

# To Stim or Not to Stim: Use of NMES With Basas Spanish Squat in Individuals With and Without Patellar Tendinopathy

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## Summary

Patellar tendinopathy is characterized by tissue dysfunction accompanied by pain during tendon loading. This investigation assessed *in vivo* patellar tendon tension, perceived effort, and pain during the Basas Spanish squat with and without superimposed neuromuscular electrical stimulation (NMES) in individuals with and without patellar tendinopathy. The results obtained may help guide treatment considerations for patellar tendinopathy.

## Introduction

Treatment for patellar tendinopathy aims to recover typical tendon structure through targeted loading [1]. Isometric exercises, like the Basas Spanish Squat, are effective in decreasing pain, and adding superimposed NMES to this exercise generates greater tendon strain compared to open kinetic chain knee extension [2]. While pain and tendon strain have been evaluated during Basas Spanish Squats with and without NMES[2], patellar tendon tension during these exercises has not been explored. The objective of this study was to assess patellar tendon tension, pain, and perceived effort during Basas Spanish Squats with and without NMES in individuals with and without patellar tendinopathy.

## Methods

Five participants with patellar tendinopathy (1F:4M, age = 24.4±4.6 years, BMI = 23.6±2.7 kg/m<sup>2</sup>), and 5 control participants matched by age, sex, and BMI (1F:4M, age = 25.2±4.5 years, BMI = 25.2±2.1 kg/m<sup>2</sup>), were included.

A custom-built shear wave tensiometer was used to measure tendon mechanical properties by inducing a shear wave through the tendon with a mechanical tapper (SparkFun Electronics) and detecting the downstream propagation of the shear wave with two mini accelerometers (PCB Piezotronics). Analysis was completed using a custom Matlab code [3]. Shear wave tensiometers were fitted to the dominant limb, defined as the one used to kick a ball, for healthy controls, and the most symptomatic limb for those with patellar tendinopathy.

Two 3x5 inch electrodes were placed over the motor points of the quadriceps muscles on the limb of interest and participants' maximum tolerated intensity of NMES was determined using a trigger-activated commercial electric stimulator (Chattanooga, Continuum). Basas squats were performed with a rigid strap behind the knees. In the SQUAT condition, participants performed a set of 8 Basas squats, with a 5s isometric hold at 90 degrees of knee flexion. This protocol was repeated in the SQUAT<sup>+</sup> condition with the addition of self-triggered NMES for the duration of the isometric hold. The SQUAT and SQUAT<sup>+</sup> conditions were repeated twice, for a total of 3 sets each.

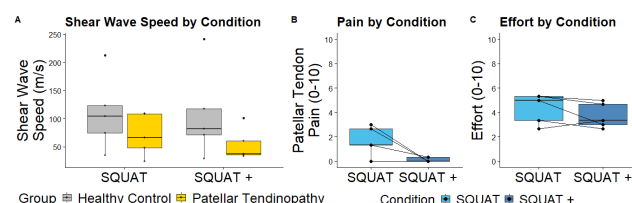
Participants rated perceived effort and knee pain during each set on a 0-10 scale.

Peak shear wave speed was extracted from shear wave tensiometry data and averaged across reps for each set of SQUAT and SQUAT<sup>+</sup>. A 2-way ANOVA was performed to assess differences in shear wave speeds between groups (control, tendinopathy) and conditions (SQUAT, SQUAT<sup>+</sup>); paired t-tests compared effort and pain ratings between conditions in the patellar tendinopathy group.

## Results and Discussion

There was no significant main effect of group ( $F[1,16]=2.67$ ,  $p=0.12$ ), condition ( $F[1, 16]=0.03$ ,  $p=0.86$ ), or the interaction between the two ( $F[1,16]=0.13$ ,  $p=0.74$ , Figure 1A) for shear wave speed. In individuals with patellar tendinopathy, pain reduction with the addition of NMES approached significance ( $p=0.05$ , Figure 1B), but perceived effort was not significantly different between conditions ( $p=0.23$ , Figure 1C). Given our small sample size, variability in individuals' tendinopathy presentations and responses to stimulation could impact these results.

While adding NMES to the Basas Squat has been shown to induce greater patellar tendon strain compared to Basas Squats alone [1], group differences in patellar tendon tension in between SQUAT and SQUAT<sup>+</sup> were not observed. All tendinopathic individuals with pain during SQUAT reported decreased pain with SQUAT<sup>+</sup>; however, a larger sample size is needed to confirm this effect.



**Figure 1:** Shear wave speed in both groups (A) and perceived effort (B) and pain ratings (C) in the patellar tendinopathy group during the SQUAT and SQUAT<sup>+</sup> conditions.

## Conclusions

When NMES is superimposed during Basas Spanish Squats, individuals with patellar tendinopathy can achieve similar tendon loading with less pain. Applied clinically, our findings can allow these individuals to achieve therapeutic dosages of tendon loading with less pain limitations.

## Acknowledgments

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## References

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