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Extracorporeal shockwave therapy versus musculoskeletal mesotherapy for Achilles tendinopathy in athlete

Reem EL-Mallah*  and Enas A. Elattar

Abstract

Background: Achilles tendinopathy (AT) is considered the commonest tendon pathology, occurring mainly in athletes. Different conservative treatment options have been introduced but with short-term effects; however, extracorporeal shockwave therapy (ESWT) and mesotherapy (MT) injections were claimed to provide longer effects and could be used in cases failure of response to conservative treatments.

The objective of our prospective 12-week study was to compare the effect of ESWT and MT on chronic Achilles tendinopathy in athletes by both clinical and ultrasonographical assessment.

Results: Forty patients with chronic AT diagnosed clinically and with high-resolution ultrasound (US) randomly allocated in two groups first received weekly ESWT session, and the other group underwent weekly MT sessions for 4 consecutive weeks. Both groups improved during the treatment and follow-up period. The mean visual analogue score (VAS) decreased in both the ESWT group and the MT group. Mean American Orthopedic Foot and Ankle Society (AOFAS) hindfoot score and VAS scores were not significantly different between ESWT and MT groups at the 4th and the 12th week of follow-up. However, US assessment significantly improved after 12 weeks in the ESWT group (as regards tendon thickness, calcifications, and Doppler signal), and for the mesotherapy group, there was the only improvement of tendon thickness.

Conclusion: ESWT showed improvement of pain and inflammation and calcifications of AT than MT injections, which was documented by US improved findings at week 12 follow up.

Keywords: Achilles tendinopathy, Extracorporeal shockwave therapy, Pain, Visual analog scale, Mesotherapy

Background

Achilles tendon is a strong ligament that conveys both the gastrocnemius and soleus muscles to their calcaneal attachment. The tendon has a fine sheath which is not a synovial one but has a lubrication function. The Achilles tendon is relatively low metabolic tendon getting almost 10% of its oxygen need from the muscle [1].

Achilles tendinopathy (AT) has been reported to range from 1 to 11% in athletes [2]. It is a common pathology that occurs mainly in athletes as well as non-athletes, where the cause is usually trauma, overuse injury, or

repeated minor traumas. The poor vascularity, mechanical de-arrangement, and ankle instability together can contribute to the pathology of the tendon. Diagnosis is mainly by clinical examination, with musculoskeletal ultrasound (US) and magnetic resonance image (MRI) [3].

Tendinopathy could be either insertional or non-insertional (3–4 cm proximal to the calcaneal insertion).

It has various pathological manifestations. In an acute stage, inflammation dominates, with increased neutrophil cell migration, peritendinous edema, local tenderness, and stiffness. In subacute and chronic cases, inflammation seems to play a minor role and complex pathophysiological manifestations such as structural degeneration of the collagen matrix, partial rupture, intra-

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tendinous neovascularization, increase neuropeptides, and cell apoptosis [4].

Different lines of management have been introduced for athletes mainly to relieve pain such as eccentric exercises and physical modalities (ultrasound waves, laser, ice); however, the effect of these lines was only short-term effect. Local injections of long-acting corticosteroids or platelet-rich plasma was also tried in the treatment of Achilles tendinopathy [5].

Shock wave therapy has been introduced to treat different types of soft tissue disorders (plantar fasciitis, elbow epicondylitis, and calcifying rotator cuff tendinopathy) [6] as well as Achilles tendinopathy [7, 8].

Low energy extracorporeal shockwave therapy (ESWT) was recommended, with an eccentric exercise program, in patients with chronic Achilles tendinopathy [9]; also, there was a recorded improvement of pain and function on using a high energy ESWT [10].

Mesotherapy (or intradermal therapy) is a series of micro-injections in the upper layers of the skin over the affected part. This depot effect of the skin retains the drug causing slow-release upon which it exerts its action. Recent studies stated that higher drug concentration in skin exerts its effect near the sensory fibers of tissues, vascular mediators of pain and inflammation, where pain is frequently triggered by inflammation of peripheral tissues (nociceptive pain), but it is also associated with a lesion (or dysfunction) in the nerve pathways (neuropathic pain) [11], for which local pharmacological therapy, if it is effective and well-tolerated, is an acceptable alternative to systemic NSAIDs. It has been used for low back pain [12], cervical pain, knee osteoarthritis, and shoulder tendinitis, tendinopathy, and calcific tendinitis [13–16].

Aim of the work

To compare the effect of extracorporeal shock wave therapy (ESWT) and mesotherapy (MT) on chronic Achilles tendinopathy (AT) in athletes by clinical and ultrasonographical assessment.

Methods

We started our study with sixty adult athletic patients (non-specific sport) who were chosen from the period of February 2017 till December 2018 diagnosed with chronic Achilles tendinopathy; only forty completed the study till the end.

We calculated the sample size online; on the confidence level of 95% in a population of 60 patients who were referred to us with a confidence interval (margin of error) of 10%, the calculated ideal sample was 37 patients; we took 40 patients (<http://www.qualtrics.com/>).

The study was approved by the local department committee and in accordance with the Declaration of Helsinki.

Inclusion criteria

- Adults with age ranged from 18 to 40 years
- Unilateral chronic AT of 6–12 months with any of these symptoms, tenderness of Achilles tendon during either plantar, dorsiflexion, or in neutral position of the foot. Swelling of tendon (insertional or non-insertional), limited range of motion of the ankle, or disturbed gait (antalgic).

Exclusion of patients

- With complete tendon tear or with previous surgery for AT, associated fracture, foot deformities, or misalignment
- With previous ESWT or any local injections in the last 3 months
- With skin lesions at tendon (as eczema, psoriasis).
- Under medical treatment NSAIDs, glucocorticoids, or anticoagulants, in the last 2 weeks before intervention.
- With systemic illness, or pregnant females.
- With inflammatory rheumatic diseases especially enthesopathy

Patients were randomly divided into 2 groups for ESWT therapy (group I) and for mesotherapy injections (group II).

Methods

- Full clinical history and examination* of the patients with stress on clinical symptoms and signs, diseased duration of AT, type of sport (how trauma happened), thickened tendon, localized swelling, signs of inflammation, range of motion of the ankle (both active and passive), and detecting any deformity of the hindfoot (were excluded) or pes planus.
- Assess pain by visual analog scale (VAS)*: on a scale ruler of 10 cm where 0 is no pain and 10 is maximum pain in the last 72 h,
- Assess function by American Orthopedic Foot and Ankle Society (AOFAS) hindfoot score*: which study three dimensions of the hindfoot (pain, function, and alignment) of 100 points [17].
- Laboratory investigations*: to exclude any systemic disorder: Complete blood picture, erythrocyte sedimentation rate, C-reactive protein, serum uric acid, glycosylated hemoglobin, and liver profile and renal profile.

e. *Radiography:*

- *Plain X-ray* to foot and ankle: anteroposterior and lateral view, to detect the presence of fracture, deformities, or any of exclusion criteria.
- *Ultrasonography* (US) was performed using General Electric Logiq P5 R4.0. with a multi-frequency linear transducer probe 3–12 MHz (General Electric, Milwaukee, Wisconsin, USA). US was performed (greyscale and power Doppler) by a one certified sonographer (blind to the clinical findings and the patient's group) according to EULAR guidelines in both transverse and longitudinal views to confirm a diagnosis of chronic tendinopathy. Greyscale findings may include localized fusiform enlargement, increased tendon thickness > 6 mm, disruption of normal fibrillar striation pattern of tendon, intra-tendinous hypoechoic areas due to chronic mucoid degeneration, focal calcifications (hyperechoic area). Power Doppler may show increased flow in the intra- and extra-tendinous regions, depending on the grade of inflammation present [18].

Intervention

Patients of group I received 4 sessions once weekly of high energy ESWT each session consists of 1500 focused shots 0.21 mJ/mm^2 and 3000 radial shots 1.8 mJ/mm^2 using BLT-5000 SWT power shockwave therapy Devise USA, done by the same operator; the session was followed by ice packs to the tendon and eccentric exercises for 15 min. Patients were advised to repeat the exercise at home three times/week.

While patients of group II were injected with a mixture of 5 ml of:

- Two milliliter ampoule of (Betamethasone dipropionate 5 mg, Betamethasone sodium phosphate 2 mg).
- Two milliliters of normal saline 0.9 %
- One milliliter of lidocaine 2%

Cleaning the skin with alcohol and using a needle for mesotherapy injections of (4 mm × 0.4 mm and 31 G) provided by (<https://dermatecheg.com>) which is commercially available in Egypt. applied to a 5-ml syringe, microinjections are perpendicular to the skin along the sides of the tendon to the depth of 2–4 mm with a total of 10–15 injections in each side of the tendon each 5 mm apart, injection starting distally from the site of tendon insertion till the musculotendinous junction proximally 0.2 ml of the mixture per single injection.

The patients received one session weekly for consecutive 4 weeks; all patients tolerated the procedure, with no recorded complications necessitating discontinuation

of the further sessions. Patients were advised to do eccentric exercises for 15 min at home three times/week.

A full detailed explanation of the procedures was offered to the patients, and a written consent was taken from all the participants

The only drug prescribed if needed throughout the 12 weeks was paracetamol for both groups.

Follow-up protocol for both groups

All patients of both groups were reassessed clinically by VAS and AOFAS and by ultrasound by the same operator at week 4 and week 12.

Statistical analysis

Analysis of data was carried out with an IBM computer using statistical program for social science version 18 software and services (released 2009, PASW Statistics for Windows, version 18.0, SPSS Inc., Chicago, IL, USA). Quantitative variables were described as mean, SD, and range. Qualitative variables were described as numbers and percentages. The χ^2 test was used to compare qualitative variables between groups. Fisher's exact test was used instead of the χ^2 test when one expected cell less than 5. The unpaired *t* test was used to compare two groups as regards quantitative variables. Paired *t* test was used to compare two variables quantitative (means) which are measured twice resulting in pairs of observations where *p* value < 0.05 is statistically significant [19].

Results

This prospective study was carried on 40 adult athletes diagnosed clinically and sonographically to have chronic Achilles tendinopathy, they were randomly assigned into 2 groups, and there was no statistically significant difference between the two groups as regards gender, age, and disease duration that was determined by the data analysis as shown in Table 1.

On clinical examination of patients, the pain of ankle and Achilles tendon was reported in all patients (100%), as well as diffuse swelling of Achilles tendon (43%) while localized (57%), tenderness over tendon especially in insertional tendinopathy (60%), limited dorsi and plantar flexion (80%), and disturbed antalgic gait (95%) of patients.

The dorsiflexors for group I mean was 24.4 ± 8.4 and for group II 23.9 ± 9.1 with no statistical difference between them before any intervention, and it increased at the 4th week to be 28.4 ± 5.4 and 28.4 ± 1.9 respectively which is statistically not significantly different. At the 12th week, it was 30.4 ± 5.9 and 31.4 ± 2.4 for groups I and II respectively which is statistically not significantly different too.

As for plantar flexion in group I, mean was 30.9 ± 10.5 and for group II 301.9 ± 13.5 with no statistical

Table 1 Descriptive data of the two groups

Variant	Group I (ESWT)	Group II (mesotherapy)	χ^2*	<i>P</i>	S
Sex (M/F) (N/%)	16(80%)/4(20%)	15(75%)/5(25%)	0.000	1.000	NS
Age (years) range			0.241 t	0.811	NS
Mean \pm SD	18–39 35.9 \pm 5.4	19–38 34.7 \pm 6.1			
Duration (months)			0.295 t	0.769	NS
Range					
Mean \pm SD	5.2 \pm 3.5	4.9 \pm 2.9			
Type of tendinopathy	11 (55%)/9 (45%)	12 (60%)/8 (40%)	0.000	1.000	NS
Insertional/non-insertional N (%)					

M male, F female, NS non-significant

*Chi-square, t; Student's t

difference at the start, and it increased at follow-up at the 4th week to be 35.4 ± 2.4 and 33 ± 4.1 respectively which is statistically not significantly different. At the 12th week, it was 40.4 ± 6.1 and 40 ± 7.2 for groups I and II respectively which is statistically not significantly different.

On studying the pain improvement by (VAS) for group I, it showed a highly significant decrease of pain at 4 and 12 weeks P_1 and p_2 (< 0.001). A highly significant decrease of pain also was noted in group II at week 4 and week 12 P_1 and p_2 (< 0.001). However, there was no statistical difference of VAS values for the two groups initially, at 4 and 12 weeks P_3 (> 0.05) which is shown in Table 2 and Fig. 1.

On studying the functional improvement using the AOFAS score for group I, it showed a highly significant improvement of function at 4 and 12 weeks P_1 and p_2 (< 0.001). A highly significant improvement of function also was noted in group II at 4 and 12 weeks P_1 and p_2 (< 0.001). However, there was no statistical difference of AOFAS values for the two groups initially, at week 4 and at week 12 P_3 (> 0.05), which is shown in Table 3 and Fig. 1.

On studying the ultrasonic findings for group I, it showed a significant decrease of tendon thickness at 4 and 12 weeks' follow-up P_1 and p_2 (< 0.01) as well as a

significant decrease of tendon thickness of group II at 4 and 12 weeks P_1 and p_2 (< 0.01). However, there was no statistical difference of tendon thickness values for the two groups initially, at 4 weeks P_3 (> 0.05), and there was a significant difference at 12th week P_3 (< 0.05), which is shown in Tables 3 and 4 and Figs. 1, 2, 3 and 4.

On studying the heterogenicity of the TA, Doppler activity, and calcification of both groups, there was no statistically significant difference initially between the two groups; however, within group I, there was a statistically significant difference as regards heterogenicity, Doppler activity, and calcifications which was not found in group II as shown in Table 5 and Figs. 3 and 4.

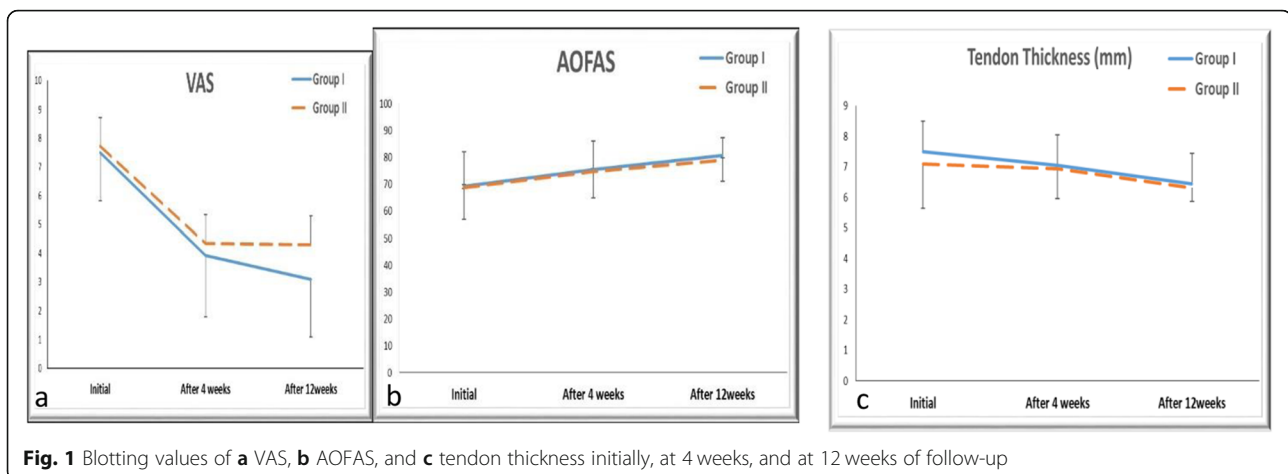
Discussion

This prospective study aimed to study the effect of both extracorporeal shock wave therapy and mesotherapy injections in chronic Achilles tendinopathy in athletes which is the commonest pathology affecting the Achilles tendon athletes fulfilling the inclusion criteria 31 (77.5%) were males and 9 (22.5) were females, which is in accordance to other studies who stated that AT is more prevalence in athletes or high activity males mostly with repetitive minor traumas [20]. Clinical and sonographic diagnosis revealed the nature of the tendinopathy as a thickened heterogeneous pattern of the tendon with

Table 2 Comparison between the two groups as regards VAS score initially, at 4 weeks and after 12 weeks

VAS	Initial	After 4 weeks	After 12 weeks	Paired <i>t</i> test	Initial–4 weeks P_1	Initial–12 weeks P_2	S
Group I	7.51 \pm 1.6	3.92 \pm 2.1	3.10 \pm 2.0	<i>P</i> value % of change	$< 0.001^*$ – 47.80%	$< 0.001^*$ 58.72	S
Group II	7.71 \pm 1.4	4.34 \pm 1.4	4.30 \pm 1.9	<i>P</i> value % of change	$< 0.001^*$ – 43.71%	$< 0.001^*$ 44.23%	S
<i>t</i>	0.403	0.734	1.935				
P_3	0.682	0.4676	0.06				
S	NS	NS	NS				

VAS visual analog scale. P_1 , p_2 , change through time. Paired *t* test, P_3 difference between groups I and II at each time**P* value



calcifications which is a common picture of tendinopathy. AT is usually presented with pain, swelling which is either insertional or non-insertional and impaired ankle function [21, 22]; our patients were chronic cases of more than 3 months duration which was similar to previous studies who gave eligibility of 3 months or more as main inclusion criterion [10, 12, 22–24]. Initial conservative treatment includes a variety of physical modalities (ice, laser therapy, ultrasound waves, TENS, Shock waves, and exercises). ESWT is one of the most commonly used conservative non-invasive approaches for chronic Achilles tendinopathy treatment. In our study, the group treated with ESWT showed a significant improvement of pain using VAS and ankle function using AOFAS by the 12th week with a significant reduction of the tendon thickness, improved heterogeneity, decreased Doppler signs, and decreased calcifications in both chronic insertional and non-insertional AT [23] which was similar to previous studies that showed a decrease of pain and increased AOFAS score in a group of AT treated with ESWT at weeks 4, 8, and 12 [24]. However, other authors stated that ESWT is effective in patients with non-calcified insertional Achilles tendinopathy while other cases with insertional tendinopathy who are not improving on conservative therapy

will need removal of the degenerated part of the calcified tendon [25]. The protocols for ESWT are variably in different studies, ranging from either single session [9], 3–4 sessions [26], weekly or twice weekly [27, 28], with either focused [7, 23, 26, 27, 29–31] or radial applications [9, 10, 28, 32, 33]. The number of pulses usually ranges from 1500 to 3000 [28, 31, 32]; our study protocol for ESWT consisted of four weekly sessions of high energy both focused and radial technique, which was similar to other authors [10]. These variable methods of application are trials to establish the optimum biological effect on tendons and soft tissues which is unclear and complex [33, 34]. Earlier studies stated that shock waves may enhance the removal of the damaged matrix of inflamed tendon [34–36]. Other authors hypothesized that ESWT may contribute to the proliferation of collagen fibers and tenocytes, hence enhancing the biological tendon repair [35, 37, 38] or promoting healing with neovascularization [27] in contrast to our results where we find decreased Doppler signs with follow-up at the 12th week rather than neovascularization. Recently, it is believed that ESWT modifies cell membrane as well as intracellular organs with subsequent nucleus stimulation and the production of specific growth factors that modify different biological repair processes at the site of injury [39].

Table 3 Comparison between two groups as regards AOFAS score initially, at 4 weeks, and after 12 weeks

AOFAS	Initial	After 4 weeks	After 12 weeks	Paired <i>t</i> test	Initial–4 weeks <i>p</i> ₁	Initial–12 weeks <i>p</i> ₂	S
Group I	69.4 ± 12.93	75.5 ± 10.81	80.9 ± 6.7	<i>P</i> value % of change	0.045* 8.79	0.011* 16.57	S
Group II	68.97 ± 11.97	74.9 ± 9.98	80.1 ± 7.8	<i>P</i> value % of change	0.048* 8.60	0.01* 14.69	S
<i>t</i>	0.109	0.182	2.610				
<i>P</i>₃	0.9137	0.856	0.062				
S	NS	NS	NS				

AOFAS American Orthopedic Foot and Ankle Society. *p*₁, *p*₂ change through time. Paired *t* test *P*₃ difference between groups I and II at each time

**P* value

Table 4 The ultrasonic findings of the two groups initially, at 4 weeks and 12 weeks

Tendon thickness mm	Initial	4 weeks	12 weeks	Paired <i>t</i> test	P1	P2	S
Group I	7.5 ± 1.68	7.06 ± 1.05	6.14 ± 0.8	<i>P</i> value % of change	0.067 5.87	0.01* 14.67	S
Group II	7.1 ± 1.45	6.93 ± 0.98	6.9 ± 0.45	<i>P</i> value % of change	0.155 2.39	0.027* 11.13	S
t	0.806	0.405	0.633				
p3	0.425	0.687	0.030				
S	NS	NS	S				

p1, p2 change through time. Paired *t* test. P3: difference between groups I and II at each time

**P* value

Almost all the studies recorded significant pain reduction after ESWT, which was explained by the decrease of substance p released from the treated area, selective loss of unmyelinated nerve fibers, or activation of the serotonergic system [40, 41]. It was noticed that these biological healing effects of ESWT are not an acute process, but occurring later within weeks after stopping the therapy, and it was recommended to detect the improvement of function after 12 weeks or 16 weeks [24]. Authors mostly use subjective tools for measuring the clinical outcome post ESWT therapy such as VAS [10, 26, 28, 29] and AOFAS [9, 10, 27]. However, ultrasonography was used as an objective tool to detect the treatment outcome [27, 28, 42] such as the thickness of the tendon, heterogeneity, calcifications, and Doppler signs, where our study outcome was measured objectively with ultrasound documenting the significant change in the tendon thickness, improved heterogeneity, and decreased calcifications and Doppler signs; others stated that ultrasound could not predict the outcome of therapy [42]. Many studies compared the effect of ESWT to Sham ESWT, where they found significant improvement of pain and function in ESWT group [10]; others compared local injections such as corticosteroids [43] where

they concluded the pain improves in short-term follow-up and sodium hyaluronate would be better in the intermediate and long-term follow-up, as mentioned in a study done by Lynen et al. [44], where they found that the usage of two injections of hyaluronan gives a greater improvement of pain than ESWT in cases of Achilles tendinopathy [45]. Platelet-rich plasma was also used in comparison to ESWT in a study done by Erroi et al. [30] where they stated that both modalities are effective for pain and function improvement in a follow-up time of 6 months. In our work, we compared ESWT to local mesotherapy injection (MT), with a clinically significant improvement of pain and tendon function all through the study till the 12th week, as well as significant objective improvement of tendon thickness and heterogeneity and decreased Doppler signs, but in comparison to the group treated with ESWT, no change in calcifications was noticed; however, an old study conducted by Capone et al. [15] using MT (disodium EDTA) to treat patients with calcific shoulder tendinitis found good effect after 24 months' follow-up, as well as another randomized double-blind study of 80 patients with calcific tendinitis of the shoulder, who were treated with mesotherapy one session per week for 1 year, and

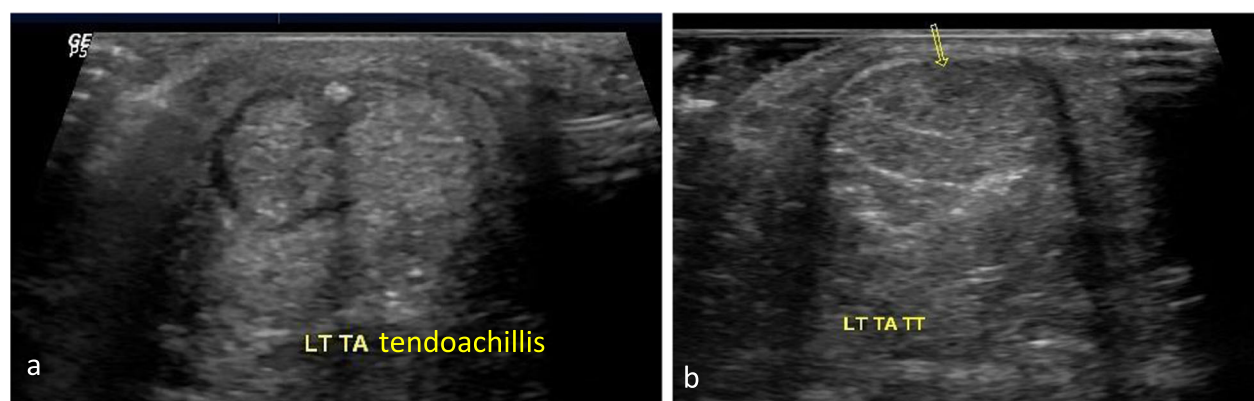


Fig. 2 **a** Greyscale transverse scan over left Achilles tendon (TA) shows hyperechoic dot of calcification inside the tendon with acoustic shadowing. **b** After 12 weeks of treatment with ESWT

Table 5 Comparison between both groups as regards heterogeneity and PD at 0 week and 12 weeks

Variables	Group I (ESWT) N = 20	Group II (mesotherapy) N = 20	χ^2	P value	S
Heterogeneity 0 weeks			1.067	0.785	NS
0	0	1			
1	8(40%)	7(35%)			
2	7(35%)	7(35%)			
3	5(25%)	5 (25%)			
Heterogeneity 12 weeks			0.210	0.976	NS
0	8 (40%)	7(35%)			
1	7(35%)	7(35%)			
2	3(15%)	4(20%)			
3	2(10%)	2(10%)			
χ^2	10.952	6.604			
P	0.012*	0.085			
S	S	NS			
PD 0 weeks			0.00	1.00	NS
0	13(65%)	12(60%)			
1	7 (35%)	8 (40%)			
PD after 12 weeks			0.00	1.00	NS
0	17 (85%)	15(75%)			
1	3(15%)	5(25%)			
χ^2	0.502	0.456			
P	0.023*	0.499			
S	S	NS			
Calcification 0 weeks			0.456	0.499	
0	12 (60%)	15 (75%)			
1	8(40%)	5(25%)			
Calcification after 12 weeks			1.765	0.1840	
0	1(5%)	5(25%)			
1					
χ^2	5.161	0.00			
P	0.023*	1.00			
S	S	NS			

PD power Doppler, S significant

placebo for controls showed a disappearance of calcifications completely in 62% and partially in 25% of patients treated with MT and 15% in the control group [16]. Musculoskeletal mesotherapy has been used in shoulder tendinitis using superoxide dismutase in a prospective study of 44 patients where they found 90% improvement of pain after 5 months' follow-up [13]; it has been used also in tendinopathy in a study by Solinas et al. Using ergotamine in 20 patients in a non-controlled study, they found pain improved when combining mesotherapy with laser therapy [14]. Previous suggested and established rationale for MT are cyclo-oxygenase (COX) inhibitors when using nonsteroidal drugs, thus reducing

prostaglandins and other inflammatory mediators and activation of neuronal nitric oxide synthase to produce nitric oxide (NO) causing peripheral antinociception. Another suggested hypothesis for MT is the activation effect of skin cytochrome on the injected analgesic or anti-inflammatory drugs [44].

Given that mesotherapy is based on the inoculation of drugs through multiple microinjections, it is possible that the efficacy recorded in the experimental observations is due not only to the local effect of the drug but also to the action of the needle, or to the combination of both [46]. Many previous studies of MT were conducted on chronic neck pain, comparing the effect of MT with

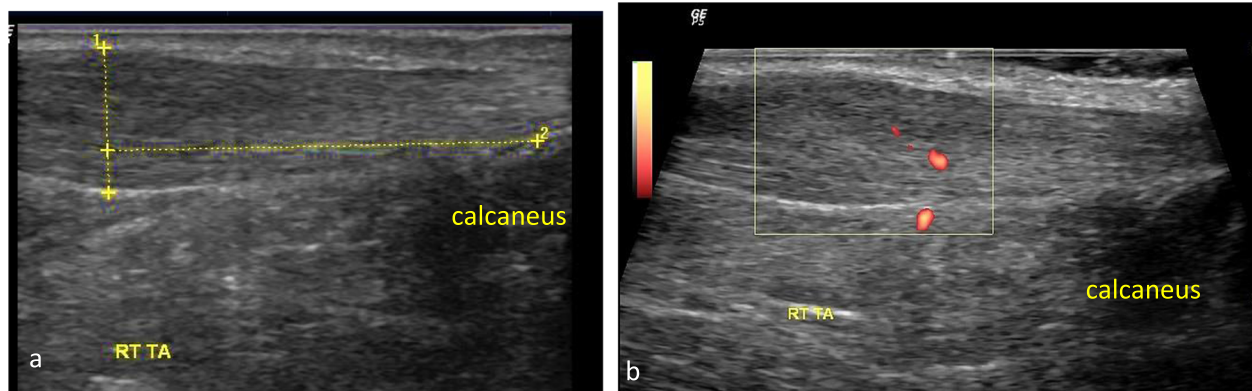


Fig. 3 **a** Greyscale ultrasound longitudinal scan over right Achilles tendon (TA) shows increased thickness (11 mm) 3.2 cm away from calcaneus with hypoechoic heterogeneity grade I of fibrillar pattern. **b** Power Doppler scan of same patient showing positive PD inside tendon

local anesthetic lidocaine hydrochloride vs dry mesotherapy for 3 sessions showing reduction of pain on VAS scale by the 12th week of the study [47], as well as acute neck pain comparing single injection MT with local anesthetic and steroids vs oral ibuprofen, which showed more analgesic effect than ibuprofen taken orally [48]. Studies on acute back pain (using sterile water microinjections) [49], and in female patients with chronic back pain during labor [50], showed a reduction of pain using VAS score; moreover, studies for chronic spinal pain using weekly MT injection (normal saline, lidocaine 2% and lysine acetylsalicylate) for 5 weeks showed improved pain and functional outcome [51]; also, in the result of a randomized controlled study of 84 patients with low back pain study using mesotherapy of lidocaine, ketoprofen, and methylprednisolone for 5 sessions and follow-up after 6 months, they found the same effect as systemic drugs given to the control group (ketoprofen, methylprednisolone, and esomeprazole) [11].

A recent study for knee osteoarthritis showed improvement of pain and functional outcome after 3

months' follow-up reported by Chen et al. [52] comparing the effect of oral diclofenac 150 mg/day to MT (2 ml lidocaine, 40 mg piroxicam, and 100 units of calcitonin) for acute knee pain and second protocol of MT (2 ml lidocaine, 2 ml organic silica, and 100 units calcitonin) for chronic knee pain, where they concluded that MT is a safe and effective procedure to decrease pain [53].

Our designed protocol for treating Achilles tendinopathy with MT was not yet typical to other protocols, but of similar drugs used before and in similarity to the conclusions of recent review done by Paolucci et al. [11] where they stated that MT is a good option for pain management, using microinjections either superficial or profound intradermal infusion in the painful area or the trigger points with the specific needle and number and correct dosage of the used drugs, with average sessions ranging from single to 9 sessions and the most used drugs are lidocaine, sterile water, isotonic saline, vitamin B solutions, long-acting corticosteroids, acetylsalicylate, ketorolac, and botulinum toxin.

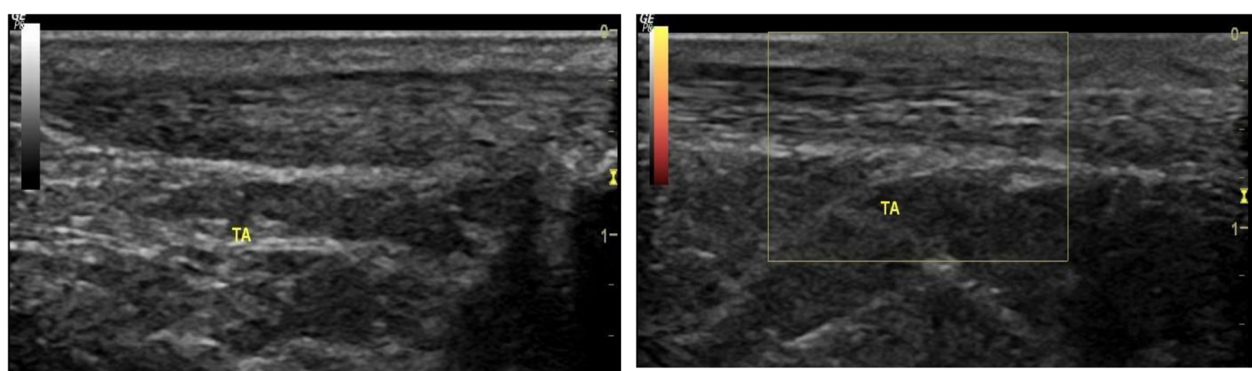


Fig. 4 **a** Greyscale ultrasound longitudinal scan over right Achilles tendon (TA) post ESWL treatment of above described patients shows improved thickness and heterogeneity of fibrillar pattern. **b** Power Doppler scan of same patient showing negative PD inside tendon after ESWL

In our results, the glucocorticoids injected group showed decreased inflammation signs by the 12th week follow-up documented ultrasonographically as decreased Doppler signs.

Both protocol used in our comparative study was followed by 15 min of eccentric ankle exercises, and patients were advised to repeat it three times per week as it is an effective documented physical intervention for Achilles tendinopathy [52] and it has been associated with clinical benefit in improving pain and function for patients with tendinopathy [54].

Our study was limited by a short duration of follow-up (12 weeks) and a small sample size.

Conclusion

Chronic Achilles tendinopathy is such a challenging clinical disorder, which needs early accurate objective diagnosis and multidisciplinary intervention. ESWT is a non-invasive well-tolerated technique documented to decreased pain, inflammation, and calcification if present and restore function, whereas mesotherapy injections are micro-invasive very well tolerated as effective as ESWT in pain reduction, decreasing inflammation and restoring function.

We suggest that it is according to initial ultrasound findings; if there are calcifications and severe inflammation, we can use ESWT. If only swelling and heterogeneous tendon, it is preferable to use MT.

In conclusion, any medicine should not be discarded if it showed clinical and objective outcome. Further study is recommended to compare the effect of both modalities with a larger number of patients, and a longer period of follow-up till 24 weeks in different types of sports would have added more value.

Abbreviations

AT: Achilles tendinopathy; ESWT: Extracorporeal shockwave therapy; MT: Mesotherapy; US: Ultrasound; VAS: Visual analog scale; AOFAS: American Orthopedic Foot and Ankle Society; MRI: Magnetic resonance image

Acknowledgements

Not applicable

Authors' contributions

EE gave the idea of the study, was responsible for mesotherapy (preparation, injection, and follow-up), and collected the patients' data and analyze them. RM put the study design, performed the ultrasound, and followed the patients post intervention. Both authors followed up of the group who underwent ESWT. EE wrote the paper with revision. They all approved the final version of the manuscript.

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Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

This study was approved by the Research Ethics Committee of the Faculty of Medicine at Ain Shams University in Egypt in 2019; the reference number is not available. All patients included in this study gave written informed consent to participate in this research.

Consent for publication

All patients included in this research gave written informed consent to publish the data contained within this study.

Competing interests

The authors declare that they have no competing interests.

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References

1. Asplund C, Best T (2013) Achilles tendon disorders. *BMJ* 346:f1262. <https://doi.org/10.1136/bmj.f1262>
2. Freedman B, Gordon J, Soslowsky L (2014) The Achilles tendon: fundamental properties and mechanisms governing healing. *Muscles Ligaments Tendons J* 4(2):245–255
3. Longo U, Ronga M, Maffulli N (2018) Achilles tendinopathy. *Sports Med Arthrosc Rev* 26(1):16–30. <https://doi.org/10.1097/JSA.0000000000000185>
4. Lian O, Scott A, Engebretsen L, Bahr R, Duronio V, Khan K (2007) Excessive apoptosis in patellar tendinopathy in athletes. *Am J Sports Med* 35:605–611. <https://doi.org/10.1177/0363546506295702>
5. Diehl P, Gollwitzer H, Schauwecker J, Tischer T, Gerdesmeyer L (2014) Conservative treatment of chronic tendinopathies. *Orthopade* 43:183–193. <https://doi.org/10.1007/s00132-013-2249>
6. Michelle W, Jason S (2011) Shock wave therapy for Achilles tendinopathy. *Curr Rev Musculoskelet Med* 4(1):6–10. <https://doi.org/10.1007/s12178-010-9067-2>
7. Gerdesmeyer L, Mittermayr R, Fuerst M, Al Muderis M, Thiele R, Saxena A, Gollwitzer H (2015) Current evidence of extracorporeal shock wave therapy in chronic Achilles tendinopathy. *Int J Surg* 24:154–159. [https://doi.org/10.1016/j.ijsu](https://doi.org/10.1016/j.ijsu.2016/j.ijsu)
8. Zamzam M, El Yasaki A, ElGarabawy N, El Ghandour L (2019) Shockwave therapy versus local steroid injection in chronic supraspinatus tendinopathy. *Egypt Rheumatol Rehabil* 46:141–147. https://doi.org/10.4103/err.err_16_18
9. Pavone L, Cannavo L, Di Stefano A, Testa G, Costarella L, Sessa G (2016) Low-energy extracorporeal shock-wave therapy in the treatment of chronic insertional Achilles. *Tendinopathy: a case series. Biomed Res Int*:1–4. <https://doi.org/10.1155/2016/7123769>
10. Vahdatpour B, Forouzan H, Momeni F, Ahmadi M, Taheri P (2018) Effectiveness of extracorporeal shockwave therapy for chronic Achilles tendinopathy: a randomized clinical trial. *J Res Med Sci* 26:23–37. <https://doi.org/10.4103/jrms>
11. Paolucci BR, Centra M, Giannandrea N, Pezzi L, Saggini R (2019) Mesotherapy in the treatment of musculoskeletal pain in rehabilitation: the state of the art. *J Pain Res* 12:2391–2401. <https://doi.org/10.2147/JPR.S209610>
12. Costantino C, Marangio E, Coruzzi G. (2011) Mesotherapy versus systemic therapy in the treatment of acute low back pain: a randomized trial. *Evidence-Based Complementary and Alternative Medicine*; 6 pages.
13. Biondi G, Romano M, Marcone E, Concetta Meo M, Attanasio L (1985) Orgotein: our experience in rheumatic pathology. *Giornale di Mesoterapia* 5:25–28
14. Solinas G, Solinas AL, Perra P, Solinas FL (1987) Treatment of mechanical tendinopathies by mesotherapy with ergotamine in combination with laser therapy. *Riabilitazione* 20(4):281–288.
15. Capone M, Stancati MT, Tolla V, Chiatti R, Muscolo V, Pasquale M (1994) Observations on the administration of sodium edetate in calcified scapulohumeral periarthritis. *Ionophoresis and mesotherapy: comparison of two techniques. Ortopedia Traumatologia Oggi* 14(4):163–168
16. Cacchio A, De Blasis E, Desiati P, Spacca G, Santilli V, De Paulis F (2009) Effectiveness of treatment of calcific tendinitis of the shoulder by disodium EDTA. *Arthritis Care Res* 61(1):84–91
17. Taylor J, Dunkerley S, Silver D, Redfern A, Talbot N, Sharp I and Guyver P (2016) Extracorporeal shockwave therapy (ESWT) for refractory Achilles

- tendinopathy: A prospective audit with 2-year follow up presented In: Monitoring Information - Royal Devon and Exeter, NHS, UK, 27/9/2017.
18. Grechenig W, Clement H, Bratschitsch G, Fankhauser F, Peicha G (2002) Ultrasound diagnosis of the Achilles tendon. *Orthopade*. 31(3):319–325. <https://doi.org/10.1007/s00132-001-0272-y>
 19. Miller M and Knapp R (1992) Clinical epidemiology and biostatistics in Tulskey D, Skalojske D, Chelune G et, al. (ed), Clinical interpretation of the WAIS-III and WMS-III, 3rd edition published by Williams & Wilkins, Maryland.
 20. Singh A, Calafi A, Diefenbach C, Kreulen C, Giza E (2017) Tendinopathy of the Achilles. *Foot Ankle Clin* 22(4):745–760. <https://doi.org/10.1016/j.fcl.2017.07.006>
 21. Jarvinen T, Kannus P, Maffulli N, Khan K (2005) Achilles tendon disorders: etiology and epidemiology. *Foot Ankle*:255–266. <https://doi.org/10.1016/j.fcl.2005.01.013>
 22. Sussmilch-Leitch S, Collins N, Bialocerkowski A, Warden S, Crossley K (2012) Physical therapies for Achilles tendinopathy: systematic review and meta-analysis. *Journal of Foot and Ankle Research* (5):1–15. <https://doi.org/10.1186/1757-1146-5-15>
 23. Furia J (2006) High energy extracorporeal shock wave therapy as a treatment for insertional Achilles tendinopathy. *Am J Sports Med* 34(5):733–740. <https://doi.org/10.1177/0363546505281810>
 24. Rasmussen S, Christensen M, Mathiesen I, Simonsen O (2008) Shockwave therapy for chronic Achilles tendinopathy a double-blind, randomized clinical trial of efficacy. *Acta Orthop* 2:249–256. <https://doi.org/10.1080/17453670710015058>
 25. Wiegerinck J, Kerkhoffs G, Van Sterkenburg M, Siersevelt I, Dijk C (2013) Treatment for insertional Achilles tendinopathy: a systematic review. *Knee Surg Sport Traumatol Arthrosc* (6):1345–1355. <https://doi.org/10.1007/s00167-012-2219-8>
 26. Furia J (2008) "High-energy extracorporeal shock wave therapy as a treatment for chronic non-insertional Achilles tendinopathy". *E. Am J Sports Med* 36(3):502–508. <https://doi.org/10.1177/0363546507309674>
 27. Santamato A, Beatrice R, Micello M, Fortunato F, Panza F, Bristogiannis C, Cleopazzo E, Macarini L, Picelli A, Baricich A, Ranieri M (2019) Power Doppler ultrasound findings before and after focused extracorporeal shock wave therapy for Achilles tendinopathy: a pilot study on pain reduction and neovascularization effect. *Ultrasound Med Biol* 45(5):1316–1323. <https://doi.org/10.1016/j.ultrasmedbio.2018.12.009>
 28. Costa M, Shepstone L, Donell S, Thomas T (2005) Shock wave therapy for chronic Achilles tendon pain. *Clin Orthop Relat Res* 440:199–204. <https://doi.org/10.1097/01.blo.0000180451.03425.48>
 29. Furia J (2006) "High-energy extracorporeal shock wave therapy as a treatment for insertional Achilles tendinopathy," *e Am J Sports Med*. 2006; (5):733–740. [doi.org/https://doi.org/10.1177/0363546505281810](https://doi.org/10.1177/0363546505281810).
 30. Erroi D, Sigona M, Suarez T, Trischitta D, Pavan A, Vulpiani M, Vetrano M et al (2017) Muscle Ligaments and Tendons *Journal* 7(1):98–106. <https://doi.org/10.11138/mlti/2017.7.1.098>
 31. Rompe D, Nafe B and Maffulli N (2007) "Eccentric loading, shock-wave treatment, or a wait-and-see policy for tendinopathy of the main body of tendoachillis,". *e Am J Sports Med* 35(3): 374–383. <https://doi.org/10.1177/0363546506295940>
 32. Rompe D, Furia J and Maffulli N (2008) "eccentric loading compared with shock wave treatment for chronic insertional Achilles tendinopathy,". *E-journal of Bone and Joint Surgery-American* 90(1):52–61. <https://doi.org/10.2106/JBJS>
 33. Rompe J, Furia J, Maffulli N (2009) "eccentric loading versus eccentric loading plus shock-wave treatment for midportion Achilles tendinopathy,". *E. Am J Sports Med* 37(3):463–470. <https://doi.org/10.1177/0363546508326983>
 34. Magdalena S, Juras G, Chmielewski D, Polak A, Kucio C and Krol P (2019) Extracorporeal shock wave therapy for Achilles tendinopathy. *Biomed Res Int* 2019(2):1–13. <https://doi.org/10.1155/2019/3086910>
 35. Wang C J, (2012) Extracorporeal shockwave therapy in musculoskeletal disorders. *J Orthop Surg Res* 20; 7:11. <https://doi.org/10.1186/1749-799X-7-11>
 36. Notarnicola A, Moretti B (2012) The biological effects of extracorporeal shock wave therapy (ESWT) on tendon tissue. *Muscle, Ligaments, and Tendons Journal* 2(1):33–37 <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3666498/>
 37. Romeo P, Lavanga V, Pagani D, Sansone V (2014) Extracorporeal shock wave therapy in musculoskeletal disorders: a review. *Med Princ Pract* 23(1):7–13. <https://doi.org/10.1159/000355472>
 38. Waugh C, Morrissey D, Jones E, Riley G, Langberg H and Screen H (2015) "In vivo biological response to extracorporeal shockwave therapy in human tendinopathy,". *European Cells and Materials* 29:268–280. <https://doi.org/10.22203/eCM.v029a20>
 39. Vetrano M, D'Alessandro F, Torrisi M, Ferretti A, Vulpiani M, Visco V (2011) Extracorporeal shock wave therapy promotes cell proliferation and collagen synthesis of primary cultured human tenocytes. *Knee Surg Sports Traumatol Arthrosc* 19(12):2159–2168. <https://doi.org/10.1007/s00167-011-1534-9>
 40. Vitali M, Rodrigues N, Pironti P, Drossinos A, Di Carlo G, Chawla A, Gianfranco F (2019) ESWT and nutraceutical supplementation (Tendisulfur forte) vs ESWT-only in the treatment of lateral epicondylitis, Achilles tendinopathy, and rotator cuff tendinopathy: a comparative study. *Journal of Drug Assessment* 8(1):77–86. <https://doi.org/10.1080/21556660.2019.1605370>
 41. Wess O (2008) A neural model for chronic pain and pain relief by extracorporeal shock wave treatment. *Urol Res* 36(6):327–334. <https://doi.org/10.1007/s00240-008-0156-2>
 42. Hausdorf J, Lemmens M HK, Grolms N, Korr H, Kertschanska S, Steinbusch H, Schmitz C, Maier M (2008) Selective loss of unmyelinated nerve fibers after extracorporeal shockwave application to the musculoskeletal system. *Neuroscience* 155(1):138–144. <https://doi.org/10.1016/j.neuroscience.2008.07.006>
 43. Cheng Y, Zhang J, and Cai Y (2016) "Utility of ultrasonography in assessing the effectiveness of extracorporeal shock wave therapy in insertional Achilles tendinopathy,". *Biomed Res Int* 1-5. <https://doi.org/10.1155/2016/2580969>
 44. Lynen N, DeVroey T, Spiegel I, Van Ongeval F, Hendrickx N, Stassijns G (2017) Comparison of peritendinous hyaluronan injections versus extracorporeal shock wave therapy in the treatment of painful Achilles' 21 tendinopathy: a randomized clinical efficacy and safety study. *Arch Phys Med Rehabil* 98(1):64–71. <https://doi.org/10.1016/j.apmr.2016.08.470>
 45. Hart L (2011) Corticosteroid and other injections in the management of tendinopathies: a review. *Clin J Sport Med* 21(6):540–541. <https://doi.org/10.1097/01.jsm.0000407929.35973.b9>
 46. Massimo M, Enrica M, Domenico R, Chiara G, Gianpaolo R, et al., (2020) Mesotherapy: From Historical Notes to Scientific Evidence and Future Prospects *Scientific World Journal* 2020(3542848). <https://doi.org/10.1155/2020/3542848>
 47. Mammucari M, Gatti A, Maggiori S, and Sabato A (2012) Role of Mesotherapy in musculoskeletal pain: opinions from the Italian Society of Mesotherapy. *Evid Based Complement Alternat Med* 2012:1–12. <https://doi.org/10.1155/2012/436959>
 48. Paolucci T, Piccinini G, Dan Trifan P, Zangrando F, Saracens V (2016) Efficacy of trigger points Mesotherapy for the treatment of chronic neck pain: a short-term retrospective study. *Int J Phys Ther Rehab* 2:113–118. <https://doi.org/10.15344/2455-7498/2016/113>
 49. Yang XN, Geng ZS, Zhang XL, Zhang YH, Wang XL, Xb Z, Cui JZ (2018) Single intracutaneous injection of local anesthetics and steroids alleviates acute nonspecific neck pain: a CONSORT-perspective, randomized, controlled clinical trial. *Medicine (Baltimore)* 97(28):e11285. <https://doi.org/10.1097/MD.00000000000011285>
 50. Cui JZ, Geng ZS, Zhang YH, Feng JY, Zhu P, Zhang XB (2016) Effects of intracutaneous injections of sterile water in patients with acute low back pain: a randomized, controlled, clinical trial. *Braz J Med Biol Res* 49(3):1–8. <https://doi.org/10.1590/1414-431X20155092>
 51. Koyucu RG, Demirci N, Yumru AE, Salman S, Ayanoglu YT, Tosun Y, Tayfur C (2018) Effects of intradermal sterile water injections in women with low back pain in labor: a randomized, controlled, clinical trial. *Balkan Med J* 35: 148–154. <https://doi.org/10.4274/balkanmedj.2016.0879>
 52. Chen L, Li D, Zhong J, Qiu B, Wu X (2018) Therapeutic effectiveness and safety of mesotherapy in patients with osteoarthritis of the knee. *Evidence-Based Compl Altern Med* 46513049. <https://doi.org/10.1155/2018/6513049>
 53. Ferrara P, Ronconi G, Viscito R, Pascuzzo R, Radulescu E, Ljoka C, Maggi L, Ferriero G, Foti C (2017) Efficacy of mesotherapy using drugs versus normal saline solution in chronic spinal pain: a retrospective study. *Int J Rehabil Res* 40(2):171–174. <https://doi.org/10.1097/MRR.0000000000000214>
 54. Maffulli N, Longo UG, Kadaki A, Sipezia F (2019) Achilles tendinopathy. *Foot Ankle Surg* 19:30052–30059. <https://doi.org/10.1016/j.fas.2019.03.009>

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