Efficacy of ultrasound therapy combined with cryotherapy in pain management and rehabilitation in patients with Achilles tendinopathy: a retrospective observational study.

Running title: Ultrasound and cryotherapy for Achilles tendinopathy.

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Key words: Achilles tendinopathy; rehabilitation; pain; ultrasound therapy; cryotherapy

Abstract

Background: Achilles tendinopathy (AT) is characterized by pain, reduced performance, and swelling in and around the tendon. The aim of our study was to evaluate and compare the effects of ultrasound therapy alone or associated with cryotherapy, delivered through cryo-ultrasound, in patients with subacute AT.

Methods: We analyzed retrospectively amateur runner patients who run at least 3 times a week, with medical and ultrasound diagnosis of subacute AT of the midportion. All patients underwent 10 sessions of ultrasounds' therapy with qmd® ultrasound cryo and a therapeutic exercise with stretching and eccentric exercises. The Cryo-Ultrasound Group (CUG, 15, 8M and7/F), during the ultrasound treatment, underwent a session of cryo-ultrasound therapy. The Ultrasound Group (UD, 15, 7M and 8F) only performed ultrasound therapy

Results: All evaluations performed show significant improvement over time in both groups. The CUG shows at T1 a greater increase in pain and function compared to the UG. Friedmann's repeated measures analysis shows that both groups improved when assessed separately over time. From the subsequent post hoc analysis, a statistically significant difference is highlighted between the values evaluated at T0 and T3.

Conclusions: The possible simultaneous delivery of the two treatment modalities, in patients suffering from tendinopathies, therefore represents a good possibility of synergistically exploiting their therapeutic actions. Future studies with a larger patient sample and longer follow-up are also needed to better evaluate the benefits of this treatment.

Background

Achilles tendinopathy (AT) is characterized by pain, reduced performance, and swelling in and around the tendon. The pathologic process may involve the distal insertion or the midportion of the tendon. The main symptom of non-insertional tendinopathy is pain localized 2 to 6 cm proximal to the insertion of the tendon in the calcaneus (1, 2).

The incidence of AT is very high (approximately 6% of the general population reports Achilles tendon pain during their lifetime) (3), with athletes representing the most affected segment of the population (6-17% of all injuries during running). The etiology of AT remains uncertain and is probably caused both by intrinsic factors (age, sex, body weight, altered vascularity, gastrocnemius / sun dysfunction or weakness and lack of flexibility) and extrinsic (cumulative microtrauma, excessive load also related to sporting technical gesture). The diagnosis is essentially clinical. Stiffness is a frequent onset symptom. Ultrasound is considered the primary imaging method. AT is difficult to treat, and the results are variable. As for conservative treatments, non-steroid anti-inflammatory drug (NSAIDs) are commonly used for the management of short-term AT. Rest, cryotherapy, therapeutic exercise, instrumental physical therapy (ultrasound therapy, electro analgesic therapy, extracorporeal shock

wave therapy, laser therapy) injections (steroids, lidocaine, hyaluronic acid and platelet-rich plasma), orthoses, drugs and surgery are the main treatment options (4, 5).

Most patients receive multiple treatments over time. Ultrasound therapy represents among all the instrumental physical therapies, the one most used as a first approach, with the aim of reducing edema, resolving pain and stimulating tissue healing. In this perspective, the possibility of providing combined treatments could lead to a shortening of rehabilitation times and a faster social and sports reintegration.

The aim of our study was to evaluate and compare the effects of ultrasound therapy alone or associated with cryotherapy, delivered through cryo-ultrasound, in patients with subacute AT.

Materials and methods

We analyzed retrospectively amateur runner patients who run at least 3 times a week, with medical and ultrasound diagnosis of subacute AT of the midportion (<3 months) in the period between October 2021 and January 2022. Patients had to meet the following inclusion criteria: ages 20-60; Presence of significant pain at the level of the AT midportion (2-6 cm proximal to the insertion) during activities of daily life, such as walking, running, go up and down the stairs, etc.; Arch Sign +; Increased pain during active plantarflexion of the ankle against resistance; Evidence of tendon distress on ultrasound examination.

Patients with concomitant systemic rheumatic or bone disease, tendon calcifications, knee or ankle instability, suffering from lumbar pathologies, sciatic nerve entrapment, and those who had received surgery or local infiltrations, or recent knee or ankle treatments were excluded from the study, or who had experienced severe trauma. Patients with pathologies that contraindicate the use of instrumental physical therapy (infections, diabetes, tumors, etc.) were also excluded.

At the first evaluation, all patients had stopped sport due to pain. The study was conducted in accordance with Helsinki ethical standards and because it is a retrospective observational study, for

this reason, it does not require approval by the ethics committee. Patients were informed about the possible side effects of the treatment. All patients signed informed consent forms (6).

Interventions

We collected data from patients treated in our outpatient's clinic with ultrasound therapy or cryo-ultrasound therapy, based on medical prescriptions. All patients underwent 10 sessions (one session per day, 3/week for 4 week, 5 minutes each) of ultrasounds' therapy with qmd® ultrasound cryo thermal (starting with 0.5 W / cm2 and progressively increasing based on the patient's response; however, not exceeding 1.5 W / cm2) and a therapeutic exercise with stretching and eccentric exercises. A group of patients instead (Cryo-Ultrasound Group-CUG, 15, 8M and 7F), during the ultrasound treatment, underwent a session of cryo-ultrasound therapy (qmd® ultrasound cryo thermal; Carrier frequency: 3 MH (superficial effect); Delivery mode: pulsed at 16 Hz with duty cycle at 20%; Output power: 1 W; Cryo at 4 ° C). The Ultrasound Group (UG, 15, 7M and 8F) on the other hand only performed ultrasound therapy (Carrier frequency: 1 MHz; Delivery mode: pulsed at 16 Hz with duty cycle at 20%; Output power: 1 W). Patients were placed lying on a bed in the prone position, while a physiotherapist, expert in the method, carried out the treatment.

Evaluations

All patients were evaluated using the Victorian Institute of Sport Assessment–Achilles questionnaire (VISA-A), a self-administered questionnaire to assess the AT clinical severity, the Visual Analogic Scale (VAS), to assess pain, and the 12-item Short Form Survey (SF12), to evaluate the functioning of the activities of daily living, at the baseline (T0) and 15 (T1), 30 (T2) and 60 (T3) days from the beginning of treatments.

Statistical analysis

For the statistical analysis, the IBM SPSS v.25 software was used, the data are expressed in terms of medians and range of variation. To evaluate the differences over time of the scales used in the two groups, the Friedman test for repeated measures on non-parametric data was used. The values of the deltas between the times of the individual variables were also evaluated (delta Dash i-j, differences

between the values of the Dash calculated in each group at time i and at time j). The differences between the calculated delta values in the two groups were evaluated using Mann Whiney non-parametric test.

Results

Thirty-three patients who met the inclusion criteria were included in our study. Three patients dropped out of care (last follow-up) for personal, non-care reasons. Of the thirty patients included (17 M, 13 F), fifteen had undergone treatment with ultrasounds therapy (UG) and fifteen with Cryo-ultrasound therapy (CUG). There were no adverse effects after the treatments. Table 1 summarizes the characteristics of the included patients.

Table 1. *Characteristics of patients included.*

Clinical parameters	Cryo-Ultrasounds Group (15)	Ultrasuonds Group (15)	P value
Age (years – mean standard deviation)	42,4±14,8	41±12,06	0,434
BMI (mean standard deviation)	20,9±2,3	21,2±2,1	0,579
Gender (n)	8M 7F	7M 8F	0,124
Dominant side (%)	100 rights; 0 left	100 rights; 0 left	-
Pain side (%)	100 rights; 0 left	100 rights; 0 left	-

BMI= Body Mass Index; Mean and standard deviation.

All evaluations performed show significant improvement over time in both groups. The CUG shows at T1 a greater increase in pain and function compared to the UG (Table 2-4).

Table 2. *Variation over time within the individual groups.*

	T0	T1	T2	T3	P value	P_{T0T1}	P_{T1T2}	P_{T2T3}	P_{T0T3}
VAS CUG						0,396	0,118	0,286	**<0,01**
(Median, min max)	4 (3-6)	3 (2-5)	2 (1-3)	0 (0-1)	**<0,01**				
VAS UG (Median,						1	0,053	0,203	**<0,01**
min max)	4 (3-6)	4 (3-5)	2 /1-4)	0 (0-2)	**<0,01**				
						0,203	0,203	0,203	**<0,01**
VISA CUG			20 (13-	7 (3-					
(Median, min max)	40 (31-59)	35 (25-49)	34)	14)	**<0,01**				
						0,243	0,243	‘,243	**<0,01**
VISA UG (Median,				8 (2-					
min max)	42 (29-62)	35 (24-54)	24 (14-39	20)	**<0,01**				

VISA: Victorian Institute of Sport Assessment–Achilles questionnaire; VAS: Visual Analogic Scale; CUG: Cryo-Ultrasounds Group; UG: Ultrasounds Group; Min: minimum; Max: maximum.

Table 3. *Comparison of changes over time between individual groups for the VAS scale.*

	CUG	UG	P value
$DeltaVAS_{T0T1}$ (Median, min max; mean)	1 (0-3); 1,27	1 (0-1); 0,53	**0,016**
$DeltaVAS_{T1T2}$ (Median, min max; mean)	1 (1-3); 1,53	2 (1-2); 1,67	0,486
$DeltaVAS_{T2T3}$ (Median, min max; mean)	1 (0-3); 1,33	**2 (1-3); 1,67**	0,267
$DeltaVAS_{T0T3}$ (Median, min max; mean)	4 (2-6); 4,13	4 (2-5); 3,87	0,539

VAS: Visual Analogic Scale; CUG: Cryo-Ultrasounds Group; UG: Ultrasounds Group; Min: minimum; Max: maximum.

Table 4. *Comparison of changes over time between individual groups for the VISA scale*

	CUG	UG	P value
Delta$VISA_{T0T1}$ (Median, min max; mean)	8 (3-19); 8,27	7 (3-12); 7,13	0,624
Delta$VISA_{T1T2}$ (Median, min max; mean)	13 (7-21); 13,20	12 (6-19)11,47	0,285
Delta$VISA_{T2T3}$ (Median, min max; mean)	13 (5-31); 14,33	18 (10-30); 17,67	0,148
Delta$VISA_{T0T3}$ (Median, min max; mean)	34 (17-55)35,8	37 (23-53)36,27	0,775

VISA: Victorian Institute of Sport Assessment–Achilles questionnaire; CUG: Cryo-Ultrasounds Group; UG: Ultrasounds Group; Min: minimum; Max: maximum.

At the end of the treatment, 85% of patients resumed sport without pain.

Friedmann's repeated measures analysis shows that both groups improved when assessed separately over time. From the subsequent post hoc analysis, a statistically significant difference is highlighted between the values evaluated at T0 and T3.

In the comparison between the variations (Δ Ti, j) of the VAS and VISA in the various follow-ups between the groups performed through the Mann Withney analysis, a statistically significant difference was found for the Δ VAS ($p = 0.016$).

Discussion

The aim of our research was to retrospectively analyse the effects of therapy with ultrasound therapy and/or cryo-ultrasound therapy in association with therapeutic exercise, based on medical prescriptions, on Achilles' tendon tendinopathy in amateur runner. Results of the study showed an improvement in pain symptoms and function at the final follow-up conducted at 2 months from the start of therapy in both groups, although the group treated with the addition of cryo-ultrasound showed a slightly better result. This effect could in part be due to the action of cryotherapy which could further reduce the inflammation process of the tendinopathy thus favouring an improvement of

the symptoms. In fact, it is known in the literature that, although we are talking about tendinopathy, without therefore highlighting the underlying degenerative or inflammatory characteristics, a certain component of degeneration is always present as well as a certain component of inflammation (7).

Nowadays, ultrasound therapy is widely used in the treatment of numerous tendinopathies (8). A recent field of study is the application of cryotherapy in addition to the latter (9,10). The rationale for this choice is precisely that cryotherapy induces a reduction in the metabolism, inflammation and tissue damage that characterize the most common tendinopathies (7). To this end, in fact, the addition of cryotherapy would reduce the duration of the acute phase of tendinopathy, interrupting the vicious circle of "inflammation, pain and immobility" which, self-perpetuating, produces a worsening of the clinical picture (7). This worsening could lead to the need to use other therapies, from the most conservative to surgery, certainly more expensive (9).

Therefore, to treat a tendinopathy it is always good to be able to ideally manage both components, also from an economic point of view. Therefore, if on the one hand ultrasound therapy has a proven effect of regenerative stimulation on the tendons (8), on the other hand, the effect of reducing inflammation is similarly supported by cryotherapy (9,10).

To our knowledge, this is the first study comparing the effectiveness of ultrasound therapy versus cryo-ultrasound therapy in patients with AT. Surely, a limitation of our study is represented by the short follow-up, even if all the patients resumed the running activity at the last follow-up. Certainly, future studies will be needed to evaluate the possible recurrence. Other limitations of our study are represented by the lack of a control group, and by the peculiarity of our patients (athletes with normal BMI, no comorbidities), future studies will be necessary in order to extend to the sedentary population and with concomitant pathologies.

Conclusions

The possible simultaneous delivery of the two treatment modalities, in patients suffering from tendinopathies, therefore represents a good possibility of synergistically exploiting their therapeutic actions. In fact, in this regard, qmd® ultrasound cryo thermal is able, through the thynk1 and thynk2

functions, during a single cycle it allows a treatment both on the surface and in depth, with the possibility of adding thermal therapy also with contrast therapy mode (alternation of hot and cold to reduce any edema). Future studies with a larger patient sample and longer follow-up are also needed to better evaluate the benefits of this treatment.

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