Individuals with Chronic Low Back Pain Show Impaired Adaptations of Lumbar Extensor Muscle Reflex Amplitude During Unexpected Perturbations

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Summary

This study investigated trunk muscle adaptability to repeated unexpected perturbations in 37 participants (19 controls, 18 with chronic low back pain (LBP)). High-density and bipolar electromyography assessed trunk muscle responses. While controls decreased lumbar reflex amplitudes over perturbation trials, individuals with LBP did not show such adaptation. Both groups decreased trunk flexor co-contraction amplitudes and LBP participants showed a cranial shift in lumbar muscle activation. These findings show that chronic LBP patients have impaired adaptative mechanisms to repeated perturbations, potentially impacting spinal stability.

Introduction

LBP, a leading cause of disability, is associated with neuromuscular adaptations such as altered lumbar muscle activation patterns and abnormal reflexive responses, which may influence pain persistence and functional disability [1]. While the nervous system can adapt neuromuscular responses to repeated perturbations in healthy individuals [2], this adaptability is impaired in experimental pain conditions, such as delayed-onset muscle soreness [3] and it remains unclear whether similar deficits occur in individuals with chronic LBP. This study investigated the adaptability of trunk muscle responses to a series of unexpected external perturbations in individuals with chronic LBP.

Methods

Thirty-seven adults participated in the study, including 19 individuals without low back pain (control group; mean age: 32.79 ± 11.70 years, 10 men and 9 women) and 18 individuals with chronic low back pain (mean age: 34.22 ± 10.40 years, 9 men and 9 women, pain 2.94 ± 1.89). All participants were submitted to 15 repetitions of unexpected trunk perturbations applied in a posterior-to-anterior direction, inducing trunk flexion. High-density surface electromyography (HDsEMG) was used to assess lumbar muscle activation strategies. Both sides of the trunk were assessed. Key variables for lumbar extensor muscles included baseline muscle activity, response latency, reflex amplitude, and the centroid (muscle activity spatial location on the HDsEMG) of reflex activity. To assess the co-contraction reflex amplitude the rectus abdominis and external obliquus were measured using bipolar EMG. A two-way repeated measures ANOVA (2x2) was conducted to compare group differences and adaptation across trials (mean of first five trials vs. mean of last five trials of perturbations).

Results and Discussion

The control group was able to reduce the reflex response amplitude of the lumbar extensor muscles throughout trials (post-hoc left side: $p = 0.026$; post-hoc right side: $p = 0.030$; Figure 1). In contrast, individuals with chronic LBP showed no significant adaptation in the reflex response amplitude of the lumbar extensor muscles (post-hoc both sides: $p > 0.05$), possibly due to rigid motor control strategies aimed at protecting the painful region [4]. This adaptation might limit their ability to optimize responses, potentially compromising spinal stability and increasing functional cost. Both groups showed a significant reduction in co-contraction reflex response amplitude across trials (main adaptation effect: obliquus externus, mean of both sides: $p = 0.005$; rectus abdominis, mean of both sides: $p = 0.017$). A cranial location in lumbar muscle activation was observed in individuals with chronic LBP compared to controls on the right side (post-hoc: $p = 0.027$). No other results reached statistical significance.

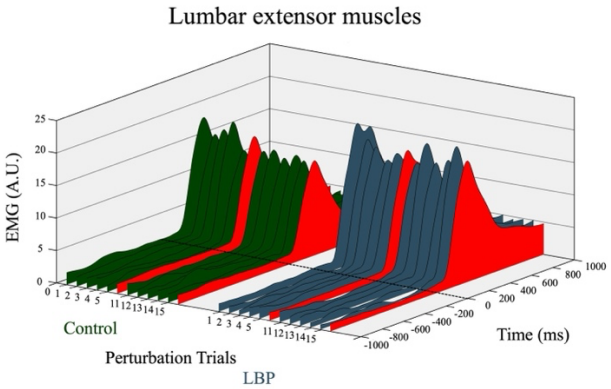

Figure 1: Mean EMG activity across HDsEMG channels on both sides. Control (green) and LBP (blue) groups show first (1–5) and last (11–15) trials; red denotes the mean of the preceding five trials. Black dotted lines: perturbation onset. (A.U.: Arbitrary Units).

Conclusions

These findings highlight the need for targeted interventions to improve motor control adaptation in LBP.

References

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