In vivo assessment of patellar tendon loading during Basas Spanish squats with neuromuscular electrical stimulation

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Summary

Patellar tendinopathy causes load-related pain in the patellar tendon that can be managed through progressive tendon loading. In this study, we employ shear wave tensiometry in healthy participants to measure loading in the patellar tendon during two methods of patellar tendinopathy intervention: Basas Spanish squats with and without superimposed neuromuscular electrical stimulation (NMES). We hypothesize that patellar tendon loading will be greater with NMES superimposed. This assessment may help establish optimal loading conditions for patellar tendinopathy rehabilitation.

Introduction

Patellar tendinopathy is a painful condition affecting everyday functionality of the knee. The Basas Spanish squat with neuromuscular electrical stimulation (NMES) has been shown to decrease pain in individuals with patellar tendinopathy through mechanical strain of the tendon [1]. Experimental limitations have prevented direct measurement of the tension through the patellar tendon during Basas Spanish squats. Shear wave tensiometry is a technique that enables the direct measurement of soft tissue load [2]. This study aims to compare changes in patellar tendon loading during Basas Spanish squats with or without NMES superimposed. We hypothesize that Basas Spanish squats with NMES will yield the largest tendon load.

Methods

Twenty healthy adult participants (9M/11F) were recruited for this study. The dominant leg of each participant was fitted with two electrodes over the quadriceps motor points to deliver NMES [1] and a shear wave tensiometer over the patellar tendon to measure patellar tendon load [2]. For the squat condition, participants performed 3 sets of 8 Basas Spanish [1] squats with a 5 second hold at 90º of knee flexion. For squat+NMES trials, participants completed 3 sets of 8 Basas Spanish squats while using a trigger to activate NMES during a 5-second hold at the bottom of each repetition. Shear wave tensiometry was used to measure patellar tendon tension during each set of Basas Spanish squats. A paired t-test in statistical parametric mapping (SPM) was used to identify differences in shear wave speed patterns between squat and squat+NMES conditions.

Results and Discussion

No statistically significant differences were found in shear wave speed patterns between squat and squat+NMES trials (SPM{t} > 3.30). While there were no significant differences in loading patterns, Table 1 shows an increase in average patellar tendon shear wave speed during the squat+NMES condition with a high degree of variance between participants.

Table 1. Mean and standard deviation of shear wave speed for squat and Squat+NMES conditions

Squat Condition	Shear Wave Speed (m/s)
Squats	37.80 ± 27.8
Squat+NMES	43.14 ± 31.0

A high degree of between-subject differences in response to the stimulations was evident in some, but not all, participants. Loading patterns for a representative subject (Fig. 1) show an individual response with increased shear wave speed in the squat+NMES condition.

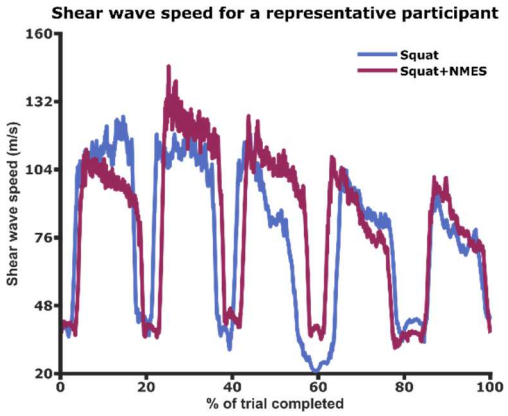

Figure 1. Shear wave speed pattern for a representative subject showing multiple repetitions of squat and squat+NMES

Our findings suggest that in some cases Basas Spanish squats with superimposed NMES could increase patellar tendon strain compared to Basas Spanish squats in some individuals. To better understand the population variability seen in this study, ongoing and future work aims to characterize strength and loading patterns using dynamometry and motion analysis.

Conclusions

Shear wave tensiometry was used to assess patellar tendon loading during Basas Spanish squats with and without NMES. While an increase in patellar tendon loading was observed, results remain inconclusive due to high between-subject variability, potentially influenced by muscular loading or movement patterns

Acknowledgments

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References

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[2] Martin et al. (2018). *Nat Commun*. **9**:1592.