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Effect of acupuncture treatment on chronic neck and shoulder pain in sedentary female workers: a 6-month and 3-year follow-up study

Dong He[a,b,*], Kaj Bo Veiersted[c], Arne T. Høstmark[a], Jon Ingulf Medbø[c]

[a]*Department of General Practice and Community Medicine, University of Oslo, Oslo, Norway*
[b]*Acupuncture Institute He Dong, Oslo, Norway*
[c]*National Institute of Occupational Health, Oslo, Norway*

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Abstract

The study was carried out to examine whether acupuncture treatment can reduce chronic pain in the neck and shoulders and related headache, and also to examine whether possible effects are long-lasting. Therefore, 24 female office workers (47 ± 9 years old, mean ± SD) who had had neck and shoulder pain for 12 ± 9 years were randomly assigned to a test group (TG) or a control group (CG). Acupuncture was applied 10 times during 3–4 weeks either at presumed anti-pain acupoints (TG) or at placebo-points (CG). A physician measured the pain threshold (PPT) in the neck and shoulder regions with algometry before the first treatment, and after the last one and six months after the treatments. Questionnaires on muscle pain and headache were answered at the same occasions and again 3 years after the last treatment. The intensity and frequency of pain fell more for TG than for CG ($P_b \leq 0.04$) during the treatment period. Three years after the treatments TG still reported less pain than before the treatments ($P_w < 0.001$), contrary to what CG did ($P_b < 0.04$). The degree of headache fell during the treatment period for both groups, but more for TG than for CG ($P_b = 0.02$). Three years after the treatments the effect still lasted for TG ($P_w < 0.001$) while the degree of headache for CG was back to the pre-treatment level ($P_b < 0.001$). PPT of some muscles rose during the treatments for TG and remained higher 6 months after the treatments ($P_w < 0.05$), which contrasts the situation for CG. Adequate acupuncture treatment may reduce chronic pain in the neck and shoulders and related headache. The effect lasted for 3 years.

Keywords: Acupuncture; Algometry; Chronic pain; Neck; Placebo or sham acupuncture; Shoulder

1. Introduction

Chronic neck and shoulder pain is a major medical and social problem. A Norwegian survey showed that 13% of the working population reported moderate or severe work-related neck and shoulder pain during the last 2 weeks (Survey of living 2000, 2001), and 11% of all Norwegian women on a long-term sick leave (more than 16 days) suffer from such pain (RTV-report, 2000). In the United States more than 10% of the population has experienced pain for periods of more than 3 months in a given year (Birch, 1997). The situation is probably largely the same in other industrialised countries. The cost of these sick leaves is thus considerable. Treatment of neck and shoulder pain may thus be of considerable medical interest.

Neck and shoulder pain are one of the main reasons for patients to take acupuncture treatment. For example, in a survey of 500 acupuncture patients in general practice, 19% of them suffered from neck and shoulder problems (Freedman, 2002). Despite this only few studies have examined whether acupuncture may be effective for these patients, and only a few reviews of neck pain rehabilitation include treatment by acupuncture (Aker et al., 1996). Nabeta and Kawakita (2002) found an immediate effect of acupuncture on the pain in the neck and shoulder regions, but the effect did not last until the next treatment. Peng et al. (1987) found that 65% of their patients showed a long-term reduction in the pain, but the authors did not explain what they meant by long-term. In a review of 14 studies on possible effects of acupuncture on chronic neck pain White and Ernst (1999) state that half of the studies showed a positive effect, but it

* Corresponding author. Address: Department of General Practice and Community Medicine, Section of Preventive Medicine and Epidemiology, University of Oslo, P. O. Box 1130 Blindern, N-0318 Oslo, Norway. Tel.: +47-22-85-06-24; fax: +47-22-85-06-20.
E-mail address: dong.he@samfunnsmed.uio.no (D. He).

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appeared that only 3 out of 11 studies of sufficiently high quality reported a significant effect. These observations suggest that there is a need for further studies on possible effects of acupuncture on neck and shoulder pain, and new studies should emphasise high quality design and a long-term follow-up (He et al., 2001; Kjellman et al., 1999; White and Ernst, 1999).

The main purpose of this study was to examine whether acupuncture treatment can reduce chronic neck and shoulder pain and related headache. A further aim was to see whether possible effects were long lasting. We have, therefore, undertaken a randomized and sham-controlled trial to compare the effect of proper acupuncture and sham-acupuncture treatment on chronic neck and shoulder pain. The effects were evaluated by self-reported questionnaires and algometric measurements of the pain threshold (PPT) in 28 trigger points. The pain status has been reexamined 6 months and 3 years after the last treatment in order to see whether there were long-term effects of acupuncture treatment.

2. Subjects and method

The Ethics Committee for Health Region II in Norway has approved the design of the study.

2.1. Subjects

Altogether 24 female office workers with chronic pain in the neck and shoulder regions were volunteers. The subjects were recruited from five large companies in Oslo by the company's occupational physician who followed our inclusion criteria. The participants received detailed information about the purpose of the study and the treatment procedure. The inclusion criteria were that the subjects should be women between 20 and 50 years old, having worked in sedentary occupations or being engaged in light repetitive activities. Their perceived pain in the neck and shoulder regions was so severe that the subjects' work and spare time activities were affected, but none of the subjects were on a sick leave at the start of the study. The 'chronic pain' was taken as being experienced for at least 3 months during the last year. Persons with diabetes, neurological, rheumatologic or other diseases were excluded, as were pregnant and breast feeding women. It was in addition required that none of the subjects received any other form of treatment for chronic pain or any other acupuncture treatment during the period of our treatments.

The subjects were divided by complete randomization, which is by drawing with replacement, into two groups, referred to as the test group (TG) and the control group (CG). None of the subjects depended on health insurance contribution or applied for such support; all of them earned their own living. There were no drop-outs neither during the treatment period nor during the two follow-ups, but two of the subjects (one in TG and one in CG) did not take part in the algometric measurements. Data on the subjects with respect to general characteristics are shown in Table 1.

Table 1
General characteristics of the subjects in the test group (TG) and the control group (CG) before the first treatment

	TG	CG	*P*
Number of subjects	14	10	
Age (year)	49 ± 8	45 ± 10	0.30
Weight (kg)	63 ± 10	68 ± 9	0.23
Height (cm)	165 ± 7	168 ± 4	0.14
Education (year)	12 ± 2	12 ± 3	0.97
Working (h $week^{-1}$)	36 ± 5	33 ± 6	0.12
Working on computer (h day^{-1})	5.8 ± 1.8	4.7 ± 1.6	0.15
Length of pain (year)	12 ± 8	12 ± 10	0.94
Total days of pain (day $week^{-1}$)	4.3 ± 0.7	4.5 ± 0.7	0.48
Exercise (h $week^{-1}$)	2.9 ± 2.8	2.2 ± 3.1	0.56

The data are mean ± SD.

2.2. Clinical examinations

The clinical examinations consisted of inspection of the neck and shoulder regions for muscle atrophy and dislocations, active and passive movements of neck and shoulder joints and provocation tests of neck and shoulder muscles. The PPT was measured by algometry (Algometer®, Somedic production AB, Sollentuna, Sweden) on 28 trigger points divided bilaterally on the neck and shoulders. A trigger point was defined according to Travel and Simons (1983) as "a focus of irritability in a tissue that, when compressed, is locally tender and, if sufficiently hypersensitive, gives rise to referred pain and tenderness". There were three locations on the supraspinatus muscle, two on the infraspinatus muscle, one on the teres minor muscle, three on the rhomboid muscle and one on the long tendon of the biceps muscle. Furthermore, one point was on the upper trapezius muscle, one on the insertion of the suboccipital tendons, and two locations were on the levator scapula muscle (Travel and Simons, 1983). A round probe with a 1 cm^2 cross-sectional area was used, and the equipment could report forces or pressures up to a maximum of 2000 kPa. When the muscle tenderness was measured, the probe was placed on the skin above the trigger point and then pressed down with a force increasing at a rate of $\approx$30 kPa s^{-1}. If the subject did not report pain before a pressure of 350 kPa was reached, that part of the muscle was defined as a none-sore muscle. The repeatability of algometric registrations has been examined and found acceptable by Levoska et al. (1993). The examinations were carried out right before the first acupuncture treatment, just after the last treatment and again 6 months after the last treatment by one of the investigators (KBV) who is a specialist in occupational medicine and has a long practice in an occupational health service. Both the patients

and the examiner were blinded as to which group the patient belonged to.

2.3. Questionnaire

Three questionnaires, A, B and C, were used to evaluate the effects of the acupuncture treatments and to get other relevant information from the subjects. In questionnaire A, which was completed before the first treatment, there were 25 questions focusing on the personal background and history of pain.

Questionnaire B consisted of 12 questions and was completed before each subsequent treatment and within one week after the last treatment. It was used to register the intensity and frequency of pain and headache, activities at work and at home, quality of sleep, frequency of tension and irritability, depression, satisfaction with life, smoking both since the last treatment and compared with that before the first treatment. The subjects also reported to what extent they carried out the ear acupressure described further below. Only results related to pain are addressed in this article, and these questions were taken from the standard Nordic questionnaire for the analysis of musculoskeletal symptoms (Kuorinka et al., 1987) and McGill pain questionnaire (Melzack, 1975). The intensity of pain, frequency of pain, and headache were measured on a Visual Analog Scale (VAS), and these data were given in arbitrary units.

Questionnaire C, containing 17 questions, was answered at the two follow-ups. The questionnaire contained largely the same questions as questionnaire B, but it also included questions related to pain and the state of life during the last month (6-month follow-up) and the last 6 months (3-year follow-up).

2.4. Acupuncture treatment

The acupuncture treatment was a combination of body acupuncture, body electroacupuncture and ear acupressure. Altogether 16 body-acupoints and six ear-acupoints were used (Table 2). Each subject received three treatments per week and totally 10 treatments over a period of 3–4 weeks. Each treatment lasted 45 min.

The TG received real acupuncture treatment, which was treatment on acupoints assumed to have a positive effect on chronic pain in the neck and shoulder regions (Huang, 1991; Ma, 1992; Wang, 1991; Wang and Peng, 1990; Yang, 1601). Electrodes of the electroacupuncture instrument (JJ205; Shenzhen Star Technology and Shanxi Pingyao Poyi Instrument Manufacturer, Shanxi, China) were first placed on the body acupoints of the neck and shoulder areas. The stimulation for each pulse was approximately half of a sinus wave lasting 100 μs and with amplitude of 170–200 V followed by ringing with an amplitude of ≤40 V decaying exponentially to a non-detectable level within 10 ms. The stimulation frequency was 5 Hz, and each electroacupuncture treatment lasted 30 min. After the electro-stimulation was started sterile acupuncture needles 25–40 mm long and with a diameter of 0.25–0.35 mm (Huatuo, needles for single use, Suzhou Medical Instruments Factory, Suzhou, China) were inserted bilaterally in three body points (Table 2), and the depth of insertion was 10–30 mm. The needles were kept on the points for 30 min and rotated every 5 min (Ma, 1992; Wang, 1991; Wang and Peng, 1990; Yang, 1601). After the electrodes and needles were removed plant seeds (Wangbuliuxingzi, Beijing, China) were placed on six ear acupoints for acupressure. Each seed was kept in place by a piece of 6 × 6 mm tape until the next treatment. The subjects were instructed to press on each of the ear acupoints a series of 100 repeats four times per day (Huang, 1991).

Table 2
Acupoints used for the test group

Type of acupuncture treatment	Acupoints (number of points used), international code
Body electroacupuncture	Jingjiaji (4), ExHN Jianjing (2), GB21 Fengmen (1), BL12 Dazhui (1), GV14 Jianzhongshu (1), SI15 Jianwaishu (1), SI14
Body acupuncture	Hegu (2), LI4 Quchi (2), LI11 Fengshi (2), GB31
Ear acupressure	Shenmen (1) Neck (1) Cervical spine (1) Shoulder (1) Shoulder joint (1) Shoulder-back (1)

The numbers in parentheses refer to the total number of points used for each treatment. When one point was used, the point was either on the medial plane of the body or the treatment was given each side of the body alternately. When two or four points were used, there were one or two points at either side of the body.

The GC received placebo treatment. The electroacupuncture for this group was carried out without applying any voltage. However, the instrument did send a short beep at each pulse given, thus giving an auditive signal that a pulse has been sent. During the sham electroacupuncture the instrument still sent beeps but no voltage. The body acupuncture was applied to points 10–40 mm distal to presumed real acupoints, and ear acupressure was applied on points 4–6 mm below to presumed real acupoints. The placebo acupuncture was thus not applied at any acupoints. Apart from the different sites of points and electroacupuncture voltage used there were no differences in the treatment procedures between TG and CG. The same acupoints were used for all patients in the TG, no matter whether the chronic pain was located to the neck, the shoulders, or both. Likewise the same placebo points were used for all patients in the CG. The acupuncture treatment was carried out by one of the authors (DH), who has more than 10 years of experience with acupuncture clinic.

2.5. Blood variables

Blood samples were taken before the treatments, after the last treatment, and again 6 months after the treatment period to get physiologic measures of possible changes in the pain status. Citrate was used as an anti-coagulant. The samples were analysed for a number of parameters including the concentration of platelets and the concentration of serotonin (5-hydroxytryptamine) in plasma and in platelets. It appeared later that the data on the serotonin concentration were unreliable because of technical problems with the analyses, and, therefore, no data on the serotonin concentration were given.

The autoanalyser used (Technicon H2, Technicon Instrument Corporation, Tarrytown, NY, USA) reports the counts of white and red blood cells, haematocrit, haemoglobin mass concentration, mean corpuscular volume, mean corpuscular haemoglobin content, mean corpuscular haemoglobin concentration, red distribution width, haemoglobin distribution width, platelet concentration, and the mean platelet volume. It also reported the state of different kinds of white blood cells.

2.6. Experimental design

The subjects did not know that some were given a placebo treatment, and they were thus blinded as to the kind of treatment they received. The acupuncturist knew what kind of treatment each subjects was given, and the study was thus single blinded in that respect. The physician examining the patients and carrying out the measurements of the PPT at the trigger points was unaware of what kind of treatment each subject received. That part of the study was thus double-blinded. Moreover, the acupuncturist was unaware of the results of the algometric measurements until the 3-year follow-up had been completed. Apart from the difference in points used between the two groups, all subjects were treated as equally as possible, in treatment procedure and communications with acupuncturist. The lack of double-blindedness in this study may not be a big problem.

Clinical experience from China suggests that treatments should be given at least every second day and as a minimum of 10 treatments for one course. As early as 400 years ago, Yang (1601) pointed out that treatments should be given every second day. Ma (1992) emphasized that acupuncture treatment should take every day or every second day, and a minimum of 7–10 treatments should be included in one course. Quite often three courses are needed to give the patients a lasting pain relief. Coan et al. (1982) pointed out that 8–10 treatments were necessary to obtain an effect of acupuncture. Bullock et al. (1999) also reported that six treatments relieved pain better than only one treatment. The Chinese tradition also suggests that an adequate treatment regime should include several acupoints, a combination of different acupuncture techniques, and that enough time of stimulation should be used during each session. We have based our treatment regime on the principles mentioned above.

2.7. Statistical analysis

The results are presented as mean ± SEM or as individual results unless and otherwise stated explicitly. Univariate tests of statistical significance (one- or two-sided whenever appropriate) were carried out by Student's matched-paired (within each group, denoted P_w) and two-sample t-tests (between TG and CG, denoted P_b). The level of statistical significance was set at 0.05.

3. Results

All of the subjects completed all 10 treatments within the preset time schedule. The subjects were in addition instructed to carry out ear acupressure four times per day, which according to the subjects were carried out as 3.43 ± 0.08 series per day (TG) and 3.58 ± 0.07 series per day (CG, $P_b = 0.18$).

3.1. Intensity of pain

Before the first treatment the intensity of pain on a scale from 0 to 100 was 57 ± 7 and 48 ± 9 units for the TG and the CG, respectively, ($P_b = 0.46$). For the TG the reported pain fell from the first treatment continuously until after the seventh treatment and then levelled off at a level around 40 units (70%) lower than before the first treatment ($P_w < 0.001$; Fig. 1a). For the CG the reported pain fell somewhat after the second treatment and stayed at a level around 14 units (29%) lower than before the first treatment for the rest of the treatment period ($P_w = 0.02$). The change during the treatment period was thus larger for the TG than for the CG ($P_b = 0.001$), and the reported pain differed systematically between the two groups after the sixth treatment and for the rest of the treatment period ($P_b = 0.01$). Consequently, after 10 treatments the intensity of pain was 15 ± 5 units for the TG (26% of the pre-treatment value) and 36 ± 8 units for the CG (75% of the pre-treatment value, $P_b = 0.02$).

At the 6-month follow-up the intensity of the reported chronic pain averaged 24 ± 7 (TG) and 36 ± 8 units (CG; $P_b = 0.15$). Three years after the last treatment the reported pain differed between the two groups again, being 19 ± 6 for the TG (33% of the pre-treatment value) and 44 ± 11 units for the CG (92% the pre-treatment value; $P_b < 0.04$).

3.2. Frequency of pain

Before the first treatment the frequency of pain was 43 ± 4 units for the TG and 47 ± 4 units for the CG ($P_b = 0.5$). During the treatment period the value fell more

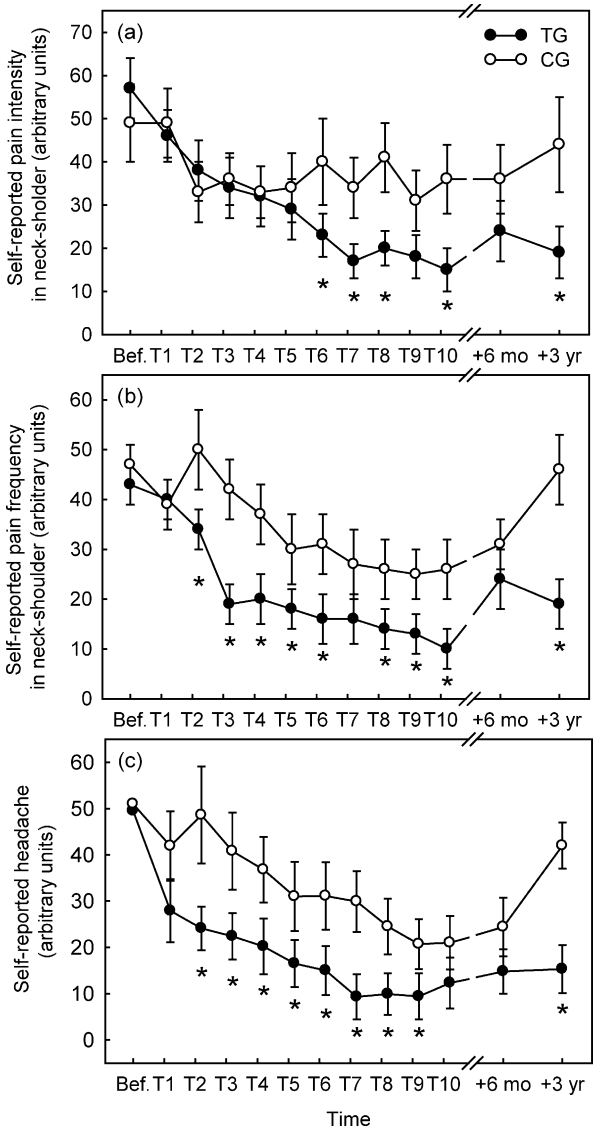

Fig. 1. Self-reported intensity of pain (upper panel), frequency of pain (middle panel) and headache (lower panel) before the first treatment, after each treatment (T1–T10) and 6 months and 3 years after the treatments for the test group (TG) and the control group (CG). The scores are arbitrary units on a scale from 0 to 100. The data are mean ± SEM for 14 (TG) and 10 (CG) subjects. * denotes significant difference between the two groups.

for the subjects in the TG than for those in the CG ($P_b = 0.04$; Fig. 1b). Consequently the average of 15 ± 4 units (35% of the pre-treatment value) for the TG during the last half of the treatment period was less than that of 28 ± 5 units (60% of the pre-treatment value) for the CG during the same period ($P_b = 0.04$).

Six months after the last treatment the reported frequency of pain was 24 ± 6 (TG, 56% of the pre-treatment value) and 31 ± 5 units (CG; 66% of the pre-treatment value; $P_b = 0.18$). Both values were less than those reported before the first treatment ($P_w < 0.003$), and they do not differ from the values at the end of the treatment period ($P_w = 0.14$). Three years after the treatments the reported frequencies of pain were 19 ± 5 (TG, 44% of the pre-treatment value) and 46 ± 7 units (CG, 98% of the pre-treatment value; $P_b = 0.003$). While the value for the TG was less than before the first treatment ($P_w < 0.001$) and similar to that during the latter part of the treatment period ($P_w = 0.5$), the value for the CG did not differ from the self-reported frequency of pain before the first treatment ($P_w = 0.6$; $P_b = 0.006$).

3.3. Headache

The degree of headache for the subjects in the TG fell by 45% of the pre-treatment after the first acupuncture treatment ($P_w = 0.003$; Fig. 1c), and it fell further after the next six treatments (to 30% of the pre-treatment value) before levelling off during the last part of the treatment period. In the follow-up period the degree of headache for the TG rose somewhat, but it was still lower than the pre-treatment value ($P_w < 0.001$). For the CG the degree of headache fell after the third treatment and continued to fall a little after each of the subsequent treatments. In the follow-up period the degree of headache for the CG was unchanged 6 months after the last treatment and less than before the treatments ($P_w = 0.004$), but 3 years after the treatments their degree of headache was back to the pre-treatment level ($P_w = 0.15$) and thus higher than at the end of the treatment period ($P_w = 0.11$).

Although the degree of headache fell for both groups during the treatment period, the value was systematically lower for the subjects in the TG than for those in the CG ($P_b = 0.02$). Six months after the last treatment there was no difference between the two groups ($P_b = 0.12$), but 3 years after the treatments the value was less for TG than for CG ($P_b < 0.001$).

3.4. Measurements of the pain thresholds by algometry

The measurements of PPT showed three different patterns in the development during the study. The first main pattern, shown for example by the trapezius muscle, was as follows (Fig. 2, left panel). Before treatments, the PPT was lower for TG than for CG (192 ± 10 vs. 268 ± 18 kPa; $P_b = 0.002$). The PPT rose by 64 ± 13 kPa during the treatment period for TG ($P_w < 0.004$) while there were no systematic changes for the CG ($P_w = 0.6$). The development during the treatment period thus differed between the two groups ($P_b = 0.002$). After the treatments there were no longer any signs of differences between the two groups ($P_b = 0.9$). There were no systematic changes for either group from just after the last treatment and to the measurements 6 months after ($P_w > 0.7$). Thus, 6 months after the last treatment the subjects in the TG reported a PPT 68 ± 15 kPa higher than before the first treatment ($P_w < 0.001$). There were no systematic differences between the muscles on the right and the left sides in the PPTs for the trapezius muscle.

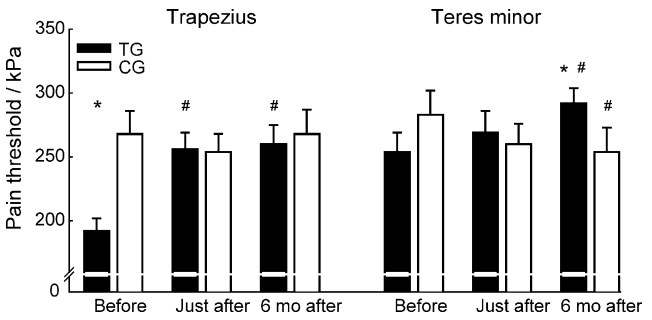

Fig. 2. Pain threshold of the trapezius (left panel) and teres minor muscles (right panel) for the test group (TG) and the control group (CG) before, just after and 6 months after the treatments. *Significant difference between the two groups; #Significant change from the pre-treatment level. The pain threshold was measured by algometry, and data from the right and left muscles have been pooled. The data are mean ± SEM of 13 (TG) and nine (CG) subjects.

The PPT of the levator scapula muscle on both sides and of the infraspinatus muscle on the right side showed largely the same differences and changes as those described for the trapezius muscle above. However, some of the differences and changes were somewhat less pronounced for these muscles than for the trapezius muscle.

The PPT for the teres minor muscle showed the second main pattern (Fig. 2, right panel). For this muscle there were no differences between the two groups before the first treatment. For the subjects in the TG the PPT rose during the study ($P_w = 0.01$), while the value fell for the muscle on the left side for the subjects in the CG when all post-treatment values were pooled ($P_w = 0.05$). Thus, 6 months after the last treatment the PPT of the left teres minor muscle was higher for the subjects in TG than for those in the CG ($P_b = 0.02$). The development during the study thus differed between the two groups for the left muscle ($P_b = 0.07$). The PPT of the romboideus muscle and the biceps longum muscle showed similar changes during the study.

For the supraspinatus muscle (three different parts) and for the suboccipital muscle there were no differences in the PPT between the two groups and no changes in the PPT during the investigation for either group. These muscles thus showed a third main pattern of possible development in the PPT.

To sum up, there were several improvements but no impairments in the PPT for the TG during the study. The CG showed no improvements but a few impairments during the same period.

3.5. Blood variables

The concentration of blood platelets was $(256 \pm 26) \times 10^9\,l^{-1}$ for the TG and $(238 \pm 10) \times 10^9\,l^{-1}$ for the CG before the treatments ($P_b = 0.5$). While there was no change for the subjects in the CG, the concentration rose to $(295 \pm 18) \times 10^9\,l^{-1}$ for the TG just after the treatments ($P_b = 0.02$ vs. CG), a 15% increase ($P_w = 0.05$). During the next 6 months there was no significant change for either group, and the value for the TG was, therefore, still higher than that for the CG ($P_b = 0.02$). The data on the other blood parameters were all within the normal range. There were no differences between the two groups in any of these values and no changes in the measured blood parameters during the study (not shown).

3.6. Other treatments in follow-up period

Five subjects in the CG (50%) and three subjects in the TG (21%) had received other treatments during the 3 years follow-up period. More specifically, two of the subjects in the CG had once undergone cupsetting, two of them had once received physiotherapy while the latter had once received psychotherapy. Two of the subjects in the TG had received one treatment of physiotherapy while another subject had received homeopathy treatment. Since the times of treatments these subjects received were only once, we assume that the treatments may not have influenced the outcome of the results in this study.

4. Discussion

The main finding in this study was that adequate acupuncture treatment reduced the intensity and frequency of muscle pain, the degree of headaches, and a number of trigger points became less tender. These effects seemed long-lasting since the results differed systematically between the subjects in the TG and the CG even 3 years after the treatments.

4.1. Reduced pain

Our results of reduced pain are in line with several studies (Allais et al., 2003; Coan et al., 1982; Ceccheerelli et al., 2001; Irnich et al., 2002; Junnila, 1987a,b; Peng et al., 1987; Petrie and Langley, 1983; Sun et al., 2001). We found in addition that the time course of the reductions differed between the intensity and the frequency of pain. For the intensity of pain there was no difference between the two groups until seven treatments were completed. This means that 8–10 treatments should be given within a few weeks to get a relief of neck and shoulder pain. That conclusion is in line with Loy (1983) who found an improvement of 67 and 87% of neck movement after six and 12 acupuncture treatment for patients with cervical spondylosis.

The frequency of pain changed largely in parallel to the degree of headache. Both parameters differed significantly between the two groups after only three treatments. In a different experimental design Tamura and Chang (2003) found that medicine injection into acupoints reduced

the degree of headache by 50 and 90% one and two weeks, respectively, after the treatment.

4.2. Pain threshold

Our results of the PPT in 28 different trigger points showed that the treatment affected the two groups differently and thus suggests that adequate acupuncture treatment may help patients reduce their muscle pain. Karst et al. (2000) found that for their treatment group the PPT was ≈15% higher 6 weeks after a treatment regime against headache. Zhu and Polus (2002) found no effect of acupuncture on the PPT measured on the same acupoints.

It is conceivable that the perceived pain may fluctuate for patients with chronic pain (Takala et al., 1992). For the trapezius muscles for example the subjects in the TG started at a very tender level, and the improvement during the treatment period only brought their PPT in this muscle up to the level of the CG. It could be argued that the effects seen on the PPTs may have been an effect of random variations. However, the subjects were randomly assigned to the TG or the CG. There is no reason to assume that only subjects assigned to the TG should experience improvements and only subjects in the CG should experience impairments during the study. Moreover, the changes appeared to last for at least 6 months after the treatments. These considerations suggest that the observed effects were consequences of the treatment and not due to random fluctuations.

Most of the acupoints used in this study lie on the neck or on the back above the scapular spine. We used no acupoints below the scapular spine. It is interesting to note that two of the three muscles that showed a clear improvement for the TG lift the shoulder and thus lie close to a number of the acupoints used. However, we saw no effect of the supraspinatus muscle or for the suboccipital muscle, two other muscles close to some of the acupoints used. The infraspinatus muscle, which showed some improvement for the TG, does not lie close to any acupoints used. We can, therefore, not say whether the distance to the acupoints used may explain the different effects seen for different muscles. In line with this Nabeta and Kawakita (2002) who inserted needles directly on trigger points, saw an immediate but no lasting effect of their treatment on the pain. The different responses seen for different muscles suggest on the other hand that several muscles should be examined to unravel a possible beneficial effect during this kind of investigations.

4.3. Headache

All of our subjects suffered from headache in addition to having chronic neck and shoulder pain. The reduced degree of headache for both groups during the treatment period is in line with the effect seen by others (Karakurum et al., 2001; Karst et al., 2000). However, none of those studies found significant differences between the treatment group and their control or placebo group. Lu et al. (2001) suggested that patient with various kinds of acute or chronic head and neck pain may experience pain relief from acupuncture treatment. In a study comparing effects on transcutaneous electric nerve stimulation (TENS), laser therapy, and acupuncture on chronic headache, Allais et al. (2003) showed that acupuncture was most effective as judged 3 months after the treatment even though both TENS and laser therapy also reduced the degree of headache. Melchart et al. (2003) concluded that acupuncture was more effective than a placebo injection in the early treatment of migraine. None of these studies did include a follow-up beyond few months. Thus, the long-lasting effect on headache seen in this study seems to be a new finding.

4.4. Blood variables

Serotonin is found in high concentrations in platelets, and during the treatment period the concentration of platelets rose for the subjects in the TG but not for those in the CG. This could be important, but without direct data on the serotonin concentration we see little reason to speculate more on this issue. However, future studies on treatments of pain should perhaps include measurements of serotonin in plasma and platelets.

4.5. Long-term effects

Our data suggest that the effect of adequate acupuncture treatment may last for at least 3 years. We are not aware of any data suggesting that a direct and immediate effect of acupuncture against chronic pain may per se last that long. However, it may be that the acupuncture treatment led to a pain relief that helped the patients break a vicious circle and thereby giving a long-lasting effect. A short-term effect may be scientifically interesting but of limited value from a clinical and medical point of view for persons with chronic pain. The long-term effect seen in our study is, therefore, important from a medical point of view.

The 3-year follow-up used in this study is also important for another reason. Six months after the last treatment some significant differences between the two groups had apparently disappeared. That could either mean that the effect of acupuncture treatment was only temporary or alternatively that random variations within quite small groups had masked a systematic effect. Speaking in favour of a long-lasting effect of acupuncture is our finding that 3 years after the treatments the subjects in the TG still experienced a pain relief while no such effect was seen for the CG. Most other studies have followed their subjects for few months or less (Coan et al., 1982; Karst et al., 2000; Sun et al., 2001; Zhu et al., 2002). Our data suggests that may be too short. In line with that Junnila (1987b) reported an effect that lasted for 2 years for 26% of the patients examined.

It could be argued that if the pain-reducing effect of acupuncture treatment disappeared within 6 months, as some of our measured parameters indicate, one would not expect

the beneficial effect to reappear 3 years after the treatments. We hypothesise that the responses seen may involve at least three components. There may be an immediate effect of the treatments that is followed by a long-term effect. In our study the long-term effect seemed nearly as strong as the immediate effect. There may finally be a significant placebo effect, at least for some parameters, that may last for at least 6 months but that disappears within 3 years. That proposed model may explain the time courses seen in our data. If this interpretation is correct, our study also suggests that a follow-up period of several years is required since the placebo effect may last for at least 6 months.

4.6. Design of the study

Each subject received altogether 10 treatments given as three treatments per week. At each treatment the subjects were given three different kinds of treatments applied at altogether 16 body acupoints and six ear acupoints, and each treatment lasted for a minimum of 45 min. The subjects carried out in addition ear acupressure several times each day. The treatment procedure was thus quite intensive, and that may have been important. For example, the effect of the treatments on the intensity of pain did not differ between the two groups before six treatments were completed.

Most studies on the effect of acupuncture treatment on chronic pain have not included a long-term follow-up. Some have followed their subjects from several weeks to 6 months. Our results suggest that the effect of acupuncture treatment may last for at least 3 years. We have in another study found that the effect of acupuncture for smoking reduction may last for at least 5 years (He et al., 2001). As pointed out above, such findings suggest that follow-ups of several years after the treatments may be important in research on possible effects of acupuncture.

Several other issues of the experimental design and the double blindness of this study have been addressed in the methods and are, therefore, not repeated here.

To sum up, adequate acupuncture treatment may reduce chronic pain in the neck and shoulder as well as related headaches. The effect may last for at least 3 years.

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