.
10. **Maganaris CN,** Narici MV, Maffulli N. Biomechanics of the Achilles tendon. *Disabil Rehabil* 2008;**30**:1542–7.
11. **Paavola M,** Paakkala T, Kannus P, *et al.* Ultrasonography in the differential diagnosis of Achilles tendon injuries and related disorders. A comparison between pre-operative ultrasonography and surgical findings. *Acta Radiol* 1998;**39**:612–19.
12. **Terslev L,** Qvistgaard E, Torp-Pedersen S, *et al.* Ultrasound and Power Doppler findings in jumper's knee—preliminary observations. *Eur J Ultrasound* 2001;**13**:183–9.
13. **Weinberg EP,** Adams MJ, Hollenberg GM. Color Doppler sonography of patellar tendinosis. *AJR Am J Roentgenol* 1998;**171**:743–4.
14. **Aström M,** Gentz CF, Nilsson P, *et al.* Imaging in chronic achilles tendinopathy: a comparison of ultrasonography, magnetic resonance imaging and surgical findings in 27 histologically verified cases. *Skeletal Radiol* 1996;**25**:615–20.