One year outcome of ultrasound (US)-guided percutaneous treatment of Achilles tendinopathy: results of a randomized controlled trial

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Achilles tendon (AT) is the largest tendon of the human body. It originates from the junction of gastrocnemius and soleus muscles' distal tendons in the middle of the calf and runs distally, gradually assuming a crescent shape, and inserts on the calcaneal posterior tuberosity (Fig. 1 on page 4). It is provided with a fibrous sheath called paratenon. Its length can vary from 3 to 15 cm.

With the muscular contraction, the AT promotes the plantar flexion of the foot necessary to stand on the toes, walking, running and jumping.

During locomotion this structure is continuously stressed: with running or sprinting, each Achilles tendon undergoes significant load transfer, from 7 up to 12.5 times the body weight.

An important feature is that the middle third of the AT presents a hypovascular area from 2 to 6 cm above the calcaneal insertion, thus being more exposed to repetitive microtraumas that can lead to chronic degenerative changes without signs of peritendinous inflammation.

This pathological condition, if untreated, can lead to major tendinous injuries and rupture.

Achilles tendinopathy (also called Achilles tendinosis) is a common cause of lower calf pain, affecting 2.35/1000 in the adult population (21-60 y). In 59% of cases the etiology is sport-related, while among all sports running is involved in 53%. Male sex is most commonly involved, from 4 to 9 times more than females. Natural history of Achilles tendinopathy remains unclear: at 8 years, 29% of patients undergo surgery.

Several risk factors are implied in the development of this condition: drugs assumption (corticosteroids and fluoroquinolone antibiotics), systemic diseases (hypertermia, autoimmune or inflammatory conditions, collagen abnormalities), and mechanical factors. Among the last ones, intrinsic or extrinsic factors are recognized (Fig. 2 on page 4); excessive loading of tendons during vigorous physical training is regarded as the main pathological stimulus for degeneration.

The cardinal symptom of Achilles tendinopathy is pain, referred as stabbing or burning. Generally it occurs at the beginning and end of a training session, with a period of diminished discomfort in between. As the pathological process progresses, pain may occur during exercise, and, in severe cases, it can interfere with activities of daily living. In the acute phase, the tendon is diffusely swollen and oedematous, and on palpation tenderness is usually greatest 2-6 cm proximal to the tendon insertion (Fig. 3 on page 5). A tender, nodular swelling is usually present in chronic cases and is believed to signify tendinosis.
The diagnosis of Achilles tendinopathy is based mainly on history and detailed clinical examination. However, diagnostic imaging may be required to verify a clinical suspicion or, occasionally, to exclude other musculoskeletal disorders.

Ultrasonography is commonly employed to examine tendon disorders, being readily available, quick, safe and inexpensive. However, it is operator-dependent, offers limited soft-tissue contrast and is less sensitive than MRI.

In a longitudinal US scan (Fig. 4 on page 6), a normal Achilles tendon appears a hyperechoic, ribbon-like structure contained within two parallel hyperechogenic bands corresponding to the paratenon. Tendon fascicles appear as alternate hypoechochogenic and hyperechogenic bands. In an axial US scan (Fig. 5 on page 7), the AT appears round- or oval-shaped, and is characterized by several homogeneously-scattered spotty echoes.

In chronic cases, peritendinous adhesions may be shown by thickening of the hypoechoic paratenon with poorly defined borders. A simple grading system has been devised for tendinopathy, measuring its anterior-posterior diameter through an axial US scan: grade 1 represents a normal tendon; grade 2 an enlarged tendon >7 mm; and grade 3 a tendon containing a hypoechoic area. High-frequency probes allow for the visualization of areas with loss of fibrillar echostructure and hypoechoic areas (Fig. 6 on page 7), which can be nodular, diffuse or multifocal, and correlate well with macroscopic findings at surgery. MRI (Fig. 7 on page 8) provides extensive information on the internal morphology of tendon and the surrounding structures, and is useful to evaluate various stages of chronic degeneration and for differentiation between peritendinitis and tendinosis.

A large variety of treatments have been proposed (stretching, night splints, weight loss, decrease of sport activity, orthotics supports, NSAIDs, shockwaves, steroid injection or surgical debridement), but no standard of care has yet been established.

The purpose of our work is to compare the short- and long-term outcome of US-guided percutaneous treatment based on dry needling and peritendinous steroid injection in these patients, compared with similar patients treated with simple steroid injection or dry needling.
Fig. 1: Origin and insertion of the Achilles Tendon (AT)

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Achilles tendinopathy: RISK FACTORS

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Fig. 2: Mechanical risk factors for Achilles tendinopathy

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Fig. 3: Affected AT presenting swollen, tender and with lumps at palpation

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Fig. 4: US longitudinal scan of a normal AT, which appears as a hyperechoic, ribbon-like structure contained within two parallel hyperechogenic bands corresponding to the
paratenon. Tendon fascicles appear as alternate hypoechogenic and hyperechogenic bands.

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**Fig. 5:** Axial US scan of the AT, which appears round- or oval-shaped, and is characterized by several homogeneously-scattered spotty echoes.

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**Fig. 6:** US longitudinal scan of a tendinosic AT, showing enlarging of its A-P diameter, loss of fibrillar echostructure and the presence of hypoechoic areas.

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Fig. 7: MRI provides extensive information on the internal morphology of tendon and the surrounding structures

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Methods and Materials

IRB approval and patients' informed consent were obtained. Among 54 patients referred for US-guided treatment of Achilles tendinopathy, 18 (9 males; age 45.7±8.6 [mean±SD]) were treated with dry needling and local injection of steroid together; 18 (9 males; age 47.2±11.8) were treated with dry needling only; 18 (11 males; age 50.7±10.0) were treated with steroid local injection.

TECHNIQUE

After sterile preparation of the skin, an axial US scan over the affected region of the tendon was made. With this approach, the axial scan of Achilles tendon and the latero-lateral direction of the needle allow its correct and continuous visualization in the soft tissues (Fig. 8 on page 10). In all groups, a small amount of local anesthetic was injected in the peritendineous soft tissues (retrocalcaneal bursa in presence of low-sited degeneration, Fig. 9) and in the tendon (up to 5mL Lidocaine 2% without adrenaline, 21G needle) (Fig. 10 on page 11). Adrenaline is not needed since vascularity is quite poor. Dry needling was made on the degenerated portion of the tendon with about 20 punctures, maintaining an axial US scan and inserting the needle with a latero-lateral direction (Fig. 11 on page 12). When steroid was needed, the needle was retracted to reach the peritendinous soft tissues and a small amount of steroid (1mL of triamcinolone acetonide 40mg/mL) was injected, avoiding the tendon. In case of low-sited degeneration, a little amount of steroid was injected also in the retrocalcaneal bursa (Fig. 12 on page 13).

After the treatment, all patients used orthotics for about 1 week.

Clinical results were assessed by means of a visual analogue scale (VAS) scoring system (Fig. 13 on page 14) at 7, 14, 30, 90, 180, and 360 days Kruskall-Wallis test was used for statistical analysis of data.
Fig. 8: Anatomical scheme showing the approach used for the US-guided treatment. A) middle third AT axial US scan. B) middle third/low third AT axial scan used in presence of low-sited degeneration.

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Fig. 9: US-guided local anesthetic injection in the retrocalcanean bursa in one case of low-sited degeenration of the AT

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**Fig. 10:** US-guided intra-tendinous injection of a small amount of local anesthetic at the middle third/lower third passage of the AT.

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Fig. 11: US-guided dry needling technique

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Fig. 12: US-guided injection of a small amount of steroid in the peritendinous soft tissues, avoiding the tendon.

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**Fig. 13:** Visual Analogue Scale (VAS) used for the scoring of patients' pain.

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Results

Fig. 14: Comparative results in terms of VAS score between the combined procedure (in red), the needling group (in yellow) and the steroid group (in blue) at 14, 30, 90, 180 and 360 days.

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At 7 days and at 14 days, the groups treated with steroid or the combined treatment showed an inferior VAS score than the dry needling only group.

At 30 days, the combined treatment group demonstrated a better outcome than the steroid or needling groups.

At 90, 180 and 360 days, patients treated with dry needling only or with the combined treatment showed a significantly reduced VAS score than the group treated with steroid only.

Mean time for each procedure was 8±1.3 minutes.

No major complications occurred.

A minor complication such as mild pain after the procedure was observed in 3/45 patients (4%).

Dry needling of tendinous tissue causes remarkable local hyperaemia and bleeding, thus producing relevant post-procedural platelets-induced recovery phenomena and healing of the tendon. The most relevant factors involved are PDGF-AA, BB, and ABTGF-#1, #2.

The total costs of the procedure were calculated as follows:

Anesthesia € 2
Needles & syringes € 1
Lubricating gel and steroid € 7,50
Sterile dressing and disinfection € 6,50
Medical staff (15') € 41
Nurse (15') € 11
US equipment and room occupancy (15') € 10

for a total of € 79, thus proposing the combined US-guided procedure as an effective and cost-containing procedure when compared to other therapies such as standard shockwaves that can cost up to 400 €.
**Fig. 14:** Comparative results in terms of VAS score between the combined procedure (in red), the needling group (in yellow) and the steroid group (in blue) at 14, 30, 90, 180 and 360 days.

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Conclusion

In conclusion, US offers a precise guidance for the infiltrative treatment of Achilles tendinopathy, revealing itself as easy, quick and minimally-invasive procedure. On the short term, combined treatment and steroid injection show comparable results. On the long term, combined treatment and needling show comparable results. Overall, the combined treatment (dry needling + steroid) demonstrated to be more effective than dry needling or steroid injection alone. If confirmed on larger samples, this procedure could represent an effective and minimally invasive option for the treatment of patients affected by Achilles chronic tendinopathy.
References


