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SCIATIC NERVE STIFFNESS INFLUENCES THE MAXIMAL ANKLE RANGE OF MOTION

^{1,2}Ricardo J. Andrade, ^{2,3}Sandro R. Freitas, ^{1,4}Guillaume Le Sant, ¹Lilian Lacourpaille, ^{1,5}François Hug, ^{1,6}Raphaël Gross, ¹Antoine Nordez

¹ University of Nantes, Laboratory "Movement, Interactions, Performance" (EA 4334), Faculty of Sport Sciences, Nantes, France;

²Universidade de Lisboa, Faculdade de Motricidade Humana, Lisbon, Portugal; ³Benfica Lisboa e Benfica LAB, Lisbon, Portugal; ⁴School of Physiotherapy (IFM3R), Nantes, France; ⁵The University of Queensland, NHMRC Centre of Clinical Research Excellence in Spinal Pain, Injury and Health, School of Health and Rehabilitation Sciences, Brisbane, Australia; ⁶Gait Analysis Laboratory, Physical and Rehabilitation Medicine Department, University Hospital of Nantes, Nantes, France

Corresponding author email: ricardo.andrade @univ-nantes.fr

INTRODUCTION

The maximal range of motion (ROM) of a joint is an important functional parameter to estimate the maximal muscle length or muscle extensibility [1]. It is a long-held belief that maximal dorsiflexion ROM is restricted by the tension within the calf muscles [2]. However, it is thought that peripheral nerves may also limit the ROM [3], but it has never been demonstrated. This study aimed to determine: 1) whether the sciatic nerve stiffness assessed using ultrasound shear wave elastography is correlated with the maximal dorsiflexion ROM (experiment I); and 2) whether a 6-min static stretch of the sciatic nerve increases the ankle's maximal ROM (experiment II).

METHODS

Sciatic nerve and *gastrocnemius medialis* (GM) shear wave velocity (SWV), an index of stiffness, was assessed using elastography. In both experiments, the knee of the tested lower limb was fully extended, and passive maximal dorsiflexion ROM was assessed with the hip neutral (HIP-neutral, 0°) or flexed at 90° (HIP-flexed), where the maximal dorsiflexion ROM is known to be considerably lower [3]. In the experiment I, the ROM difference between these two hip positions (Δ ROM) was calculated for 29 healthy participants. The sciatic SWV was then assessed in HIP-neutral during one ankle rotation (2°/s). Pearson (r) correlation coefficients were calculated at different ankle angles to determine whether the Δ ROM depends on the sciatic nerve stiffness.

In the experiment II, 15 healthy participants performed Stretch and Control sessions, in a randomized order. In both sessions, the maximal dorsiflexion ROM (HIP-neutral and HIP-flexed), ankle torque, the electromyography (EMG) of calf and *tibialis anterior* muscles, and SWV of the sciatic nerve and GM were assessed before and immediately after the intervention. Participants underwent a total of 6-min rest in HIP-neutral (Control session) or sciatic nerve stretching (Stretch session), where the hip joint was passively flexed, and followed by thoracic and cervical flexion. During both interventions, the knee of the tested lower limb remained in full extension, and the ankle angle was maintained in neutral position (0°) to minimize the stretch of the calf muscles. Repeated measures ANOVAs were performed to analyze the effects of nerve stretch of the aforementioned variables.

RESULTS AND DISCUSSION

In the experiment I, large correlations were observed between the sciatic nerve stiffness and the maximal ROM in dorsiflexion ($0.570 < r < 0.712$, $p < 0.001$, Figure 1A), suggesting that nerve stiffness can play an important role on the maximal dorsiflexion ROM. In the experiment II, the nerve stretching induced a 13.3% ($\pm 7.9\%$) decrease in the sciatic stiffness ($p < 0.0001$) and an increase in the maximal dorsiflexion ROM ($+25.1\% \pm 20.1\%$; $p < 0.0001$); in the absence of any changes in GM stiffness, ankle torque, and

EMG (Figure 1B). No changes were found for all the variables in the Control session. These results showed that it is possible to considerably alter the maximal dorsiflexion ROM without stretching the calf muscles. As the sciatic nerve stiffness decreased, we are confident that the increase in maximal ROM is due to the decrease in sciatic nerve stiffness. A further analysis showed that after the nerve stretch (Stretch session) the increase in maximal dorsiflexion ROM in HIP-flexed, position that strongly stretches the sciatic nerve, was correlated to the decrease in the nerve stiffness ($r = -0.529$, $p = 0.042$; Figure 1C).

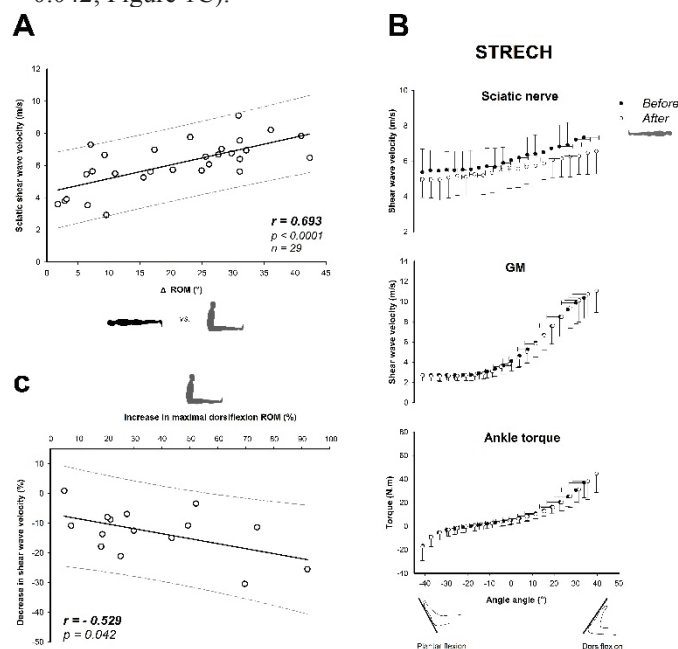


Figure 1: A, Correlation between the SWV and the Δ ROM; B, Effects of nerve stretch (Stretch session) on the sciatic nerve and GM SWV and ankle torque; C, Correlation between the changes induced by the nerve stretch in sciatic nerve SWV and maximal dorsiflexion ROM (HIP-flexed).

CONCLUSIONS

The present study shows that: 1) the maximal dorsiflexion ROM can be limited sciatic nerve stiffness, a non-muscular tissue; and ii) a sciatic nerve stretching induces a significant decrease in local nerve stiffness that is accompanied by an increase in ankle's flexibility without altering calf muscles stiffness and ankle torque.

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