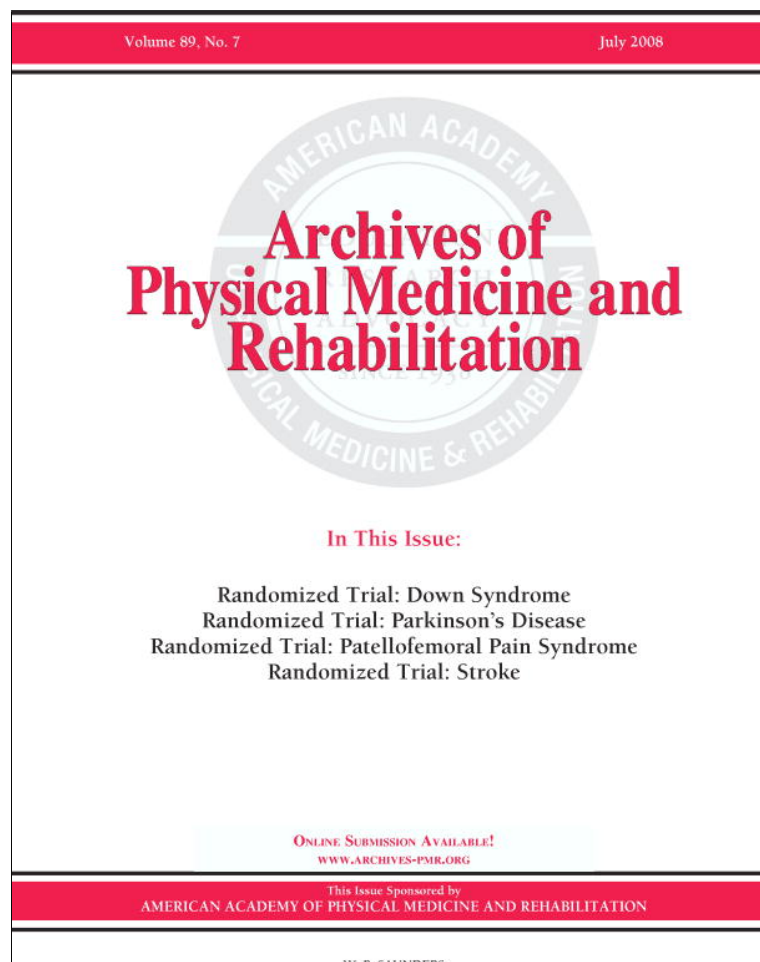


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A Distinct Pattern of Myofascial Findings in Patients After Whiplash Injury

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Objective: To identify objective clinical examinations for the diagnosis of whiplash syndrome, whereby we focused on trigger points.

Design: A cross-sectional study with 1 measurement point.

Setting: A quiet treatment room in a rehabilitation center.

Participants: Patients (n=124) and healthy subjects (n=24) participated in this study. Among the patient group were patients with whiplash-associated disorders (n=47), fibromyalgia (n=21), nontraumatic chronic cervical syndrome (n=17), and endogenous depression (n=15).

Interventions: Not applicable.

Main Outcome Measure: Each patient and control subject had a manual examination for trigger points of the semispinalis capitis, trapezius pars descendens, levator scapulae, scalenus medius, sternocleidomastoideus, and masseter muscles bilaterally.

Results: Forty (85.1%) of the patients with whiplash had positive trigger points in the semispinalis capitis muscle. The patients with whiplash had a significantly higher prevalence of positive trigger points in the semispinalis capitis muscle than any of the control groups ($P<.05$). For the other examined muscles, the prevalence of trigger points in the patients with whiplash did not differ significantly from the patients with fibromyalgia or nontraumatic chronic cervical syndrome. It did differ from the patients with endogenous depression and the healthy controls.

Conclusions: Patients with whiplash showed a distinct pattern of trigger point distribution that differed significantly from other patient groups and healthy subjects. The semispinalis capitis muscle was more frequently affected by trigger points in patients with whiplash, whereas other neck and shoulder muscles and the masseter muscle did not differentiate between patients with whiplash and patients with nontraumatic chronic cervical syndrome or fibromyalgia.

Key Words: Myofascial pain syndromes; Rehabilitation; Trigger points, myofascial; Whiplash injuries.

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WHIPLASH INJURY OF THE neck and the associated disorders that often accompany it are a controversial issue. The most frequent symptoms and complaints after whiplash injury are pain and stiffness of the neck, referred to as the *cervical syndrome*. In addition, patients often complain about headache, brachialgia (pain radiating into 1 or both arms), vertigo or dizziness, chewing and swallowing problems, visuo-motor disturbances such as blurred vision and reduced coordination, fatigue and reduced energy, neuropsychologic dysfunction, depression, irritability, and sleep disorders.¹⁻³

In 1995, a classification system of whiplash-associated disorders according to the severity of the symptoms was proposed by the Quebec Task Force on Whiplash-Associated Disorders.⁴ Grade I describes a patient who has subjective neck complaints of pain, stiffness, and tenderness, but without objective physical signs. Grade II includes patients who also show musculo-skeletal signs such as decreased ROM and point tenderness. Patients with neurologic symptoms, such as muscle weakness or sensory deficits, are classified as grade III. Grade IV includes patients with a fracture or dislocation.

This study focuses on the cervical pathology that can include injuries of the cervical spine and of the surrounding soft tissues. The pain syndrome can be caused by injuries to the muscles, facet joints, ligaments, disks, and nerve roots.⁵⁻⁷

On clinical examination, reduced ROM of the cervical spine is usually the prominent finding. One can distinguish between the mobility of the upper cervical spine and the mobility of the lower cervical spine. Detailed palpation of the neck and shoulder muscles reveals myogeloses, trigger points, and taut bands. In some patients, the myofascial tension of the scalene muscles causes a functional thoracic outlet syndrome that may in some cases explain the complaint of brachialgia.⁸

One reason for the controversy that surrounds the diagnosis of whiplash is the lack of objective clinical findings specific for this condition. The only consistent finding reported in the literature so far is a painful facet joint dysfunction C1-2, verified by the effect of local bupivacaine injections.^{9,10} Accordingly, we aimed at identifying a simple but objective clinical method to diagnose cervical syndrome after whiplash injury confidently.

The main aim of this study was to document the prevalence and distribution of trigger points in the neck and shoulder musculature in patients with whiplash, and compare them with patients with fibromyalgia, nontraumatic chronic cervical syndrome, endogenous depression, and healthy controls.

Our main hypothesis was that patients with whiplash disorder would display more trigger points in the semispinalis capitis muscle, which is localized in the upper neck, on the basis of the biomechanics of the injury and the findings by

List of Abbreviations

BDI	Beck Depression Inventory
ROM	range of motion
VAS	visual analog scale

Table 1: Characteristics of the Patients and Control Subjects

Characteristics	WAD	Fibromyalgia	CHR	Endogenous Depression	Healthy Controls
n	47	21	17	15	24
Mean age \pm SD (y)	38.57 \pm 10.18	47.52 \pm 8.12	46.18 \pm 8.58	48.07 \pm 9.14	37.42 \pm 11.34
Female sex, n (%)	35 (74.5)	19 (90.5)	6 (35.3)	6 (40.0)	11 (45.8)

Abbreviations: CHR, chronic nontraumatic cervical syndrome; WAD, whiplash-associated disorder.

Barnsley⁹ and Lord¹⁰ and colleagues. On the other hand, healthy persons as well as patients with fibromyalgia or non-traumatic chronic cervical syndrome typically have trigger points in the lower neck and in the shoulder girdle.^{11,12} A further hypothesis was that the masseter muscle would be significantly affected in the patients with whiplash, according to predictions by the Quebec Task Force.⁴

METHODS

Study Design and Participants

The presented study is a cross-sectional study with 1 measurement point. Between July 2002 and March 2006, we recruited 144 patients and healthy subjects, 124 of whom finished the whole examination procedure and were included in the data analysis (table 1). All patients and healthy subjects gave written informed consent.

We recruited 4 different patient groups from 3 specialized treatment centers. Patients with cervical syndrome caused by whiplash injury (n=47) were recruited at Reha Rheinfelden Rehabilitation Center in Switzerland. Patients with fibromyalgia (n=21) were recruited from the Rehabilitation Center Rheumaklinik Bad Säckingen in Germany. Patients with non-traumatic chronic cervical syndrome (n=17) were recruited from Reha Rheinfelden, and patients with endogenous depression (n=15) from the Psychiatrische Klinik Sonnenhalde, a psychiatric hospital in Riehen, Switzerland. All recruited were consecutive patients who were admitted to the respective treatment centers. The mean time \pm SD between the whiplash injury and the examination in our study was 1.47 \pm 1.8 years for the whiplash injury group. All patients from the whiplash injury, chronic cervical syndrome, and fibromyalgia groups were symptomatic for over 6 months and had outpatient physiotherapy. Participants for the healthy control group (n=24) were recruited from different departments of the Reha Rheinfelden.

Exclusion criteria were age over 60 years, insufficient German language knowledge, and significant additional internal or neurological diseases.

Examination Procedure

All study participants were examined during a 1-hour session. Participants were first asked to indicate their current general pain level from 0 to 10 on a VAS and to localize their pain in a body chart. The participants filled in the German version of the BDI¹³ to control for the influence of mood. Then 6 muscles of the neck, head, and face bilaterally were examined by manual palpation: the semispinalis capitis, trapezius pars descendens, levator scapulae, scalenus medius, sternocleidomastoideus, and masseter. These muscles were chosen on the basis of the clinical experience that they are frequently affected after whiplash injury, and because they can be identified unequivocally by palpation. We aimed at including 1 marker muscle each for the upper cervical and lower cervical spine, neck, shoulder girdle, and face. The semispinalis capitis was

included because its referred pain zone is parieto-occipital and periorbital,¹⁴ which in our experience is the most frequent pattern of referred pain to the head in patients with whiplash. We limited the number of muscles included to minimize the pain during examination. The splenius capitis was one of the muscles not included, because trigger points in this muscle are often difficult to differentiate from underlying painful facet joints C1-2 and C2-3. The examination was performed by a physiotherapist with specialist training in manual diagnosis and treatment of myofascial trigger points. The physiotherapist was blind to each patient's diagnosis. The examination was performed with the patient in an upright sitting position. Both feet were on the floor. Each muscle was tested in a stretched and a rested position for the following criteria^{14,15}: (1) palpable hardening (trigger point and/or taut band) in the muscle belly, (2) pressure pain in the trigger point or taut band, (3) referred pain while manipulating the trigger point in the taut band, and (4) recognition of the elicited pain as the patient's known and familiar pain. A positive trigger point was diagnosed if 3 of the 4 described criteria were fulfilled. In addition, we investigated the passive lengthening of each muscle, the intensity of the pain during palpation of the trigger point or taut band, and the existence of edema in the taut band.

Furthermore, ROMs of cervical flexion, extension, lateral bending, and axial rotation mobility of the cervical spine were examined with a Zebris 3-dimensional ultrasound measurement device^{16,17,a} and an inspection of their posture, the shape of the spinal column, and the mobility of the thoracic and lumbar part of the spinal column and the iliosacral joints. These findings will appear separately.

Statistical Analysis

All statistical analyses focused on our main hypothesis: we expected a higher frequency of trigger points in the semispinalis capitis muscle and masseter muscle in the whiplash injury group than all other groups.

For statistical analysis, we compared the whiplash group with each control group using chi-square tests for all cross-tabulations. One-sided *P* values of less than .05 were considered to indicate statistical significance. We adjusted the level of significance with a Bonferroni correction.

For the analysis of pain intensity, we followed the same hypothesis. The scores were validated for normative distribution with the Kolmogorov-Smirnov test. Means were compared with 1-sided *t* tests, corrected according to Bonferroni. *P* values less than .05 were considered to indicate statistical significance.

For all statistical analyses, we used the SPSS software.^b

RESULTS

Prevalence of Trigger Points

We analyzed the complete examination data from 124 of the 144 included patients (see table 1). Twenty patients with whiplash injury discontinued the examination of the trigger points

Table 2: Prevalence of Trigger Points in the Examined Muscles

Groups	n	Semispinalis Capitis	Trapezius	Levator Scapulae	Scalenus Medius	Sternocleido-mastoideus	Masseter
WAD	47	40 (85.1)	40 (85.1)	36 (76.6)	30 (63.8)	24 (51.1)	10 (21.3)
Fibromyalgia	21	12 (57.1)	19 (90.5)	18 (85.7)	10 (47.6)	10 (47.6)	7 (33.3)
CHR	17	6 (35.3)	11 (64.7)	11 (64.7)	8 (47.1)	7 (41.2)	4 (23.5)
Endogenous depression	15	4 (26.7)	8 (53.3)	4 (26.7)	2 (13.3)	5 (33.3)	0 (0.0)
Healthy controls	24	2 (8.3)	8 (33.3)	5 (20.8)	3 (12.5)	3 (12.5)	1 (4.2)

NOTE. Values are n (%).
Abbreviations: CHR, chronic nontraumatic cervical syndrome; WAD, whiplash-associated disorder.

because of high pain intensity and were not included in the data analysis.

Our findings show (table 2, fig 1) that 40 (85.1%) of the 47 patients with whiplash injury had positive trigger points in the semispinalis capitis muscles, 25 (53.2%) bilaterally and 15 (31.9%) unilaterally. The prevalence of trigger points in the semispinalis capitis muscle was significantly higher in the whiplash injury group than in each of the other groups (whiplash injury vs fibromyalgia, $P < .05$; whiplash injury vs chronic cervical syndrome, $P < .001$; whiplash injury vs depression, $P < .001$; whiplash injury vs healthy control group, $P < .001$). In contrast, for the other examined muscles, the prevalence of trigger points in the patients with whiplash injury did not differ significantly from that in patients with fibromyalgia and chronic cervical syndrome. It did differ significantly from that in patients with depression and the healthy control group ($P < .001$).

Scores for the BDI range from 0 to 63, whereby higher scores indicate more severe depression. The patients with whiplash injury with BDI scores of 18 or higher did not have a higher prevalence of trigger points than the patients with whiplash injury with lower BDI scores.

Pain Intensity of the Detected Trigger Points

Comparisons of the whiplash group with the other groups regarding the semispinalis capitis muscle showed the following results. The reported mean pain intensity \pm SD on the VAS in patients with whiplash injury was 5.42 ± 2.08 ; in the fibromyalgia group, 6.45 ± 1.72 ; in the chronic cervical syndrome group, 4.88 ± 2.62 ; in the depression group, 2.05 ± 2.35 ; and in

the healthy control group, 0.50 ± 1.17 . The difference between the whiplash injury and fibromyalgia groups was not statistically significant, but the differences between the whiplash injury and the chronic cervical syndrome group ($P < .043$), the depression group ($P < .001$), and the healthy control group ($P < .001$) were significant. For the masseter muscle, we found a significant difference in pain intensity comparing the whiplash injury group with the depression group ($P < .005$) and the healthy control group ($P < .02$), but not with the chronic cervical syndrome and the fibromyalgia groups.

We found no difference in pain intensity for the 6 examined muscles between patients with whiplash with BDI scores of 18 or higher and patients with whiplash with lower BDI scores (fig 1).

DISCUSSION

The aim of this study was to identify objective clinical examinations to help in the diagnosis of the whiplash syndrome, whereby we focused on trigger points. This study is, to our knowledge, the first to demonstrate objective clinical findings in patients with whiplash that distinguish them from patients with fibromyalgia, nontraumatic chronic cervical syndrome, and endogenous depression, and healthy control subjects.

Our findings show that 85.1% of patients with whiplash had positive trigger points in the semispinalis capitis muscles, 53.2% bilaterally and 31.9% unilaterally. The patients with whiplash had a significantly higher prevalence of positive trigger points in the semispinalis capitis muscle than patients and subjects of any of the control groups, even after Bonferroni corrections. In contrast, the other examined neck muscles and the masseter muscle were not more affected by trigger points in patients with whiplash than in patients with fibromyalgia and nontraumatic chronic cervical syndrome. Patients with whiplash syndrome therefore showed a distinct pattern of trigger point distribution that differed significantly from other patient groups and a healthy control group. The interrater reliability for the diagnosis of trigger points is good if examiners are experienced and well trained in the diagnosis of trigger points.^{18,19}

Our findings support the hypothesis that the most severe musculoskeletal pathology after whiplash is found in the upper part of the cervical spine. They are consistent with the biomechanics of the injury and the findings by Barnsley⁹ and Lord¹⁰ and colleagues of a painful C1-2 facet joint dysfunction. In contrast, trigger points in the other patient groups and in healthy people were predominantly found in the lower cervical spine and the shoulder girdle.

Evidence from physiologic and histologic studies has led to the hypothesis that the critical trigger point abnormality is a neuromuscular dysfunction at the motor endplate of a skeletal muscle fiber.²⁰⁻²³ According to this model, a mechanical trauma stimulates the release of excessive amounts of acetyl-

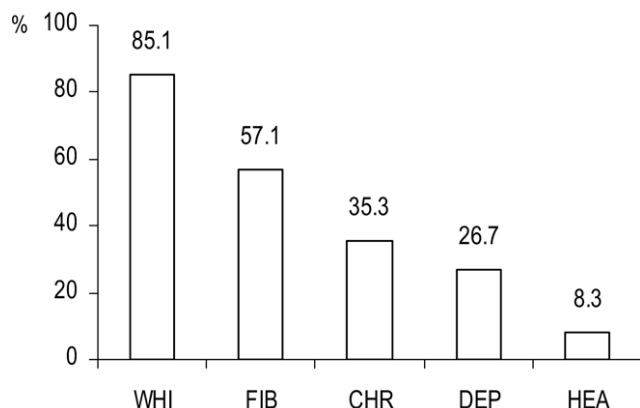


Fig 1. Percentages of patients with trigger points in the semispinalis capitis muscle. Abbreviations: CHR, chronic nontraumatic cervical syndrome; DEP, endogenous depression; FIB, fibromyalgia; HEA, healthy control subjects; WHI, whiplash-associated disorder. WHI vs FIB: $P < .05$; WHI vs CHR: $P < .001$; WHI vs DEP: $P < .001$; WHI vs HEA: $P < .001$.

choline at the neuromuscular junction and of intracellular calcium, which activates maximal local muscle contraction. This causes increased metabolism and relative ischemia locally, which in turn leads to failure of the Ca^{++} pump within muscle cells. Consequently, the calcium continues to stimulate contraction, and a vicious circle develops. The pain is thought to be a result of stimulation of nociceptors by substance P released in reaction to the local metabolic crisis.

Our study did not provide support for the Quebec Task Force's hypothesis of a significant involvement of the masseter muscle in the symptomatology of patients with whiplash. However, those patients whose masseter muscles are affected may very well have a disabling pain syndrome that makes chewing difficult.

An incidental finding of note is the prevalence of trigger points in the lower cervical spine and shoulder of the patients with fibromyalgia. Previous studies²⁴ have reported that some patients with fibromyalgia may have not only tender points, as is traditionally assumed, but also trigger points. In our study, the prevalence was similar to that of the patients with whiplash and nontraumatic chronic cervical pain, which was unanticipated.

Our findings are relevant not only for the diagnosis of whiplash-associated disorders but also for their treatment. It provides guidance to physical therapists and physicians for where to focus their treatment efforts, which may include muscle stretches, local cooling, and injections of anesthetics.

Study Limitations

As explained in the Methods section, we included only 1 marker muscle each for the upper cervical spine, lower cervical spine, neck, shoulder girdle, and face. Considering our finding of a distinct pattern of trigger point distribution in the patients with whiplash, affecting mainly the semispinalis capitis muscle, future studies should examine more muscles of the upper cervical spine, such as the splenius capitis. Furthermore, studies are needed to establish whether focusing the physical treatment on the upper cervical spine is beneficial to patients with whiplash.

CONCLUSIONS

Patients with whiplash syndrome showed a distinct pattern of trigger point distribution that differed significantly from other patient groups and healthy subjects. The semispinalis capitis muscle was more frequently affected by trigger points in patients with whiplash, whereas other neck and shoulder muscles and the masseter muscle did not differentiate between patients with whiplash and patients with nontraumatic chronic cervical syndrome or fibromyalgia.

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Suppliers

- Noraxon, Grafen-von-Berg-Str 10, 50769 Cologne, Germany.
- Version 13.0; SPSS Inc, 233 S Wacker Dr, 11th Fl, Chicago, IL 60606.