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## THE EFFECTS OF EXPERIMENTALLY INDUCED LOW BACK PAIN ON SPINE ROTATIONAL STIFFNESS AND LOCAL DYNAMIC STABILITY.

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**Preferred Presentation:** Oral Presentation

**If your abstract is not accepted as an oral do you wish to be considered for a poster?:** Yes

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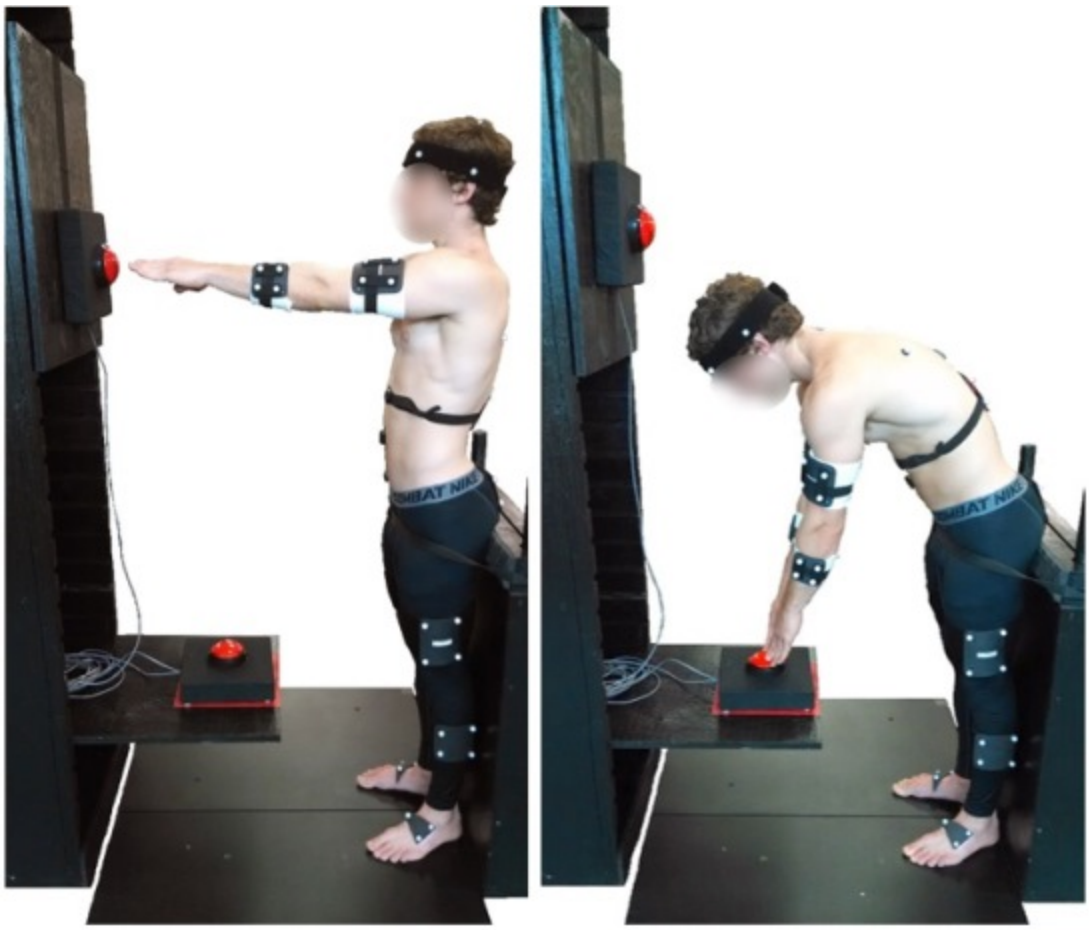
**Introduction and Objectives:** Local dynamic stability, quantified using the maximum finite-time Lyapunov exponent ($\lambda_{max}$), and the muscular contributions to spine rotational stiffness can provide pertinent information regarding the neuromuscular control of the spine during movement tasks [1]. Studying patients with low back pain (LBP) is traditionally difficult due to: large variation in subjective pain ratings across individuals; high numbers (80-90%) of non-specific diagnoses (i.e. there is no accurate or precise diagnosis and no valid and objective diagnostic tool); no pain-free data exist to compare results to; and accurate maximum voluntary contractions are nearly impossible to obtain [2,3]. The primary goal of the present study was to assess if experimental capsaicin-induced LBP affects spine stability and the neuromuscular control of repetitive trunk movements in a group of healthy participants with no history of LBP.

**Methods:** Fourteen healthy males were recruited for this investigation. Participant mean age, height, and mass were 21.79 years (SD = 2.8), 180.51 cm (SD = 7.0), and 77.83 kg (SD = 9.1), respectively. Upon arrival, participants filled out two questionnaires related to kinesiophobia: 1) Tampa Scale for Kinesiophobia (TSK), and 2) The Pain Catastrophizing Scale (PCS) [4]. Each participant was then asked to complete three trials of a repetitive trunk flexion/extension task (Figure 1), at a rate of 0.25Hz for 35 cycles: 1) baseline, 2) in pain, and 3) recovery (1 hour later). Pain was induced using a heat-capsaicin model using over-the-counter topical 0.075% capsaicin cream. Throughout these trials, trunk kinematics and electromyography were monitored as per [1], and directly before and after each trial participants rated their pain on a 100mm visual analogue scale (VAS). The local dynamic stability of spine kinematics and the muscular contributions to spine rotational stiffness were extracted using published methods [1]. Local dynamic spine stability was assessed using the maximum finite-time Lyapunov exponent (local divergence exponent), $\lambda_{max}$ [1]. Conversely, rotational stiffness was calculated about all three primary axes of movement by entering data into an anatomically-detailed EMG-driven biomechanical model consisting of 58 muscle lines of action representing seven bilateral muscle groups crossing the $L_4/L_5$ spinal joint [1]. Then, to get an estimate of total stiffness the three axes were summed, and the mean, maximum, and minimum stiffness were extracted across all cycles and averaged [1].

**Results:** The capsaicin cream was successful in inducing significantly higher levels of pain than those observed at either baseline or recovery ($p<0.001$). Local dynamic stability and the minimum muscular contributions to lumbar spine rotational stiffness were significantly impaired during the low back pain trial compared to the baseline trial ($p<0.05$); additionally, there was a trend for these measures to recover after one hour rest (Table 1). Strong correlations were found between increased perceived levels of pain and decreased spine stability and rotational stiffness. There were also strong correlations between increased kinesiophobia and perceived pain levels, and decreased spine rotational stiffness and stability.

**Figure:**



**Caption:** Figure 1. Experimental protocol. Participants were required to repetitively touch the instrumented targets with their hands held together to the beat of a metronome at a rate of 0.25Hz.

**Conclusion:** This study provides evidence that low back pain induced by capsaicin can effectively impair/inhibit spine rotational stiffness and local dynamic stability. Our current research is assessing changes to these same variables during pain induced via interspinous ligament injections, as well as further studying the relationship between kinesiophobia and LBP. An overarching goal of this research is to develop an objective diagnostic tool for assessing spine impairment and treatment effectiveness in chronic LBP patients.

**Table:**

| Mean (SD) Results | | | | Repeated-Measures ANOVA P-Value Results | | | |
|---|---|---|---|---|---|---|---|
| | Baseline | Capsaicin | Recovery | Main Effect | Baseline vs. Capsaicin | Baseline vs. Recovery | Capsaicin vs. Recovery |
| Local Dynamic Spine Stability (λmax) | 2.00 (0.15) | 2.11 (0.23) | 2.06 (0.26) | **0.048** | **0.019** | 0.442 | 0.243 |
| Mean Total Spine Stiffness (Nm/rad) | 4563.24 (137338) | 4383.20 (1591.16) | 4529.43 (1528.78) | 0.095 | 0.063 | 0.708 | 0.053 |
| Max Total Spine Stiffness (Nm/rad) | 6918.61 (2068.44) | 6781.27 (2885.77) | 7040.21 (2907.53) | 0.224 | 0.641 | 0.648 | 0.082 |
| Min Total Spine Stiffness (Nm/rad) | 2738.98 (933.39) | 2570.83 (879.32) | 2629.98 (843.80) | **0.005** | **0.009** | 0.165 | 0.101 |

**Caption:** Table 1. Local dynamic spine stability and the total muscular contributions to spine rotational stiffness results. Bolded values indicate a significant effect at $p<0.05$.

**References:** [1] Graham et al., J. Biomech., 45: 1593-1600, 2012.
[2] Marras et al., Spine, 24: 2091-2100, 1999.
[3] Zedka et al., J. Physiol., 520: 591-604, 1999.
[4] Karayannis et al., Plos One, 8: p. e67779, 2013.

**Disclosure of Interest**: None Declared