An Open Study Comparing Manual Therapy with the Use of Cold Packs in the Treatment of Post-Traumatic Headache

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One year after head trauma, 23 patients with post-traumatic headache entered a prospective clinical controlled trial to find out if specific manual therapy on the neck could reduce the headache. The study was completed by 19 patients (83%). Ten patients were treated twice with manual therapy and nine patients were treated twice with cold packs on the neck. The pain index was calculated blindly. Two weeks after the last treatment the mean pain index was significantly reduced to 43% in the group treated with manual therapy compared with the pretreatment level. At follow-up five weeks later, the pain index was still lower in this group compared with the group treated with cold packs, but this difference was not statistically significant. The pain index for all 19 patients was significantly correlated to the use of analgesics as well as to the frequency of associated symptoms (number of days per week with dizziness, visual disturbances and ear symptoms). It is concluded that the type of manual therapy used in this study seems to have a specific effect in reducing post-traumatic headache. The result supports the hypothesis of a cervical mechanism causing post-traumatic headache and suggests that post-traumatic dizziness, visual disturbances and ear symptoms could be part of a cervical syndrome. • *Post-traumatic headache, dizziness, eye and ear symptoms, treatment, the cervical factor*

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Various theories have been proposed to explain the pathogenesis of post-traumatic headache but the mechanism still remains obscure. It is generally believed that both psychological and organic factors are involved but controversy continues about which of these two factors is the more important (1-3).

The organic source of this headache has been thought to be localized in the brain, in the scalp or in the soft tissue of the neck. In the present study we have tried to elucidate the cervical aspect.

Head trauma invariably implies some traumatic impact to the neck; in 0.2 to 2% of cases causing a fracture of the cervical vertebrae (4). Muscles and ligaments are probably damaged to a greater or lesser extent in the rest of cases, and most of this damage would not be visualized by ordinary x-rays of the cervical spine.

The facet joints of the cervical spine are recognized as important pain-producing structures (5). Chronic pain conditions have been treated by radiofrequency facet denervation (6). Sluijter and Koetsveld-Baart (7) showed that this technique was efficient in patients with chronic headache as part of a cervical syndrome. Sixty-three percent of these patients showed improvement.

According to anecdotal reports (5), manipulation of the cervical spine is of value in treating some types of headache, and this kind of treatment is used by chiropractors, some physiotherapists and general practitioners. Unfortunately, only very few controlled trials have been performed to show the efficiency of this type of treatment as well as other neck treatments for headache and especially for post-traumatic headache. The purpose of this study is to show whether or not examination of the neck of patients with post-traumatic headache can reveal specific changes and furthermore to try out the efficiency of specific manual therapy of the neck in a controlled study.

Materials and methods

In the period from August 1986 to August 1987, 233 patients aged from 18 to 60 years were admitted to the County Hospital of Aarhus with the diagnosis of cerebral concussion or suspected cerebral concussion. Nine; to 12 months after the trauma 168 (72%) of these were interviewed by telephone regarding post-traumatic symptoms with special reference to headache (8). Patients who were unconscious for more than 24 h following the trauma, and patients with contusion of the brain or intracerebral haematoma were not interviewed.

Persons with post-traumatic headache were asked to participate in a prospective clinical controlled trial concerning the efficiency of two different neck treatments, namely manual therapy or cold packs. New or worsened headache since the trauma was reported by 64 patients. Of these, 32 accepted the invitation to participate in this study. Nine patients were excluded before the start of the treatment. The reasons for exclusion were:-other diseases: three patients (epilepsy, manic-depressive psychosis, severe psychosomatic problems); alcoholism: two patients; x-ray changes of the cervical spine: two patients (one with sequelae after fracture of dens axis, one with suspected instability of C1-C2); drop-out before the start of treatment: two patients.

Thus 23 patients entered and 19 patients completed (83%) the study. Four patients did not finish the study: one patient dropped out in each treatment group and two patients from the cold pack group did not return their pain schedules.

The 19 patients consisted of 12 women and 7 men, and the mean age was 31.6 years (range 19-48 years). Of the 64 patients with post-traumatic headache, 44 complained of headache more often than 1 day/week. All of the 19 patients completing the study- except one-belonged to this group. The treatment group of 19 patients did not differ significantly from the 44 patients with significant post-traumatic headache regarding age, sex, unconsciousness in connection with the trauma or location of the headache.

A healthy control group consisting of 19 persons who belonged to the hospital staff were chosen to match the treatment group concerning age and sex distribution. These persons had no history of headache, neck or back trouble and had not been exposed to head trauma.

All 23 patients entering this trial were fully informed and written consent was obtained. The study was approved by the Regional Ethical Review Committee.

Methods of treatment

Manual therapy. The treatment is based on the principle that precise localization of tenderness and segmental hypomobility can be diagnosed by detailed examination of the neck, the so-called segmental spine examination. By means of specific holds it is possible to mobilize these hypomobile segments, so that the segmental mobility is normalized (9). Mobilization consists of soft passive movements of the joint at the outer range of motion. In high velocity manipulation there is a high velocity low amplitude thrust at the joint. In muscle energy technique the treatment is started by an isometric muscle contraction performed by the patient in the opposite direction to the manual treatment (10). All these techniques can be used specifically at one segment or non-specifically including more segments.

In the present study specific mobilization has been used often combined with muscle energy technique. Since the upper part of the thoracic spine and the cervical spine are functionally connected, the upper six thoracic segments have been involved in the examination and treatment. The treatments were given according to the result of the segmental examination. At each treatment session two to three segments were treated.

Cold packs. After the segmental spine examination had been performed, a cold pack (-14°C) was placed under the neck and shoulders of the patient. The duration of each treatment was 15 to 20 min and both treatments were given by one of the authors (OKJ).

Study design

The duration of the trial was 12 weeks,

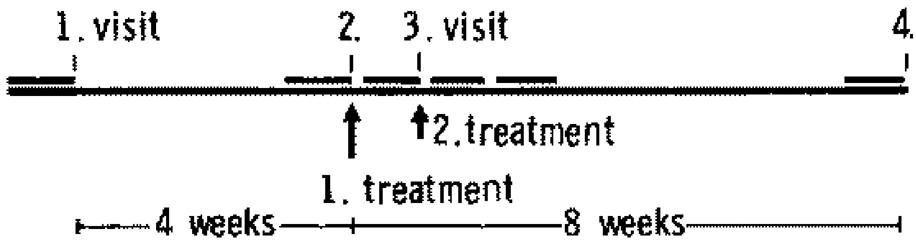

Fig. 1. Study design. Pain schedules were completed in weeks marked with double line.

the first four weeks being an observation period (Fig. 1). The patients reported four times for examination. The first visit took place less than two months after the interview. Measure of active range of neck motion was taken at every visit and if there was any pain while moving, this was recorded. The measurements were done with a protractor with the patient sitting upright without back support.

1st visit. Interview concerning previous diseases, traumas, neck or back troubles. Measure of neck motion.

2nd visit. X-ray of the cervical spine. Measure of neck motion. Segmental spine examination including sensibility by skinrolling test, tenderness by neck compression test. After inclusion in the study the patient was randomized to either manual therapy or cold packs, and the treatment was given immediately after. Randomization: four envelopes, two enclosing an indication of manual therapy and two an indication of cold packs, were mixed and put in a box. The envelopes were selected from the top and put in another box. When the first box was empty, the procedure was repeated. Out of the 19 patients completing this study, 10 patients were randomized to manual therapy and nine patients to cold packs.

3rd visit. Measure of neck motion. Segmental spine examination. The treatment was repeated.

4th visit. Measure of neck motion. The condition of the patient was evaluated and follow-up treatment was eventually arranged.

Pain schedules were completed by the patients for each week preceding a visit and for a further of two weeks after the last treatment, a total of six weeks (Fig. 1). The intensity of the headache was recorded on a visual analogue scale four times a day: early in the morning, late in the morning, afternoon and evening. Once a day the use of analgesics as well as the presence of associated symptoms (dizziness, visual disturbances, ear symptoms: a plugged sensation or tinnitus) was reported on the same schedule. At the end of the study the pain index was calculated for each week as the total of all markings measured in millimeters. Thus each pain index was based on 28 registrations. The calculations were performed by two of the authors (FFN, LV) without knowing to which treatment group the pain schedules belonged. Use of analgesics was calculated on the number of tablets per week. In a similar way the frequency of associated symptoms was calculated on the number of positive markings per week indicating dizziness, visual disturbances or ear symptoms. Each of these figures was based on seven recordings.

Alterations in the pain index were computed in absolute figures. The mean value of the two pretreatment weeks was used as the starting point of change. Changes in the use of analgesics and number of associated symptoms were computed in a similar way.

The method of measuring neck motion and the result of x-ray analysis are described elsewhere (11, 12).

Statistics

Student's *t*-test (two-tailed) was used to analyse the parametric observations in Tables 1, 3, 4 and 5. Because the figures in Table 5 were not perfectly normally distributed, this Table was analysed by Wilcoxon's test as we ll. Furthermore, this test was used to analyse the non-parametric observations on which Figs. 4 and 5 were based. Chi-square test was used to analyse Table 2.

Spearman's analysis of correlation was used to estimate the connection between the pain index, use of analgesics and frequency of associated symptoms (Table 6). A 5% level of significance was chosen.

Results

The first visit of the 19 patients completing the study took place on average 359 (range 302-423) days after the trauma. The mean

Table 1. Pretreatment characteristics (mean and range) of the two treatment groups. Pain index indicates mean index per patient in weeks 1 and 2. Use of analgesics indicates mean number of tablets per patient in weeks 1 and 2. Frequency of associated symptoms indicates mean number of positive markings of dizziness plus visual disturbances plus ear symptoms per patient in weeks 1 and 2. There were no significant differences between the two groups.

	Manual therapy	Cold packs
Age (years)	32.3 (19-48)	30.8 (21-45)
Sex (M: male, F: female)	4 M, 6 F	3 M, 6 F
Pain index (mm/week)	534.0 (141-1001)	777.9 (271-1925)
Use of analgesics (no. tabl/week)	5.6 (0-22)	11.1 (0-45)
Frequency of assoc. symptoms (no. of markings/week)	3.05 (0-8)	5.44 (0.5-9.5)

pretreatment period was 32 (27-62) days and the mean follow-up period was 50 (47-69) days. There were no significant differences between the two treatment groups.

The two groups were comparable regarding age, sex, pain index, use of analgesics and frequency of associated symptoms (Table 1).

Pain index, use of analgesic and frequency of associated symptoms were lower in the manual therapy group, but the differences were not statistically significant.

History

Ten patients reported headache before the trauma, only two of these complaining of headache more often than 1 day/week (Table 2). A history of back trouble within the last five years before the trauma was reported by nine patients. Six of these had received treatment. Only three patients reported neck trouble before the trauma. There were no significant differences between the two treatment groups.

Headache

The location of headache showed considerable variation, with frontal and occipital location occurring most often (Table 2). The typical cervicogenic headache localized at the back of the head and radiating to the forehead was reported by only a few]patients. Pain at or behind the eye was described by six patients. The headache pattern varied considerably over a 24-h period and also on a day-to-day basis.

Table 2. Previous symptoms and trauma, unconsciousness in connection with the trauma and location of pain for the 19 patients who completed the study. The figures in parentheses indicate the number of patients with unilateral headache.

	Manual therapy	Cold packs	All
Headache before trauma	4	6	10
Neck trouble before trauma	3	0	3
Low back trouble before trauma	3	6	9
Previous head trauma	1	1	2
Previous back trauma	1	1	2
Unconsciousness in connection with the trauma			
Not unconscious	3	2	5
Unknown	1	0	1
Unconscious less than 15 min	5	6	11
Unconscious more than 15 min	1	1	2
Location of pain			
Headache: diffuse	0	1	1
frontal	3	2 (2)	5
occipital	4	2 (1)	6
frontal-occipital	1 (1)	1	2
vertex	0	2 (1)	2
temporal-vertex	2 (2)	0	2
frontal-vertex	0	1	1
Neck pain	0	1	1

Associated symptoms

The number of positive markings indicating dizziness, visual disturbances and ear symptoms was different from week to week except for three patients, two of whom reported visual disturbances and one ear symptoms daily or almost daily. Only one patient had none of the symptoms described below.

Table 3. The most important findings by neck examination. Side flexion omitted (for explanation see text). The figures in parentheses are standard deviations.

	Manual therapy	Cold packs	All
Joint block of one or more of the upper three cervical and upper three thoracic segments			
Both regions	8	6	14
Upper cervical	1	3	4
Upper thoracic	1	0	1
Segmental hyperaesthesia by skin-rolling test			
Eyebrow	0	2	
Upper cervical	1	0	6
Upper thoracic	2	3	
Suboccipital tenderness	3	5	8
Paravertebral tenderness			
C2-C3	5	3	8
C3-C4	9	8	17
C4-C5	6	6	12
Pain or discomfort at extreme neck movements	8	8	16
Active range of movement (degrees)			
Extension	53.8 (7.5)	55.3 (11.2)	
Flexion	53.5 (6.5)	56.1 (9.5)	
Rotation right	54.5 (8.6)	54.2 (7.0)	
Rotation left	57.3 (7.9)	59.2 (5.0)	

Table 4. Comparison of active range of neck motion measured in degrees with a healthy control group of 19 persons (mean age: 31.0, range: 19-50 years, 7 M, 12 F). The figures in parentheses are standard deviations. *p < 0.05. Side flexion omitted (for explanation see text).

	Treatment (n = 19)	Control (*n* = 19)
Extension	54.5 (9.1)	56.8 (8.5)
Flexion	54.7 (6.5)	57.4 (7.9)
Rotation right	54.3 (7.6)	60.0 (5.5)*
Rotation left	58.4 (6.9)	61.6 (5.5)

Dizziness. Dizziness was most often described as a feeling of unsteadiness when standing or walking, sometimes occasioned by rising to an upright position. A few patients described the symptom as a short-lasting rotational sensation provoked by altered posture. According to the pain schedules 15 patients reported dizziness, two patients reporting it for a single day, the rest indicating a higher frequency during the six-week observation period.

Visual disturbances. This symptom was typically described as blurring of vision, especially while reading or changing head posture. A few patients described it as a shortlasting sensation of everything going black, and one patient described it as spots before one of the eyes. Visual disturbances were noted by 15 patients, five of these for a single day. The rest had more frequent disturbances during the six weeks that they were under observation.

Ear symptoms. Only a plugged sensation or tinnitus was registered. One or the other of these symptoms was reported by 10 patients. Five patients had noted ear symptoms only once. The rest observed this more frequently during the six weeks they were under observation.

Neck examination

All patients had one or more hypomobile segments among the upper cervical or thoracic segments, most often in both regions (Table 3). The cervical segment most often affected was C1-C2, and the thoracic segment most often affected was Th2-Th3. Hyperaesthesia by the skinrolling test was found in six patients, of these two patients

Table 5. Changes in pain index during the six-week observation period. Figures in parentheses are standard deviations. The corresponding changes in percent are shown in Fig. 2. *Difference between mean change of the two treatment groups significant (t-test: p < 0.05, Wilcoxon's test: p < 0.05) as well as compared to pretreatment levels (paired t-test: p < 0.02, Wilcoxon's test for pairs: p < 0.02). §Pain schedule missing from one patient, which is the reason for the lack of accordance between difference compared to pretreatment and mean change.

	Manual therapy Mean pain index	Mean change	Cold packs Mean pain index	Mean change
Pretreatment				
Week 1	587.3 (370.3)		750.2 (664.6)	
Week 2	480.7 (261.4)	-106.6 (249.3)	805.6 (624.5)	55.4 (173.8)
Mean pain index of weeks 1 and 2	534.0 (295.2)		777.9 (638.9)	
Treatment				
Week 3	432.0 (230.8)	-135.0 (346.8)§	755.8 (578.6)	-22.1 (295.7)
Week 4	381.1 (314.9)	-152.9 (380.6)	790.4 (756.2)	12.5 (328.4)
Week 5	228.3 (159.5)	-305.7 (329.5)*	845.3 (795.0)	67.4 (362.4)
Follow-up				
Week 6	446.4 (467.0)	-87.6 (404.8)	831.3 (647.9)	53.4 (370.5)

had hyperaesthesia in the upper thoracic region as well as in the upper cervical region or at the eyebrow. Maximal tenderness was located at C2-C5.

Pain or discomfort at the outer range of neck motion was reported by 16 patients and tenderness by the neck compression-test was reported by eight patients. Range of neck motion did not differ significantly between the two treatment groups (Table 3). Range of side flexion is not indicated because the intraperson variation of this measure was greater than the interperson variation.

The range of neck motion was a little less for the treatment group compared to the healthy control group (Table 4). Only rotation to the right was significantly reduced. Pain or discomfort on neck motion was reported by only three persons in the healthy control group.

Course of treatment

Pain index. The pain index of the manual therapy group declined after the two treatments while remaining relatively constant for the cold pack group (Table 5 and Fig. 2). The maximum reduction was found in the fifth week. In this week the pain index of the manual therapy group was 43% of the pretreatment level, which was a statistically significant difference compared with the pain index of the cold pack group ($p < 0.05$) as

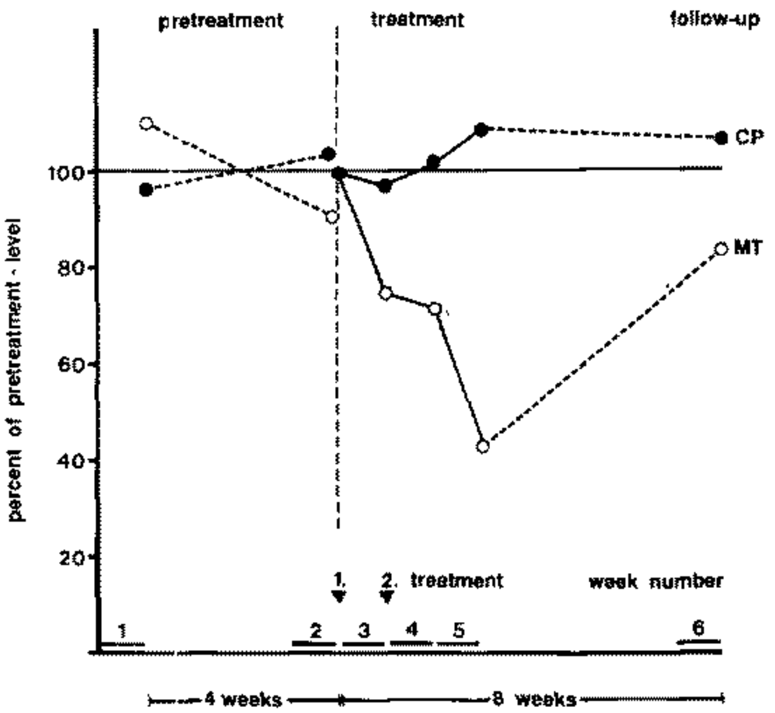

Fig. 2. Pain index. The curves indicate mean pain index of the two treatment groups measured in percent of pretreatment level. Full-drawn lines: continuous pain registration. Dashed lines: pain registration only at the end points. MT: 10 patients treated with manual therapy. CP: 9 patients treated with cold packs.

well as in relation to the pretreatment level ($p < 0.02$). In the sixth week the pain index of the manual therapy group increased to 84% of the pretreatment level.

The pretreatment pain index showed an increasing tendency for the cold pack group and a slightly more pronounced decreasing tendency for the manual therapy group (Table 5 and Fig. 2). None of these changes was statistically significant. To reveal the

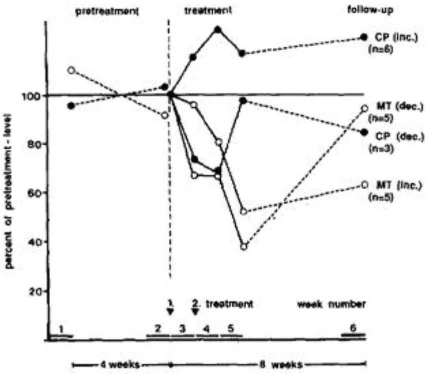

Fig. 3. Alterations of pain index for subgroups. The curves indicate mean pain index of the four subgroups measured in percent of pretreatment level. Inc: patients with increasing tendency of pain index before start of treatment. Dec: patients with decreasing tendency of pain index before start of treatment.

importance of the pretreatment changes each treatment group was divided into two subgroups with either increasing or decreasing tendency before the start of treatment (Fig. 3). The two manual therapy subgroups showed an almost parallel course from the second to the fifth week. Because of this, pretreatment changes were not considered to have any influence on the difference in pain index observed in the fifth week.

Use of analgesics and the frequency of associated symptoms. The curves reflecting the use of analgesics looked similar to the curves representing changes in the pain index (Fig. 4). In the fifth week the mean use of analgesics for the manual therapy group was down to 36% of the pretreatment level. This decline was not statistically significant as the number of patients was small and there was too great a variation.

The changes in associated symptoms looked somewhat similar to the changes in pain index (Fig. 5). Compared with the pre-treatment level the mean number of associated symptoms in the manual therapy group was reduced to 52% in the fifth week. This decline was not statistically significant. The transient increase in the fourth week was

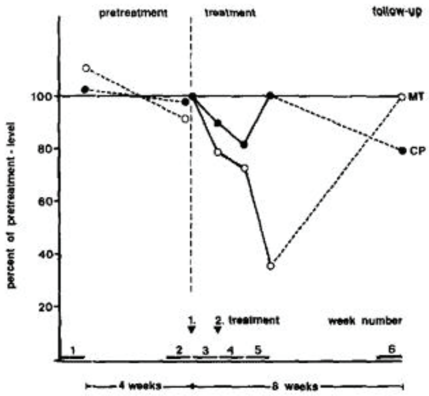

Fig. 4. Use of analgesics. The curves indicate mean use of analgesics of the two treatment groups measured in percent of pretreatment level. Full-drawn lines: continuous registration. Dashed lines: pain registration only at the end points.

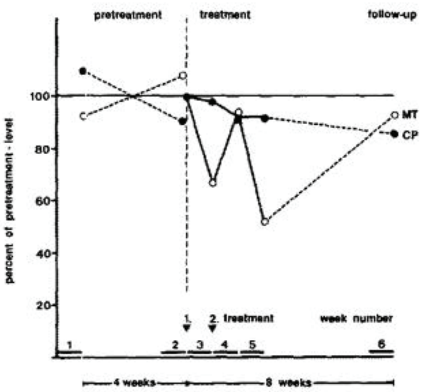

Fig. 5. Associated symptoms. The curves indicate mean number of positive markings of dizziness plus visual disturbances plus ear symptoms measured in percent of pretreatment level. Full-drawn lines: continuous registration. Dashed lines. Pain registration only at the end points.

solely due to an increase of positive markings indicating dizziness.

Association between pain index, use of analgesics and associated symptoms

A positive correlation was found between

Table 6. Correlation between mean pain index for the six-week observation period, mean use of analgesics and mean frequency of associated symptoms. 'r' refers to Spearman's correlation coefficient, and 'p' to the p-value. *Mean number of positive markings of dizziness plus visual disturbances plus ear symptoms for the six-week observation period.

	Pain index	
	r	*p*
Use of analgesics	0.73	<0.01
Associated symptoms (all*)	0.70	<0.01
Dizziness	0.13	NS
Visual disturbances	0.65	<0.02
Ear symptoms	0.72	<0.05

the mean pain index during the six-week observation period, the mean use of analgesics and the mean number of positive markings of associated symptoms (Table 6). The pain index and dizziness were not significantly correlated. Only after combining dizziness with both visual disturbances and ear symptoms was a significant correlation to the pain index found.

Analysis of the correlation for each of the six weeks showed a significant correlation between the pain index and the use of analgesics in four of the six weeks, and between the pain index and the associated symptoms in five of the six weeks. Visual disturbances were significantly correlated to the pain-index in four of the six weeks, and ear symptoms in three of the six weeks. Dizziness was only significantly correlated to the pain index in one of the six weeks.

Discussion

The segmental spine examination revealed small inconsistencies in all of the 19 patients completing this study, and the range of neck motion was slightly reduced compared to a healthy age and sex matched control group. An important parameter seemed to be the pain or the discomfort at the outer range of neck motion, since this was indicated by almost all the patients in the treatment group compared with only three persons in the control group. Hypomobile joints were most often localized among the upper three cervical and thoracic segments, and maximum tenderness was localized in the midcervical region. Segmental hyperaesthesia was found in a few patients and was most often localized in the upper thoracic region.

The treatment group constituted 43% of all 44 patients with significant post-traumatic headache (more than 1 day/week). Considering the results from the interview-investigation (8) we have no reason to suspect that the patients who did not participate in this study differed significantly from the treatment group of 19 patients. It should be remembered that patients with symptoms following severe brain injury were excluded from this study.

The course of treatment showed that post-traumatic headache can be influenced by manual therapy directed to the affected thoracic and cervical segments but that the improvement was only temporary. Whether the condition could be improved more permanently through further treatment remains as yet an unanswered question. As expected, the reduction of headache was reflected in the reduced use of analgesics. Surprisingly, it was found that the frequency of associated symptoms was similarly reduced, although the reduction was not statistically significant.

The result of this study supports the theory of a cervicogenic mechanism causing post-traumatic headache. The significant correlation between pain index and associated symptoms seems to indicate that dizziness, visual disturbances and ear symptoms are associated with headache and as such might be connected to the neck findings. In other words, headache, dizziness, visual disturbances and ear symptoms following a head trauma could be part of a cervical syndrome.

In the majority of patients the associated symptoms were not present every day, but for a varying number of days per week depending on the pain index. This fits in well with the theory of a cervicogenic mechanism since the neck is mobile and in different balance from day to day depending on biomechanical relationships and psychological factors. If the symptoms were the result of a local lesion in the brain one would expect these to be present more permanently.

Pain is transmitted from the neck to the head partly through tender muscle insertions at the scalp and partly via the so-called trigemino-cervical complex (13). The former mechanism is well known and is probably based on the experience that headache is improved by massage of the tender suboccipital neck muscles. The latter mechanism is well substantiated (14, 15). Thin pain transmitting fibres from all three divisions of the trigeminal nerve are represented at as low as the C2 level via the spinal part of the trigeminal nucleus (16). Pain information from the neck is transmitted to the spinal cord through the dorsal cervical roots. These fibres reach the dorsal horn from where the impulses are spread upwards and downwards (17). The spinal part of the trigeminal nucleus is located in close connection with the dorsal horn of C1-C2. Functionally these two structures are closely connected as common ascending pathways have been proved to exist (18). It has been shown that irritation of the upper cervical rootlets can provoke headache, especially frontal headache (19).

The most prominent symptom of the 19 patients was headache. Only one reported neck pain. Nevertheless nine of 10 patients benefited from manual therapy at the thoracic and cervical facet joints two weeks after the last treatment had been given. This seems to show that the trigemino-cervical complex is the most important pain transmitting structure, since the suboccipital muscles were not treated in this study. It has been suggested that nociception from the facet joints could result from pathological changes in the joints, although such changes are usually not found in the joints of patients with headache (20). The result of the present study suggests another mechanism. Pain could be caused by a functional disturbance in the coordination of the facet joints in the upper cervical as well the upper thoracic region.

Accordingly, there is a theoretical basis for understanding the mechanism of cervicogenic headache. The mechanism causing a cervicogenic dizziness is understandable as well, since the positional proprioceptors are located in the upper 3-4 cervical facet joints (21). There is, however, no clear explanation as yet of a cervical mechanism causing visual disturbances and ear symptoms.

The type of manual therapy used in this study seems to be suitable as part of the treatment given to patients with post-traumatic headache. But the study does not indicate the number of such treatments required to attain a satisfactory result. Nor does it attempt to answer if other forms of treatments in conjunction with manual therapy will prove more useful. More controlled studies are need to clarify these aspects.

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