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Effects of myofascial technique in patients with subacute whiplash associated disorders: a pilot study

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Background. **Whiplash associated disorders commonly affect people after a motor vehicle accident, causing a variety of disabling manifestations. Some manual and physical approaches have been proposed to improve myofascial function after traumatic injuries, in order to effectively reduce pain and functional limitation.**
Aim. **To evaluate whether the application of the Fascial Manipulation© technique could be more effective than a conventional approach to improve cervical range of motion in patients with subacute whiplash associated disorders.**
Design. **Pilot randomized clinical trial.**
Methods. **Eighteen patients with subacute whiplash associated disorders were randomized into two groups. Group A (N.=9) received three, 30-minute sessions, (every five days during a two week period) of neck Fascial Manipulation©. Group B (N.=9) received ten, 30-minute sessions (five days a week for two consecutive weeks) of neck exercises plus mobilization. Patients were evaluated before, immediately after and two weeks post-treatment. Primary outcome measures: cervical active range of motion (flexion, extension, right lateral-flexion, left lateral-flexion, right rotation, and left rotation).**
Results. **A statistically significant improvement in neck flexion was found after treatment in favour of Group A (60.2±10.8°) compared with Group B (46.3±15.1°). No differences were found between groups for the other primary outcomes at post-treatment or follow-up.**
Conclusion. **The Fascial Manipulation© technique may be a promising method to improve cervical range of motion in patients with subacute whiplash associated disorders.**
Clinical Rehabilitation Impact. **Myofascial techniques may be useful for improving treatment of subacute whiplash associated disorders also reducing their economic burden.**

KEY WORDS: Cervical spine - Neck pain - Manual therapy - Fascia.

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Whiplash is one of the most common injuries associated with motor vehicle accidents, affecting up to 83% of individuals involved in collisions.[1] It is a significant public health problem and

an important cause of disability, considering that its incidence is estimated at 4 per 1000 persons and its overall economic burden (including medical care, disability and sick leave) has been evaluated at $ 3.9 billion annually in the United States.[2]

Whiplash injury is defined as "bony or soft tissue injuries" resulting "from rear-end or side impact" as an effect of "an acceleration-deceleration mechanism of energy transfer to the neck",[3] and occurs as a consequence of hyperextension of the lower cervical vertebrae in relation to the relative flexion of the upper cervical vertebrae, which produces an S-shape of the cervical spine at the time of impact.[4] Whiplash associated disorders (WAD) include a wide variety of clinical manifestations such as neck pain, neck stiffness, arm pain and paresthesias, headache, dizziness, problems with memory and concentration, visual disturbances and psychological distress.[1] According to the Quebec Task Force classification for WAD, grade I signifies neck complaints of pain, stiffness, or tenderness without physical signs; grade II represents neck complaints and musculoskeletal signs including decreased range of motion and point tenderness; grade III indicates neck complaints and neurological signs including a sense of heaviness, arm muscle fatigue, and paresthesias into the arm; grade IV includes neck complaints and fracture or dislocation.[3] Taking into account the time from injury, WAD has been described as acute (less than 2 weeks), subacute (2 to 12 weeks) or chronic (longer than 12 weeks).[5]

Connective tissue has been suggested to become tighter after traumatic injuries, altering its histological, physiological and biomechanical characteristics.[6-14] Even though the processes that induce pathological modifications of myofascial tissue after trauma remain unclear (an alteration of collagen fibre composition, fibroblasts or ground substance has been hypothesized),[14] the alteration of fascial pliability has been described as a source of body misalignment, potentially leading to poor muscular biomechanics, altered structural alignment, and decreased strength and motor coordination.[7, 14-16] Several manual and physical approaches have been proposed to improve myofascial function after traumatic injuries, in order to effectively reduce functional limitation and pain.[17-20] In particular, the Fascial Manipulation© technique has recently shown interesting evidences, as well as providing plausible anatomical explanations for the results obtained.[7, 12-14]

Based on our clinical experience regarding the usefulness of this technique in treating patients with musculoskeletal disorders after traumatic injuries, we decided to carry out this pilot study mainly aimed at evaluating whether the application of the Fascial Manipulation© technique could be more effective than a conventional rehabilitation approach to improve cervical range of motion in patients with WAD during the subacute phase of illness. The secondary aim was to assess whether the Fascial Manipulation© technique can also reduce neck pain and disability due to subacute WAD.

Materials and methods

This pilot, single blind, randomized clinical trial was performed in the Neurological Rehabilitation Unit of the Azienda Ospedaliera-Universitaria Integrata of Verona, Italy. Subjects between 18 and 60 years of age, with diagnosed whiplash injury (grades I and II according to the Quebec Task Force classification),[3] caused by a motor vehicle accident, who experienced symptoms within 72 hours, and wore a soft collar between 5 and 7 days after collision qualified for inclusion. Exclusion criteria were: fractures or dislocations of the cervical spine; amnesia or unconsciousness in relation to the accident; a second accident resulting in injuries of the head, neck, or thorax while participating in the study; history of chronic or recurrent head, neck or thorax pain of any aetiology within six months prior to the accident requiring medical treatment; significant pre-existing psychiatric disease; known alcohol or drug abuse; presence of diseases or conditions representing contraindications for one of the scheduled treatment procedures; presence of other neurological and orthopaedic conditions involving the head, neck, or thorax. The protocol was carried out according to the Declaration of Helsinki and was approved by the local Ethics Committee.

All participants were outpatients and gave their written informed consent for participation in the study. After baseline evaluation, performed between two and four weeks from the accident, patients were allocated into two treatment groups according to a simple randomization scheme generated by using the Website Randomization.com (http://www.randomization.com).[21] The randomization list was accessible only to one investigator (NS). Two experienced

therapists (GL and AT), unaware of the aim of the study, treated patients. One therapist performed the Group A training and the other performed the Group B training. Both therapists knew that they were participating in a study, but they were not aware of the type of treatment performed by the other group. During treatment and follow-up, patients did not undergo any form of physiotherapy other than that scheduled in the study protocol.

Patients allocated in Group A underwent a treatment procedure according to the Fascial Manipulation© technique,[7, 12-14] consisting of three, 30-minute sessions, every five days, during a two weeks period. The manual therapy technique known as Fascial Manipulation© is based on a biomechanical model which considers the myofascial system as a three-dimensional continuum. This technique divides the body into 14 segments (namely: head, neck, thorax, lumbar, pelvis, scapula, humerus, elbow, carpus, digits, hip, knee, ankle and foot), each one served by six myofascial units consisting of mono-articular and bi-articular unidirectional muscle fibres, their deep fascia and the articulation that they move in one direction on one plane.[7, 12-14] The forces generated by a myofascial unit are considered to converge on one point which has a precise anatomical location within the muscular fascia. According to the Fascial Manipulation© model, musculoskeletal dysfunction is considered to occur when muscular fascia no longer slides, stretches, or adapts correctly, resulting in local fibrosis at these specific points of tension. The manual technique of Fascial Manipulation© consists of creating localised heat by friction, using the elbow, knuckle or fingertips on the above-mentioned points.[7, 12-14] This would produce both stress effects (mechanical and chemical) on connective tissue and causes a local rise in temperature at the ground substance of the deep fascia in order to restore its function.[7, 12-14]

Comparative palpation determined the selection of points requiring treatment. In each session the physiotherapist defined four points needing treatment within the head, neck, scapula and thorax segments.[7, 12-14] During the first treatment session we focused on points placed in the sagittal plane. During the second session we concentrated on points in the frontal plane, while points in the horizontal plane were treated during the last treatment session.

Patients allocated to Group B underwent a training program consisting of ten, 30-minute sessions, five days a week (from Monday to Friday), for two consecutive weeks. Each session included 20 minutes of neck mobilization exercises and 10 minutes of neck muscle stretching. Patients were evaluated before (T0), immediately after treatment (T1) (primary endpoint), and two weeks after the end of treatment (T2). All patients were evaluated at T0, T1 and T2 by the same examiner (AP) who assessed all the outcome measures (primary and secondary) and was blind of the treatment received by the patients.

The primary outcome measure was the cervical active range of motion (AROM). Assessment of range of cervical motility is commonly used in cases of whiplash injury as an outcome measure, discriminating between asymptomatic persons and those with WAD.[22] Neck mobility was assessed with patients sitting on a chair with both feet flat on the floor, hips and knees at 90° angles, and buttocks positioned against the back of the chair. The goniometer was placed on the forehead, the temple and the top of the head respectively, while the subject was asked to move the head as far as possible in flexion, extension, right lateral-flexion, left lateral-flexion, right rotation, and left rotation. Three trials were recorded for each direction of movement, and the mean was used in the analyses.[23]

We considered as secondary outcomes the Visual Analogue Scale (VAS) score, the Neck Disability Index (NDI), and the pressure pain threshold (PPT). The mechanical VAS, for the reporting of subjective neck pain, was completed using a plastic mechanical 0 to 10-cm slide-ruler. The VAS is a simple and reliable instrument for assessing pain intensity in clinical settings and research.[24] The NDI was used to assess disability problems related to neck pain.[25] It includes 10 items that attempt to describe the impact of neck pain: pain intensity, personal care, lifting, reading, headaches, concentration, work, driving, sleeping, and recreation. Each item score ranges from 0 to 5. The total score is the sum of the ten items and ranges from 0 to 50.[25] The PPT is defined as the minimal amount of pressure where a sense of pressure first changes to pain.[26] A mechanical pressure algometer (Wagner Instruments, Greenwich, CT, USA) was used to measure PPT levels. The algometer consists of a 1 cm^2 rubber-tipped plunger mounted on a mechanical force gauge, which continuously indicates the force of pressure applied. The rate of perpendicular pressure increase was maintained at an average constant rate of 1 kg/s.

When the pain threshold was reached, participants requested the examiner to stop the pressure stimulation. Three measurements of PPT at intervals of 30 seconds were obtained by the same examiner, and the mean of the 3 trials was used for analysis.[27] The PPT levels were assessed over C2, C5 and C7 transverse processes and spinous process.

Statistical analysis

The Mann-Whitney U test was used for testing the homogeneity between groups before the study. The Friedman test was used to analyze changes in performance in the different evaluation sessions within each patient group. Wilcoxon signed ranks test on the pre-/post-treatment scores and on the pre-treatment/follow-up scores for the different outcome measures were carried out in each group of patients. The Mann-Whitney U test was used to compare the effect of treatment in the two patient groups. The alpha level for significance was set at $P<0.05$. The Bonferroni correction [28] was used in multiple comparisons ($P<0.025$). Statistical analysis was carried out using the SPSS for Windows statistical package, version 16.0.

Results

Eighteen subjects (7 males and 11 females; mean age: 40.5 years; SD: 12.8 years) presenting with WAD as a result of a motor vehicle accident (mean time from onset: 25.2 days; SD: 2.8 days) were recruited from 38 outpatients consecutively admitted to our Rehabilitation Unit during the period from November 2009 to October 2010. Nine patients were allocated to each group. There were no drop-outs

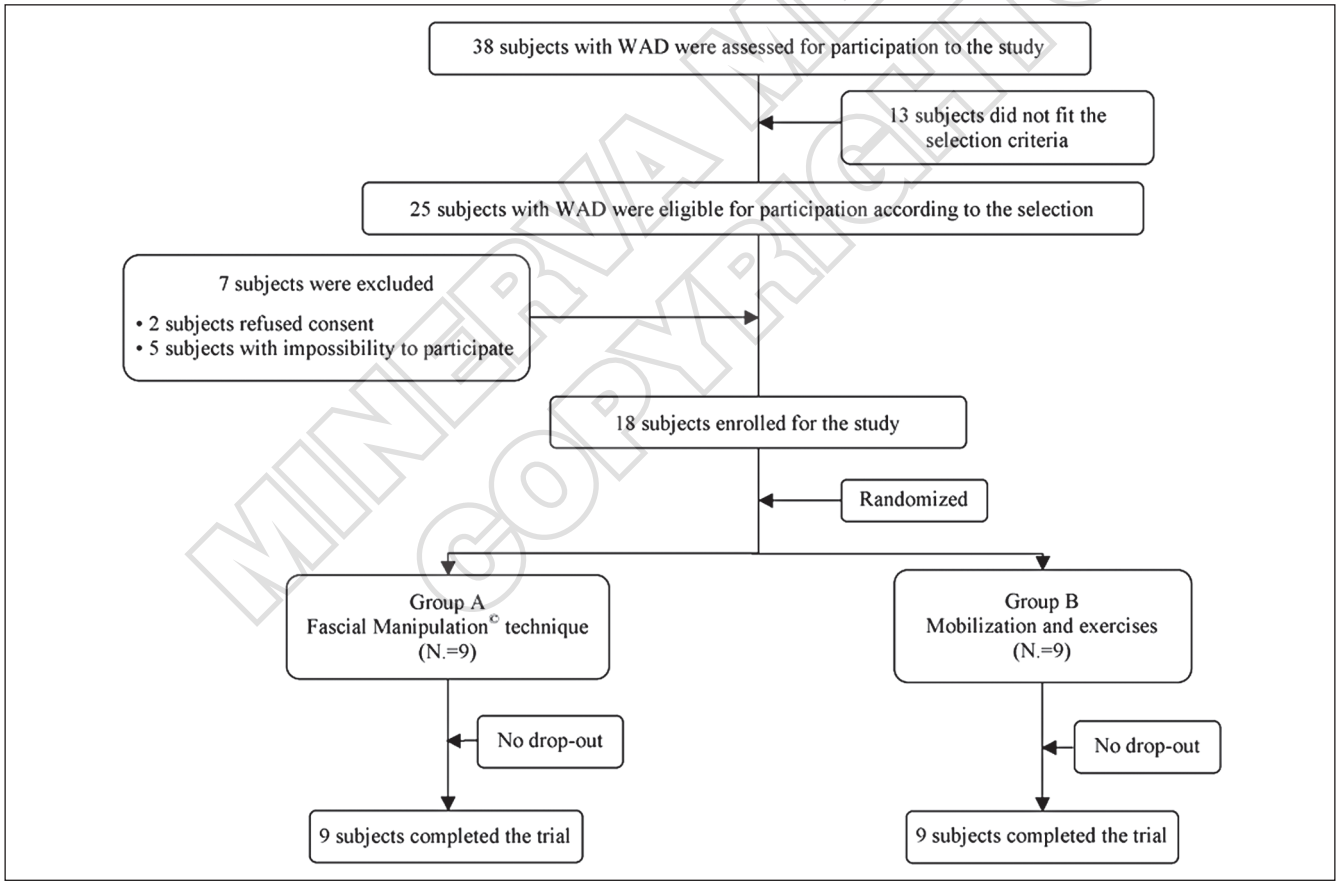

Figure 1.—Flow diagram of the study.

TABLE I.—*Demographic and clinical features of patients.*

Parameter	Group A (N.=9)	Group B (N.=9)
Age (years)		
mean (SD)	41.9 (12.4)	39.1 (13.7)
range	24-58	24-59
Sex		
(male/female)	4 / 5	3 / 6
Disease duration (days)		
mean (SD)	25.3 (2.7)	25.1 (3.1)
range	21-28	20-28
WAD severity (Quebec Task Force classification)		
(grade I/grade II)	2/7	1/8

SD: standard deviation; N.=number of patients; WAD=whiplash associated disorders.

and no adverse events occurred during the study in either of the groups. The flow diagram of the study is reported in Figure 1.

Multiple separate independent-sample Mann-Whitney tests showed that age, length of illness and cervical AROM were not statistically different between the two groups at T0 evaluation. Patients' demographic and clinical characteristics are detailed in Table I.

Primary outcomes

Between-groups comparisons showed that patients in Group A performed significantly better than those in Group B in cervical AROM during flexion only at the post-treatment evaluation (P=0.03; Z=-2.172) but not at follow-up. No significant changes in performance in the different evaluation sessions were found in regards to the other cervical AROM parameters (namely: extension, right lateral-flexion, left lateral-flexion, right rotation, and left rotation).

In Group A, overall significant improvements in cervical AROM in the different evaluation sessions were found in regards to all parameters (flexion: P<0.001, X=15.943; extension: P=0.008, X=9.657; right lateral-flexion: P=0.001, X=13.543; left lateral-flexion: P=0.001, X=14.222; right rotation: P=0.004, X=10.889; left rotation: P=0.002, X=12.514). As reported in Table II, within group comparisons showed that improvements in performance were significant at both the post-treatment and follow-up evaluations. In Group B overall significant improvements in cervical AROM in the different evaluation sessions were found only in regards to right rotation (P=0.003, X=11.486) and left rotation (P=0.008, X=9.556). As reported in Table II, within group comparisons showed that improvements in right rotation were significant at both the post-treatment and follow-up evaluations, while improvements in left-rotation were significant only at T1. Row data (means and standard deviations) of patients' performance at before, after and follow-up evaluations are reported in Table II.

Secondary outcomes

Between-groups comparison showed that no significant changes in the different evaluation sessions

TABLE II.—*Comparison of treatment effects within group in primary outcome measures.*

Primary outcome measures Cervical AROM	Group	Before Mean (SD)	After Mean (SD)	2 weeks-FU Mean (SD)	Within group comparison (Wilcoxon signed ranks test)	
					After-Before P value (Z)	2 weeks FU-Before P value (Z)
Flexion (°)	Group A	40.1 (7.4)	60.2 (10.8)	53.8 (9.1)	0.008 (-2.668)	0.008 (-2.668)
	Group B	35.1 (21.8)	46.3 (15.1)	47.7 (15.2)	0.008 (-2.666)	NS
Extension (°)	Group A	39.2 (10.5)	52.6 (7.9)	49.0 (14.0)	0.008 (-2.666)	0.008 (-2.668)
	Group B	34.6 (20.7)	42.7 (13.3)	44.2 (12.5)	NS	NS
Left lateral-flexion (°)	Group A	31.7 (7.1)	44.1 (9.7)	40.5 (9.3)	0.008 (-2.673)	0.018 (-2.374)
	Group B	28.2 (10.4)	39.0 (7.0)	35.4 (5.4)	NS	NS
Right lateral-flexion (°)	Group A	30.4 (6.5)	43.6 (9.9)	40.8 (6.4)	0.012 (-2.524)	0.008 (-2.668)
	Group B	29.6 (13.8)	35.1 (5.8)	36.1 (9.3)	NS	NS
Left rotation (°)	Group A	51.2 (9.8)	66.5 (8.9)	63.7 (10.2)	0.008 (-2.666)	0.012 (-2.524)
	Group B	46.6 (21.2)	61.3 (14.4)	58.4 (8.6)	0.008 (-2.668)	NS
Right rotation (°)	Group A	45.6 (12.9)	63.4 (12.3)	58.1 (9.2)	0.013 (-2.490)	0.008 (-2.668)
	Group B	39.3 (18.5)	51.0 (13.9)	51.0 (15.5)	0.015 (-2.429)	0.008 (-2.666)

SD: standard deviation; FU: follow-up; AROM: active range of motion; degrees; NS: not significant.

were found in regards to the secondary outcome measures.

In Group A, within group comparisons showed that reductions in the VAS score, NDI score and C2 right transverse process PPT were significant at both the post-treatment (VAS: P=0.008; NDI: P=0.007; C2 right transverse PPT: P=0.024) and follow-up (VAS: P=0.008; NDI: P=0.018; C2 right transverse PPT: P=0.015) evaluations, while reductions in C2 left transverse process PPT was significant only at the post-treatment evaluation (P=0.011). In Group B, within group comparisons showed that reductions in VAS score and NDI score were significant only at the post-treatment evaluation (VAS: P=0.008; NDI: P=0.007).

Discussion

In regards to the main aim of the study, our results showed that patients with subacute WAD who underwent Fascial Manipulation© technique showed better post-treatment improvements in neck flexion compared to those who performed conventional rehabilitation (exercises and mobilization).

Physical impairment and disability are related to a reduced range of cervical motion, mostly affecting sagittal plane movements (flexion and extension), in patients with WAD.[22] This is in keeping with the complex mechanism of whiplash injury, in that the stretching of the anterior and compression of the posterior elements of the lower cervical spine beyond the normal physiological limits, as a consequence of the formation of a S-shaped curvature of the cervical spine in the early phase of trauma, produces hyperextension at lower levels and flexion at the upper levels.[29] Dysfunction in the neck flexor muscles has been found to be associated with neck pain of whiplash origin.[30] Taking into account the important role of deep cervical flexors (longus colli and capitis) in support of the physiological cervical lordosis,[30] Jull *et al*. described the presence of altered patterns of coordination between the deep and superficial cervical flexors (sternocleidomastoid), reporting an increased electromyographic activity of the superficial neck flexor muscles as a compensation for reduced deep neck flexor muscle activation in patients with WAD.[30-32] Moreover, cervical flexor endurance has been described as an important index of neck function in whiplash, considering that previous studies demonstrated a reduction in the symptoms of neck pain following cervical flexion endurance training.[33, 34] A recent paper by Elliott *et al*.[35] further emphasized the role of neck flexors in WAD, describing the presence of muscular fatty infiltration and changes in the cross sectional area in the cervical anterior muscles during the chronic phase of illness. Authors observed that the most substantial changes in muscular fatty infiltration were present in the deeper muscles (longus capitis and colli) when compared to the more superficial sternocleidomatoid muscle.[35] Authors described that the fatty infiltration varied by cervical level, with the longus capitis/colli having the largest amount at the C2-C3 level.[35] It is interesting to note that, although histological modifications have been observed in neck muscles during the chronic phase of WAD,[35] and alterations in connective tissue after traumatic injuries has been suggested in literature,[6-14] as a source of potential motor dysfunctions, to date no earlier study investigated the role of muscular fascia and its treatment as a method to improve neck mobility in patients with WAD. Our preliminary findings are in line with the role of neck flexors in WAD described above, showing that the Fascial Manipulation© technique, compared with conventional rehabilitation, better improves one of the most relevant dysfunctions in neck muscles after whiplash injury: cervical flexion impairment. It would be interesting to investigate if the development of muscle alterations described in chronic WAD could be influenced by rehabilitation procedures performed during the earlier phases of illness, and in particular the possible preventative role of manual approaches for treating connective tissue, such as the Fascial Manipulation© technique.

Whiplash injury is associated with significant economic costs as a result of lost work productivity, medical care, and legal services, with the majority of disability-related expenses generated by patients with chronic symptoms.[5] Considering that an estimated 50% of patients still complain of neck pain one year after injury,[36] the development of effective therapies that prevent chronic pain and disability is crucial. Mobilization and exercise programs have been reported to effectively reduce pain intensity and improve range of cervical motility in patients with WAD during the acute and subacute phases of illness.[37, 38] By contrast, immobilization of the neck using soft cervical collar has been shown to possibly impede natural recovery by inhibiting move-

ment and promoting prolonged neck stiffness in acute WAD.[37] Although the only significant change found between the two groups was in one primary outcome, neck flexion, within groups comparisons showed that cervical AROM improved in all movement directions after Fascial Manipulation©, while conventional rehabilitation improved AROM only in half of the examined motions. As to neck pain and related disability, even though all our patients demonstrated to reduce VAS and NDI scores after treatment, only those who underwent Fascial Manipulation© maintained the same level of score at the two week follow-up, and also reduced PPT. With regards to the clinical management of subacute WAD, it is interesting to note that patients who underwent Fascial Manipulation© performed only three treatment sessions while those in the Group B performed ten treatment sessions. This is very relevant considering the great economic burden of whiplash injury. One possible explanation for our preliminary evidence could be found in the more incisive action of Fascial Manipulation© on deep myofascial structures, acting on their pliability and function.[30-35] Results regarding secondary outcomes further support this inference considering that patients who underwent Fascial Manipulation© showed significant reductions in PPT at C2 level, where deep flexors showed the greater amount of fatty infiltration.[35] Unfortunately, our investigation did not include any radiological or anatomical evaluations (as done in previous papers which discuss the Fascial Manipulation© technique),[12, 13] that could provide more information about muscles and fascial anatomical substratum of the neck.

This was a pilot study with several limitations and it is important to point out that the strength of our conclusions is limited. First, the sample size was small. The population size may have hindered the evaluation of some effects of the Fascial Manipulation© technique in patients with subacute WAD. In order to further validate our findings, randomized controlled trials involving a larger subject population and longer follow-up evaluations are needed. Second, we investigated patients with subacute WAD. In this phase of illness the clinical signs are not completely stabilized and this may have interfered with therapeutical procedures, partially conditioning their effects. Third, we did not consider the direction of impact or head position in relation to it. Future studies should take into account these aspects, especially considering that they have been reported to play a role in whiplash injury mechanism.[39] Fourth, the lack of comparison with other treatment modalities (such as joint manipulation) and rehabilitation approaches, other than mobilization plus exercises.

Conclusions

Patients with subacute WAD who underwent three sessions of Fascial Manipulation© showed a greater improvement in neck flexion than those who performed ten sessions of conventional rehabilitation (exercises plus mobilization). The Fascial Manipulation© technique may be a promising method to improve cervical range of motion in patients with subacute WAD, considering that movements in the sagittal plane have been reported to be most often affected in patients with WAD,[30-35] and also taking into account the overall economic burden of whiplash injury.

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