EFFECTS OF MUSCLE FATIGUE ON SHOULDER JOINT POSITION SENSE
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INTRODUCTION
The shoulder complex relies heavily on sensory-motor control for maintaining functional joint stability, due to its poor osseous and capsuloligamentous stability. Proprioceptive deficits have been related to shoulder injuries and some studies have shown that muscle fatigue can also decrease proprioceptive acuity [1-3]. However, these studies have focused on shoulder internal and external rotation movements, which may not be functional for the general population. Therefore, this study aimed to investigate the effects of muscle fatigue on shoulder joint position sense during an active repositioning task at different angles of shoulder elevation in the scapular plane.

METHODS
At the time of this abstract submission, the dominant arm of five healthy subjects (3 females, 2 males, mean age 22.6±3.6 years), with no history of shoulder injury and no currently involvement in sports with upper limbs were evaluated. Initially, the participants performed 3 maximal isometric voluntary contractions (MVIC) of shoulder abduction, 5 seconds each, at 90° of shoulder elevation in the scapular plane. The average force between 2 and 3 seconds was considered. The mean of the three trials was used to calculated the weight to be used during the fatigue protocol, correspondent to 20% of MVIC.

Joint position sense was evaluated during active joint repositioning tasks, using an app for iPod touch developed at the Orthopaedic Biomechanics Lab. The device was attached to the distal arm of the subjects. The initial position was with the arm at the trunk side. The subjects were instructed to elevate their arm in the scapular plane until a verbal tone was silenced. This happened when their arm was within 2° of the target. They were instructed to hold this target position for 3 s and subsequently return the arm to the initial position. After 2 s, they were instructed to reproduce the target position, with no audio or verbal feedback. Three target angles of elevation (50°, 70° and 90°) were presented, two times each, in a randomized order. The differences between the target and reposition angles were calculated, and the mean (constant error) used for analysis.

Following the baseline JPS evaluation, subjects performed a fatigue protocol, which consisted of performing shoulder elevation in the scapular plane, up to 90° of shoulder abduction, at a frequency of 1Hz. When the subjects could not perform the movement at this frequency or through the complete range of motion, the MVIC was tested again. If the force had fallen less than 50% of baseline MVIC, the exercise was continued. When the drop in force was higher than 50% of baseline MVIC, the exercise was stopped and JPS immediately reassessed.

RESULTS AND DISCUSSION
Figure 1 shows that the constant errors increased after the fatigue protocol. This finding is in accordance with previous studies that found deficits in shoulder internal and external rotations repositioning and threshold of movement detection after fatigue [1-3].

The pre fatigue results shows a pattern of smaller errors at higher elevation angles, as previously found [4]. However, after muscle fatigue, the relationship between target angle and repositioning error was altered, with greater increase in the errors at higher elevation angles. Similar results were found in subjects with subacromial impingement in a recent study [5]. That study evaluated patients before and after a local anesthetic injection, which did not change this pattern, suggesting that other mechanisms than pain are responsible for that pattern.

CONCLUSIONS
Preliminary results indicate that muscle fatigue affects joint position sense for shoulder elevation in the scapular plane and disrupt accuracy at higher elevation angles. However, more subjects need to be evaluated to confirm these results. Future studies could test potentials interventions to try to minimize these JPS deficits, aiming to prevent shoulder injuries in risk populations.

REFERENCES

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