



EFFECT OF SHOCK WAVE THERAPY AND ULTRASOUND THERAPY WITH ECCENTRIC EXERCISE FOR PROXIMAL HAMSTRING TENDINOPATHY IN ATHLETES

Original Research Article

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ABSTRACT

Background: The aim of the study is to compare the effectiveness of shock wave therapy and ultrasound therapy with eccentric exercise for the treatment of chronic proximal hamstring tendinopathy in athletes. **Methods:** The subjects with proximal hamstring tendinopathy (n=20) were selected randomly from the physiotherapy department of as per inclusion criteria and divided into two groups. The pre-test and post-test measurements of pain and stiffness were measured using on visual analogue scale, stiffness intensity numerical rating scale, Perth hamstring tendinopathy, modified bent knee test and puravan – orava test. Group A received shock wave therapy and Group B received ultra sound therapy along with eccentric exercise for a period of 4 weeks. Post test was conducted after 4 weeks. **Results:** The comparison within Group A and Group B pre and post- test values in groups showed highly significant difference in mean value at $P \leq 0.001$, but Group A which has a higher mean value is more effective in visual analogue scale, stiffness intensity numerical rating scale, Perth hamstring tendinopathy, modified bent knee test and puravan – orava test. The shock wave therapy given to proximal hamstring tendinopathy patients were found to reduce pain and stiffness by improving the functional activities of the patients. **Conclusion:** This study concludes that extracorporeal shock wave therapy was best in among subjects with proximal hamstring tendinopathy, it also improvement in functional activities and reduction in pain and stiffness when compared to ultrasound therapy along with eccentric exercise.

Key words: Shock wave therapy, ultrasound therapy, visual analogue scale, stiffness intensity numerical rating scale, puraven orava test, modified bent knee test.



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INTRODUCTION

Proximal Hamstring Tendinopathy is a painful musculoskeletal condition. PHT is a chronic degenerative disease associated with progressive morbidity and functional decline [1]. PHT is a common among distance runner and athletes performing either primarily sagittal plane (e.g., sprinting, hurdling). The condition may also affect people who do not participate in sport and not uncommonly. Prevalence was about 16.6 per 1000 patients with hamstring tendinopathy and the incidence rate of 7.9 per 1000 patients. People who run middle and long distances have a higher incidence. Additionally, when these demands happen repeatedly, athletes who endure moderate to rigorous physical loads incur a likelihood of developing tendinopathy, which may transpire in repetitious tendon overloading and tension. Numerous extraneous and inherent variables are thought to play a role in the intricate pathophysiology of tendinopathies. Tendinopathy pain does not solely correlate with tissue destruction, reflecting that other neurophysiological or psychological factors are potentially at action [2]. Jumping and kicking like runners, people who regularly jump or kick, such as dancers or track athletes, may develop this chronic condition [3]. It is characterized by deep, localized pain in the region of the ischial tuberosity that often worsens during or after running, lunging, squatting and sitting. Proximal hamstring tendinopathy is considered to be an insertional tendinopathy, and compression of the tendon at its attachment during hip flexion/adduction is thought to be a etiological factor. Proximal tendons are compressed during hip flexion due to their position on the ischial tuberosity. This compressive loading might be a key factor in the pathogenesis of chronic injury. Its progressive could be due to its self- reinforcing nature, as the tendon thickness, compression increases [4].

Pathological Proximal hamstring tendon show increased cellularity, ground substance accumulation, collagen disorganization, and neurovascular ingrowth. Result in cell proliferation and activation eventually producing large proteins (proteoglycans). Continued cell production and protein presence disturbs cellular matrix. If load continues and the cell production and protein presence destructs the matrix further eventually leading to neovascularity. As pathology disturbs collagen structure the tendon is well designed to take loads. Pathology was defined as abnormalities at the proximal hamstring tendon substance, ill-defined pain, especially while performing sports activity or when sitting, in the ischial tuberosity that radiates distally towards the popliteal fossa. Path mechanics for this tendinopathy, with compression of the deepest fibres occurring against the ischium in position of hip flexion. The semimembranosus is most commonly affected as it sits deepest, running behind the common origin of the

biceps femoris long head and semitendinosus. The combination of compressive and tensile loads is most damaging to tendon; higher tensile loads will be induced by posterior of stretch hip flexion and knee extension. The hamstrings group is highly active in late swing and early stance. Reflecting a period of high compressive and tensile loads for the hamstring tendons. During this phase the hamstring tendon will also be undergoing a period of significant energy storage and release, often referred to as a stretch shortening cycle [5].

Athletes presenting with tendinopathy of the proximal hamstring segment fare more susceptible to pain that may descend downward through posterior aspect of the thigh and frequently manifests itself adjacent to the impacted limb's ischial tuberosity. Sciatic nerve may be directly irritated by the proximal hamstring injury, creating true sciatic nerve involvement, however most often PHT mimics sciatica causing hamstring pain that refers down the posterior thigh [6]. Symptoms may occur due to excessive use of static stretches, e.g.... yoga and Pilate's posture that involve sustained end range hip flexion. Common symptoms include pain with prolonged sitting, primarily on hard surface, pain with forward flexion of the trunk and pain with running, often noted in later part of swing phase [7]. Appropriate outcome measures for PHT is visual analogue scale (VAS) is used to measure the intensity or frequency of various symptoms. Stiffness intensity numerical rating scale (SINRS) and Perth hamstring assessment tool (PHAT) [8]. Outcome measures OF PHT, diagnosed clinically sit and reach test, puraven – orava test, modified bent knee stretch test. [9]. With respect to all 3 tests, hamstring tendinopathy or strain is indicated by increasing posterior thigh pain with extension of the knee[10]. Several non-surgical options for the treatment of PHT, including shock wave therapy, eccentric exercises with trunk, pelvis musculature strengthening, corticosteroid injection, massage and soft tissue mobilization, platelet rich plasma injection, and a combined chiropractic approach [11].

Regarding the therapeutic management of tendinopathy patients, eccentric muscular bolstering currently constitutes an exceptionally widely acknowledged therapeutic exercise approach. Eccentric hamstring exercise include hamstring curls, reverse cable curls, weight bearing hamstring curls on the exercise ball, reverse plank, kneeling leg curls, and standing single or double leg dead lifts. The majority of hamstring exercise focus on resisted knee flexion, whereas runners primarily on hip extension, knee flexion to increase their speed [12]. After three, six, and twelve months, the authors eventually reached a verdict that ESWT was superior in contrast to conventional physical therapy, when speaking of discomfort as well as functionality in individuals with hamstring tendinopathy appeared to be reliable and efficient [13].

Extracorporeal Shock wave therapy as an acoustic wave, characterized by high peak pressure amplitudes (500 bar) with rise times of less than 10 nanoseconds, a short lifecycle (<10ms), and frequency spectrum ranging from 16Hz to 20MHz. Shock wave therapy is applied in a frequency up to 5Hz with 1500-2500 impulses per session used for proximal hamstring tendinopathy. Effect of intervention regarding functional disability, pain reduction, self-perceived recovery and patient rated pain reduction. Addressing injuries to the Achilles tendon issues, extracorporeal shock wave therapy (ESWT) is an additional therapeutic strategy. Cell association with the extracellular matrix and interactions between cells are all rendered conceivable by shock waves. This triggers membrane protein conformational modifications, which in response prompt's the fabrication of an intracellular signal that evolves gene expression and dissipates growth factors results in a phenomenon referred to as mechanotransduction which promotes tendon healing [14]. Shockwaves were provided by a radial shockwave generator consisting of a control unit, a hand piece, and a medical air compressor. The compressor creates pneumatic energy, which is used to accelerate a projectile inside the hand piece. A shockwave emanates when the projectile encounters the 15 mm-diameter metal applicator, propagating radially around it and throughout the area of discomfort. Ultrasound therapy is applied in a frequency of 1MHz and depth of 3 – 5 cm is used for proximal hamstring tendinopathy. It is sound wave to penetrate deep tissue. While this still has a minor warming effect on the tissue, this helps to decrease the inflammatory response, reducing tissue swelling and thus decreasing pain [15]. This research creatively combines shock wave therapy and ultrasound therapy with eccentric exercise, providing a thorough comparison to identify the best course of action for athletes with proximal hamstring tendinopathy alongside that this study bridges existing research gaps by directly comparing shock wave and ultrasound therapies with eccentric exercise, providing valuable insights into optimal treatment for proximal hamstring tendinopathy in athletes

METHODS

Design and Setting

This is a comparative pre-test and post-test study and was carried out in the outpatient physiotherapy department and took around three months.

Participants

Proximal hamstring tendinopathy was diagnosed by Modified Bent Knee Stretch Test, Puranen-Orava Test and Sit and Reach Test. The participants were adults from 22 - 45 years.

Inclusion Criteria

- Age 22 - 45 years
- Positive on Modified Bent Knee Stretch Test, Puranen-Orava Test and Sit and Reach Test
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Exclusion Criteria

- Open wound
- Skin disease
- Severe neurological disorder
- Skin over sensitivity

Sample size and Sampling method

A total of 40 volunteers participated in the study and 20 volunteers satisfied the inclusion criteria. Convenience sampling was used to obtain the subjects. The subjects were randomly allocated in group A (Shockwave Therapy) and group B (Ultrasound Therapy with eccentric exercise) using computer generated randomization.

Ethical Consideration

The study received approval from the Institutional Ethical Committee in January 2022. (Reference: G_16/PHYSIO/IRB/2021-2022). The study and questionnaire were explained to the subjects before recruitment and written informed consent was obtained from the subjects prior to inclusion into the study.

Intervention

Group A - Shockwave therapy (SWT): 3 sessions of SWT were given at an interval of two weeks. 2500 shocks were applied at 4 bars (energy flux density 0.18 mJ/mm^2) and with 10 shocks per second. Total energy flux density for each shockwave session was approximately 350 mJ/mm^2 . Shockwave was given

over the most painful area. Rotational technique was used over the area of maximum soreness. After each session, ice was applied over the treated area for 15-20 minutes at an interval of every hour for 4 hours.

Group B - Ultrasound Therapy (UST) and Eccentric exercise: 2 sessions of ultrasound therapy per week at an interval of 4 days. The frequency used was 1 MHz and the depth of penetration was 3 - 5 cm. Proper angle of transducer head was placed over the most tender area. Ultrasound gel was applied and the transducer head was then placed on the skin and then ultrasound was applied.

In addition eccentric exercises were done which included; kneeling leg curls (12×15 reps, 1RM), hamstring curls (8×12 reps, 1RM). The stretching exercises were sitting hamstring stretch with anterior pelvic tilt (4×20 seconds), standing hamstring stretch with anterior pelvic tilt (4×20 seconds) and standing contract-relax hamstring stretch with foot on a stool (4 sets of 10 seconds of contraction and 20 seconds of stretch). Activities that aggravate the condition were avoided.

After pre-test both group's received their respective treatment for a duration of 4 weeks and then post-test was carried out using the same protocol.

Outcome measures

There were three outcome measures used in this study to assess pain, stiffness and functional limitation pre and post intervention.

Visual Analogue Scale (VAS): Pain intensity was assessed using VAS as this is a valid and commonly used tool for measuring pain in musculoskeletal conditions. A 10 cm line was used with one end labelled as "no pain" and the other end labelled as "worst pain imaginable". The participant was asked to mark a point that represents the pain intensity at that time and the distance from the "no pain" end was measured in cm. The greater the distance the greater is the pain intensity. This scale is widely used in this field [16].

Stiffness Intensity Numerical Rating Scale (SINRS): Stiffness intensity was measured using this numerical scale. The participant is asked to rate the stiffness present in the hamstrings. Greater the score indicates more stiffness. The score is assigned on the basis of the stiffness perceived at the time of measurement [17].

Perth Hamstring Assessment Tool (PHAT): A tool which has been used to assess functional limitation due to proximal hamstring tendinopathy was used. This is a condition specific and patient reported outcome measure. It was originally developed by Blakeney et al., for proximal hamstring tendon injury and has been shown to be highly internally consistent (Cronbach's alpha 0.80), highly repeatable (ICC 0.84) and highly sensitive to change. PHAT has a score ranging from 0 to 100. The higher the score the greater is the function and lower the limitation. This tool has been used and validated in numerous studies of hamstring injury outcomes [18].

Statistical Analysis

All data were tabulated and analysed using descriptive and inferential statistics using SPSS 24. All data analyses were carried out at a 95% confidence interval and statistical significance level of $p < 0.05$. Data normality was carried out using the Shapiro-Wilk test. The data for VAS ($p = 0.513$), SINRS ($p = 0.215$) and PHAT ($p = 0.329$) was normally distributed ($p > 0.05$) and so parametric tests were used. An unpaired (independent) t-test was used to compare data between Group A and Group B and a paired t-test was used to compare pre- and post data within the groups.

RESULTS

20 patients participated in this study. 10 patients were included in each group (Group A: Shockwave Therapy and Group B: Ultrasound Therapy with eccentric exercise).

Mean Visual Analogue Scale scores (VAS) for Group A and Group B showed a significant reduction in pain intensity at post-test. Pre-test the means of the VAS values for both the groups were not significantly different (Group A: 7.30 ± 0.674 and Group B: 7.00 ± 0.666 ; $t = 1.00$, $df = 18$, $p = 0.331$). Post-test the mean VAS value for Group A was 4.10 ± 0.737 as compared to Group B 5.30 ± 0.674 . There was a significant difference in pain intensity reduction between the two groups ($t = -3.79$, $df = 18$, $p = 0.000$). Hence the null hypothesis was rejected. Shockwave Therapy was more effective in reduction of pain intensity as compared to Ultrasound Therapy with eccentric exercise. (Table 1)

TABLE-1 COMPARISON OF VISUAL ANALOGUE SCALE SCORE (VAS) BETWEEN GROUP – A AND GROUP - B IN PRE AND POST TEST

VAS	#Group - A		#Group - B		t - Test	df	Significance
	Mean	S.D	Mean	S.D			
Pre Test	7.30	.674	7.00	.666	1.00	18	.331*
Post Test	4.10	.737	5.30	.674	-3.79	18	.000***

(* - $P > 0.05$), (** - $P \leq 0.001$)

Mean Stiffness Intensity Numerical Rating Scale values (SINRS) for Group A and Group B also showed a significant reduction in stiffness at post-test. Pre-test mean values of SINRS for the two groups were not significantly different (Group A: 5.80 ± 0.788 and Group B: 5.90 ± 0.567 ; $t = -0.325$, $df = 18$, $p = 0.331$). Post-test mean value of SINRS for Group A was 3.70 ± 0.674 as compared to 4.30 ± 0.483 for Group B. There was a significant difference in reduction of stiffness between the two groups ($t = -2.28$, $df = 18$, $p = 0.000$). Hence the null hypothesis was rejected. Shockwave Therapy was more effective in reduction of stiffness as compared to Ultrasound Therapy with eccentric exercise. (Table 2)

Mean values of the Perth Hamstring Assessment Tool (PHAT) for Group A and Group B showed a significant increase in functional ability at post-test. Pre-test mean values of PHAT for the two groups were not significantly different (Group A: 55.50 ± 4.11 and Group B: 55.90 ± 4.06 ; $t = -0.219$, $df = 18$, $p = 0.829$). Post-test mean value of PHAT for Group A was 28.60 ± 2.63 as compared to 41.40 ± 4.83 for Group B. There was a significant difference in functional improvement between the two groups ($t = -7.35$, $df = 18$, $p = 0.000$). Hence the null hypothesis was rejected. Shockwave Therapy was more effective in functional improvement as compared to Ultrasound Therapy with eccentric exercise. (Table 3)

Intra-group analysis of pre-test and post-test VAS, SINRS and PHAT values showed highly significant difference for both the groups ($p \leq 0.001$). This shows a significant improvement in pain, stiffness and functional ability with both the therapy groups. Inter-group analysis consistently favoured Group A

(Shockwave Therapy) over Group B (Ultrasound Therapy with eccentric exercise) in reduction of pain and stiffness and improvement in functional ability.

TABLE – 2 COMPARISON OF SINRS SCORE BETWEEN GROUP – A AND GROUP - B IN PRE AND POST TEST

SINRS	#Group - A		#Group - B		t - Test	df	Significance
	Mean	S.D	Mean	S.D			
Pre Test	5.80	.788	5.90	.567	-.325	18	.331*
Post Test	3.70	.674	4.30	.483	-2.28	18	.000***

(* - $P > 0.05$), (** - $P \leq 0.001$)

TABLE – 3 COMPARISON OF PHAT SCORE BETWEEN GROUP – A AND GROUP - B IN PRE AND POST TEST

PHAT	#Group - A		#Group - B		t - Test	df	Significance
	Mean	S.D	Mean	S.D			
Pre Test	55.50	4.11	55.90	4.06	-.219	18	.829*
Post Test	28.60	2.63	41.40	4.83	-7.35	18	.000***

(* - $P > 0.05$), (** - $P \leq 0.001$)

DISCUSSION

To our knowledge there is no study which compares the effectiveness of shock wave therapy and ultrasound therapy along with eccentric exercise intervention of proximal hamstring tendinopathy. In this study Group A with a mean value of ($P \leq 0.001$) showed significant changes after performing both extra corporeal shock wave therapy and ultrasound therapy improved flexibility and reduced stiffness and pain. Whereas after performing ultrasound therapy Group B showed mild changes compared to Group A. the extra corporeal shock wave therapy showed greater improvement with mean value ($P \leq 0.001$).

Its reported that by applying extra corporeal shock wave therapy is more effective in reducing stiffness and improve flexibility [7]. The Proximal Hamstring Tendinopathy Utilizing Eccentric Training, Lumbopelvic Stabilization is effectiveness of this treatment.it was observed that pain and stiffness of the hamstring is reduced within 1 to 2 weeks of treatment [8].

The result of our study showed that Group A (extra corporeal shock wave therapy) had beneficial effect or improvement in reducing pain and improving functional activities. Group B (ultrasound therapy) along with eccentric exercise showed mild improvement in reduction pain and improvement in functional activities Both the groups showed significant decreased in post – test Mean values on visual analogue scale, but group A (extra corporeal shock wave therapy) which has the lower mean value is more effective than (Group B - Ultrasound Therapy and eccentric exercises) 5.30 at $P \leq 0.001$. On comparing the mean values of Group A & Group B on SINRS Score, it shows a significant decrease in the post-test mean values in both groups, but (Group A - Shock Wave Therapy) shows 3.70 which has the lower mean value is more effective than (Group B - Ultrasound Therapy and eccentric exercises) 4.30 at $P \leq 0.001$. On comparing the mean values of Group A & Group B on PHAT Score,

It shows a significant decrease in the post-test mean values in both groups, but (Group A - Shock Wave Therapy) shows 28.60 which has the lower mean value is more effective than (Group B - Ultrasound Therapy and eccentric exercises) 41.40 at $P \leq 0.001$. On comparing Pre-test and Post-test within Group A & Group B on VAS, SINRS and PHAT score shows highly significant difference in mean values at $P \leq 0.001$.

CONCLUSION

This study concludes that extracorporeal shock wave therapy was best in among subjects with proximal hamstring tendinopathy, it also improvement in functional activities and reduction in pain and stiffness when compared to ultrasound therapy along with eccentric exercise. This investigation exhibits a paradigm shift, highlighting that Extracorporeal Shock Wave Therapy is the benchmark of excellence for treating athletes with proximal hamstring tendinopathy. Its unprecedented aptitude to reduce pain and increase function signals the commencement of an innovative era in sports medicine by providing athletes with unprecedented levels of recuperation as well as advancement."

LIMITATIONS

This research has some limitations. Firstly, the sample sizes were small (20 participants total, 10 in each group). This reduces the statistical strength and transferability of the results. It also used convenience sampling rather than random sampling from the target population which may have created selection bias. Another limitation is that this was a single centre study which reduces external validity. There was no control or placebo group so the improvement made could have been through natural recovery or placebo. There was also no blinding of outcome assessors which may have caused assessor or participant bias. Finally the follow up was only at the time directly after intervention (4 weeks) so long term response or relapse is not possible to assess.

FUTURE SCOPE

Further research could use a multi centre design with larger sample sizes and randomised participants. This would increase the statistical strength and transferability of the results. Using a control or sham therapy group would also increase the strength of the results. Blinding of outcome assessors could also increase the strength of the results. Longer term follow up could be undertaken at 3, 6 and 12 months to look at response and relapse. Further research could look at different shockwave dosing regimes. Eccentric exercise regimes in combination with shockwave treatment could also be investigated. Objective measures of the tendon such as MRI or ultrasonography could be used. A cost effectiveness analysis could also be carried out to assist with clinical choice.

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