Posturographic evaluation of tendinopathy of the rear of sportsmen's feet treated using radial shock waves

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Resume

The aim of this study is to examine the influence of radial shock wave treatment (RSWT), by itself and also in conjunction with mesotherapy, on tendinopathy of the rear of sportsmen's feet as well as its possible posturographic repercussions.

Our study was based on 13 test persons (average age 50.5 years) whom we divided at random into 2 groups. One group received exclusively treatment via RSWT, the other received mesotherapy in addition. We evaluated the pain (VAS = visual analogical scale) prior to the start of the treatment (T0), at the end of the treatment (T30) and one month after the end of the treatment (T60). A posturographic analysis was also carried out on a standardised platform.

The statistical analysis shows a significant reduction in pain at T30 (81% for the RSWT group alone and 61% for the RSWT + mesotherapy group). This reduction is maintained at T60. Even if the results of the RSWT group appear better, there is no statistically significant difference between the 2 groups. As far as the posturography is concerned, no statistically significant difference was revealed.

The RSWT treatment considerably diminishes the pain and makes it possible to regain mobility *(80% were able to resume their sporting activities)*, but does not appear to influence the posturography. 83% of the patients estimate that the results are satisfactory (16%) to very satisfactory (67%). The combination with mesotherapy does not improve results.

Introduction

Thomas (1940) studied the role of muscular proprioception in the body's general attitude and of "optical impressions" in male statics.

EKLUND then demonstrated that the postural movements of standing males vary according to the stimulation of the ankle muscles. The body moves forward when the rear leg muscles are stimulated and backwards when the sural triceps are stimulated.

Gilhodes, Kavounoudias and Roll have demonstrated a chain of successive proprioceptive links from the foot muscles as far as the extra ocular muscles.

Ceyte H et al (2007), Barbieri G et al (2008), Caudron S et al (2007) confirmed the effects of vibrations of the Achilles tendon on postural orientation.

But what is the situation with radial shock waves on a therapeutic as well as a posturographic level?

If tendonitis of the Achilles tendon and aponeurosis do not cause clinical diagnosis problems for a well-informed doctor, the situation is completely different as regards medical treatment.

All possible forms of tendinopathy can affect the Achilles: corporeal tendinopathy, problems at the muscular-tendon join, lesion of the entheses, peritendonitis, partial ruptures, degenerative tendonitis. The most frequent situations are corporeal tendinopathy and ruptures.

They are generally the result of hyper-solicitation and are found mainly in sportsmen. runners, jumpers, walkers. Degenerative elements weaken the tendon little by little, frequently leading to a rupture. The rupture occurs brutally through passive stretching during dorsiflexion of the foot.

Numerous writers have evaluated the wide therapeutic spectrum in the case of treatment of tendinopathy and illustrated a large variation in results.

In some chronic cases, following possible treatment of medication-induced etiology (quinolones) or postural etiology via biomechanical reprogramming in osteopathy, there is continuing very disabling pain causing the person to stop sporting activity. It is against the

background of these indications that we evaluated a recent therapy derived from lithotripsy, radial shock waves.

Shock waves have been used in urology since the 1980's to destroy kidney stones. This is the extra-corporeal shock wave therapy or EWST. In this particular case, one talks of lithotripsy. At the beginning of the 1990's, people started to study them in traumatology for their capacity to help the healing of fractures, particularly in the case of delayed setting of the fracture, non-union or pseudo arthritis. In the ensuing period, this therapy was used more and more frequently for treatment of different types of muscular-skeletal lesions. Here, one talks of orthotripsy.

These shock waves are characterised by a very abrupt increase in pressure followed by a rapid phase of negative pressure. The area of action is ellipsoidal (or cigar-like) in shape. The different types of ESWT generators create their shock waves with the help of complex physical procedures. Alongside the shock wave devices there are now devices which develop much weaker RSWT (Radial Shock Wave Therapy) or RSW (Radial Shock Waves) energy.

In general, devices producing a differing, radial pressure wave with the energy being spread over a large surface are classified as RWST (Radial Shock Wave Therapy). These pressure waves (RSW) are generated by pneumatic means and introduced into the body over a large surface area using an ultra-convenient hand device. These impulses spread over the entire pain area. The projectile situated in the applicator reaches a high speed via a ballistic movement and, upon striking the shock wave transmitter integrated in the hand device, creates a pressure wave which is transmitted to the body. In contrast to classical ESWT, the action area of the radial wave is a cone whose tip is situated on the nose of the hand piece. The radial wave is released directly upon contact with the skin and it weakens rapidly as it enters the tissue, achieving no more than 3 to 3.5 cm in depth with a classic transmitter. The form of the wave as well as the depth of action depends on the type of transmitter integrated into the hand piece. The parameters with which we can play are the type of transmitter, the impulse frequency, the pressure (which determines the energy transmitted), the number of impulses as well as the number of sessions.

The action mechanisms of acoustic wave therapy are not yet clear. The characteristics of the extra-corporeal waves lead to cavitation (production of gaseous bubbles) in the interstitial liquids producing micro-injuries to the tissue. The micro-injuries caused by the cavitation are responsible for part of the therapeutic effect. Other micro-injuries are caused directly by the mechanical effects on the tissue. Certain authors have suggested that for degenerative ailments of limp tissue, such as degenerative or chronic tendinopathy, stimulation of an inflammatory process could help stimulate the regeneration of the tendon.

Methods

The evaluation concerned 13 patients (7 males and 6 females), runners, with an average age of 50 (53 for the men, 48 for the women). These patients had been suffering for more than 3 months and had not improved through various forms of "traditional" treatment well carried out. Surgery was envisaged most of the time. We excluded ruptures of the tendon as well as litigation with insurance companies or federations.

We divided these test persons (randomly) into 2 groups. The first was treated solely with RSWT and the second with RSWT + mesotherapy (a mixture of 2 cc of calcitonine 100 ui, 0.5 cc Piroxicam and 0.5 cc Mesocaine) following the RSWT session.

We used MP100 from Storz Medical for the RSWT, all other simultaneous treatment was prohibited and sporting activities were not forbidden.

Posturographic recording will be made on a Satel platform with 3 pressure sensors standardised as per APE at 40 Hz, with a static Eyes open and Eyes closed sequence foam or

soles for those wearing such, and dynamics on oscillating Freeman turntable right/left Eyes open and Eyes closed front rear Eyes open and Eyes closed.

The first static eyes open recording, considered as adaptation to the platform, was not kept.

The statistical analysis was carried out with the help of the XLSTAT software, version 2007.7 from Addinsoft.

The diagnosis is essentially clinical, the images are of no use for most of the time and could be sometimes misleading. Nevertheless, all these chronic patients had already received an ultrasound scan or MRI (for those for whom intervention via carding had been envisaged). The palpation shows a more or less painful thickening of the tendon. The three-stage examination (functional, passive dorsiflexion of the foot and passive equinism of the foot) is carried out in identical manner for tendonitis or a rupture.

Functional elements: standing on tiptoe with both feet, standing on tiptoe with one foot, hopping on both feet, hopping on one foot. All of these tests are possible with tendinopathy of the Achilles but can be painful. The degree of gravity results from the fact that the pain appears even with the most simple movements (1 more serious than 2, etc.) The rupture is characterised by the impossibility of performing the tests on one foot. The injured person can stand on tiptoe on two feet but not on the injured foot. These tests are very important because in 40% of cases the patient is not aware of the rupture. In actual fact, the rupture, which was very painful initially, rapidly ceases to be painful, has relatively little effect on walking and does not become apparent until the functional tests.

Passive dorsiflexion of the foot: With the patient lying on his or her back, pressure is applied to the ends of the feet. The angle of the foot to the leg is the same on either side with tendinopathy and greater on the injured side with ruptures.

Passive equinism of the foot: the sick person is observed lying on his or her stomach, the feet extended beyond the examination table. If the position is equine and symmetrical, the tendon is healthy (or it is a case of tendonitis). One of the two feet falling to the vertical position indicates a rupture of the Achilles tendon.

The patients are informed that they will be included in an evaluation process, that they do not have to follow any other form of treatment and that they can continue their sporting activities within their tolerance limits. They can withdraw from this evaluation at any time.

If the process for the mesotherapy and the posturographic analysis is fully known and standardised, things are completely different as far as the RSWT process is concerned. Consequently, as far as the RSWT is concerned and for lack of a consensus, we have chosen a personalised procedure based on existing literature.

The procedure is as follows:

- T0, date of the initial consultation: diagnosis, decision to include in the evaluation or not, visual analogical scale (VAS) for the purpose of evaluating the pain and posturographic analysis in accordance with the AFP standard.
- T30, end of the treatment: functional analysis, VAS and posturographic analysis
- T60, one month after the end of the treatment: functional analysis and VAS. A posturographic analysis was envisaged but could not be carried out as a result of technical problems.

The treatment will consist of 4 sessions (an interval of 7 days between each session) of RWST only for group 1 (6 persons) and the same plus mesotherapy at the end of the session for group 2 (7 persons).

The RSWT has been applied with 2 different transmitters (the head initially focuses on the tendon and then the D-Actor® on the muscle):

- Focus Head (Fig. 1): this head “concentrates” energy on a smaller “radial window” and is preferably applied when the pain is located superficially and/or

in the vicinity of the bone: A pressure of 2.5 to 3 bar (depending on patient sensitivity) was used which creates an energy of 0.12mJ/mm² (11 MPa). A frequency of 10 Hz was used over 3,000 strikes. Contact gel was placed on the skin and pressure exerted which was comfortable for the patient. We always began with the most painful and most thickened point of the tendon. Small circular movements were made and the inclination of the hand piece varied during the application.

- D-Actor® Head (Fig. 2): produces impulses associated with vibrations of a weak amplitude (infrasound combined with the RSWT technique) which enable activation of muscular and conjunctive tissue and create hypothermia. This is advisable in cases of muscular contractions, myofascial pain and for the trigger points. In this case, contact gel was applied over the entire muscular zone (the gastrocnemius muscles), a frequency of 15 Hz was used with a pressure of 3 bar for a total of 1,000 strikes. The applicator was moved over the length of the muscle with small circular movements. A certain pressure was exerted in order to achieve excellent contact.

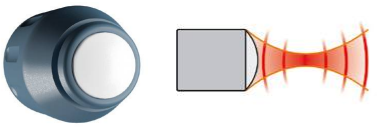


Figure 1 (Focus Head)

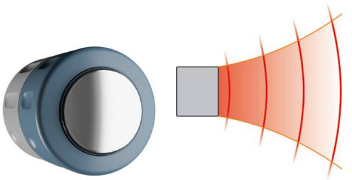


Figure 2 (D-Actor® Head)

In terms of the posturography, the variables measured comprised:

- Static stabilometry: the subject was placed on the platform, standing up and instructed to keep his arms next to his body and his head straight. The position of the feet was standardised: feet at 30°, heels 2 cm apart, barycentre of the base still situated at the same point whatever the size of the subject. We record the statokinesigram over a period of 51.2 seconds for each test. With eyes open (EO) and just before closing the eyes (EC) the subject focused on a target (luminous point) placed 5 metres in front of him. In orthostatism, based on the statokinesigram EO/EC, the variables studied and defined by AFP were: The surface of the ellipse drawn by the successive positions of the centre of foot pressure noted during the course of the acquisition (average +/- E.T.) in mm. The total length of the statokinesigram (average +/- E.T.) in mm. The average X: average position of the centre of foot pressure on the lateral axis in mm (X axis). The average y: average position of the centre of foot pressure on the antero-posterior axis in mm (X axis). The Romberg quotient: ratio of the surface of the eyes to the surface of open eyes. The FFT +: frequential analysis of the statokinesigrams representing the three frequency bands corresponding to the different sensorimotoric regulation loops used, expressed in % of the total energy (band 1 = 0 to 0.5 Hz, band 2 = 0.5 Hz to 2 Hz, band 3 = more than 2 Hz).
- *Dynamic stabilometry:* following the placement of a mobile platform above the initial platform, the subject was placed in the same position as during the static test. The position of the feet, the environment and the instructions were respected. We proceeded to the recording of the antero-posterior EO and then EC equilibrium and to the recording of the right/left lateral equilibrium EO then EC.

The duration of each recording was 25.6 seconds, the frequency 40 Hz. The same variables were studied.

As far as the VAS is concerned, a small bar with a 10 cm line was presented vertically to the resting subject, with just 2 icons (one showing a happy face, free of pain and the other a crying face, maximum pain). The cursor was systematically placed at the bottom and the subject was requested to raise the cursor as far as the level which he felt at this time between no pain at all and the maximum bearable pain. The number of mm was noted.

Results

The comparisons between two groups were studied via a t and z test as well as an analysis of the variances. The correlations were studied using Pearson coefficients followed by linear regression in the event of significance. The statistical significance threshold was set at 5%.

Group

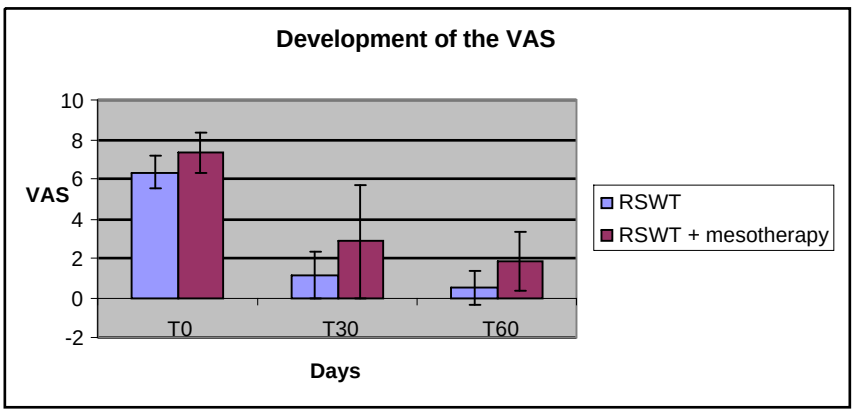
	No. of patients	Male	Female	Age
RSWT group	6	3	3	49
RSWT + mesotherapy group	7	4	3	51

Functional analysis

	Test	T0	T30	T60
RSWT	- standing on tiptoe on 2 feet	83%	100%	100%
	- standing on tiptoe on 1 foot	0%	83%	100%
	- hopping on tiptoe on 2 feet	33%	83%	100%
	- hopping on tiptoe on 1 foot	0	83%	100%
RSWT + mesotherapy	- standing on tiptoe on 2 feet	57%	86%	86%
	- standing on tiptoe on 1 foot	0%	71%	86%
	- hopping on tiptoe on 2 feet	14%	86%	86%
	- hopping on tiptoe on 1 foot	0%	71%	86%

VAS

VAS	T0	T30	T60
RSWT group	6.33 ± 0.82	1.17 ± 1.17	0.5 ± 0.84
RSWT + mesotherapy group	7.33 ± 1.03	2.83 ± 2.71	1.83 ± 1.47



Patient appreciation

	TS	S	I	D	A
RSWT	67%	16%	16%	0	0
RSWT + mesotherapy	57%	28%	0	14%	0

Very satisfactory (VS), satisfactory (S), insufficient (I), disappointing or zero (D), aggravation (A).

Posturography

As far as the posturography is concerned, no statistically significant difference was revealed.

Discussion

Treatment using radial shock waves shows excellent improvement in terms of both pain and functional mobility on these patients with chronic tendinopathy that has not been improved by various forms of treatment (for 10 of these, this was mesotherapy). 80% were able to resume their sporting activity, a fact which is all the more remarkable as they had been recommended to undergo surgery.

Mesotherapy does not potentiate treatment via RSWT – the results are slightly less good. This may appear surprising as this mesotherapy procedure produces good results for simple forms of tendinopathy; one could think that supplementary vasodilatation and the analgesic effect of the calcitonine could improve the effectiveness of the RSWT.

Treatment using RSWT thus appears to be establishing itself as a reference treatment for tendinopathy of the Achilles, even in chronic cases.

As far as pain is concerned, the analysis with the help of VAS shows a clear reduction in pain on the level of the 2 groups. The statistical analysis shows a significant reduction in pain at T30 (81% for the RSWT group alone and 61% for the RSWT + mesotherapy group). This reduction is maintained at T60. Even if the results of the RSWT group appear better, there is no statistically significant difference between the 2 groups.

In terms of mobility, at least 83% of the RSWT group regained their mobility at T30 and 100% at T60, whilst in the RSWT + mesotherapy group, at least 71% regained their mobility at T30 and 86% at T60.

83% of the patients estimate that the results are satisfactory (16%) to very satisfactory (67%) whilst 16% consider them unsatisfactory for the RSWT group. 86% of the patients estimate that the results are satisfactory (29%) to very satisfactory (57%) whilst 14% consider them disappointing for the RSWT + mesotherapy group.

CONCLUSION

Treatment using RSWT produces excellent results in terms of patient satisfaction, the VAS as well as the functional tests and the return to activity; however, it does not appear to influence posturography. The combination with mesotherapy does not improve results, rather the opposite is the case.

In view of these results, it is clear that treatment via RSWT should be proposed before surgery.

This preliminary study needs to be carried out using a higher number of test persons and compared to a reference group.

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