Muscle Reflex Latencies During Trunk Perturbations

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Introduction

Manipulative treatment has been speculated to increase range of motion and relieve pain through modulation of excitability of the sensory and motor portions of the central nervous system. However, this hypothesis has received few systematic investigations particularly in relation to low back pain (LBP). Accordingly, we systematically examined the effects of joint manipulation on both cortical and spinal reflex properties. We used a combination of biomechanical and electrophysiological techniques (e.g., motion analysis, transcranial magnetic brain stimulation, surface electromyography) to determine the influence of a high velocity low amplitude (HVLA) manipulation on 1) coordinated lumbar excursions in active, voluntary movements and sudden unknown perturbations, 2) the magnitude of short- and long-latency reflex responses, and 3) intracortical facilitatory and inhibitory properties. Outcomes were assessed before manipulation and immediately following manipulation. Only onset latencies for perturbations are presented in these results.

Collectively these data tested the **hypotheses** that HVLA manipulation reduces the excitability of motor systems and improves motor coordination. They also serve to localize within the central nervous system the site of altered excitability. These hypotheses would be consistent with, and extend, our recent observation that manipulative treatment attenuates the side-to-side differences in muscle activity in LBP as assessed *via* muscle functional magnetic resonance imaging. That study provided evidence for end organ changes in response to manipulation; this proposal explores the underlying mechanisms. The **novel** application of the muscle reflex and brain stimulation techniques allowed us to precisely delineate *in vivo* neurophysiologic properties of the lumbar muscles that have historically been limited.

Methods

Procedures

Twenty-two subjects (10 healthy controls, 12 with LBP) were recruited for the study. All participants signed an informed consent form approved by the Institutional Review Board of Ohio University. During the visit, subjects were screened for eligibility and completed the study questionnaires (McGill Pain Questionnaire, Tampa Scale for Kinesiophobia, Pain Anxiety Symptoms Scale, and the Roland and Morris Disability Questionnaire), and basic anthropometric data. During the session, we performed a series of mechanical and physiologic tests including subjects performing a standardized reaching task, reacting to unexpected perturbations in six directions, and assessing their spinal reflex using a mechanical back-tapper (short latency reflexes) and seated perturbations (long latency reflexes). Additionally, cortical excitability was tested using transcranial magnetic stimulation (TMS) to the multifidus and erector spinae muscles. After completing these tests subjects received HVLA spinal manipulation of the SIJ or lumbar region. Following the HVLA, the subject repeated the testing procedures.

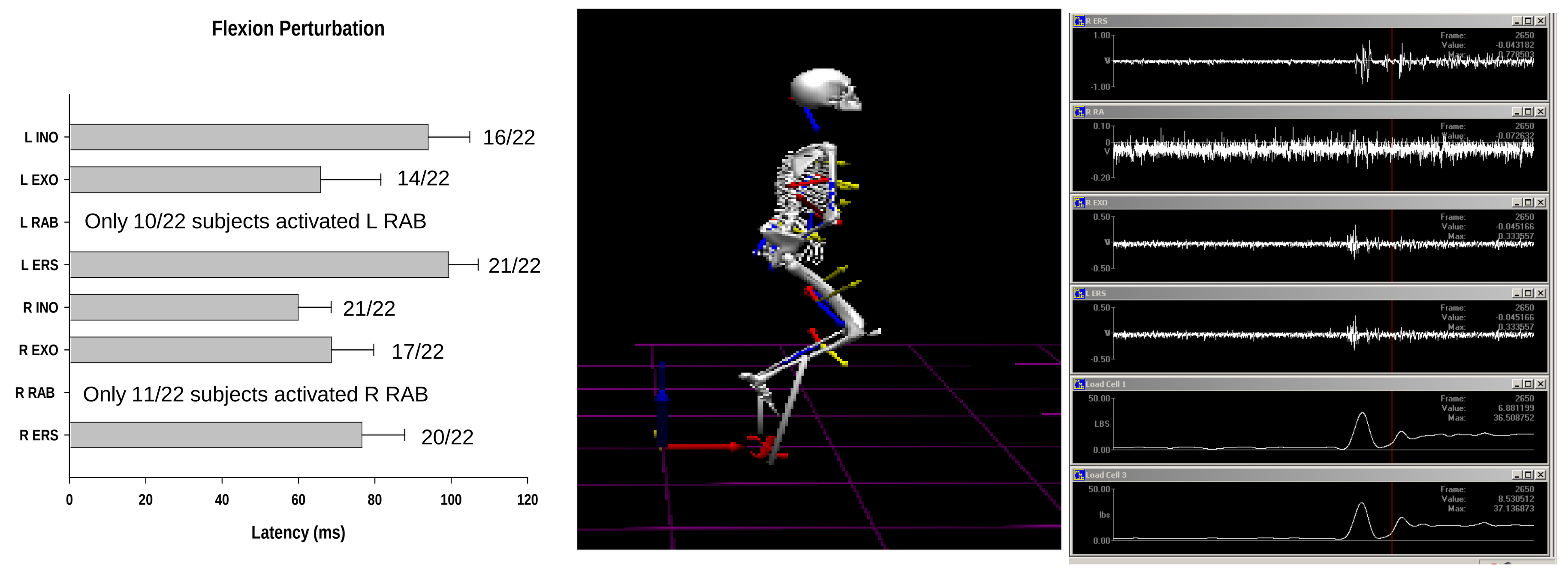
Electromyographic (EMG) Recordings

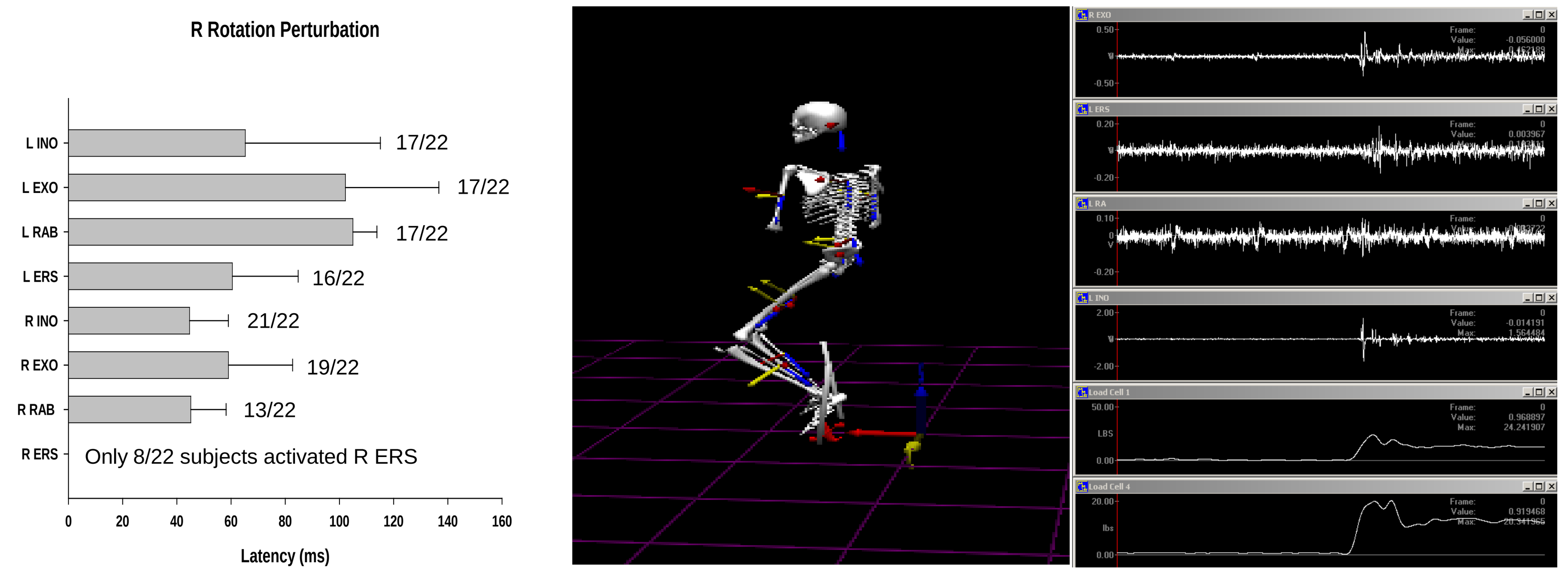
In order to measure muscle activity and reflexes of the lumbar muscles, EMG recordings were used. The electrodes were placed at an area halfway between the center of the innervation zone and the distal tendon. Surface electrodes were placed on the left and right sides of the body over the following muscles: erector spinae, rectus abdominus, internal abdominal obilque, and external abdominal oblique.

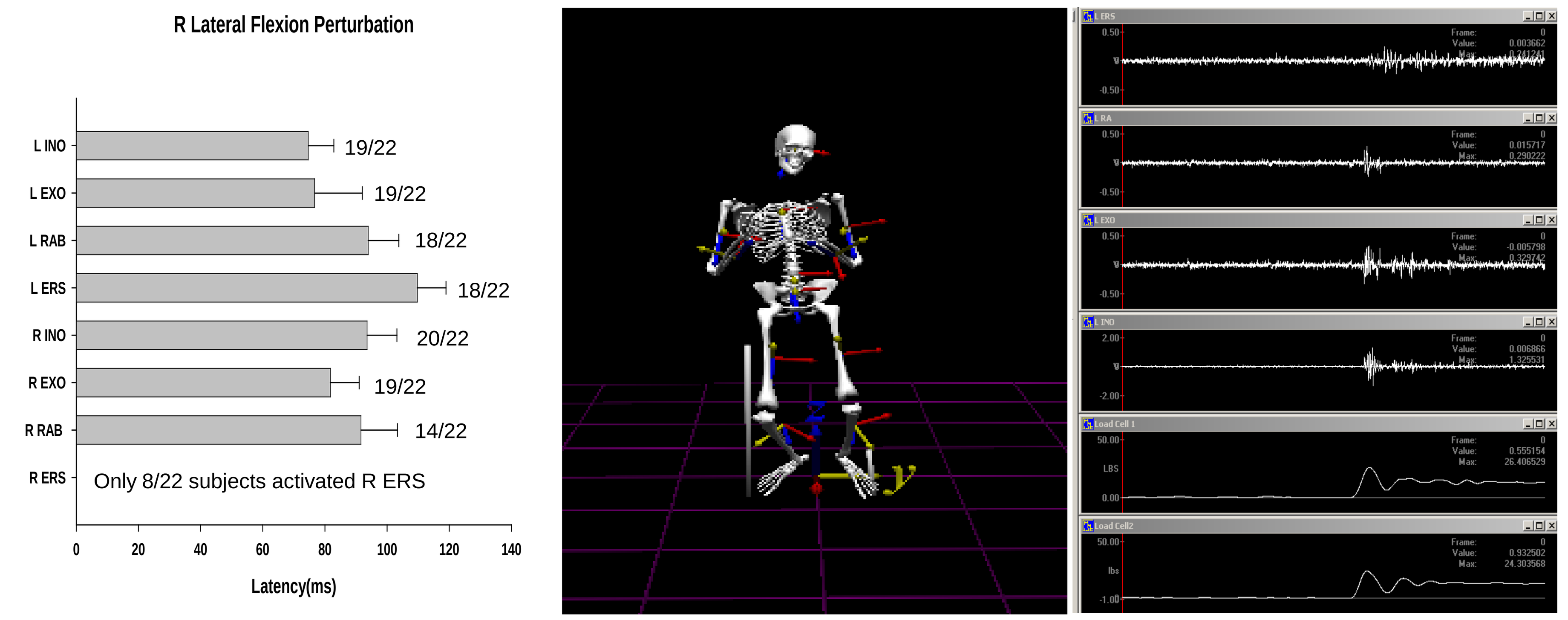
Data Collection

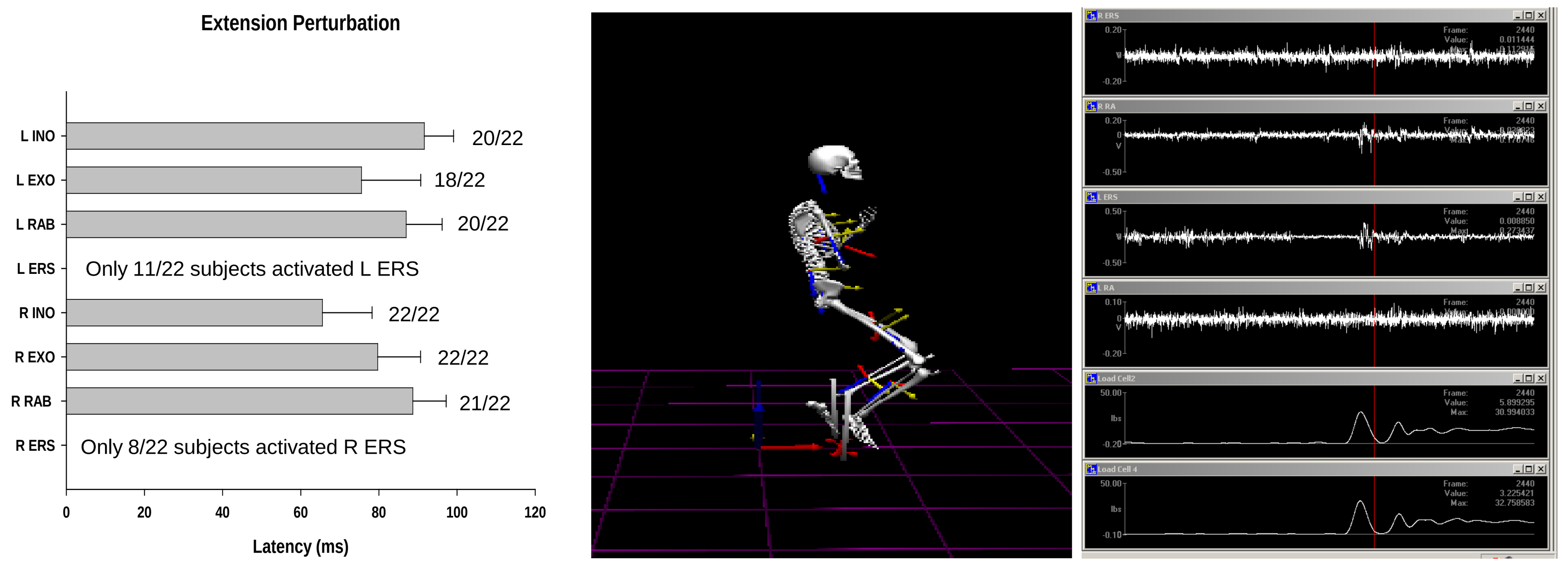
Movements of the forearm, humerus, trunk, pelvis, thigh, and shank were recorded using a Motion Monitor system. Sensors were attached to the left and right shank, thigh, humerus, and forearm. Sensors were also placed on the sacrum, 2nd and 4th lumbar vertebral levels, 1st thoracic vertebral level, and the head. Data were sampled at 100 Hz for 4 seconds per trial.

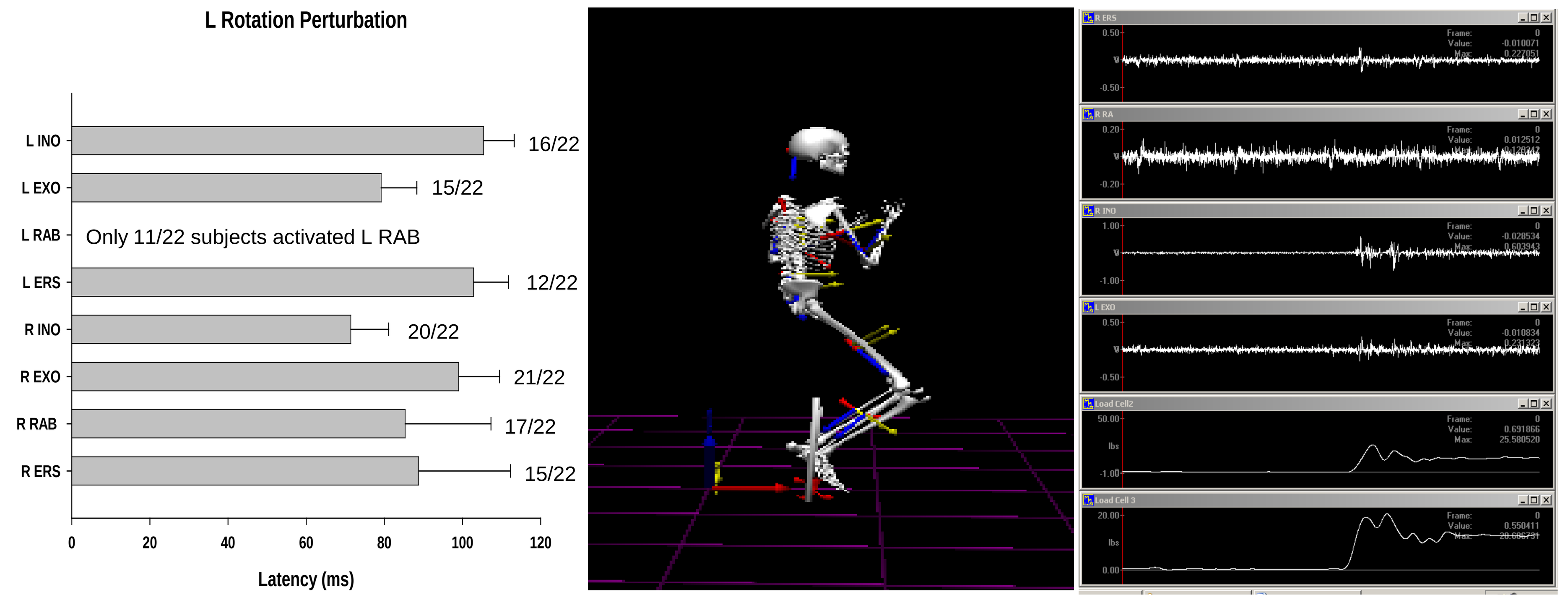
Electromyography: The muscle activity was pre-amplified at the recording site and recorded with a bandwidth of 20-500Hz. The data was then A/D converted at a sampling rate of 1000Hz. The onset, peak amplitude, and average amplitude was used for data analyses.

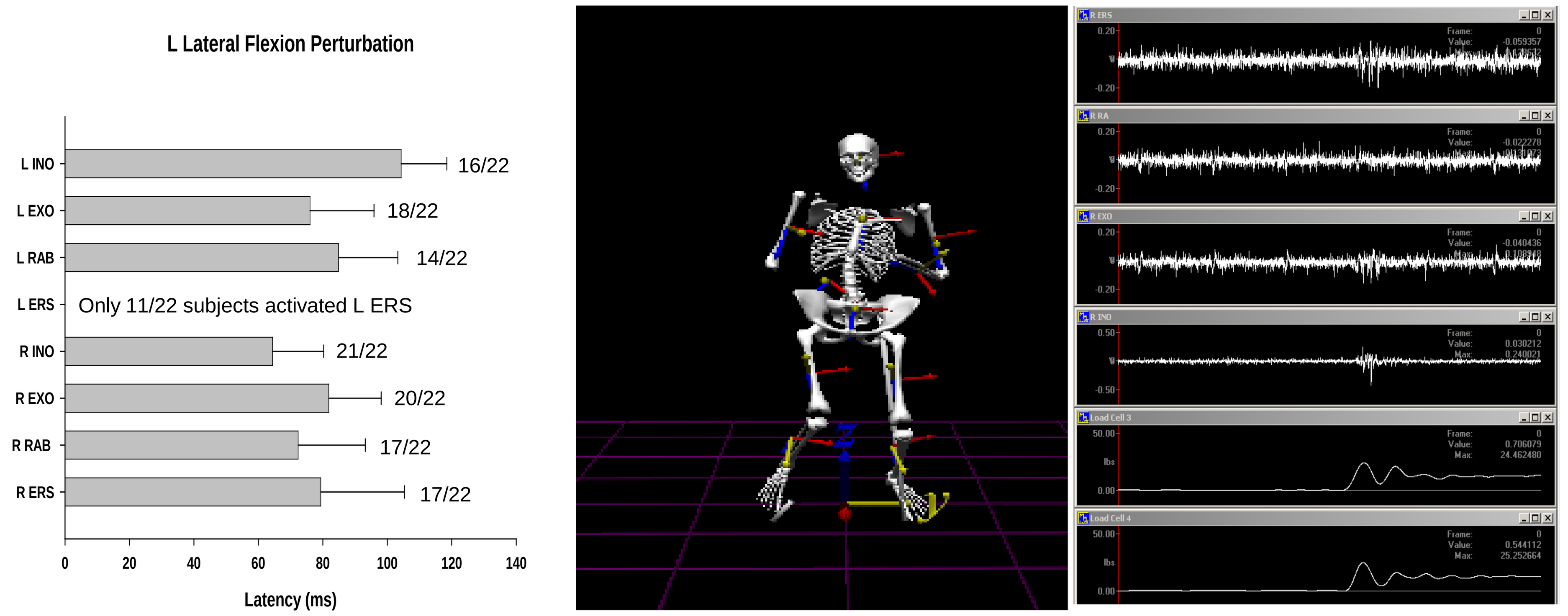












Results

Presented are descriptive data indicating presence of a specific trunk muscle activation and the short-latency stretch reflex following an unexpected perturbation. No significant differences were found between gender, pre and post manipulation, and presence of LBP on onset latencies. Therefore, all data were aggregated, averaged, and presented as overall results. Latencies greater than 120 ms were excluded from the results analysis because latencies greater than 120 ms are considered voluntary responses. The first of three individual depictions for each direction of perturbation shows the quantitative results of the number of subjects who activated each of the eight trunk muscles tested and the timing of the activation of the short-latency stretch reflex. The average latencies for each trunk muscle were only presented if more than half of the trials in that direction resulted in a muscle activation. The second item in the figure is a skeletal representation of each identifying perturbation. The third item shows the time series EMG of four select muscles and the applied load. Flexion perturbations did not activate the R RAB and L RAB as expected. Extension perturbations did not activate the R ERS and L ERS. The R ERS was not consistently recruited during right rotation perturbations and the L RAB was not consistently recruited during left rotation perturbations. Right rotation perturbations generally showed shorter reflex latencies than all other perturbation directions. As expected, a right lateral flexion perturbation did not consistently activate the R ERS and a left lateral flexion perturbation did not activate the L ERS.

Conclusions

The findings indicate that subjects utilize a variety of muscle recruitment strategies during unexpected perturbations. The results also show that healthy control and LBP subjects respond similarly to random perturbations. An unexpected finding was that manipulation did not have an effect on the subjects. Other studies have shown that manipulation has resulted in delayed onset latency in the trunk musculature. We believe that the lack of effect of the manipulations between healthy controls and LBP subjects may be due to a number of LBP subjects having had a low level of LBP relative to a normal distribution of the LBP population. We believe that some of the extraneous muscle activations may be due to the relatively large loads placed on some subjects, since all subjects received equal perturbation loads despite a variety of different subject body masses. Other studies have shown a gender difference in the activation latencies; however, we did not find a difference.

Future Directions

- We seek to determine the magnitude of the effect that a universal load had on the data in this study by normalizing the load in future studies based on a percentage of the subject's weight.
- In this study, only one manipulative thrust was delivered to the lumbar spine or SIJ; however, the quantity of manipulative therapy that may result in a significant change in short-stretch reflex latencies is unknown and will be investigated further.
- Future studies will include fine-needle EMG analysis of the multifidus muscle and the transverse abdominus.
- Our intent is that future studies will include individuals with a higher degree of low back pain related disability to investigate changes at a higher level of impairment.