Immediate effects of a high-velocity spine manipulation in paraspinal muscles activity of nonspecific chronic low-back pain subjects

Eduardo Bicalho, João Antônio Palma Setti, Jones Macagnan, José Luis Rivas Cano, Elisangela Ferretti Manfra

Original Article

Abstract

High-velocity spinal manipulation is commonly adopted for treating chronic low-back pain (CLBP) and has been associated with changes in muscle activity, but the evidence is controversial. The aim of this study was to analyse the immediate effects of high-velocity spine manipulation on paraspinal activity during flexion–extension trunk movements. Forty nonspecific CLBP patients were randomised into two groups, manipulation (n = 20) and control (n = 20). While the manipulation group received high-velocity spine manipulation at the L4-L5 level, the control group remained lying in the same position. EMG-related variables, perceived pain intensity (100 mm VAS) and finger-floor distance were collected before and after spinal manipulation at the L4-L5 level. EMG surface signals from the right and left paraspinal muscles (L5-S1 level) were acquired during trunk flexion–extension cycles. EMG activity during the static relaxation phase was significantly reduced following intervention for the manipulation group but not for the control group. The extension-phase EMG activity was also reduced after manipulation, but the flexion-phase EMG levels remained unchanged. Accordingly, the percent changes in FRR and ERR were significantly larger for the manipulation group compared to the control. The results suggest that a high-velocity spinal manipulation is able to acutely reduce abnormal EMG activity during the full-flexion static phase and activation during the extension phase.

1. Introduction

Physiotherapists, osteopaths and chiropractors worldwide are adopting high-velocity spinal manipulation as a conservative approach for treating musculoskeletal disorders (Maigne and Vautravers, 2003; Ernest, 2006). Usually, spinal manipulation aims to diminish pain, reduce muscle spasms and improve mobility (Pickar, 2002; Maigne and Vautravers, 2003).

Some hypotheses have been formulated to explain the mechanisms behind the effectiveness of these techniques. Most of these are based on neurophysiological reflexes triggered by sensory receptors mechanically stimulated by the manipulative act (Triano, 2001; Pickar, 2002; Maigne and Vautravers, 2003). Experimental studies in humans (Colloca et al., 2000; Colloca et al., 2003; Keller et al., 2003; Colloca et al., 2004; Ritvanen et al., 2007) and animals (Sung et al., 2004; Ge et al., 2005; Colloca et al., 2006; Pickar and Kang, 2006) have supported these ideas.

Chronic low-back pain (CLBP) is among the many indications for a spinal manipulation prescription (Triano, 2001) and is often treated with this conservative method. Spinal disorders, such as CLBP, are commonly associated with abnormal neuromuscular control as demonstrated by electromyography (EMG) signals (Finneran et al., 2003; Colloca and Hinrichs, 2005; Demoulin et al., 2006). Specifically, it has been observed that the flexion–relaxation phenomenon (FRP) during trunk flexion (Colloca and Hinrichs, 2005) is frequently absent in CLBP patients. FRP is a reduction or absence of electromyographic signals in paraspinal muscles when the subject remains relaxed during trunk forward flexion (Sarti et al., 2001). CLBP patients usually have abnormal muscle activity during trunk flexion, failing to reach relaxation due to muscle spasms, reduced range of motion, exaggerated stretch reflexes or protection of injured structures (Neblett et al., 2003; Demoulin et al., 2006; Marshal and Murphy, 2006a).

Some studies analysed the effects of spinal manipulation on paraspinal behaviour during static tasks performed by CLBP patients. However, few of them analysed the paraspinal electromyographic dynamic activity, and the results are controversial. For instance, while Keller and Colloca (2000) found improvement
paraspinal activity, Lehman and McGill (2001) did not report changes in paraspinal activity during dynamic tasks after spine manipulation.

The aim of this study was to analyse the acute effect of high-velocity spinal manipulation on electromyographic activity in paraspinal muscles of nonspecific CLBP subjects, examining three phases (flexion, full flexion and extension) of trunk movements.

2. Methods

2.1. Subjects and protocol outline

The inclusion criteria for this study were age between 18 and 55 years old, absence of back pain for at least three months and no treatment or spinal manipulation within the last 6 months. Subjects were excluded from this study if they had pain radiating below the knee, skeletal or neuromuscular disorders identified by magnetic resonance imaging or plain film radiographs or any Accident Compensation Corporation red flags (Koes et al., 2006). The Universidade do Vale do Itajai Research Ethics Committee approved all procedures used in this work.

All subjects gave informed consent after receiving an explanation of the experimental protocol and were randomly assigned to one of two groups: the control and manipulation groups. Subjects then underwent an initial evaluation protocol that included a physical examination, filling out a form with physical and health data and answering the Oswestry Low-Back Pain questionnaire.

Subjects were requested to lie on their right side on an appropriate surface. The manipulation group received a high-velocity lumbar manipulation (L4–L5), while subjects in the control group remained in this position without any other intervention. The re-evaluation was performed in both groups immediately after this procedure.

2.2. Oswestry Low-Back Pain Disability Index (ODI)

The measure chosen for self-reported functional capacity was the Brazilian version of the Oswestry Low-Back Pain Disability Index (ODI) (Vigatto et al., 2007). It consists of a ten-item questionnaire with six alternatives each. For each alternative, there is a score ranging from 0 (“no problem”) to 5 (“not possible”), according to the extent that back pain affects daily life activities. The score is expressed as a percentage of a maximum value, which depends on how many items were properly answered and can reach at most 50 points. Oswestry score ranges from 0 to 100%, with higher scores corresponding to worse pain states (Vigatto et al., 2007).

2.3. EMG instrumentation

Two pairs of Ag/AgCl bipolar surface adhesive electrodes (Kendal Meditrac, Canada, 1 cm diameter) were placed on the belly of the right and left paraspinal muscles at the L5–S1 level. Before electrode positioning, excessive body hair was shaved, and the skin was cleaned with an alcohol swab. Electrodes were placed 20 mm lateral to the spinous process and aligned with the body longitudinal axis with a centre-to-centre distance of 20 mm. The subjects were asked to keep their trunk bent during this procedure in order to prevent electrodes from slipping during full trunk flexion. A ground reference electrode was attached to the ulnar styloid process.

Electromyographic activity was acquired by a Powerlab/800 ADInstruments data acquisition system (common mode rejection ratio of 96 dB at 50 Hz, input impedance of 1 MO, 16-bit resolution and 2-kHz sample rate A/D conversion). EMG signals were amplified 1000 times and bandpass-filtered between 3 and 1 kHz with an ETH-225 filtering and amplification module.

2.4. Data collection procedure

Pain intensity, finger-floor distance and EMG signals were collected before and after spinal manipulation. EMG signals were acquired while the subjects performed flexion–extension trunk movements (flexion–extension procedure).

Before the flexion–extension procedure, all subjects performed the Sorensen endurance test (Biering-Sorensen, 1984) while lying stabilised on a cushioned surface. The maximal one-second RMS activity recorded during the Sorensen test was defined as the maximal voluntary contraction (MVC) value and was used as a reference for other EMG data.

During the flexion–extension procedure, subjects stood barefoot inside a square marked on the floor with their arms hanging relaxed and their feet shoulder-width apart. They were then required to perform trunk flexion (flexion phase) during a three-second interval with knees extended, upper limbs loose toward the ground and their chin touching the chest. When total trunk flexion was reached, subjects were asked to remain in this position for three seconds and to “totally relax the spine” (relaxation phase). Afterwards, they were asked to return to the starting position during a three-second movement (extension phase). A metronome was used to pace the movement.

The subjects were asked to practice the movement before data collection (Marshall and Murphy, 2006a). Data from three flexion–extension trials were then collected, with a one-minute rest between each cycle. The finger-floor distance (left middle finger to the floor) was measured at the third trial with the subjects at the fully flexed position. After completing the last flexion–extension cycle, the subjects were asked to indicate their perceived pain intensity along the visual analogue scale (VAS-100 mm).

2.5. EMG data processing and analysis

The off-line analysis of EMG signals was performed using the LabVIEW platform. Data were digitally filtered (Butterworth fourth-order) using a 20–500 Hz bandpass filter and a 60 Hz notch filter. The RMS calculation was carried out on EMG signals using a sliding window of 1 s, moving at a 50 ms rate (Farina and Merletti, 2000). The three phases of the flexion–extension cycle (flexion, relaxation and extension) were manually identified in the RMS signal, and the maximal value during each phase was registered. These readings were then normalised and expressed as a percentage of the MVC value in order to obtain the relative activity during each phase.

The flexion–relaxation ratio (FRR) was obtained by dividing the maximal relative EMG value during the flexion phase by that during the relaxation phase. The extension–relaxation ratio (ERR) was obtained in a similar way, but the extension and relaxation phases were considered (Watson et al., 1997; Marshall and Murphy, 2006a). The extension–flexion ratio (EFR) was obtained by considering the extension and the relaxation phases (Sihvonen et al., 1991; Ambroz et al., 2000). Each EMG variable was averaged among the three flexion–extension cycles.

2.6. Spinal manipulation

Subjects in the experimental (manipulation) group underwent high-velocity spinal manipulation at the L4–L5 level (Ricard, 1998) performed by a trained osteopath (C.O. Escuela de Osteopatía de Madrid) with more than five years of experience with this technique. In order to perform the manipulation, subjects were first
positioned in right lateral decubitus, and then the therapist located the L4–L5 joint and performed passive flexion and rotation to the selected spinal level. The therapist’s right forearm was positioned at the subject’s pelvis, parallel to the left thigh, while his left elbow stabilised subject’s upper trunk and shoulder. When the tissue tension was maximised, the therapist applied a high-velocity low-amplitude impulse with his right forearm, rotating the subject’s pelvis downward.

2.7. Statistical analysis

The normality of the data was checked using the Shapiro-Wilk test.

Values before (baseline) and after (final) manipulation within each group were compared using the paired sample t-test for normally distributed data, or the non-parametric Wilcoxon test for non-normally distributed data. Additionally, percent differences were calculated for FRR, ERR and EFR (Eq. (1)).

\[
\text{Percent difference} = \frac{\text{POST} - \text{PRE}}{\text{PRE}} \times 100
\]

Anthropometric/demographic data, ODI, percent differences and baseline values of all measures were compared across the groups using independent sample t-tests (normally distributed data) or the non-parametric Mann–Whitney test (non-normally distributed data). The significance threshold used in this study was 0.05.

3. Results

The control group (n = 20) was composed of 8 males and 12 females volunteers, while 5 males and 15 females volunteers comprised the manipulation group (n = 20). The anthropometric data, ODI scores and average time since symptom onset are summarised in Table 1. The comparisons across groups showed that they were homogeneous with respect to all characteristics. Also, baseline values of VAS, finger-floor distance and all EMG-derived variables were similar for both groups. Although not required by the inclusion criteria, none of the participants had experienced spinal manipulation before this study.

Table 2 shows the pain intensity and finger-floor distance before and after manipulation. Unlike the control group, the manipulation group had a statistically significant decrease in the pain intensity. The average differences between the baseline and final VAS values were 2.2 ± 10.7 mm for the control group and –11.0 ± 10.6 mm for the manipulation group, corresponding to a significant difference between groups (p = 0.0379, independent sample t-test).

The maximum relative EMG values during each phase of the flexion–extension cycle are summarised in Table 3. The flexion phase values did not change significantly following manipulation for any group. On the other hand, there was a significant decrease in the relaxation and extension phase values for the manipulation group but not for the control group.

The comparison of the percent changes in the maximum relative EMG during the flexion phase, performed with the Mann–Whitney test, demonstrates that there was no difference between the manipulation and control groups for right (p = 0.833) and left (p = 0.086) paraspinal muscle values. Similarly, there was no statistically significant difference across groups for the percent changes in the right (p = 0.05) or left (p = 0.107) muscles, as shown by the independent sample t-test. On the other hand, percent changes in the maximum normalised EMG during relaxation were different across groups for the right (p = 0.001, independent sample t-test) and left (p < 0.001, Mann-Whitney test).

The FRR and ERR increased significantly after intervention for the manipulation group but remained unchanged for control group (Table 4). On the other hand, EFR values were unchanged after manipulation in all groups.

Percent differences in FRR, ERR and EFR are depicted in Figs. 1–3, respectively. FRR and EFR percent differences were significantly larger for the manipulation group compared to the control, while EFR percent differences were similar for both groups.

4. Discussion

The sample in this study was built by convenience, and its size was chosen to be 20 individuals in each group. Sample size calculations, based on minimal clinically important change (MCIC) of VAS and not shown here for the sake of clarity, revealed that the sample was larger than the necessary to detect changes in the measures under study. Moreover, the controversial studies that mainly motivated this research (Keller and Colloca, 2000; Lehman and McGill, 2001) have sample sizes equal or smaller than that in this work. The experimental groups in Keller and Colloca (2000) had 20 and 10 individuals, and their control group also had 10 individuals. Lehman and McGill (2001) reported an experimental group with 14 individuals and did not have a control group. Moreover, even with this relatively small sample size, it was possible to observe very clearly, for instance, the differences between baseline and final values in activity during the relaxation phase in the manipulation group and the differences between both groups in this variable. There were no significant differences between the groups regarding anthropometric data, ODI, time since symptom onset and baseline values of all measures. Thus, the randomisation procedure gave rise to homogeneous groups as expected.

In general, the results for EMG-derived measures revealed significant changes in muscle activation after spinal manipulation similar to those in other studies addressing low-back pain patients (Colloca et al., 2000; Keller and Colloca, 2000; Colloca and Keller, 2001; Lehman and McGill, 2001; Lehman et al., 2001; Devotch et al., 2005; Suter et al., 2005; Ferreira et al., 2007), asymptomatic subjects (Herzog et al., 1999; Dishman et al., 2005) and animals (Pickar and Wheeler, 2001; Sung et al., 2004; Colloca et al., 2006; Pickar and Kang, 2006). However, the EMG results of each phase of the flexion–extension cycle and their ratios deserve a detailed discussion.

The absence of changes in the electromyographic activity during the flexion phase for all groups (Table 3) agrees with the results reported by Lehman and McGill (2001) and is also similar to results obtained by Marshall and Murphy (2006b). However, these last authors analysed the results of a 12-week exercise intervention and not a single manipulation as in this study.

---

Table 1

<table>
<thead>
<tr>
<th>Variable</th>
<th>Control group (n = 20)</th>
<th>Manipulation group (n = 20)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>26.5 (8.27)</td>
<td>29.5 (9.64)</td>
<td>0.289*</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>73.05 (18.04)</td>
<td>73.05 (18.04)</td>
<td>0.299*</td>
</tr>
<tr>
<td>Height (m)</td>
<td>1.72 (0.10)</td>
<td>1.67 (0.08)</td>
<td>0.100*</td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td>24.34 (3.96)</td>
<td>24.25 (2.75)</td>
<td>0.933*</td>
</tr>
<tr>
<td>Oswestry index (0–100)</td>
<td>16.60 (7.37)</td>
<td>14.60 (5.62)</td>
<td>0.327b</td>
</tr>
<tr>
<td>Time since pain onset (years)</td>
<td>3.48 (3.35)</td>
<td>5.26 (4.97)</td>
<td>0.208b</td>
</tr>
</tbody>
</table>

Data are presented as mean (SD) values.  
* P values from the paired t-test.  
* P values from the Mann–Whitney test.
On the other hand, in this study, muscle activity during the extension phase decreased significantly after manipulation, which contrasts with the ideas of Lehman and McGill (2001), who state that spinal manipulation has no immediate effect on paraspinal muscle activity during any dynamic phase (flexion or extension). This divergence might be due to differences in the manipulation technique applied or the EMG measurement procedure or might be due to the smaller sample size \((n = 14)\) of Lehman and McGill (2001) compared to the one in this study \((n = 20)\). It must be highlighted that our control group EMG values during the extension phase did not change after manipulation, which supports the idea that observed changes are related to the manipulation procedure. Therefore, further investigations with larger samples should be carried out in order to clarify this issue.

Still regarding the extension phase, it might be interesting to compare the results found here with those of Keller and Colloca (2000), who studied the effects of a single spinal manipulation on paraspinal muscle EMG outcomes. Even though isometric trunk extension was investigated in that study, while dynamic extension was performed in this study, activation of trunk extensors is highlighted that our control group EMG values during the extension phase did not change after manipulation, which supports the idea that observed changes are related to the manipulation procedure. Therefore, further investigations with larger samples should be carried out in order to clarify this issue.

Two different scenarios might explain the reduction of EMG muscle activity following spinal manipulation observed here: (i) the alpha motor unit drive was decreased after manipulation or (ii) manipulation increased the alpha motor unit inhibition. The first scenario might be suitable for those situations in which voluntary muscle activity is necessarily present, such as posture maintenance in a static upright position or dynamic trunk extension. However, most of the authors favor the second scenario and point out that manipulative procedures tend to inhibit neuromuscular activity in static situations (Lehman and McGill, 2001; Lehman et al., 2001; Pickar and Wheeler, 2002; Devotch et al., 2005). Because low-back pain patients exhibit abnormally high levels of paraspinal activity in rest situations (Sihvonen et al., 1991; Neblett et al., 2003; Geisser et al., 2004), Dishman et al. (2005) suggest that manipulation techniques lead to motor neuron segmental inhibition, directly influencing muscles innervated by the treated spinal segment. The same authors found a reduction in the Hoffman reflex of lower limb muscles after spinal manipulation applied with subjects lying in lateral decubitus, thus demonstrating a reduction in motor neuron excitability of the manipulated segment (Dishman et al., 2005). Pickar (2002) noted that the manipulation on the isometric and dynamic motor control mechanisms.

Regarding the relaxation phase, the data of Table 3 and the comparisons of EMG relative changes across the groups strongly suggest that manipulation was able to reduce paraspinal muscle activity at the static fully flexed trunk position. Keeping in mind the methodological differences, this result agrees with several other studies from the literature. For example, Lehman et al. (2001) showed that manipulations caused a reduction of paraspinal muscle activity at rest in response to painful stimuli applied to the spinous processes of manipulated vertebrae. Similarly, Devotch et al. (2005) found a decrease of about 25% in the paraspinal muscle activity at rest after the application of a high-speed manipulative stimulus in a population with back pain.

Two different scenarios might explain the reduction of EMG muscle activity following spinal manipulation observed here: (i) the alpha motor unit drive was decreased after manipulation or (ii) manipulation increased the alpha motor unit inhibition. The first scenario might be suitable for those situations in which voluntary muscle activity is necessarily present, such as posture maintenance in a static upright position or dynamic trunk extension. However, most of the authors favor the second scenario and point out that manipulative procedures tend to inhibit neuromuscular activity in static situations (Lehman and McGill, 2001; Lehman et al., 2001; Pickar and Wheeler, 2002; Devotch et al., 2005). Because low-back pain patients exhibit abnormally high levels of paraspinal activity in rest situations (Sihvonen et al., 1991; Neblett et al., 2003; Geisser et al., 2004), Dishman et al. (2005) suggest that manipulation techniques lead to motor neuron segmental inhibition, directly influencing muscles innervated by the treated spinal segment. The same authors found a reduction in the Hoffman reflex of lower limb muscles after spinal manipulation applied with subjects lying in lateral decubitus, thus demonstrating a reduction in motor neuron excitability of the manipulated segment (Dishman et al., 2005). Pickar (2002) noted that the
mechanical stimulus on sensory receptors caused by manipulation might lead to muscle inhibition. This inhibition would be a reflex response target for afferent stimuli initiated in the tissue sensory receptors (Pickar, 2002). Capsule stretching, induced by the manipulative act, could be directly related to inhibition of paraspinal activity during the relaxation phase. In fact, the works of Pickar and Wheeler (2001) and Pickar and Kang (2006) demonstrated that high-velocity spinal manipulation stimulates muscle, tendon and capsule receptors. Accordingly, Indahl et al. (1997) have shown that receptors located inside interapophyseal joint capsules have an important role in regulating neuromuscular spine control.

Changes in FRR and ERR (Figs. 1 and 2) are certainly related to the EMG discussion already presented. However, because FRR has been used to distinguish between populations with and without low-back pain (Watson et al., 1997; Zedka et al., 1999; Kuriyama and Ito, 2005) and also as a measure of therapeutic intervention efficacy (Mannion et al., 2001; Neblett et al., 2003; Marshal and Murphy, 2006a; Ritvanen et al., 2007), it is worthwhile to discuss it in more detail.

FRR baseline values found here (Table 4) are typical of low-back pain patients (Watson et al., 1997). The FRR final value increased significantly in the manipulation group relative to the control group. Lalanne et al. (2009) also report an acute increase in FRR after lumbar spine manipulation. Other researchers have found improvement in FRR after different pain treatment approaches. For example, Marshal and Murphy (2006a) registered a significant increase in FRR after a therapeutic intervention with a Swiss ball for subjects with back pain, and, as observed here, the largest changes in the EMG activity occurred during the relaxation phase. Similar results were reported by Neblett et al. (2003) after a functional restoration rehabilitation program for low-back pain patients. Because different approaches have led to FRR improvement, it seems that this ratio is more related to pain mechanisms than to the treatment itself. However, Ritvanen et al. (2007) gave another

<table>
<thead>
<tr>
<th>Table 4</th>
<th>Summary of flexion–relaxation ratio (FRR), extension–relaxation ratio (ERR) and extension–flexion ratio (EFR) data.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control group (n = 20)</td>
</tr>
<tr>
<td></td>
<td>Baseline</td>
</tr>
<tr>
<td>FRR (right)</td>
<td>3.34 (1.51)</td>
</tr>
<tr>
<td>FRR (left)</td>
<td>3.10 (1.12)</td>
</tr>
<tr>
<td>FRR (average)</td>
<td>3.11 (1.18)</td>
</tr>
<tr>
<td>ERR (right)</td>
<td>5.78 (3.13)</td>
</tr>
<tr>
<td>ERR (left)</td>
<td>5.58 (1.66)</td>
</tr>
<tr>
<td>ERR (average)</td>
<td>5.48 (2.07)</td>
</tr>
<tr>
<td>EFR (right)</td>
<td>1.73 (0.33)</td>
</tr>
<tr>
<td>EFR (left)</td>
<td>1.86 (0.42)</td>
</tr>
<tr>
<td>EFR (average)</td>
<td>1.78 (0.32)</td>
</tr>
</tbody>
</table>

Data are presented as mean (SD) values. *Significant.

- P values from the independent sample t-test.
- P values from non-parametric Wilcoxon test.

Please cite this article in press as: Bicalho E, et al., Immediate effects of a high-velocity spine manipulation in paraspinal muscles activity of..., Manual Therapy (2010), doi:10.1016/j.math.2010.03.012
explanation for the unexpectedly similar decreases in FRR that they observed following a two-month treatment with spinal manipulation and conventional physiotherapy. Their electromyographic revaluations were performed one month after the last therapeutic session, and this delay might have allowed for long-term adaptations, diluting possible therapy-specific particularities. Therefore, it seems clear that spinal manipulation is able to increase FRR, but more specific studies are necessary to clarify whether the mechanisms behind this increase differ from those related to other therapeutic approaches.

Baseline EFR values found here were similar to those reported by Ritvanen et al. (2007). Moreover, no significant changes in the EFR occurred after spinal manipulation because this ratio depends on EMG values during the two dynamic phases of movement, which were unmodified or only poorly modified. This result is in accordance with Ritvanen et al. (2007), who found no significant changes in EFR after therapeutic interventions, although these authors investigated the effects of long-term manipulation.

Regarding VAS values, although the manipulation group showed a significant decrease after manipulation and behaved differently from the control group, the average change (−11.0 ± 10.6 mm) was below the MCIC, which is around 18 mm (Hägg et al., 2003) or 20 mm (Ostelo and de Vet, 2005). However, it is important to point out that the authors state that these values should be used as indications only (Ostelo and de Vet, 2005). Moreover, one has to consider that such values are proposed to assess long-term treatment periods such as two years (Hägg et al., 2003) and not to assess the acute effect of a single intervention as performed in this study. Additionally, the changes in VAS found by Ritvanen et al. (2007) after a two-month treatment (traditional bone setting and physiotherapy) are also below the aforementioned MCIC values. Therefore, it would be worthwhile to include the MCIC value related to a single intervention or shorter treatment periods in future studies.

Finger-floor distance values decreased significantly after manipulation for both the control and manipulation groups. Regarding the manipulation group, many authors suggest that that spinal manipulation techniques could directly change the biomechanics of the vertebral segment, releasing restrictions of mobility, thus promoting a better articular function (Richard, 1998; Triano, 2001; Pickar, 2002; Maigne and Vautravers, 2003). However, the control group was not exposed to all these factors, and its mobility improvement was an unexpected result. Mechanical (Keller et al., 2003; Colloca et al., 2004; Sung et al., 2004; Colloca et al., 2006) and neurophysiological (Geisser et al., 2004) mechanisms have been proposed to explain mobility increases after manipulation. Therefore, our results suggest that these mechanisms might also be a consequence of the act of positioning. Alternatively, the flexion–extension cycles performed by the groups during the initial evaluation could be responsible for acutely increasing the mobility and allowing for smaller values of finger-floor distance at the second evaluation.

5. Conclusions

The results reported here allow us to conclude that a high-velocity spinal manipulation technique acutely modifies the EMG activity during flexion–extension movements performed by chronic low-back patients. Abnormal activity during the full-flexion static phase and activation during the extension phase are both reduced following manipulation. However, the activation during the dynamic flexion phase was not influenced by the manipulation procedure. The ratios involving the static phase (FRR and ERR) had a significant increase due to the manipulative act, in contrast to the EFR.

Acknowledgments

The authors are grateful to M. Olandoiski for the help with statistical analysis, to both reviewers for the enriching comments and ideas and to A.L. Lando for helping with manuscript revision.

References


