



CLINICAL APPROACHES

Manual treatment of post-whiplash injury

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Abstract Introduction: There are many therapeutic approaches aimed at treating the clinical syndrome resulting from whiplash injury. However, there seems to be little agreement between therapists as to the ideal treatment for these patients. Spinal manipulation/mobilization and soft tissue mobilization techniques are manual therapies commonly used in the management of neck disorders. The aims of the present paper are to detail a manual approach developed by our research group, to help in future studies of the management of the sequels to whiplash injury, and to suggest explanations for the mechanisms of this protocol. These manual approaches are considered by the authors to be more effective than conventional physical therapy in the management of whiplash patients.

Vertebral manipulations: The biomechanical analysis of whiplash injury showed that upper cervical manipulation, cervicothoracic junction manipulation, thoracic spine manipulation, and pelvic girdle manipulation are the major areas requiring such treatment, for beneficial outcomes to be assured. Although the exact biological mechanisms underlying the effects of spinal manipulation are not clearly understood, there are previous papers justifying most methods used in the current experimental protocol.

Soft tissues manipulation techniques: The soft tissues techniques used in this protocol were neuromuscular technique in paraspinal muscles, muscle energy techniques in the cervical spine, myofascial release in the occipital region, and myofascial trigger point manual therapies as required.

Clinical dissertation: The definition of spinal joint dysfunction (hypomobility) implies that muscle shortening is involved. This suggests that manual treatment of persons suffering from whiplash injury requires the treatment of muscular and fascial shortening, as well as the treatment of spinal joint dysfunction, when appropriate.

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Introduction

The Quebec Task Force adopted the following definition of whiplash (Spitzer et al., 1995):

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 injury includes neck pain, upper thoracic pain, cervicogenic headache (Drottning et al., 2002), tightness, dizziness, restriction of cervical range of motion, tinnitus, and blurred vision (Hohl, 1975; Dvorak et al., 1989). The exact nature of these symptoms is not clearly understood, although the pain is attributed to musculoskeletal disorders, i.e. involving the soft tissues and facet joint dysfunction, caused by the impact (Wiley et al., 1986). Moreover, experimental research involving human cadavers has demonstrated that a variety of musculoskeletal injuries can occur during whiplash, such as muscle and ligament sprains (Barnsley et al., 1998). Several theories have been postulated to explain these symptoms, including vertebral artery insufficiency and injury of the cervical sympathetic chain, in relation to visual disturbances and dizziness (Bogduk, 1986), C1–C2 facet joint injury in relation to headaches (Lord et al., 1996), and paraspinal muscle spasm in relation to neck pain (Teasell and Shapiro, 2001). Moreover, some authors have reported that people suffering from whiplash injury display signs of both central and peripheral sensitization (Koelbaek et al., 1999).

Numerous forms of treatment have been suggested to relieve the symptoms of this clinical syndrome. However, there seems to be little or no agreement between therapists as to the ideal treatment of whiplash symptoms (Valera et al., 2003). Following a literature review relating to the conservative treatment of persons suffering from whiplash injury, Peeters et al. (2001), reported that, despite the many treatments available for these patients, there continues to be no evidence for their accepted use.

Spinal manipulation/mobilization, and soft tissue mobilization, techniques are manual therapies commonly used in the management of neck disorders (Gross et al., 2002). There are many clinical trials that have analysed the effectiveness of cervical manipulation/mobilization in people suffering from mechanical neck pain (Vernon et al., 1990; Cassidy et al., 1992), but there are a

few papers analysing the effects of spinal manipulation in people suffering from whiplash injury (Osterbauer et al., 1992).

In a previous paper (Fernández et al., 2004a) our research group demonstrated that current manual treatment methods were more effective than conventional physical therapy in the management of whiplash patients. In this trial it was found that people who were treated with this manual approach had a greater improvement in cervical range of motion, and a greater scores on visual analogue scales, than those treated with conventional physical therapy treatment (comprising massage, ultrasound therapy, exercises at home, and low energy high frequency pulsed electromagnetic therapy). Moreover, patients from the osteopathic group in that trial required 9 sessions to complete the treatment, whereas those from the physiotherapy group needed 23 sessions ($P = 0.002$). The study concluded that the improvement in the experimental group was faster and greater than the improvement in the physiotherapy group.

The manual treatment mentioned in the previous trial (Fernández et al., 2004a) included high velocity–low amplitude techniques (HVLA) applied to the upper cervical spine, cervicothoracic junction, thoracic spine, thoracolumbar junction, and pelvic girdle, as well as neuromuscular technique (NMT) of the paraspinal soft tissues (Chaitow, 2003), muscle energy techniques (MET) applied to the cervical spine (Mitchell, 1995; Chaitow, 2001), craniosacral techniques (von Piekartz and Bryden, 2001), and myofascial trigger point (MTrP) manual therapies (Hou et al., 2002).

The aims of this paper are:

- to detail the manual treatment developed by our research group, to help in future studies involving the management of persons suffering from whiplash injury, and,
- to offer hypotheses of the mechanisms of this protocol

Vertebral manipulations (HVLA techniques)

The goal of joint manipulation is to restore maximal, pain-free movement of the musculoskeletal system (Whittingham and Nillson, 2001). It is suggested that only joints that are found to be hypomobile should be considered as candidates for HVLA techniques. Vertebral manipulations are currently used in the treatment of whiplash injury without the benefit of scientific evidence, so

further analysis is required to find a biomechanical justification for HVLA treatment in whiplash injury. A previous paper (Fernández et al., 2003a) showed that upper cervical manipulation, cervicothoracic junction manipulation, thoracic spine manipulation, and pelvic girdle manipulation have biomechanical justifications in the scientific literature (Panjabi et al., 1998a; Bogduk and Yoganandan, 2001; Yoganandan et al., 2002). Based on this biomechanical analysis, our research group considered it appropriate to manipulate only these segments, and only if hypomobility could be demonstrated.

A brief description of the manipulative techniques is given below, after which explanations are offered as to possible mechanisms whereby benefit might be gained from these procedures.

Upper cervical spine manipulation

- *Pattern of restriction.* Upper cervical manipulation is applied only if rotation restriction of C1 has been identified by the therapist. The examination is based on palpatory examination and gliding motion test of the atlas. Before this manipulation, an extension–rotation test, for vertebro-basilar insufficiency assessment should be applied, although its specificity, validity and reliability is controversial (Mitchell, 2003).
- *Patient position.* Supine with the neck in a neutral relaxed position.
- *Practitioner stance.* At the head of the couch.
- *Hand contacts.* The hand of the therapist makes contact with the index finger over the posterior arch of the atlas, on the side contra-lateral to the restriction. In this example, with restriction of right rotation of the atlas, the hand of the therapist makes contact over the left side of posterior arch of the atlas. The other hand cups the chin.
- *Direction of the manipulation.* Rotation is gently introduced, toward the right, until slight tension is palpated in the tissues at the contact point.
- *Thrust.* A HVLA thrust is applied directed towards the corner of the person's mouth (Fig. 1).

Cervicothoracic junction manipulation

- *Pattern of restriction.* Cervicothoracic manipulation is applied only if side-flexion restriction of C7 on T1 has been identified by the therapist. The examination is based on palpatory examination and a gliding motion test of C7 on T1.
- *Patient position.* Prone with the head and neck rotated. In this example, with lateral-flexion of



Figure 1 Upper cervical spine manipulation.

C7 on T1 restricted to the left, the neck is turned to the right.

- *Practitioner stance.* The therapist stands on the right side of the person, facing cephalad.
- *Hand contacts.* The left hand of the therapist makes contact, with the thumb on the left side of the spinous process of T1. The right hand supports the head, making contact on the temporal bone.
- *Direction of the manipulation.* The head/neck is gently lateral-flexed to the left, until slight tension is palpated in the tissues.
- *Thrust.* A HVLA thrust is applied, of the spinous process of T1, toward the person's right side shoulder (Fig. 2).

Thoracic spine manipulation

- *Pattern of restriction.* Thoracic spine manipulation is applied only if extension restriction of T1–T4 has been identified by the therapist. The examination is based on palpatory examination and gliding motion test of high dorsal vertebrae (Fernández et al., 2004b).
- *Patient position.* Supine with the arms crossed over the chest and hands wrapped around the shoulders. The thoracic spine is in a neutral position.
- *Practitioner stance.* On one side of the patient, facing cephalad.
- *Hand contacts.* The clenched hand of the therapist makes contact over the spinous process of T4. The other hand stabilizes the head, neck and upper thoracic spine, making contact over the spinous process of T3.



Figure 2 Cervicothoracic junction manipulation.



Figure 3 Thoracic spine manipulation.

- *Direction of the manipulation.* Gentle flexion of the upper thoracic spine is introduced until slight tension is palpated in the tissues at the contact point.
- *Thrust.* A HVLA technique is applied, downwards towards the couch, and in a cephalad direction (Fig. 3).

- *Direction of the manipulation.* A compressive upwards force is introduced until slight tension is palpated in the tissues at the contact point.
- *Thrust.* Maintaining all holds and pressure, the patient is brought backwards. A HVLA technique is applied towards the therapist, and slightly upwards in a cephalad direction (Fig. 4).

Thoracolumbar junction manipulation

- *Pattern of restriction.* Thoracolumbar junction manipulation should be applied in all patients with the aim of restoring maximal free movement of T12–L1 region, because the biomechanical analysis of whiplash injury implies a compression spine dysfunction at this level (Panjabi et al., 1998a; Bogduk and Yoganandan, 2001; Yoganandan et al., 2002).
- *Patient position.* Sitting with arms crossed behind the trunk, and knuckles over the thoracolumbar junction (T12–L1).
- *Practitioner stance.* Standing directly behind the patient.
- *Hand contacts.* The therapist places his/her abdomen against the hands of the patient (abdomen of the therapist placed over the spinous process of T12–L1 junction). Hands of the therapist passed around the abdomen of the patient.

Pelvic girdle manipulation

- *Pattern of restriction.* Pelvic girdle manipulation should be applied to all patients, with the aim of restoring maximal free movement of the sacroiliac region, because biomechanical analysis of whiplash injury implies a compression dysfunction of the pelvic girdle (Panjabi et al., 1998a; Bogduk and Yoganandan, 2001; Yoganandan et al., 2002).
- *Patient position.* The person lies on the side, with the upper body in light flexion and hips flexed approximately 90°. The upper knee of the person is flexed until the heel of the foot is placed just anterior of the knee of the lower leg.
- *Practitioner stance.* Standing in front of the person, and close to the couch.
- *Hand contacts.* The therapist makes contact with a forearm on the lateral aspect of the pelvic girdle. The other hand should be resting against

the person's pectoral and rib cage region. The knee of the therapist is placed over the patient's upper knee.

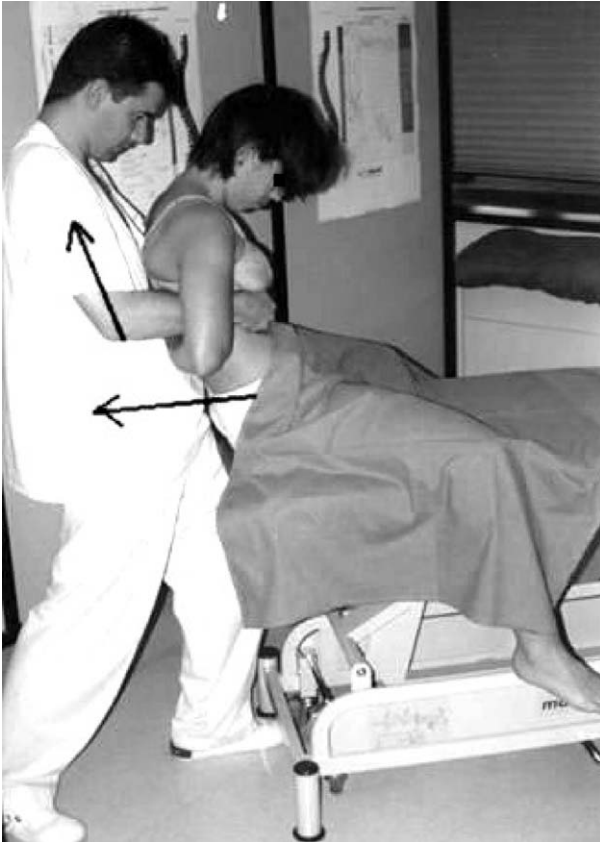


Figure 4 Thoracolumbar junction manipulation.

- *Direction of the manipulation.* Gentle contralateral rotation of the person's upper body is introduced, taking the upper body posteriorly and the pelvis anteriorly, until slight tension is palpated at L5–S1 junction.
- *Thrust.* A HVLA technique is applied downwards towards the couch (Fig. 5).

What are the therapeutic mechanisms involved in these manipulations?

The biological mechanism underlying the effects of spinal manipulation is not clearly understood, however we hypothesize possible mechanisms of the applied manipulations in the current protocol, as follows:

Upper cervical manipulation

Penning postulated that the main mechanism of whiplash injury is hyper-translation of the head (Penning, 1992a, b). This has been confirmed recently by other authors who reported that upper cervical spine performs a hyperextension motion during the first phase of the whiplash injury (Panjabi et al., 1998a; Bogduk and Yoganandan, 2001; Yoganandan et al., 2002). This hyperextension of the head might be one of the causes of C1–C2 facet joint injury and adaptive muscle shortening. This head motion distracts the anterior structures with a concomitant compression of the posterior structures, specifically the suboccipital muscles. Therefore, compression of the

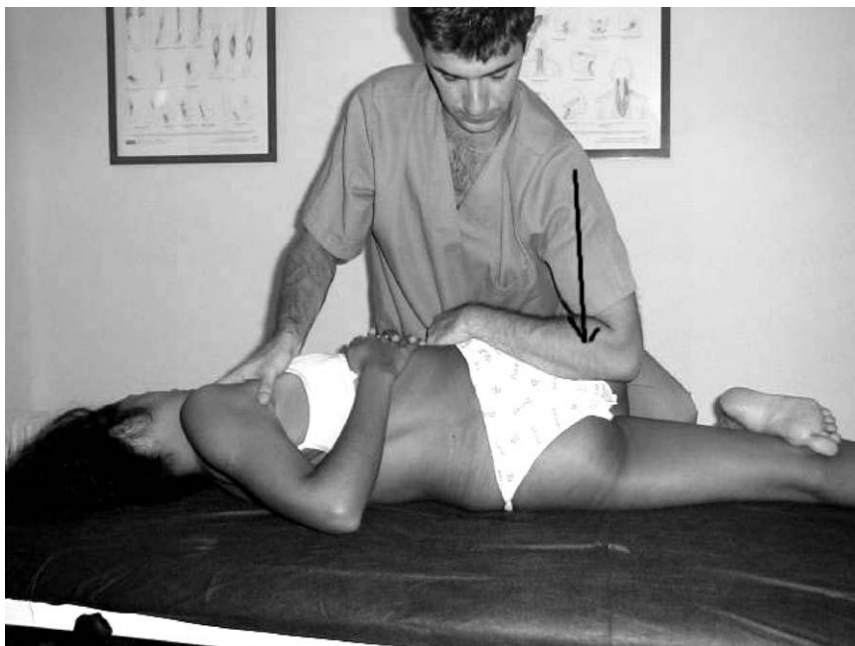


Figure 5 Pelvic girdle manipulation.

atlantoaxial junction may activate a myofascial pain syndrome in the suboccipital muscles. Moreover, during whiplash, the head and neck are exposed to multiple forces in flexion, extension and rotation, so that myofascial pain syndrome can be initiated due to these force patterns during each phase of the accident (Simons et al., 1999). Three additional anatomical findings may be involved:

- (a) There is a connective tissue bridge between the rectus capitis posterior minor muscle (RCPM) and the dorsal spinal dura at the atlanto-occipital junction (Hack et al., 1995),
- (b) The cervical posterior spinal dura between C1–C2 vertebrae is attached to the ligamentum nuchae (Mitchell et al., 1998),
- (c) The posterior dura is much thicker than the anterior dura in the upper cervical spine (Taylor et al., 1996).

We hypothesize that adverse tension in the spinal dura can result in cervicogenic headache (Vernon, 1995), a common whiplash associated disorder (Drottning et al., 2002). This situation might explain the effectiveness of the upper cervical spine manipulation in these patients. Some authors reported that 20% of people suffering from chronic whiplash injury demonstrate atrophy of the RCPM (Hallgren et al., 1994). This could suggest that HVLA involving the upper cervical spine might be indicated in these cases. However, upper cervical manipulation restores pain-free movement at the atlantoaxial junction, so its effect is aimed at the joint proprioceptors. The atlantoaxial region requires soft tissue techniques, such as suboccipital release, NMT and MET applied to the cervical spine, to reduce adverse tension in the spinal dura, and to encourage a minimal restoration of a neuromuscular connection in RCPM.

Cervicothoracic junction, thoracic spine, and thoracolumbar junction manipulations

Although whiplash injury may result from rear, side and frontal impacts, rear-end crashes account for about 85% of all of whiplash associated disorders (Yoganandan et al., 1998). The presence of thoracic joint dysfunctions and C7-T1 can be explained through a kinematical analysis of a rear-end impact. Recent papers (Panjabi et al., 1998a; Bogduk and Yoganandan, 2001; Yoganandan et al., 2002) investigating the biomechanical mechanism of whiplash injury, have hypothesized that, during the initial phase of a rear-end impact, the upper cervical spine responds in flexion, concomitant with lower cervical and upper thoracic spine extension, resulting in an S-curve (Fig. 6). This

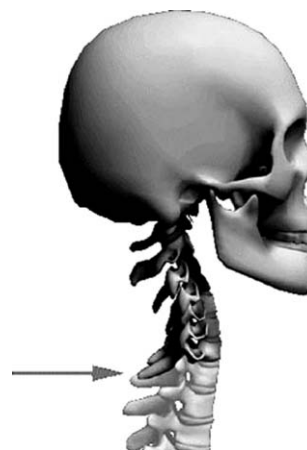


Figure 6 S-curve of the cervical spine during the initial phase of a rear-end impact.

situation is attributed to the upward and forward thrust of the upper trunk during the first 100 ms after the rear impact (Bogduk and Yoganandan, 2001). This is the consequence of the thoracic kyphosis extension which is attributed to the seatback (Matsushita et al., 1994). This rapid thoracic extension distracts the anterior aspects of the spine with a concomitant compression of the posterior structures, specifically the thoracic soft tissues. The S-curve of the cervical spine could explain the presence of cervicothoracic junction dysfunction, whereas thoracic extension could explain the presence of thoracic joint dysfunction.

In a previous trial performed by our research group, it was demonstrated that thoracic joint dysfunctions are more prevalent in persons suffering from whiplash injury than in persons suffering from mechanical neck pain. Moreover, it was found that some of the whiplash associated disorders (head, neck, and upper thoracic pain) decreased in response to thoracic manipulation (Fernández et al., 2004b).

Pelvic girdle manipulation

Pelvic girdle manipulation is commonly necessary 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 (Gay and Levine, 2002). Later, the restraining lap belt might cause compression of the lumbo-pelvic region. Moreover, the forward rebound of the seat back may contribute to a second phase of this compression. This compression of the lumbopelvic region produces a hypomobility in the pelvic girdle, which it is necessary to manipulate. Therefore, the presence of a hypomobility in the pelvic region could be expanded to include secondary adaptive



Figure 7 NMT in paraspinal soft tissues.

or maladaptative changes in the cervical and thoracic regions (Mitchell, 1995).

Soft tissues manipulation techniques

It has been demonstrated, that after whiplash injury, soft tissues that have been traumatized may develop MTrPs (Schuller et al., 2000). MTrPs can contribute significantly to acute and/or chronic pain syndromes following whiplash injury, a scenario that is often overlooked (Hong and Simons, 1993).

MTrPs and cervical joint dysfunctions are thought, by some authors, to be among the most important causes of musculoskeletal disorders in people suffering from whiplash injury (Bronfort et al., 2001; Shrawan et al., 2002).

A MTrP is a hyperirritable spot, associated with 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, as well as autonomic phenomena (Simons et al., 1999). The formation of an MTrP may result from a variety of factors, however sudden stretching and overloading of tissues are likely to be effective mechanisms for MTrP activation (Simons et al., 1999). The muscle lengthening that occurs during a rear-end impact is consistent with producing some of the cervical soft tissue symptoms experienced by these patients (Brault et al., 1998). Panjabi et al. (1998b) suggested that the S-shaped curvature that precedes full cervical extension may potentially be most damaging, as it stretches the anterior elements of the lower cervical spine beyond their normal yield limits. The S-shaped curvature may result in lengthening of the sternocleidomastoid and longus colli muscles, and result in a contraction-induced muscle injury of these muscles (Panjabi et al., 1998b).

Brault et al. (1998) reported a 6% lengthening of the sternocleidomastoid muscle after a rear-end impact. Moreover, Shrawan et al. (2002) reported

that the SCM reach 179% of their maximal voluntary contraction in rear-end impacts. These two mechanisms might explain the activation of MTrPs at the sternocleidomastoid muscle.

The aims of the soft tissues techniques used in this manual protocol are to alter mechanical stress, caused by MTrPs and fascial sprain, thought to contribute to the post-whiplash symptoms. The soft tissues techniques used in this protocol include NMT applied to paraspinal soft tissues (Chaitow, 2003) (Fig. 7); MET applied to the cervical spine (Mitchell, 1995); myofascial release applied to the occipital region (Saunders and Saunders, 1993), and MTrP manual deactivation approaches (Simons et al., 1999). A description is outlined below of the MTrP manual therapies used in this protocol, and the occipital release technique.

Myofascial trigger point (MTrP) manual therapies

In a previous review of the literature (Fernández et al., 2003b), it was found that MTrPs are common in the following muscle groups: scalenes (81%), splenius capitis (77%), sternocleidomastoid (Baker, 1986), upper fibres of trapezius, and pectoralis minor (37%) (Hong and Simons, 1993)

These muscles are treated as follows:

- (a) *Trigger point compression technique*: the person lies supine with the cervical spine in a neutral position. The therapist applies gradually increasing pressure to the MTrP until the person begins to feel a degree of discomfort. The pressure is maintained until the discomfort eases, at which time, pressure is increased again until discomfort starts again. This technique is most effective when executed with the muscle in a lengthened position (Simons et al., 1999).
- (b) *Spray and stretch*: This technique involves passive stretching of the target muscle with

simultaneous cutaneous application of a vapocoolant spray (ice cold) according to the protocol originally described by Travell and Simons (Simons et al., 1999).

Occipital release (Saunders and saunders, 1993)

The patient lies supine with the cervical spine in a neutral position. A mild manual compression is applied to the posterior suboccipital musculature, using the practitioner's flexed fingers. Direct pressure is applied at the musculotendinous junction of the cervical muscles at the base of the skull, specifically at the atlanto-occipital junction, until they release significantly (Fig. 8). In our clinical experience we have observed that it is necessary to maintain the digital pressure for about 15 min to obtain a good myofascial release.

Proposed therapeutic mechanisms associated with the soft tissues manipulation techniques

Myofascial trigger point (MTrP) manual therapies

The mechanism of pain relief of these techniques remains unclear. A recent systematic review of manual therapies in treatment of MTrPs, concluded that there have only been a few randomized controlled trials that have analysed treatment of MTrPs using manual therapy. Moreover, the hypothesis that manual therapies have specific efficacy beyond placebo in the management of MTrPs is neither supported nor refuted by the research to date. However, although different manual therapies are being used in MTrP treatment, often without adequate scientific evidence, clinical practice confirms that these therapies are effective in reducing post-whiplash and MTrP symptoms (Fernández et al., 2004c).

- (a) Simons has hypothesized that the pain relief from trigger point compression technique may result from reactive hyperemia in the MTrP region, or a spinal reflex mechanism for the relief of muscle spasm (Simons et al., 1999). It is known that the pressure treatment of MTrP is effective; however, clinical experiences show that is unnecessary to apply excessive force, sufficient to provoke ischemia. There seems to be no reason to provoke additional ischemia in an area already suffering reduced blood supply and loss of oxygen (Han and Harrison, 1997; Hong and Simons, 1998; Mense et al., 2000).
- (b) The pain relief from the spray and stretch technique may be explained as the therapeutic effect of the cold spray and its facilitation of release of taut bands by stretching (Simons et al., 1999). This technique has been analysed in previous studies that demonstrated efficacy in the treatment of MTrPs. Jaeger and Reeves (1986) analysed the isolated effectiveness of this technique, obtaining a significant improvement ($P < 0.01$) of 1 kg/cm^2 of the pressure pain threshold (PPT), and an improvement of 2.6 on scores on the visual analogue scale. Hong et al. (1993) compared the effectiveness of various physical medicine modalities: spray and stretch, deep pressure soft tissue massage (mixture of conventional massage and ischemic compression), hydrocollator superficial heat, and ultrasound deep heat. Results showed that all techniques were effective regarding the increase in PPT, establishing that the best results were obtained with the deep pressure soft tissue massage. The improvement obtained with spray and stretch technique was $1.3 \pm 0.2 \text{ kg/cm}^2$ in the PPT ($P < 0.01$).

Occipital release

This technique was applied for the treatment of cervicogenic headache in whiplash patients.



Figure 8 Myofascial release in the suboccipital muscles.

Hanten et al. (1997) reported that this technique was no more efficacious than placebo intervention when treating MTrPs. However, if the methodology of this trial is analysed it is clear that the technique was not applied in the same way, or with the same aim, as that in the current protocol. In our clinical experience we have observed that it is necessary to maintain the digital pressure about 15 min to obtain a good myofascial release.

The therapeutic rationale for this technique is based on the existence of a connective tissue bridge between the RCPM muscle, and the dorsal spinal dura at the atlanto-occipital junction (Hack et al., 1995). The mild and continuous pressure over RCPM provokes a myofascial release of the suboccipital region, potentially offering a beneficial effect to the spinal dura at this level. In our clinical practice we have observed that, after the application of this technique, post-whiplash patients commonly report relief of their head and neck symptoms.

Clinical dissertation

Spinal joint dysfunction can be defined as a temporary reduction of mobility, in one or more planes, of a spinal segment (Triano, 2001). This reduction of spinal motion is caused by a hypertonus of the deep muscles supplied from the spinal segment (Denslow, 1944). This hypertonus is thought to be caused by incorrect spinal-cord setting of the gamma neuron control of intrafusal muscle fibres. This high "gamma gain" may be the basis for the reduction of vertebral motion (Korr, 1975). The present definition of spinal joint dysfunction implies that muscle shortening is indeed a feature. Moreover, there are different authors (Lewit, 1991; Kuan et al., 1997) who have described the existence of a relationship between joint dysfunction and MTrPs. Lewit emphasizes the clinical importance of the treatment of MTrPs, and joint dysfunction, when both are present (Lewit, 1991). This situation implies that all manual treatment in people suffering from whiplash injury should include the treatment of muscular and fascial dysfunction (principally MTrPs), as well as the treatment of spinal joint dysfunctions.

Conclusions

The manipulative protocol developed by our research group has been shown to be effective in the management of whiplash injury (Fernández et al., 2004a). The biomechanical analysis of a rear-end impact justifies some of the manipulative techni-

ques: upper cervical manipulation, dorsal manipulation, cervicothoracic joint manipulation, and pelvic girdle manipulation. However, lower cervical spine manipulation seems to not be necessary in the management of these patients (Fernández et al., 2003a). MTrPs in trapezius muscles, suboccipital muscles, scalene muscles and sternocleidomastoid muscles, commonly play an important role in the treatment of people suffering from post-whiplash symptoms (Fernández et al., 2003b).

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