



Immediate effects of dry needling and acupuncture at distant points in chronic neck pain: results of a randomized, double-blind, sham-controlled crossover trial

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Abstract

To evaluate immediate effects of two different modes of acupuncture on motion-related pain and cervical spine mobility in chronic neck pain patients compared to a sham procedure. Thirty-six patients with chronic neck pain and limited cervical spine mobility participated in a prospective, randomized, double-blind, sham-controlled crossover trial. Every patient was treated once with needle acupuncture at distant points, dry needling (DN) of local myofascial trigger points and sham laser acupuncture (Sham). Outcome measures were motion-related pain intensity (visual analogue scale, 0–100 mm) and range of motion (ROM). In addition, patients scored changes of general complaints using an 11-point verbal rating scale. Patients were assessed immediately before and after each treatment by an independent (blinded) investigator. Multivariate analysis was used to assess the effects of true acupuncture and needle site independently. For motion-related pain, use of acupuncture at non-local points reduced pain scores by about a third (11.2 mm; 95% CI 5.7, 16.7; $P = 0.00006$) compared to DN and sham. DN led to an estimated reduction in pain of 1.0 mm (95% CI –4.5, 6.5; $P = 0.7$). Use of DN slightly improved ROM by 1.7° (95% CI 0.2, 3.2; $P = 0.032$) with use of non-local points improving ROM by an additional 1.9° (95% CI 0.3, 3.4; $P = 0.016$). For patient assessment of change, non-local acupuncture was significantly superior both to Sham (1.7 points; 95% CI 1.0, 2.5; $P = 0.0001$) and DN (1.5 points; 95% CI 0.4, 2.6; $P = 0.008$) but there was no difference between DN and Sham (0.1 point; 95% CI –1.0, 1.2; $P = 0.8$). Acupuncture is superior to Sham in improving motion-related pain and ROM following a single session of treatment in chronic neck pain patients. Acupuncture at distant points improves ROM more than DN; DN was ineffective for motion-related pain. © 2002 International Association for the Study of Pain. Published by Elsevier Science B.V. All rights reserved.

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1. Introduction

Chronic neck pain is a major medical and social problem causing severe discomfort and reduced ability to work (Bland, 1987; Bovim et al., 1994). In many cases pain is correlated with limited cervical spine mobility (Hagen et al., 1997). A wide range of treatments are proposed including drugs, physical medicine methods, manual treatments, immobilization, traction, local or epidural injection and patient education, but there is still a lack of consensus about optimal management (Aker et al., 1996). Increasingly,

patients are turning to complementary treatment methods, where conventional treatments are ineffective or unpleasant (Eisenberg et al., 1998). Acupuncture is one of these complementary methods. The results of acupuncture trials which have used control groups like physiotherapy (Loy, 1983; David et al., 1998), sham acupuncture (Yue, 1978; Gallacchi et al., 1981), Mock-TENS (Petrie and Hazleman, 1986), no-treatment control (Coan et al., 1982; Löhnert et al., 1996) or additive therapy (Aigner et al., 1999) are contradictory and have not provided evidence for the efficacy of acupuncture in the treatment of chronic neck pain (NIH, 1998; White and Ernst, 1999; Smith et al., 2000). However, in a recently published large scale trial we have shown that acupuncture is more effective than massage in the treatment of chronic neck pain (Irnich et al., 2001; Vickers, 2001).

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Results of controlled studies in chronic pain patients might often be influenced by the natural course of disease (Whitney and Von Korff, 1992). This influence can be minimized by evaluating immediate effects of a single treatment. Blinding of the therapist is another methodological problem in placebo-controlled trials of needle acupuncture (Vincent and Richardson, 1986). We decided to use the novel method of a deactivated laser acupuncture device. This allows blinding of the therapist as well as patients and assessors. The aim of our study was to evaluate immediate effects of two different modes of acupuncture (non-local, non-segmental acupuncture at distant points and local needling of myofascial trigger points) on motion-related pain and cervical spine mobility in chronic neck pain patients compared to a sham acupuncture procedure.

2. Methods

2.1. Subjects

Thirty-six patients with chronic neck pain and limited mobility of the cervical spine participated in the study. They were consecutively selected from patients who presented at the Department of Physical Medicine and Rehabilitation and the Interdisciplinary Pain Unit at the University of Munich. Though this number of patients was pre-planned, we did not conduct a formal sample size calculation. The first assessment included a detailed examination and collection of baseline data. Patients were included if they had had neck pain for longer than 2 months and if they had myofascial syndrome or irritation syndrome according to a classification of cervical syndromes based on history, pain characteristics, manual examination and radiological findings (Schöps et al., 2000). In cervical myofascial syndrome, pain and limited mobility are associated with active myofascial trigger points (Travell and Simons, 1983). Cervical irritation syndrome is characterized by diffuse, intense pain and irritated soft tissues with prolonged aggravation after motion and pressure. Patients were excluded if they had radicular cervical syndrome, segmental instability, fracture or surgery of the cervical spine, contradictions to acupuncture, or if they had had any kind of drug treatment, physical therapy or manual treatment in the last 4 weeks. In addition, 21 healthy subjects were included to evaluate the repeatability of mobility measurements. The study protocol was approved by the local ethics committee of the University of Munich. Patients were given detailed information about study procedures and written consent was obtained.

2.2. Randomization

A crossover design with three modes of treatment was performed. In this setting six different sequences of treatment are possible. Every sequence was assigned to a number from 1 to 6 (Fig. 1). A random list for 36 patients was then prepared by rolling dice. In case a number was thrown more than six

times it was no longer counted in order to ensure six groups with six different treatment sequences each including six patients. This procedure was performed before the trial began. After initial evaluation by a physician, patients were referred to an independent researcher who checked eligibility and implemented randomization by consecutively assigning patients to a treatment sequence. All referred patients were enrolled; treatment allocation was therefore fully concealed.

2.3. Blinding

Patients were blinded for the treatment. They were told before randomization that one of the three treatments might be a sham procedure.

In addition, sham laser acupuncture was performed double-blind: patient and therapist were not informed about the inactivation of the laser pen. The measurements were performed by an independent investigator who was not informed about the treatment sequence or the treatment the patient received before each measurement.

2.4. Treatment

Each patient was treated once with non-local needle acupuncture (NLA) at distant points, dry needling (DN) of local myofascial trigger points and sham laser acupuncture (sham). To eliminate carry-over treatment effects, a 1 week wash-out period between the treatments was chosen. Each treatment session lasted for 30 min. Acupuncture was performed with sterile needles by two therapists with more than 8 years experience and an acupuncture license from the German Medical Acupuncture Association (DÄGfA). Sham laser acupuncture was performed by an acupuncturist who had 2 years of acupuncture training. No additional treatment was allowed.

2.4.1. Needle acupuncture at distant points

Acupuncture points were selected according to the theory of channels (Cheng Xinnong, 1987) of Traditional Chinese Medicine (TCM) and varied individually. Affected channels were indicated by pain localization and the predominant direction of limited mobility. Classical distant acupuncture points at the extremities and few regional non-segmental points, localized on affected channels, were used (Table 1). In addition one to two ear points were chosen. A more detailed description of the acupuncture used in this study has been published (Irnich, 1999). The mean number of inserted needles was 7.1.

2.4.2. Dry needling

From the viewpoint of TCM, DN is a 'reducing' technique with strong manual stimulation on tender spots traditionally called 'ah shi' points (Cheng Xinnong, 1987). This technique has been further developed (Gunn et al., 1980; Baldry, 1993). Nowadays, its application is based on the diagnosis of myofascial trigger points (Travell and Simons, 1983). Practice requires experience in palpation and locali-

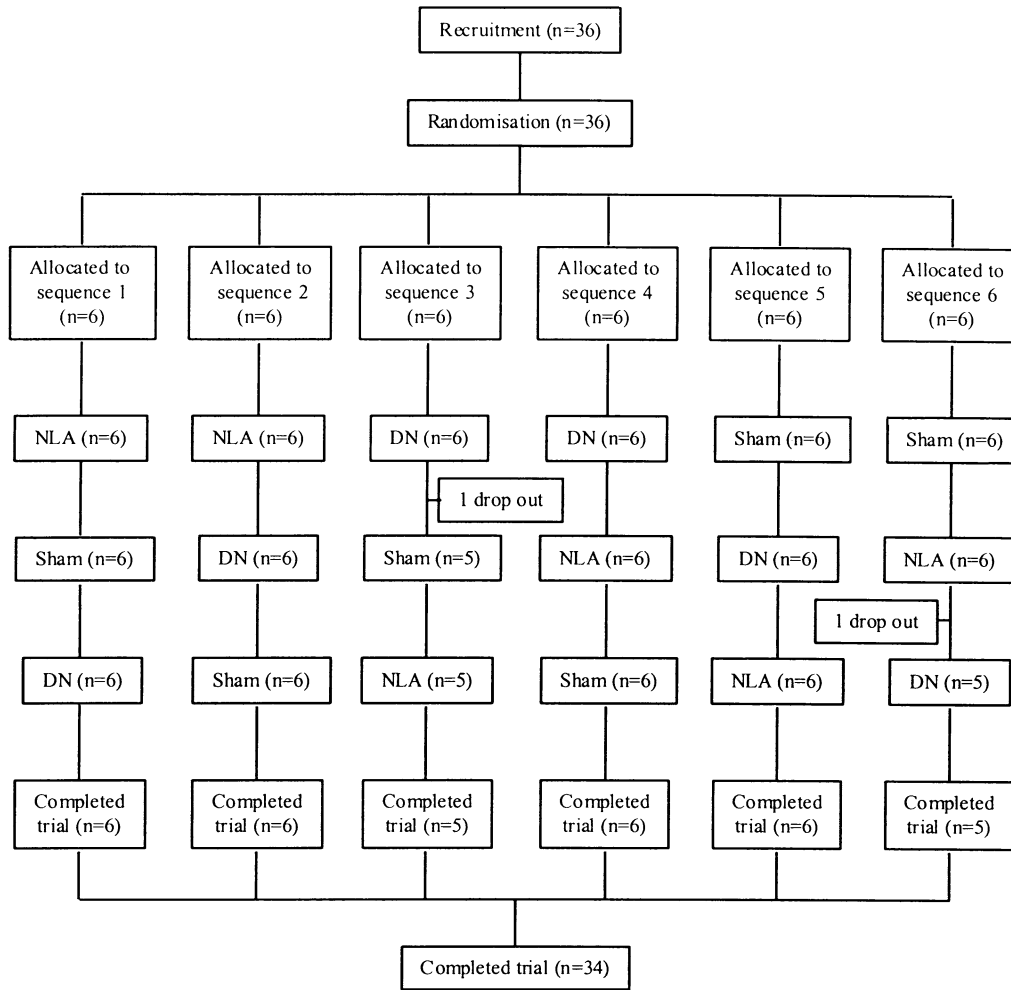


Fig. 1. Patients progress through the trial. Assessments were performed immediately before and after each treatment. Wash-out period between treatments was 1 week. Two patients had to be excluded (drop out). NLA, non-local acupuncture; DN, dry needling; Sham, sham laser acupuncture.

zation of taut muscle bands and myofascial trigger points. Precise needling of identified active myofascial trigger points provokes a short contraction of muscle fibers. This local twitch response should be elicited for a successful

therapy, but it may be painful and post-treatment soreness is frequent (Dexter and Simons, 1981; Hong, 1994). In this study, the most important muscles of the head and neck region were examined for myofascial trigger points (Table 2). If trigger points were located, the needle was inserted and manipulated until at least one local twitch response was elicited. The mean number of inserted needles was 7.4.

Table 1
Localization and frequency of acupuncture points treated in the acupuncture group and the sham laser acupuncture group (n = 34)

Acupuncture points	Acupuncture left/right	Sham laser left/right
SI 3	32/32	13/12
KI 27	9/9	5/5
Ex 28	14/15	5/7
LU 7	8/1	7/8
BL 60	1/1	11/11
CV 21	9	2
CV 22	11	3
GV 20	4	9
GV 14	3	7
LI 4	1/3	8/8
Ear 'cervical spine'	14	14
Ear 'stellate ganglion'	19	6

2.4.3. Sham laser acupuncture

Sham laser acupuncture was performed using a handy laser pen, which was inactivated by the manufacturer (Laser Pen®, Seirin). Only red light was emitted. Treatment was performed double-blind: patient and therapist were not informed about the inactivation of the laser pen. To increase the power of this sham procedure, visual and acoustic signals usual for this type of laser pen accompanied the red light emission. Criteria of point selection were the same as in the NLA group (Table 1). Every point was 'irradiated' 2 min. The laser pen did not touch the skin, the distance was 0.5–1 cm. The mean number of irradiated points was 6.8.

Table 2
Localization and frequency of myofascial trigger points treated in the DN group ($n = 34$)

Muscle	DN left	DN right
M. trapezius desc.	32	42
M. splenius cap.	19	18
M. sternocleidom.	17	17
M. levator scap.	14	15
Paravert. muscles	14	15
M. scalenus post	9	5
M. scalenus med.	5	9
M. semispin. cap.	4	2
M. scalenus ant.	–	2

2.5. Outcome measures

Evaluation included motion-related pain intensity, range of motion (ROM) and an assessment of changes of general complaints. Patients were assessed immediately before and 15–30 min after treatment. Assessors were blinded to the type of treatment. Technical aspects of the measurement procedure such as patients' and evaluators' posture, sequence of movements and pain evaluation were standardized.

2.5.1. Motion-related pain

Patients rated the motion-related pain intensity for six movements (flexion, extension, rotation right/left, lateral flexion right/left) using a 100 mm visual analogue scale (VAS). Maximum pain was scored for each movement direction. In order not to demand too much from the patients, we did not ask for any differentiation between pain during or at the end of movement. Patients were clearly instructed in the use of the VAS before the first assessment.

2.5.2. Range of motion

ROM of the cervical spine was assessed for six movement directions. Flexion, extension, rotation right and left were measured using a custom-made hemispherical measuring shell. The measuring system consisted of a hemisphere with a diameter of 140 cm and a vertical and horizontal scale attached inside. An adjustable lamp was fixed on the patients forehead and was pointed to the zero point of both scales. The patient's head was in the anatomical position and eyes were closed. An evading movement of the upper body was prevented by a horizontal sternal boundary. Lateral flexion was measured by a goniometer, a simple and reliable instrument to evaluate ROM (Schöps et al., 2001).

2.5.3. Repeatability of mobility measurements

The repeatability of mobility measurements was evaluated by a repeat measurement of 21 healthy and untreated subjects. The technical details and time between the two measurements were the same for untreated subjects and patients. Analysis of mean values and standard deviations showed that the largest within-subject difference of the 21

healthy persons between the two measurements was 0.60 units (measurement 1: 60.52 ± 9.70 ; measurement 2: 59.92 ± 8.92) for flexion for the measuring shell and 0.61 units (measurement 1: 42.90 ± 9.54 ; measurement 2: 42.29 ± 8.92) for lateral flexion to the left side for the goniometer. This suggests that the measuring procedure had good repeatability.

2.5.4. Assessment of change

Patients scored changes of general complaints on an 11-point rating scale ($-5 =$ much worse; $0 =$ no change; $+5 =$ much better) by answering the following question immediately after treatment: 'In what way did your complaints change after this treatment?'

2.6. Statistical analysis

Scores for both motion-related pain and ROM were calculated for each patient by averaging across movement directions. Comparison of groups was by general linear modeling of post-treatment scores with pre-treatment scores, session (first, second or third), diagnosis of myofascial pain (yes /no) and treatment as co-variables. Treatment was coded as two dummy variables: needling and non-local points. NLA, DN and Sham were thus coded 1, 1; 1, 0 and 0, 0, respectively. This analysis estimates the effects of needling and point-selection independently. The *xtgee* procedure was used on the Stata 6 statistics package (College Station, TX, USA) with specification of an exchangeable correlation structure. Patient assessment of change during treatment was compared between treatments using paired *t*-tests.

To check for carry-over effects, an upper limit of restricted ROM was defined as the mean ROM of the healthy subjects minus one standard deviation for each direction. Patients were considered as limited in a direction if the ROM for this direction was less than its limit. Frequencies of occurrence of limited ROM were compared before each treatment by using the Kruskal–Wallis *H*-test.

3. Results

3.1. Patients characteristics

Thirty-four of 36 patients (mean age 51.9 years) with a mean pain duration of 36.7 months completed the trial (Table 3). Patients progress through the trial is shown in

Table 3
Characteristics of patients and healthy subjects

Characteristics	Treatment group	Norm group
Number	34	21
Sex (female/male)	25/9	11/10
Mean age (years; range)	51.9 (24–81)	45.8 (25–84)
Mean pain duration (months; range)	36.7 (2–144)	–

Fig. 1. Data of two randomized patients were excluded from analyses, because of violation of the study protocol leading to non-utilizable data. The first patient, allocated to sequence 3 (Fig. 1), refused the post-treatment assessment after being treated with DN, which was his first treatment. The next day he retired from the trial by telephone call. The second patient, allocated to sequence 6, received the first treatment (sham), but the time between treatment and post-treatment assessment was more than 1 h. The second treatment had to be postponed for 3 days, because the patient missed the appointment. After treatment and another delay between treatment and post-treatment the patient was excluded from the trial.

Another patient received all treatments, but DN measurements were not performed due to absence of the independent investigator. This patient was not excluded from the analyses.

Twenty-seven of 34 patients (79.4%) suffered from myofascial syndrome, in seven patients cervical irritation syndrome (20.6%) was diagnosed. Ten patients (29.4%) had a history of whiplash injury. In three cases (one NLA, two DN), treatment had to be interrupted due to needle reaction, characterized by mild hypotonia and sweating. Immediate recovery after withdrawal of needles allowed treatments to be continued with patients' agreement after a short rest. No serious adverse events were observed.

3.2. Testing of carry-over of treatment effects

The sequence of therapies had no influence on the results. The Kruskal–Wallis *H*-test showed no significant differences regarding the number of limited patients before each treatment ($P = 0.76$). The wash-out period of 1 week seemed to be adequate and significant carry-over effects could be excluded.

3.3. Motion-related pain

Pre-treatment and post-treatment scores for motion-related pain are given, by group, in Table 4. In the regression model, only pre-treatment and use of non-local points were associated with post-treatment pain. Use of non-local points reduced pain scores by about a third (11.2 mm; 95% CI 5.7, 16.7; $P = 0.00006$). The effects of DN led to an estimated reduction in pain of 1.0 mm (95% CI $-4.5, 6.5$;

Table 4
Scores for motion-related pain (0–100 mm VAS)^a

Group	Pre-treatment			Post-treatment		
	<i>n</i>	Mean	SD	<i>n</i>	Mean	SD
Sham	34	30.4	18.62	34	28.0	19.36
DN	33	33.4	19.41	33	29.2	21.9
NLA	34	35.0	22.64	34	19.1	16.11

^a Sham, sham laser acupuncture; DN, dry needling; NLA, non-local acupuncture.

Table 5
Scores for ROM (°)^a

Group	Pre-treatment			Post-treatment		
	<i>n</i>	Mean	SD	<i>n</i>	Mean	SD
Sham	34	47.1	6.26	34	47.4	7.06
DN	33	45.7	6.94	33	48.1	6.95
NLA	34	46.7	9.96	34	50.7	8.00

^a Sham, sham laser acupuncture; DN, dry needling; NLA, non-local acupuncture.

$P = 0.7$). This suggests that NLA is effective and DN ineffective compared to sham.

3.4. Range of motion

Pre-treatment and post-treatment scores for ROM are given, by group, in Table 5. Along with pre-treatment ROM, both DN and use of non-local points were associated with post-treatment ROM in the regression model. DN slightly improved ROM by 1.7° (95% CI 0.2, 3.2; $P = 0.028$) with use of non-local points improving ROM by an additional 1.9° (95% CI 0.3, 3.4; $P = 0.014$).

3.5. Assessment of change

Assessment of change on the verbal rating scale was 2.4 (SD 1.9), 0.8 (SD 2.5) and 0.6 (SD 1.5) points for NLA, DN and Sham, respectively. NLA was significantly superior to both Sham (1.7 points; 95% CI 1.0, 2.5; $P = 0.0001$) and DN (1.5 points; 95% CI 0.4, 2.6; $P = 0.008$) but there was no difference between DN and Sham (0.1 points; 95% CI $-1.0, 1.2$; $P = 0.8$).

Similar results were found when differences between groups for change assessment were analyzed by non-parametric methods ($P = 0.0003, 0.007$ and 0.6 , respectively).

4. Discussion

Our results indicate that acupuncture has specific effects on motion-related pain and ROM in patients with chronic neck pain. Moreover, point selection appears important with distant points improving ROM more than needling at local points, and local points seeming ineffective to obtain immediate pain relief.

4.1. Clinical relevance

Changes in pain score and subjective rating of treatment effects in the NLA group are statistically and clinically relevant and confirm that acupuncture at distant points can be a pain relieving treatment with immediate onset.

It is difficult to draw conclusions about the clinical relevance of changes in ROM, if we take into account that for statistical analysis scores were calculated for each patient by averaging across both limited and unlimited movement

directions. On the understanding that patients with chronic neck pain are not necessarily limited in all six movement directions, we think that the improvement of ROM score in the NLA group, which was about 10% compared to sham might be clinically useful.

DN of local myofascial trigger points was not effective in reducing pain, changes in ROM were minor and of questionable clinical relevance. One explanation for the lack of effect of DN might be the fact that in all patients needling of local myofascial trigger points provoked a short contraction of muscle fibers, which is known as local twitch response of muscle bands and causes a typical soreness in the treated region for some hours. This soreness can overlie the original pain and might have influenced patients' rating immediately after treatment in our study. Further studies of DN should take this experience into account.

From a clinical point of view, short term effects are of less significance compared to lasting effects. However, immediate pain reduction may motivate the patient to continue treatment. This can be especially important in chronic pain patients, who are often dissatisfied and demotivated by precedent ineffective treatments. In addition, immediate pain reduction may facilitate further physiotherapy.

Regarding the practice of acupuncture, the results support the importance of distant points in the selection of points. In our experience, starting a treatment with needles at distant points makes it easy to gain patients' confidence in acupuncture, especially because it can be less painful than needling in the affected region.

4.2. *Physiological implications*

Our results suggest that non-segmental pain relieving mechanisms play a major role in mediating acupuncture analgesia, because we did not observe pain relief after local needling. Consequently, the observed analgesic effects might be due to a release of endogenous opioid peptides, which is well established as an important mechanism in mediating acupuncture analgesia (Mayer, 2000). However, this explanation is not convincing, because local needling should have had the same effects on opioid release as needling at distant sites. Furthermore, the clinical relevance of opioid release following acupuncture has been proven only for electrical needle stimulation, which we did not perform.

Hence, it is more probable that in our clinical trial non-segmental acupuncture has activated descending inhibitory pain control systems (Willer et al., 1984) and/or the propriospinal heterosegmental antinociceptive system (Sandkühler, 1996), which both can be activated by heterotopic mechanical stimuli. It is noteworthy that in animal experiments the latter mechanism may lead to depression of long-lasting pain-induced changes of signal transduction in the spinal cord (Sandkühler, 1996).

4.3. *Study design*

The study design focused on the evaluation of immediate

effects of a single treatment and on the blinding of patient and therapist for the placebo procedure. A single treatment is not adequate in chronic pain patients, but there are methodological advantages. Natural remission of disease, regression to the mean in clinical studies and other factors disturbing the internal validity of results (Whitney and Von Korff, 1992; Ernst and Resch, 1995) should play a minor role compared with other study designs. In addition, the crossover design is statistically efficient (Altman, 1990).

One earlier trial comparing a single acupuncture treatment to no treatment, described an improvement of mobility in chronic neck pain (Löhnert et al., 1996), but in this trial placebo effects were not controlled. Most placebo-controlled studies of neck pain performed needling at other sites or superficial acupuncture, which cannot be considered as real placebos (Vincent and Lewith, 1995). We believe that sham laser acupuncture was an appropriate placebo control for the current study. Laser acupuncture is a common mode of acupuncture without counter irritating effects, and sham laser treatment cannot be distinguished from real laser treatment, if visual and acoustic signals are the same. We did not assess the credibility of treatments, but in another acupuncture trial we found that sham laser was equally credible compared to acupuncture and massage (Irnich et al., 2001). The blinded therapist treated with the psychological attitude as if giving a real treatment. Though we cannot completely exclude an enhanced placebo effect of acupuncture, the differential effects of needle placement at distant and needling local points are unlikely to be explained by placebo effects and do suggest a specific effect of acupuncture.

4.4. *Limitations*

Our results were limited to patients with myofascial syndrome or irritation syndrome, to be characterized more generally as non-specific neck pain (Bogduk, 1984; Bourghouts et al., 1998), since patients with radicular syndrome, structural damage of vertebrae (surgery, injury) and segmental instability of the cervical spine were excluded.

Beyond the issue of local over distal points, our results do not address the specificity of acupuncture point selection. Therefore, it is not possible to conclude from our data whether needling classical acupuncture points is more effective than needling other sites.

A major limitation of the present study is the lack of information as to how long pain relief lasted after treatment. There was no more pain relief 1 week after treatment, but additional post-treatment measurements with shorter intervals would have provided useful information to making definitive inferences about the clinical relevance and the underlying physiological mechanism.

4.5. *Conclusions*

Two main conclusion can be drawn from the results of the present study.

First, a single acupuncture treatment has good immediate effects on pain and mobility in patients with chronic neck pain. In managing these patients acupuncture may be a helpful initial or adjunct therapy.

Second, better effects of stimulation at distant points compared to local needling indicate that in mediating acupuncture analgesia non-segmental antinociceptive systems may play a major role.

Duration and strength of pain relief compared to established therapies and the underlying physiological mechanism of acupuncture-induced analgesia in chronic neck pain patients needs to be investigated.

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References

- Aigner N, Fialka C, Stocker R, Aigner A, Petje G. Acupuncture versus laser acupuncture in the treatment of whiplash injury – A prospective randomized study (Akupunktur versus Laserakupunktur in der Therapie des Schleudertraumas). *Dtsch Z Akupunkt* 1999;1:4–11.
- Aker PD, Gross RA, Goldsmith CH, Peloso P. Conservative management of mechanical neck pain: a systematic overview and metaanalysis. *BMJ* 1996;313:1291–1296.
- Altman DG. *Practical statistics for medical research*. London: Chapman and Hall, 1990.
- Baldry PE. *Acupuncture, trigger points and musculoskeletal pain*. London: Churchill Livingstone, 1993.
- Bland J. *Disorders of the cervical spine*. Philadelphia, PA: W.B. Saunders, 1987.
- Bogduk N. Neck pain. *Aust Fam Physician* 1984;13:26–30.
- Bourghouts JAJ, Koes BW, Bouter LM. The clinical course and prognostic factors of non-specific neck pain: a systematic review. *Pain* 1998;77:1–13.
- Bovim G, Schrader H, Sand T. Neck pain in the general population. *Spine* 1994;19:1307–1309.
- Cheng Xinnong. *Chinese acupuncture and moxibustion*. Beijing: Foreign Languages Press, 1987.
- Coan RM, Wong G, Coan PL. The acupuncture treatment of neck pain: a randomized controlled study. *Am J Chin Med* 1982;4:326–332.
- David J, Modi S, Aluko AA, Robertshaw C, Farebrother J. Chronic neck pain: a comparison of acupuncture treatment and physiotherapy. *Br J Rheumatol* 1998;10:1118–1122.
- Dexter JR, Simons DS. Local twitch response in human muscle evoked by palpation and needle penetration of trigger point. *Arch Phys Med Rehabil* 1981;62:521–522.
- Eisenberg DM, Davis RB, Ettner SL, Appel S, Wilkey S, Van Rompay M, Kessler RC. Trends in alternative medicine use in the United States, 1990–1997: results of a follow-up national survey. *J Am Med Assoc* 1998;18:1569–1575.
- Ernst E, Resch KL. Concept of true and perceived placebo effects. *BMJ* 1995;311:551–553.
- Gallacchi G, Müller W, Plattner GR, Schnorrenberger CC. Akupunktur- und Laserstrahlbehandlung beim Zervikal- und Lubalsyndrom. *Schweiz Med Wochenschr* 1981;37:1360–1366.
- Gunn CC, Milbrandt WE, Little AS, Mason KE. Dry Needling of muscle motor points for chronic low back pain. A randomized clinical trial with long term follow up. *Spine* 1980;5:279–291.
- Hagen KB, Harms-Ringdahl K, Enger NO, Hedenstad R, Morten H. Relationship between subjective neck disorders and cervical spine mobility and motion-related pain in male machine operators. *Spine* 1997;13:1501–1507.
- Hong CZ. Persistence of local twitch response with loss of conduction to and from the spinal cord. *Arch Phys Med Rehabil* 1994;75:12–16.
- Irnich D. Acupuncture in complaints of the locomotor system, especially of the cervical syndrome (Akupunktur bei Beschwerden des Bewegungssystems am Beispiel des HWS-Syndroms). *Dtsch Z Akupunkt* 1999;2:81–90.
- Irnich D, Behrens N, Molzen H, König A, Gleditsch J, Krauss M, Natalis M, Senn E, Beyer A, Schöps P. Randomised trial of acupuncture compared with conventional massage and ‘sham’ laser acupuncture for treatment of chronic neck pain. *BMJ* 2001;322:1574–1577.
- Löhnert V, Roniger I, Keusch R, Tilscher H. Akupunktur bei Zervikalsyndromen. *Manuelle Med* 1996;34:269–274.
- Loy TT. Treatment of cervical spondylosis. *Med J Aust* 1983;2:32–34.
- Mayer DJ. Biological mechanisms of acupuncture. *Prog Brain Res* 2000;122:457–477.
- NIH Consensus Conference. Acupuncture. *J Am Med Assoc* 1998;17:1518–1524.
- Petrie JP, Hazleman BL. A controlled study of acupuncture in neck pain. *Br J Rheumatol* 1986;25(3):271–275.
- Sandkühler J. The organization and function of endogenous antinociceptive systems. *Prog Neurobiol* 1996;1:49–81.
- Schöps P, Siebert U, Azad SC, Friedle AM, Beyer A. Diagnostic criteria and new classification of the cervical spine syndrome (Diagnostische Kriterien und neue Klassifikation des Halswirbelsäulensyndroms). *Schmerz* 2000;14:160–174.
- Schöps P, Siebert U, Friedle AM, Beyer A. Interexaminer reliability and normative values in measuring the cervical range of motion. *Scand J Rehabil* 2002 (in press).
- Smith LA, Oldman AD, McQuay HJ, Moore RA. Teasing apart quality and validity in systematic reviews: an example from acupuncture trials in chronic neck and back pain. *Pain* 2000;86:119–132.
- Travell JG, Simons DG. *Myofascial pain and dysfunction. The trigger point manual*, vols. 1, 2. Baltimore, MD: Williams and Wilkins, 1983/1992.
- Vickers AJ. Results of reanalysis of Irnich trial using statistical methods of greater efficiency. *BMJ* 2001;323:1306.
- Vincent CA, Lewith G. Placebo controls for acupuncture studies. *J R Soc Med* 1995;88:199–202.
- Vincent CA, Richardson PH. The evaluation of therapeutic acupuncture: concepts and methods. *Pain* 1986;24:1–13.
- White AR, Ernst E. A systematic review of randomized controlled trials of acupuncture for neck pain. *Rheumatology* 1999;38:143–147.
- Whitney CW, Von Korff M. Regression to the mean in treated versus untreated chronic pain. *Pain* 1992;50:281–285.
- Willer JC, Roby A, Le Bars D. Psychophysical and electrophysiological approaches to the pain-relieving effects of heterotopic nociceptive stimuli. *Brain* 1984;4:1095–1112.
- Yue SJ. Acupuncture for chronic back and neck pain. *Acupunct Electrother Res* 1978;3:323–324.