

Manipulative Treatment vs. Conventional Physiotherapy Treatment in Whiplash Injury: A Randomized Controlled Trial

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ABSTRACT. Introduction. The aim of this clinical trial is to compare the results obtained with a manipulative protocol developed by our investigation group with the results obtained with a conventional

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The authors would like to devote this paper to our deceased friend Alejandro Plaza Fernández.

physiotherapy treatment in patients suffering from whiplash injury. No controlled experimental trials have been published documenting the effects of this manipulative protocol.

Design. A randomized controlled trial.

Materials and Methods. Three hundred eighty volunteers subjects, 300 men and 80 women, participated in this trial. All patients were diagnosed with acute whiplash injury of less than 3 months duration, and classified in grades II and III according to the Quebec Task Force (QTF). Patients were divided randomly in 2 groups, using a table of random numbers: Group A (experimental group) and Group B (control group). Group A was treated with a manipulative protocol which includes "high velocity-low amplitude techniques," soft tissues manipulation and mobilization techniques. Group B was treated with a conventional physiotherapy treatment which includes active exercises, electrotherapy, ultrasound therapy and diathermy (best evidence). Patients in Group A have received weekly manipulative treatment, whereas Group B received daily physiotherapy treatment. All subjects signed the required consent sheet before becoming part of the research. The outcome measures were the visual analogue scale (VAS), the cervical range of motion (CROM) in flexion and rotation, and number of sessions needed to complete the treatment. Data were collected pre-treatment, after each 4 sessions in Group A and after each 10 sessions in Group B.

Results. Patients of manipulative group needed an average of 9 sessions to complete the treatment, whereas physiotherapy group needed an average of 23 sessions ($P = 0.002$). Results showed that the manipulative group had more benefits than the physiotherapy group in the VAS and CROM, specifically after the first 4 sessions with a decrease of 40% in the VAS ($P = 0.003$) and an improvement of 20 degrees in cervical rotation ($P = 0.02$).

Conclusions. Patients who had received manipulative treatment needed fewer sessions to complete the treatment than patients who had received physiotherapy treatment. The improvement in the manipulative group was achieved with fewer treatment sessions and was greater than the improvement in physiotherapy group. In the future, we plan to analyze if this improvement will be maintained over time by assessing and checking the patients after 6 months and 1 year. [Article copies available for a fee from The Haworth Document Delivery Service: 1-800-HAWORTH. E-mail address: <docdelivery@haworthpress.com> Website: <<http://www.HaworthPress.com>> © 2004 by The Haworth Press, Inc. All rights reserved.]

KEYWORDS. Whiplash injury, manipulative treatment, spinal manipulation, physiotherapy

INTRODUCTION

Whiplash injury of the cervical spine continues to challenge the medicolegal system and society in general. The Quebec Task Force adopted the following definition of whiplash (1): “Whiplash is an acceleration-deceleration mechanism of energy transfer to the neck. It may result from rear-end or side-impact motor vehicle collisions, but can also occur during diving or other mishaps. The impact may result in *bony or soft tissue injuries* (whiplash injuries), which in turn may lead to a variety of *clinical manifestations* (whiplash associated disorders).” The clinical syndrome of whiplash includes neck pain, restriction of neck motion, dizziness, headaches, tinnitus and blurred vision (2,3). The exact nature of these symptoms is not clearly understood. Several theories have been postulated to explain these features including vertebral artery insufficiency and cervical sympathetic chain injury for visual disturbances and dizziness (4), upper facet joint injury for headaches (5), and paraspinal muscle spasm for neck pain (6).

Although whiplash injury may result from rear, side and frontal impacts, rear-end crashes account for about 85% of all of the whiplash associated disorders (7). There are many biomechanical studies which have analyzed the kinematical spinal motion during a rear-end impact (8-10). All of them conclude that the cervical spine response involves an S-curve which may result in a pinching mechanism of the facet joints. Moreover, experimental research on human cadavers has demonstrated that a variety of musculoskeletal injuries can occur, specifically muscle and ligament sprains (11).

There is no agreement among physiotherapists about treatment for whiplash patients (12). Borchgrevink concluded that patients do not obtain wholly satisfactory results with conventional therapies (13). Peeters reported, from a literature’s review of conservative treatment, that despite the many treatments available for patients with whiplash injury, there continues to be no evidence for their accepted use (14). Spinal manipulation/mobilization and soft tissue mobilization techniques are manual therapies commonly used in the management of neck disorders (15). There are some clinical trials that have analyzed the effectiveness of the cervical manipulation/mobilization in mechanical neck pain (16,17), but not specifically in whiplash injury. Our clinical experience with these patients has demonstrated that manipulative treatment gives better results than conventional physiotherapy treatment (18). Our investigation group has developed a manipulative protocol for the management of whiplash injury. No randomized controlled trials have been published documenting the effects of this manipulative protocol. The

aim of this clinical trial is to compare the results obtained with the manipulative protocol developed by our investigation group with the results obtained with a conventional physiotherapy treatment in patients suffering from whiplash injury.

The following null hypothesis was tested: no significant differences exist among whiplash patients receiving our manipulative protocol and whiplash patients receiving conventional physiotherapy treatment in a number of outcome measures.

MATERIALS AND METHODS

Subjects

Patients diagnosed with acute whiplash injury were recruited from a private clinic of manual therapy and physiotherapy (MAPFRE). Three hundred eighty volunteers patients, 300 men and 80 women, aged of 18 and 35 years old (mean = 27 years, standard deviation = 7 years) participated in this clinical trial. All patients were diagnosed of whiplash injury, and classified in grades II (neck complaint and musculoskeletal signs) and III (neck complaint, musculoskeletal signs, and neurologic signs) according to the Quebec Task Force (1). Patients were divided randomly in 2 groups, using a table of random numbers: Group A or experimental group and Group B or control group. All patients signed the required consent sheet before beginning the study. The research has been supervised by the International School of Osteopathy (E.O.M), and the Teaching and Research Unit of Physiotherapy, Occupational Therapy, Physical Medicine and Rehabilitation of the Rey Juan Carlos University (Spain). It was approved by the Ethical Committee in Clinical Research of the University.

The following exclusion criteria were established: (1) Whiplash injury more than 3 months duration, (2) Previous whiplash injury before beginning the study, (3) Previous cervical surgery, (4) Having manipulative or manual therapy within the past one month before the study, (5) Articular instability (fracture, luxation).

Outcome Measures

The outcome measures were: (1) The monitoring of the head and neck pain on a visual analogue scale (VAS) from 0-100 millimetres (19,20), (2) Active cervical range of motion (CROM) in flexion and ro-

tation using a goniometer, (3) Number of sessions needed to complete the treatment.

Data were collected before beginning the treatment (pre-treatment data), after each 4 sessions (monthly collection) in experimental group, and after each 10 sessions (2 weeks collection) in control group. The reason for these different time intervals was that experimental group was treated *weekly*, whereas control group was treated *daily*.

Treatment Protocols

Control group (Group B) was treated *daily* with a conventional physiotherapy treatment. Some of the best evidence for conventional physiotherapy treatment was applied: ultrasound in cervical soft tissues (21), active exercise at home (22,23), multimodal therapy (24) and low energy high frequency pulsed electromagnetic therapy (25).

The experimental group (Group A) was treated *weekly* with the manipulative protocol developed by our investigation group. This protocol includes “high velocity-low amplitude techniques” (26) of the upper cervical spine, cervicothoracic junction, thoracic spine, thoracolumbar junction and pelvic girdle; neuromuscular technique in paraspinal soft tissues (27); muscle energy techniques in the cervical spine (28); craniosacral techniques (29), and myofascial trigger point manual therapies (30-32). We would like to describe, based in our clinical experience, some of the techniques of this manipulative protocol:

- *Upper cervical spine manipulation.* The patient lay supine with the cervical spine in neutral position. The hand of the therapist contacts with the index finger over the posterior arch of the atlas on the painful side of the neck. The other hand takes the chin. Gently contralateral rotation from the painful side (homo-lateral rotation from the restricted side) is introduced until slight tension is palpated in the tissues at your contact point. Then, a high velocity-low amplitude (HVLA) technique directed towards the corner of the patient’s mouth is applied. This technique must be applied with the upper cervical spine in flexion (Figure 1). This technique was applied if the extension-rotation test, for vertebrobasilar insufficiency diagnosis, was negative (33). Most patients of experimental group were manipulated at the upper cervical spine at the 3rd session.
- *Thoracic spine manipulation.* The patient lay supine with the arms crossed over the chest and hands passed around the shoulder. The thoracic spine is in neutral position. The hand of the therapist contacts with a neutral hand position over the spinous process of T4.

The other hand stabilizes the head, neck and upper thoracic spine of the patient. Gently flexion of the thoracic spine is introduced until slight tension is palpated in the tissues at the contact point. Then, HVLA technique downwards towards the table, and in a cephalad direction is applied (Figure 2).

- *Pelvic girdle manipulation.* The patient lay contralateral side with the upper body in light flexion and hips flexed to approximately 90°. Upper knee of the patient is flexed until the heel of the foot is placed just anterior of the knee of the lower leg. Gently contralateral rotation of the patient's upper body is introduced until slight tension is palpated in L5-S1 junction. The therapist contacts with the forearm in the lateral side of the pelvic girdle. The other hand should be resting against the patient's pectoral and rib cage region. The knee of the therapist is placed over the patient's upper knee. Then, HVLA technique downwards towards the table is applied (Figure 3).
- *Myofascial trigger point (MTrP) manual therapies (28-30).* The ischemic compression technique was applied in the trapezius (34) and sternocleidomastoid muscles (35-36), principally. The patient lay supine with the cervical spine in neutral position. The therapist applies gradually increasing pressure on the MTrP until the patient begins to feel a degree of discomfort. At that moment, the pressure is kept until the patient stops feeling discomfort. Then, pressure is increased again until the degree of discomfort starts again. This process has to be repeated during 90 seconds. This technique is executed with the muscle in a taut position (37).

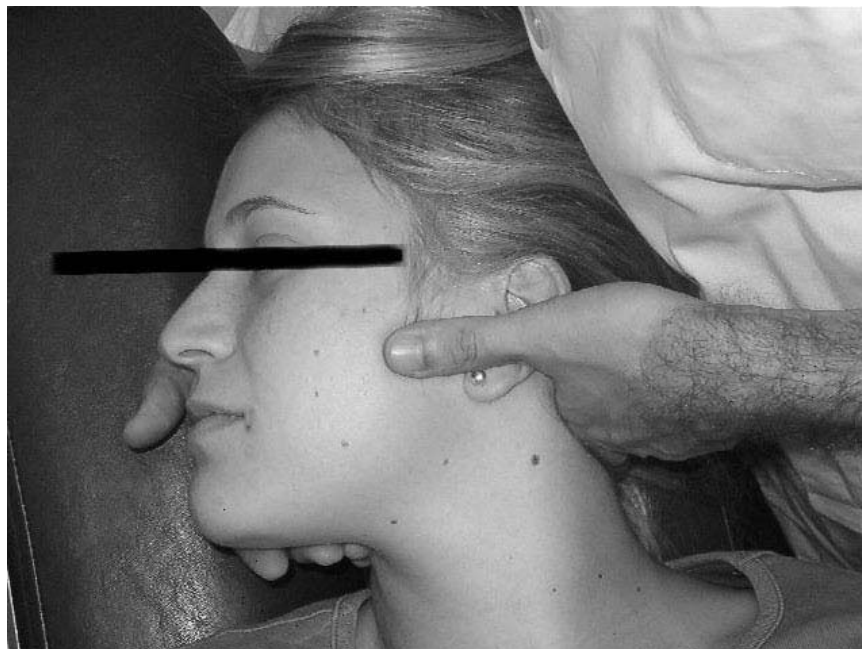
Analysis of Data

Data were introduced in the Statistical Package for Social Scientist (SPSS) version 11.5. Mean and standard deviation were calculated for the pre-test, post-test and difference scores. Paired Student test was used to compare the mean of the changes in the outcome measures. A P value less than 0.05 was considered as statistically significant.

RESULTS

At the beginning of the study, there were no statistically significant differences between the two groups on visual analogue scale ($P = 0.7$) and in active cervical range of motion ($P = 0.55$ in cervical flexion; and

FIGURE 1



$P = 0.6$ in cervical rotation); it could therefore be assumed reasonably that they were comparable in the outcome measures at the start of the research. The basic clinical data of both groups are shown in Table 1.

The experimental group, whose patients were treated with the manipulative protocol, needed 9 ± 1.5 sessions to complete the treatment, whereas the control group, whose patients were treated with the conventional physiotherapy protocol, needed 23 ± 3.2 sessions ($P = 0.002$).

Results showed that the manipulative group obtained more benefit than the physiotherapy group in the visual analogue scale (VAS), and cervical range of motion (CROM) outcome measures. Figure 4 summarizes the VAS changes over time in both groups during the research.

Further analysis of the change in visual analogue scale for pain showed that, after the first 4 sessions, the experimental group obtained an average decrease of 40% in head and neck pain, whereas the control group, after the first 10 sessions, obtained a decrease of 19% ($P = 0.03$). Table 2 shows the statistical comparison of the VAS decrease.

FIGURE 2



The changes in the active cervical range of motion were similar to visual analogue scale. An improvement of 20° in cervical rotation and 17.5° in cervical flexion were obtained after the first 4 sessions in experimental group. This was statistically significant in comparison with the control group ($P = 0.02$ in rotation, and $P = 0.035$ in flexion) which yielded improvement of 2.5° and 6° , respectively. Figures 5 and 6 summarize the flexion and rotation scores for both groups during the trial.

DISCUSSION

This clinical trial has demonstrated that head and neck pain decrease with fewer treatment sessions in response to a manipulative treatment protocol as compared to a physiotherapy treatment protocol among patients diagnosed with acute whiplash injury. Furthermore, active cervical range of motion, in flexion and rotation, has been increased after the

FIGURE 3



TABLE 1. Basic Clinical Data of Each Group

| | CONTROL GROUP | EXPERIMENTAL GROUP |
|------------------------------------|------------------|--------------------|
| NUMBER OF CASES | 190 subjects | 190 subjects |
| MALE/FEMALES | 160/30 subjects | 140/50 |
| AGE X (SD) | 27.5 (6.9) years | 26.9 (7.4) years |
| GRADES OF WHIPLASH II / III | 150/40 | 155/35 |

X = Mean

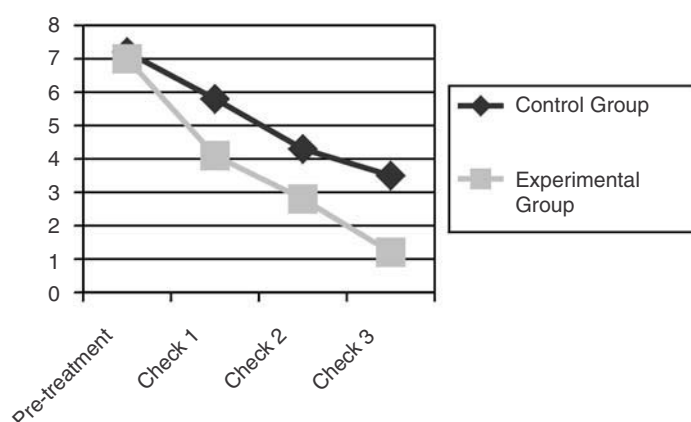
SD = standard deviation

GRADE II = neck complaint and musculoskeletal signs

GRADE III = neck complaint, musculoskeletal signs, and neurologic signs

first manipulative sessions, more than with a conventional physiotherapy treatment. The effectiveness of the spinal manipulation was analyzed in patients with mechanical neck pain (16,17), but not specifically in whiplash injury. Cassidy (16) proposed that cervical manipulation exerts a reflex on pain and muscle tension. Vernon (17) observed that

FIGURE 4. Visual Analogue Scale Changes Over Time in Both Groups.



Check 1 = It was performed after 4 sessions in the Experimental Group, and after 10 sessions in the Control Group.

Check 2 = It was performed after 8 sessions in the Experimental Group, and after 20 sessions in the Control Group.

Check 3 = It was performed at the finish of the treatment of each patient.

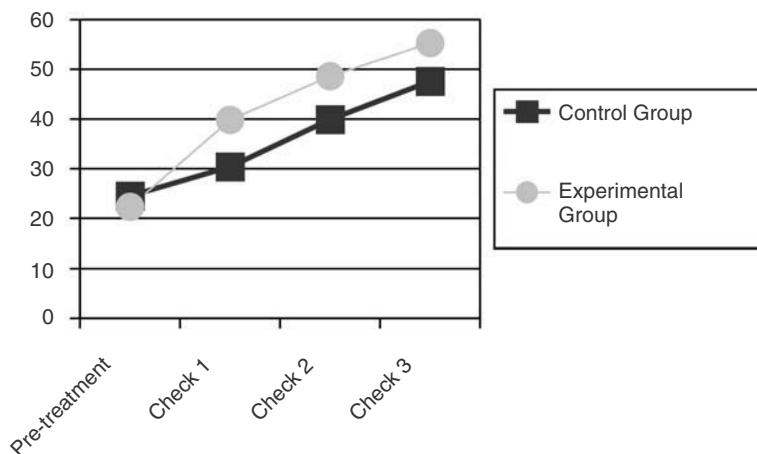
TABLE 2. Statistical Comparison of the Visual Analogue Scale Values

| | CONTROL GROUP | EXPERIMENTAL GROUP |
|---------------|---------------|--------------------|
| PRE TREATMENT | 7.2 (0.9) | 7 (0.4) |
| CONTROL 1 | 5.8 (1) | 4.1 (0.7) |
| CONTROL 2 | 4.3 (0.8) | 2.8 (0.5) |
| CONTROL 3 | 3.5 (0.8) | 1.2 (0.2) |

Values are showed in mean (standard deviation)

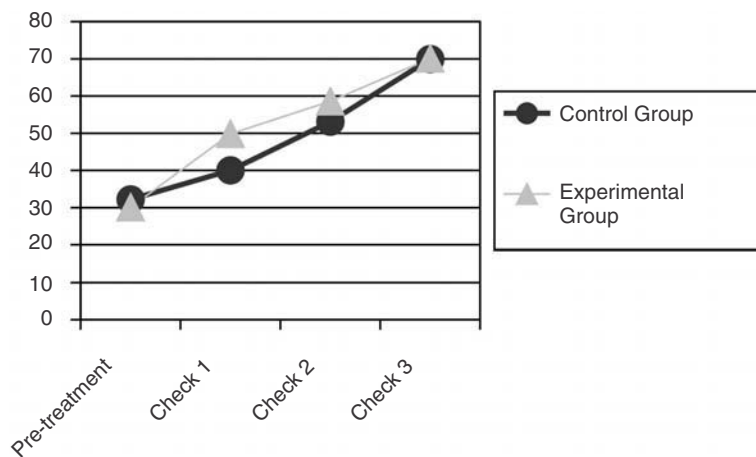
cervical manipulation increase local paraspinal pain threshold levels. However, our investigation group thinks that it is necessary to manipulate a number of spinal levels with the exception of the lower cervical spine (18). The goal of joint manipulation is to restore maximal, pain-free movement of the musculoskeletal system (38). Only joints that are found to be hypomobile should be considered as candidates for high velocity-low amplitude (HVLA) techniques. Spinal joint dysfunction and myofascial pain syndrome are thought by some authors to be one of the greatest causes of musculoskeletal disorders in patients diagnosed with whiplash injury (11,36,39). Spinal joint dysfunction (fixation, hypo-

FIGURE 5. Cervical Flexion Improvement in Both Groups



Check 1 = It was performed after 4 sessions in the Experimental Group, and after 10 sessions in the Control Group.
 Check 2 = It was performed after 8 sessions in the Experimental Group, and after 20 sessions in the Control Group.
 Check 3 = It was performed at the finish of the treatment of each patient.

FIGURE 6. Cervical Rotation Improvement in Both Groups



Check 1 = It was performed after 4 sessions in the Experimental Group, and after 10 sessions in the Control Group.
 Check 2 = It was performed after 8 sessions in the Experimental Group, and after 20 sessions in the Control Group.
 Check 3 = It was performed at the finish of the treatment of each patient.

mobility) can be defined as a temporary reduction of mobility, in one or more planes, of a spinal segment (40). This reduction of spinal motion is thought to be caused by a hypertonus of the deep muscles innervated from the spinal segment (41). This hypertonus is thought to be caused by “incorrect” setting of gamma neuron control of intrafusal muscle fibres at the level of the spinal cord. This high “gamma gain” may be the basis for the reduction of vertebral motion (42).

Myofascial pain syndrome is characterized by myofascial trigger points (MTrPs) (43). A MTrP is a hyperirritable area within a palpable taut band of a skeletal muscle that is painful on compression or stretch and that can give rise to a typical referred pain pattern and autonomic phenomena (44). The aim of the manipulative protocol developed by our investigation group is to alter mechanical stress, caused by spinal joint dysfunction and myofascial trigger points, thought to contribute to patient symptoms (45). The biological mechanism underlying the effects of spinal manipulation is not clearly understood. However we would like to propose a hypothesis of the possible mechanism by which the manipulations applied in this protocol have been effective.

Upper Cervical Manipulation

Penning postulated that the main mechanism of whiplash injury is hyper-translation of the head (46,47). This hypertranslation of the head could be one of the causes of upper cervical injury. This head motion distracts the anterior structures with a concomitant compression of the posterior structures. A compression mechanism of the atlantoaxial junction could activate a myofascial pain syndrome in the suboccipital muscles (37). Three anatomical findings are noteworthy:

1. There is a connective tissue bridge between the rectus capitis posterior minor muscle and the dorsal spinal dura at the atlanto-occipital junction (48),
2. The cervical posterior spinal dura between C1-C2 vertebrae is attached to the ligamentum nuchae (49), and
3. The posterior dura was much thicker than the anterior dura in the upper cervical spine (50).

In this context, we could hypothesize that adverse tension in the spinal dura could result in cervicogenic headache (51,52). This analysis could explain the effectiveness of the upper cervical spine manipulation (26), and craniosacral techniques (29) in these patients.

Thoracic Joint Manipulation

The presence of thoracic joint dysfunction (TJD) may cause secondary adaptative or maladaptative changes in cervical and sacroiliac joints (28). It is reasonable to hypothesize that cervical changes provoked by TJD may contribute to the resulting headaches and neck pain. In a previous study performed by our investigation group, we could observe that some of the whiplash associated disorders (head, neck and upper thoracic pain) decreased in response to a dorsal manipulation (53).

Pelvic Girdle Manipulation

Pelvic girdle manipulation may be beneficial because, in a rear-end impact, as the target vehicle is accelerated forward, the seatback contacts the lumbopelvic region, causing the seat to deflect backward, away from the upper torso (54). This compression of the lumbopelvic region produces a hypomobility in the pelvic girdle what it is necessary to manipulate (18).

Myofascial Trigger Points Treatment

It has been demonstrated, that after whiplash injury, soft tissues are damaged in these patients. The sternocleidomastoid muscle (SCM) undergo lengthening in any rear-end impact. A 6% lengthening has been reported in a previous research (55). Stretching is likely to be a very effective mechanism for myofascial trigger point activation (37). Moreover, the SCM reaches 179% of their maximal voluntary contraction in rear-end impacts (36). The muscle lengthening measured in a rear-end impact is consistent with producing some of the cervical soft tissue symptoms experienced by these patients (55). Manual treatment of MTrP in the SCM muscle can explain the neck rotation's improvement in whiplash patients.

Limitations of the Study

The main limitation of the trial was the time intervals in the outcome measures. We have to take into account that physical therapy group was treated daily, and manipulative group was treated weekly, so we thought that the best time intervals for the outcome measures was after each 4 sessions in the manipulative group, and after each 10 sessions in the physiotherapy group. The reasons for this procedure were the following:

1. Physical therapy is commonly applied daily in Spain in patients suffering from whiplash injury.
2. The physiotherapy treatment applied in the control group was similar that the treatment used in previous researches (21-25). In these trials patients were treated daily, so the control group of the present study was treated in the same way.
3. Moreover, our clinical experience with these patients has demonstrated that one session per week of manipulative treatment provokes a good improvement in patients suffering from whiplash injury (18). However, we would like to repeat the same procedure treating twice a week patients in the manipulative group.

This procedure was the reason for the differing time intervals in the outcome measures. We recognize that this procedure was the main limitation of the trial, so we would like to repeat the procedure changing these time intervals in the outcome measures. However, the results of the study are according with the initial aim of the research, because patients in the manipulative group needed an average of 9 sessions to complete the treatment, whereas physiotherapy group needed an average of 23 sessions ($P = 0.002$). Moreover, we note that patients in the manipulative group finished the treatment 2 months after the beginning of the research, whereas patients in the physiotherapy group finished the treatment 1 month after the beginning of the trial; recovery of these patients could have been partly due to the natural course of the injury. However, the main aim of the trial was demonstrated because patients suffering from whiplash injury who received manipulative treatment needed fewer sessions to complete the treatment than patients who had received physiotherapy treatment.

Further studies are required to investigate the effectiveness of manipulative treatment in these patients. In the future, we plan to analyze if this improvement will be maintained over time by assessing and checking the patients after 6 months and 1 year.

CONCLUSIONS

The manipulative protocol developed by our investigation group has demonstrated to be effective in the management of whiplash injury. Results of this clinical trial have demonstrated that manipulative treatment is more effective in the management of whiplash injury than conventional physiotherapy treatment. The biomechanical analysis of a rear-

end impact may give insight into the benefit of our manipulation protocol: upper cervical manipulation, dorsal manipulation, cervicothoracic joint manipulation and pelvic girdle manipulation. Myofascial pain syndrome for neck muscles, specifically in trapezius and sternocleidomastoid muscles, also likely plays an important role in the treatment of whiplash patients.

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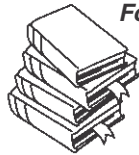
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