Original article

The effect of electrical stimulation on the remediation of pain associated with patellar tendinosis: A pilot study

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ABSTRACT

Objectives: Patellar tendinosis is a common condition associated with individuals who participate in repetitive muscular actions of the knee extensors. There is very little literature examining the effectiveness of electrical stimulation on the treatment of pain associated with patellar tendinosis. The objective was to compare the effectiveness of two different protocols on pain remediation in patients with patellar tendinosis.

Material & Methods: Ten volunteers (5 females, 5 males) who were physician-diagnosed with patellar tendinosis were randomly assigned to either a 4-week standard treatment group or a 4-week electrical stimulation treatment group. Main effects and interactions were analyzed by mixed-model repeated measures ANOVA with post hoc analysis, Tukey's HSD. Dependent variables included pain intensity and pain occurrence.

Results: The main effect for treatment time differences was not significant for the pain occurrence data ($P > 0.05$). The main effect for treatment group differences was not significant for the pain occurrence data ($P > 0.05$). The main effect for Time was significant for the pain intensity data ($P \leq 0.0001$). Post-hoc analysis revealed that this difference occurred for the stimulation group's pain intensity scores between the pre-test and week four ($P < 0.05$). The main effect for the Group was not significant for the pain intensity data ($P > 0.05$). A significant Time x Group interaction was present for the pain occurrence data ($P < 0.05$). A significant Time x Group interaction was present for the pain intensity data ($P < 0.05$).

Conclusions: Clinicians may consider using the described electrical stimulation treatment protocol as the treatment may be beneficial.

Key Words: jumper's knee, tendinosis, tendinopathy

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INTRODUCTION

Increased participation in fitness activities has led to an increase in the development of numerous bone, joint, and tendon overuse injuries.[1,2,3,4] Patellar tendinosis (tendinosis, tendinopathy and tendinitis are all used in the literature), commonly referred to as jumper's knee, is a prevalent condition associated with individuals who participate in repetitive submaximal or maximal force production of the knee extensor musculature.[2,5,6,7] Fredberg and Bolvig[8] state that patellar tendinosis is a microtearing anywhere along the knee extensor mechanism from the proximal quadriceps tendon insertion to the distal patellar tendon insertion. It usually presents as aching pain in the anterior aspect of the knee, slightly inferior to the patella.[1,3,6] A number of studies have examined patellar tendinosis, focusing on sport specific populations, such as elite basketball and volleyball players.[7,10,11] Research has shown that subjects with patellar tendon pain were greater in body mass, weight trained more frequently (about 2 hours more per week), and performed more jumping bouts than a control group.[7] Muscle fatigue and overuse of tendinous tissue are thought to be important factors for the development of patellar tendinosis.[1,3] Overtraining introduces an increased strain rate that may lead to micro traumas which exceed the reparative process of the tendon.[8,12] Due to the jumping/landing mechanics of high-level athletes, they tend to be more susceptible to patellar tendinosis.[8]

Blazina, et al. & Roels et al. have developed a classification scheme that quantifies the progress of the condition: 1 – pain after activity; 2 – pain at the beginning of activity, disappearing after warming up and reappearing after completion of activity; 3 – continuous pain during and after activity and is usually accompanied by mild or severe limitations; 4 – complete rupture of the tendon and requires surgical attention.[2,3,6,9]

Treatment for patellar tendinosis can range from preventative to therapeutic to surgical.[3] Individuals in phases 1-3 of the Blazina scale are treated conservatively.[2,3,4] Traditional treatment methods for patellar tendinosis include rest, medication (NSAIDS), ice, physical therapy and the use of an infrapatellar strap. Therapeutic treatment modalities include ultrasound, phonophoresis, electrical stimulation (more recently Extracorporeal Shockwave Therapy), cross-friction massage, and stretching and strengthening exercises.[3,4,6] However, there does not seem to be a standard treatment protocol for patellar tendinosis.[2,4,5,11] Also, it can be challenging to get the individual to rest from their respective activity as they do not want to lose valuable training time. A treatment program utilized by one of the clinical authors is anecdotally showing positive results treating this condition while also allowing the individual to continue in their activity. Few controlled treatment studies of patellar tendinosis utilizing electrical stimulation have been completed.[5,8] Thus; it is the aim of the present investigation to determine the effectiveness in reducing pain of a treatment protocol involving electrical stimulation compared to the identical protocol without the use of the electrical stimulation in active individuals who present with patellar tendinosis.

MATERIALS & METHODS

Subjects

Ten moderately to highly active, college-age (20 yrs ± 2.0) males (5) and females (5) who presented with patellar tendinosis gave written informed consent to participate in the study. The college Institutional Review Board approved the project. We defined moderate to high intensity as participating in a club/varsity sport or in recreational athletics greater than, or equal to, 4 days/week. Activities included volleyball, basketball soccer and running. Subjects were diagnosed and graded with levels 1-3 (Blazina[2,3,4]) patellar tendinosis by a physician[6], fellowship-trained in

TABLE 1. Pain intensity scale

Please check the description that best describes the *intensity* of your pain when it occurs.

0_____No longer have pain.

1_____Mild, slight amount of discomfort.

2_____Moderate-1, substantial amount of discomfort, but tolerable.

3_____Moderate-2, substantial amount of discomfort, nearly intolerable.

4_____Severe, intolerable amount of discomfort.

sports medicine. Subjects were randomized into either the standard treatment (S) or the electrical stimulation treatment (E) group.

Procedures

Both groups underwent 4 weeks of treatment taking place 3 days per week. On the first day of each week during the 4-week treatment period, subjects were asked to evaluate their knee pain. Two pain scales were used.6 The first scale assessed the subjective intensity of their pain (Table 1). The second scale measured the occurrence of pain during activity (Table 2). The same researcher administered the assessment scales, treatment program and monitored subject compliance.

Treatment Groups

One group of subjects performed the treatment listed below while the second group performed the identical treatment protocol as the first, excluding electrical stimulation. The treatment protocol is outlined below.

- Goal
  - o Diminish pain

TABLE 2. Pain occurrence scale

Please check the description that most accurately describes the *occurrence* of your present pain.

0_____No pain.

1_____Pain only occurs after participating in an activity.

2_____Pain appears when starting the activity; disappears after "warming up" but reappears after the activity is completed.

3_____Pain is present during the activity and after the activity. It is severe enough to prevent participating in the activity.

4_____Pain is constantly present. It is severe enough to prevent participation in all activity.

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- Treatment Regimen
  - o Transverse friction massage to patellar tendon for 5 minutes with massage cream
  - o Warm-up on a bicycle ergometer (10-12 min)
  - o Standard stretch of the hamstrings, quadriceps, and gastrocnemius
  - o Application of electrical treatment to patellar tendon (10 min)
    - Electrical stimulation parameters
      - Waveform: Russian
      - Frequency: 2500 Hz pulse; Width: 200 ms; Rate: 50 sec
      - 60 pulses per second
      - Duty cycle 10 on / 10 off; ramp of 5 second
      - Intensity was as high as subject could tolerate to start, and was increased every 3 minutes
    - Pad placement
      - 1"x1" electrodes placed on each side of patellar tendon
    - Quadriceps strengthening program
      - Eccentric quadriceps loading utilizing a 30 deg decline tilt board
      - Forward touchdowns

Statistical Analysis

We analyzed the data using SPSS (version 14.0; SPSS Inc, Chicago, IL) statistical software. Main effects and interactions of both pain assessments were analyzed by mixed-model repeated measures ANOVA with post hoc analysis, Tukey's HSD, where appropriate. Dependent variables included pain intensity and pain occurrence. The independent variable was the two different treatment protocols. The level of significance for all statistical tests was set at $P \leq 0.05$.

TABLE 3. Pain intensity and pain occurence assessment descriptive statistics

Time	Pain Intensity M + SD	Pain Occurrence M + SD
Pre		
Group N	2.60 + 0.894*	3.00 + 0.707#
Group E	1.80 + 0.447	1.80 + 0.447#
Week 1		
Group N	1.80 + 0.837	2.60 + 0.548
Group E	1.40 + 0.548	1.80 + 0.837
Week 2		
Group N	1.80 + 0.837	2.00 + 0.707
Group E	1.60 + 0.548	1.80 + 0.837
Week 3		
Group N	1.20 + 0.837	2.20 + 0.837
Group E	1.60 + 0.548	2.40 + 0.548
Week 4		
Group N	1.00 + 0.707*	2.20 + 0.837
Group E	1.40 + 0.548	2.40 + 0.548

N = no electrical stimulation used during treatment
E = electrical stimulation used during treatment
*, # indicates statistically significant difference at $P \leq 0.05$

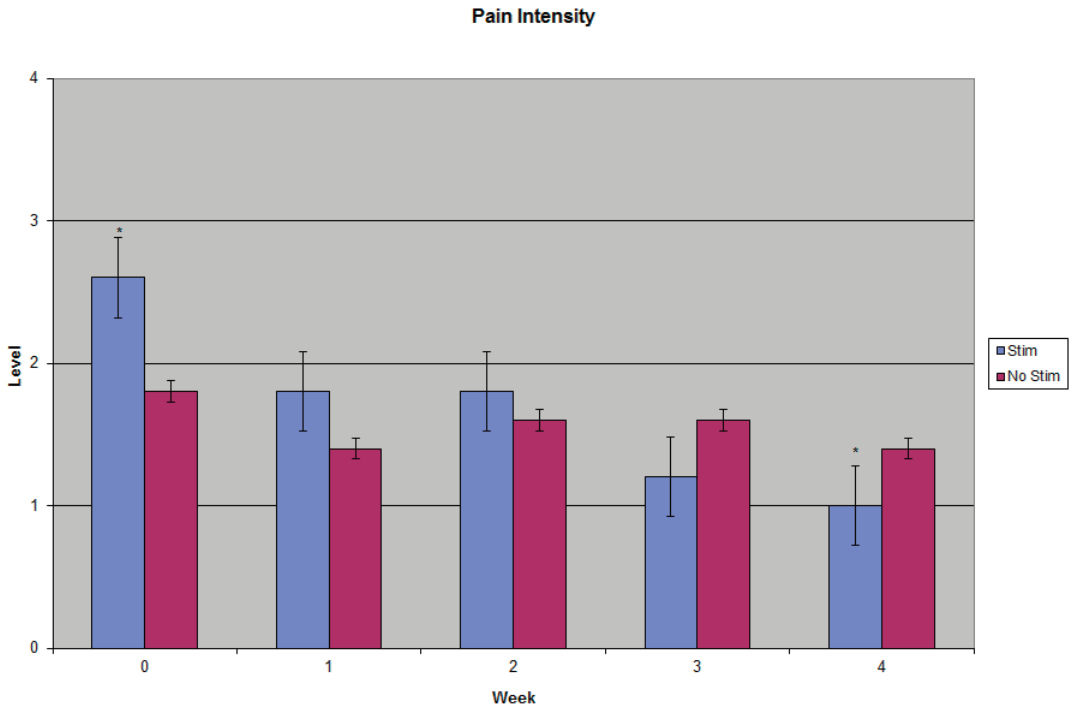

FIGURE 1. Pain Intensity Assessment Data. *Indicates statistically significant difference ($P \leq 0.05$).

RESULTS

Descriptive statistics for both the pain intensity and pain occurrence assessments are presented in Table 3 and Figures 1-2. The mixed-model ANOVA examined the effects of the group (e-stim or

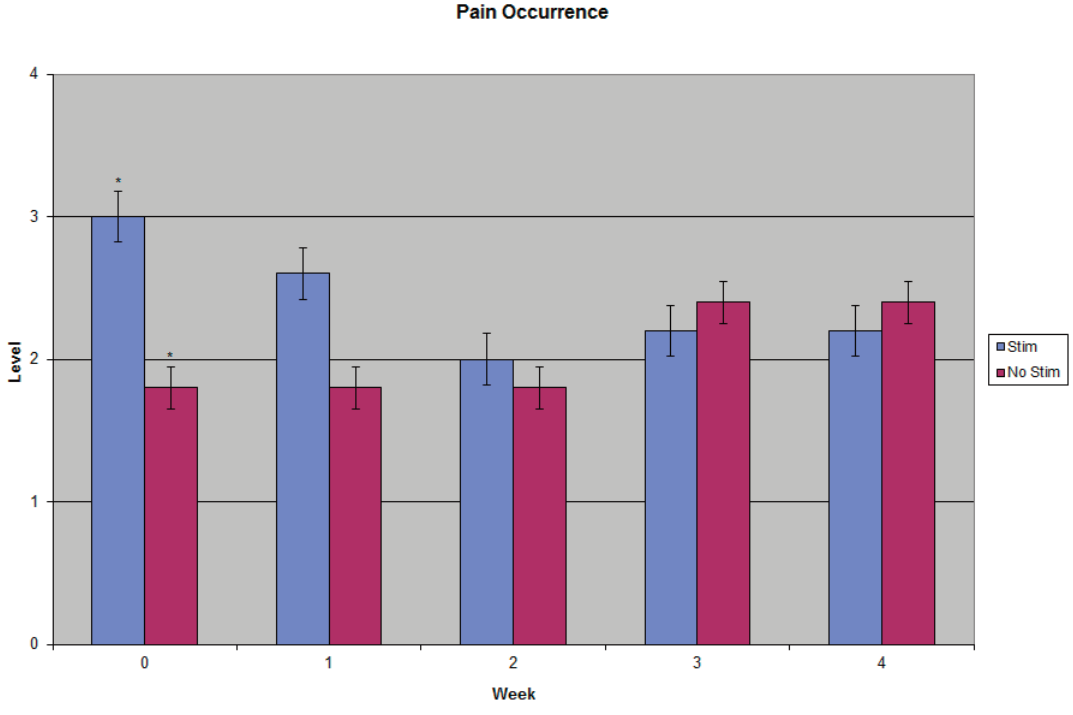

FIGURE 2. Pain Occurrence Assessment Data. *Indicates statistically significant difference ($P \leq 0.05$).

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no e-stim) and time (pre, wk1, wk2, wk3, wk4) on pain intensity and occurrence. There was no statistically significant difference for pre-test data between the two groups for pain intensity or pain occurrence. A significant Time x Group interaction was present for the pain intensity data ($F_{4,32} = 4.945$, $P = 0.003$). The calculation of effect size revealed that the interaction between time and group accounted for 7% of the treatment variance. The main effect for Time was significant for the pain intensity data ($F_{4,32} = 10.327$, $P \leq 0.0001$). Post-hoc analysis revealed that this difference occurred for the stim group's pain intensity scores between the pre-test and week four ($P = 0.043$). The calculation of effect size revealed that the time variable accounted for 18% of the treatment variance. The main effect for Group was not significant for the pain intensity data ($F_{1,8} = 0.097$, $P = 0.763$). Thus, there were no differences between the two groups for any of the weekly assessments of pain intensity.

A significant Time x Group interaction was present for the pain occurrence data ($F_{4,32} = 3.959$, $P = 0.010$). Step down analysis revealed this difference occurring between the pre-test data of both groups. The calculation of effect size revealed that the time variable accounted for 11% of the treatment variance. The main effect for Time was not significant for the pain occurrence data ($F_{4,32} = 1.510$, $P = 0.223$). The main effect for Group was not significant for the pain occurrence data ($F_{1,8} = 1.102$, $P = 0.324$). All possible treatment sessions were attended by each subject.

DISCUSSION

It was the purpose of the study to compare the effectiveness of two different protocols on the remediation of pain associated with patellar tendinosis. Overuse injuries, including tendinosis, account for nearly 7 percent of all injury-related physician office visits in the United States.[13] While there are many proposed treatments for patellar tendinosis ranging from conservative therapy to surgical interventions; the literature does not recommend a standardized treatment regimen. The study utilized a treatment protocol that incorporates the usage of electrical stimulation across the patellar tendon. The authors have noted clinical success with this protocol on the remediation of pain associated with patellar tendinosis even while the individual continued their activity.

One of the issues presented within the methodology was how to measure the effectiveness of the treatment protocols. Concern developed on whether to use physical measures (i.e., isometric, isoinertial, or isokinetic strength, ROM and/or functional tests) or subject-driven measures of the protocols' effectiveness. As noted from the methods section, the decision was made to incorporate rating scales of pain intensity and pain occurrence. It was felt that the subjects' ratings of their pain was more clinically and practically relevant to both the subject and clinician. These types of measurements have been utilized in other studies of patellar tendinosis treatment.[14] There are a number of research trials examining the treatment of patellar tendinosis. However, we found no studies (Article First, Blackwell Synergy, Health Source, Kluwer Online, MEDLINE, Periodical Abstracts, PubMed, Science Direct, Sport Discus &Wilson Select Plus) which included the usage of electrical stimulation across the patellar tendon as part of the protocol.

For pain intensity, a significant difference was noted between the pre-test and week 4 data for the electrical stimulation group. Even though this was the only statistically significant data points for the pain intensity scale, one would be remiss not to note the trend for the group means. The treatment group's pain intensity scores dropped eight-tenths of point from pre-test to weeks 1 and 2. There was six-tenths of a point drop from week 2 to week 3. Also, there was two-tenths of a point drop from week 3 to week 4. Relating this data back to the pain intensity scale a move from a "nearly intolerable" pain level to a "slight amount of discomfort" level is noted. From a practical and clinical perspective, this is substantial improvement over a 4-week time period.

Especially when compared to the pain intensity data for the control group which made four-tenths of a point improvement over the same amount of time.

The pain occurrence data noted a small shift from pre-test to week 4 data for either of the groups. Even though there were not statistically significant differences within each group for pain occurrence, the trend for the treatment group is encouraging as there was eight-tenths of a point improvement. The non-electrical stimulation group means for each data point are noteworthy in that an increase in pain occurrence of six-tenths of a point over the 4-week treatment protocol. Again, practically and clinically the data seems to support the usage of electrical stimulation as part of a pain remediation program for patellar tendinosis.

While the study did not show statistical difference between the treatment groups, within group statistical differences were noted and both the between group and within group data trends positively for the support of this type of treatment protocol. Future studies should attempt to substantiate our preliminary findings by utilizing a greater number of subjects which would increase statistical power. Various electrical stimulation protocols should be examined. The utilization of other pain assessment scales may also be warranted. Lastly, research should lend itself to the development of standardized protocols for the treatment of patellar tendinosis.

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