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ORIGINAL REPORT

EFFECT OF MANUAL THERAPY AND STRETCHING ON NECK MUSCLE STRENGTH AND MOBILITY IN CHRONIC NECK PAIN

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Objective: **To study the effect of manual therapy and stretching on neck function in women with chronic neck pain.**
Methods: **A total of 125 women were randomized into 2 groups. Group 1 received manual therapy twice a week for 4 weeks followed by stretching exercises. Group 2 performed stretching 5 times a week for 4 weeks followed by manual therapy. Neck function was assessed by isometric neck strength and mobility measurements, and spontaneous neck pain during the past week and strain-evoked pain during the neck strength trials using a visual analogue scale.**
Results: **Both neck muscle strength (11–14%) and mobility (7–15%) improved similarly in both groups, with the exception of greater passive flexion-extension mobility ($p = 0.019$) in group 1 at week 4. Pain during the neck strength trials decreased from the baseline to week 4 by 26–35% and to week 12 by 39–61% similarly in both groups. Average neck pain during the past week decreased by 64% and 53% in groups 1 and 2, respectively, during the first 4 weeks, remaining rather stable thereafter. The decreases in neck pain during both the past week and strength trials showed association with the changes in neck strength results ($r = 0.20$–0.29).**
Conclusion: **Both manual therapy and stretching were effective short-term treatments for reducing both spontaneous and strain-evoked pain in patients with chronic neck pain. It is possible that the decrease in pain reduced inhibition of the motor system and in part improved neck function. However, the changes in neck muscle strength were minor, showing that these treatments alone are not effective in improving muscle strength.**

Key words: cervical pain, massage, mobilization, range of motion, strength testing.

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INTRODUCTION

Pain is an unpleasant sensation associated with actual or potential tissue damage (1). In conditions of chronic pain, the sensory processing of the affected body region may become abnormal, leading to detectable changes in the central information processing system, in the experience of pain and in motor control (2, 3). Pain may lead the individual to avoid work and/or exercise. The consequent decrease in muscle loading may then cause muscle weakness. In patients with chronic neck pain, reductions in neck strength of 20–50% have been reported (4–8). Lower strength levels have also been reported in patients with long-standing painful limb (9) or back problems (10–12). Even in the absence of pain a pathological condition may inhibit muscle activity and cause weakness and muscle wasting (13).

Neck pain reported during strength tests trials has correlated inversely with the results of these tests, showing an association between pain, and decreased force production (14). A low neck pain threshold may also, at least in part, explain the low neck strength values found for patients with chronic neck pain compared with healthy controls (7, 8, 15). The reason for the difference may be neural inhibition caused by pain felt during isometric test efforts or during joint and muscle movements when performing dynamic tests, neither of which types of activity evoke pain in healthy subjects. If neck pain is the main cause of reduced neck strength, the implications for therapy are that the focus should be on treating that pain.

Massage and mobilization are the most common therapies used in the treatment of chronic neck pain (16–20). These therapies have been shown to be effective short-term treatments if the objective is relief of pain, but no evidence has been found for their long-term effectiveness in the treatment of chronic neck pain (17, 18). However, in addition to reducing pain, active neck strengthening and stretching exercises have also improved neck function (21). As many earlier studies have combined active and passive therapies, insufficient evidence has been obtained thus far on the relative effectiveness of these types of therapies on neck function. Hence, the first aim of this study was to compare whether manual therapy or stretching would be more effective in increasing neck mobility and muscle strength in women with chronic neck pain. The second aim was to study the associations between neck function and spontaneous neck pain or strain-evoked neck pain.

METHODS

The major employers in the town of Jyväskylä (population ~80,000) were informed about the study. Applicants were then sent a postal

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questionnaire containing questions about their current health and neck symptoms to confirm their status regarding the inclusion and exclusion criteria. The inclusion criteria were: women, age 25–53 years, permanently employed, motivated for exercise and treatment, and neck pain lasting more than 6 months. The exclusion criteria were specific disorders of the cervical spine, such as disk prolapse, spinal stenosis, postoperative conditions, severe trauma, hypermobility, spasmodic torticollis, frequent migraine, peripheral nerve entrapment, fibromyalgia, shoulder diseases, inflammatory rheumatic diseases, severe psychiatric illness and other diseases that prevent physical loading, and pregnancy.

Participants

Out of 420 volunteers, 125 women fulfilled the inclusion criteria and were selected for the study on the basis of their questionnaire answers, medical history and a study-related clinical examination carried out by an experienced physician (JY). They were randomized pair-wise into 2 groups (Fig. 1). Group 1 had manual therapy twice a week for 4 weeks and group 2 performed neck stretching exercises 5 times a week at home. After 4 weeks the therapies in the groups were changed. Both groups were followed up at weeks 4 and 12. The study was approved by the ethics committee of Jyväskylä Central Hospital, Finland. All the participants gave their written consent before entering the study.

Treatment programmes

Manual therapy consisted of 3 components: (*i*) a 10-min session of low-velocity osteopathic-type mobilization of the cervical joints based on 8 osteopathic-type mobilization techniques with no manipulation, i.e. high-velocity thrusts with low-amplitude: translation upwards, translation sideways, side bending, rotation and side bending in the same direction, rotation and side bending in the opposite direction, rotation with small range of motion (ROM), and mobilization of the upper cervical joints and the jaw joint; (*ii*) traditional massage for 15 minutes; and (*iii*) passive stretching for 5 minutes applied to the scalene, upper part of the trapezius, pectoralis minor muscles and interspinous muscles and ligamentum nuchae. A detailed description of the manual therapy techniques used has been published previously (22).

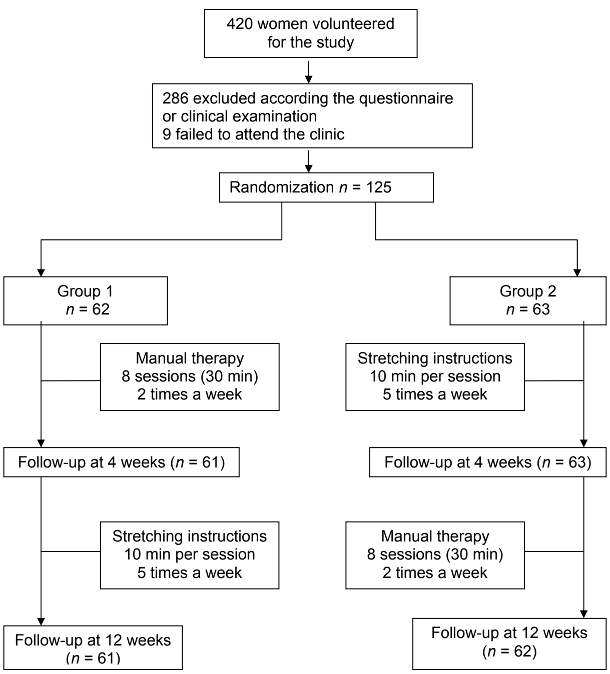

Fig. 1. Patient flow during the study (one patient from each group was lost to follow-up for personal reasons).

Stretching techniques were performed in the following order: towards lateral flexion (upper part of trapezius), ipsilateral flexion and rotation (scalene) and towards flexion (extensor muscles) each for 30 sec and repeated 2–3 times. Finally, a neck straightening exercise was performed by retruding the head (suboccipital muscles) 5 times for 3–5 sec. Each patient was individually advised how to perform the stretching exercises and information was also given in writing. Patients were instructed to perform the exercises 5 times a week. A single counselling session lasted about 10 minutes.

Experimental procedure

An isometric neck strength testing machine (Kuntoväline Ltd, Helsinki, Finland) was used to test various parameters of neck strength. Rotation forces were measured first, followed by flexion and extension forces. The methodology followed the standard testing procedure described previously in the reliability study (23). The subjects made at least 3 maximal efforts in all directions after warm-up trials. If the third result was more than 5% higher than either of the previous 2, extra trials were performed until the improvement in strength remained under 5%. The best result was used in the final analysis. Pain felt during the neck strength trials in the different directions was assessed by a visual analogue scale (VAS) (24). In addition, information on spontaneous neck pain unrelated to patient action or other stimuli was collected separately.

A 3-dimensional motion-testing device (Keno, Kuntoväline Ltd, Helsinki) was used to measure passive cervical ROM (25). The subject was seated with the head and trunk held erect. Measurements were always conducted in the same order; flexion, extension and rotation. All the tests were performed in the department of physical medicine and rehabilitation of the central hospital by an experienced physiotherapist blinded to the group to which the patient had been assigned. To ensure that the tester remained blinded to the treatments the latter were performed in the massage therapy training centre.

Statistics

The results were expressed as means with standard deviations (SD) or with a 95% confidence interval (95% CI). The normality of variables was evaluated by the Shapiro-Wilk statistic. We analysed the continuous outcome variables by using a covariance model (ANCOVA) with baseline values as covariates. The α-level was set at 0.05 for all tests. Correlation coefficients were calculated by the Spearman method.

RESULTS

No significant differences were observed between the groups in either the anthropometric or clinical data (Table 1). Neck muscle strength was on the same level in both groups at the baseline. Neck muscle strength showed a similar improvement of 11–14% in both groups at the 4-week follow-up (Table II). No further improvement occurred from weeks 4 to 12 in either group. At the baseline the ratio between flexion and

Table I. *Baseline data on the subjects*

Demographics	Group 1 (*n* = 62) Mean (SD)	Group 2 (*n* = 63) Mean (SD)
Age, years	42 (9)	43 (8)
Height, cm	165 (5)	166 (5)
Weight, kg	69 (13)	70 (13)
Body mass index, kg/cm^2	25 (5)	25 (4)
Duration of neck pain, years	3.8 (3.8)	3.0 (3.0)

SD: standard deviation.

Table II. *Muscle strength and neck pain during the follow-up. Group 1 started with manual therapy and continued with self-administered stretching after 4 weeks. Group 2 had the same therapies in reverse order*

	Baseline		Change from baseline to 4 weeks			Change from baseline to 12 weeks		
	Group 1 Mean (SD)	Group 2 Mean (SD)	Group 1 Mean (95% CI)	Group 2 Mean (95% CI)	Difference between the groups†	Group 1 Mean (95% I)	Group 2 Mean (95% CI)	Difference between the groups†
Neck strength								
Flexion N	71.6 (20.6)	69.4 (21.9)	8.3 (5.0–11.5)	9.9 (6.2–13.6)	0.61	10.1 (5.6–14.5)	9.2 (5.6–12.7)	0.75
Extension N	164.2 (45.9)	157.1 (48.4)	17.9 (8.9–26.9)	16.8 (7.8–25.8)	0.43	16.3 (7.9–24.7)	25.7 (16.9–34.9)	0.77
*Strain-evoked neck pain (VAS)**								
Flexion	27 (26)	30 (30)	–9 (–15 to –3)	–9 (–15 to –2)	0.59	–15 (–21 to –9)	–18 (–25 to –11)	0.46
Extension	16 (21)	18 (20)	–6 (–11 to –1)	–5 (–11 to –5)	0.43	–6 (–12 to –1)	–11 (–16 to –5)	0.25
*Spontaneous pain (VAS)**	50 (22)	49 (19)	–26 (–33 to –20)	–19 (–27 to –12)	0.06	–19 (–27 to –12)	–19 (–25 to –13)	0.91

*Visual analogue scale (0–100 mm).
†Analysis of covariance (ANCOVA) baseline values as covariate.
CI: confidence interval; SD: standard deviation.

extension strength was 0.5 in both groups with no significant change at either of the follow-ups. The change in neck extension strength was associated with the baseline strength value ($r = 0.44$, $p < 0.001$).

The neck pain levels evoked during the strength test trials were comparable between the groups at the baseline (Table II). Strain-evoked neck pain from the baseline to week 4 decreased by 26–35% and from baseline to week 12 by 39–61% in both groups. Strain-evoked neck pain had an inverse correlation with both neck flexion ($r = –0.28$; $p = 0.002$) and extension strength ($r = –0.29$; $p = 0.001$) at the 12-week follow-up.

There were no between-group differences in neck mobility at baseline (Table III). Both groups showed comparable changes (7–15%) in mobility except in passive mobility towards flexion-extension, which was better in group 1 at week 4 ($p = 0.019$). Thereafter the changes in mobility were minor and non-significant in either group. Furthermore, the changes in ROM were inversely associated with the corresponding baseline ROM values (flexion $r = –0.61$, extension $r = –0.61$, rotation $r = –0.35$, in all $p < 0.001$).

Spontaneous neck pain during the past week did not differ between the groups at baseline (Table II). Pain decreased by 64% in group 1 and by 53% ($p < 0.001$) in group 2 during the first 4 weeks, stabilizing thereafter. The change in spontaneous neck pain was associated with the changes in neck flexion ($r = 0.20$; $p = 0.023$) and extension ($r = 0.27$; $p = 0.002$) strength, and with the change in rotation mobility ($r = 0.23$; $p = 0.009$).

All the patients who completed the study (one patient from each group was lost to follow-up for personal reasons) received 8 manual therapy sessions, as planned. Furthermore, according to the training diaries, mean (SD) stretching frequency was 5 (1) times a week in group 2. For group 1, which received manual therapy first, this data is not available.

DISCUSSION

Neck muscle strength increased slightly during the first 4 weeks in both the manual therapy and stretching groups. After the change-over in therapies at week 4 no further changes took

Table III. *Cervical range of motion (ROM) at the baseline and changes after the intervention. Group 1 started with manual therapy and continued with self-administered stretching after 4 weeks. Group 2 had the same therapies in reverse order*

	Baseline		Change from baseline to 4 weeks			Change from baseline to 12 weeks		
	Group 1 Mean (SD)	Group 2 Mean (SD)	Group 1 Mean (95% CI)	Group 2 Mean (95% CI)	Difference between the groups†	Group 1 Mean (95% CI)	Group 2 Mean (95% CI)	Difference between the groups†
Active ROM, degrees								
Flexion – extension	123 (22)	125 (18)	14 (9–18)	8 (4–11)	0.072	12 (8–16)	13 (8–17)	0.95
Lateral flexion	68 (15)	70 (16)	12 (9–14)	8 (6–11)	0.11	11 (9–14)	11 (8–14)	0.86
Rotation	138 (19)	141 (17)	10 (6–14)	9 (6–13)	0.85	4 (1–8)	10 (6–14)	0.055
Passive ROM, degrees								
Flexion – extension	139 (23)	141 (18)	15 (11–19)	8 (5–12)	0.019	12 (8–16)	11 (7–15)	0.86
Lateral flexion*	78 (16)	79 (17)	12 (9–14)	8 (6–11)	0.080	11 (9–13)	11 (8–13)	0.78
Rotation*	161 (20)	164 (19)	14 (10–18)	12 (8–16)	0.49	10 (6–14)	16 (12–20)	0.057

†Analysis of covariance (ANCOVA) baseline values as covariate.
*The results are expressed as the sum of the right and left sides.
CI: confidence interval; SD: standard deviation.

place in either group up to the 12-week follow-up. Neck pain experienced during the past week decreased considerably in both groups during the first 4 weeks, after which it levelled out. The decrease in neck pain showed a small association with the increase in neck muscle strength. In earlier studies muscle pain has been reported to affect motor control, possibly leading to functional deficits (22, 27, 28). In chronic neck pain the changes have included altered motor control of the upper trapezius muscle and greater activation of the accessory neck muscles. Moreover, there has been a delay in the activation of the neck muscles and a deficit in the automatic feed-forward control of the cervical spine, leaving the neck vulnerable to cumulative microtrauma and pain. Owing to low-level muscle contraction, pain may also change the excitability of the motor pathway and sensory system, as well as reduce capillary flow and intracellular oxygen concentration (26, 27–29).

It was assumed that pain-relieving therapy would improve neck function, as several studies have found strength increases following passive treatments. Levoska et al. (30) found that heat, massage and stretching 3 times a week for 5 weeks increased maximal isometric neck strength by 14% in lateral flexion and 17% in extension, and the occurrence of neck pain decreased significantly. Jordan et al. (31) reported that chiropractic manipulation, massage and manual traction therapy performed twice a week for 6 weeks led to increases of 15% in isometric neck flexion and 24% in neck extension strength. In their study, neck pain experienced during the past week decreased by about 50%. However, in addition to passive therapies, their patients were instructed to perform active exercises for the neck and shoulder muscles as well as stretching, which may partly explain the results (31). Ylinen et al. (21) found an increase of 10% in neck flexion and rotation and 7% in neck extension strength with a 28% decrease in neck pain after 12 months in women with chronic neck pain who were performing stretching exercises twice-weekly. Recently, Chiu et al. (32) found an increase in strength of 15% in flexion and 20% in extension after infrared radiation treatment twice weekly for 6 weeks in patients with chronic neck pain, while neck pain was reduced by 12%.

The reported increases in strength measured after passive therapies have, however, only been slight. Small, though statistically significant, improvements may be less the result of the treatment applied and rather that of spontaneous pain, biological variation, measurement error and learning effect due to repeated testing. Levoska et al. (30) found an increase of 4% in lateral flexion and 10% in extension in healthy subjects when the measurements were performed 2 months apart. Ylinen et al. (24) reported mean improvements in extension, flexion and rotation strength of 6–8% measured 2 days apart in healthy subjects and of 3–13% in women with chronic neck pain on successive days. In that study the measurements were performed with the same device and a similar testing protocol as in the present study where the improvements were only a few percentage points greater. To be meaningful, the increases in neck muscle strength should be much greater than the increases attributable to passive therapies or repeated testing.

In the present study the improvements in active and passive neck mobility were marginal and mainly occurred during the first 4-week period in both groups. The initial ROMs of the neck in all directions were very similar to the normative values given in earlier studies (33, 34) and thus large increases could not be expected. Earlier studies have reported similar findings. Ylinen et al. (21) showed similar increases in passive neck mobility after 12 months' stretching, while in the neck strength training group in the same study the improvements were greater, especially towards lateral flexion (22%). Jordan et al. (31) reported only marginal and statistically non-significant improvements (~6%) in active extension after either passive therapies or intensive training. After 5 therapy sessions over a period of 3 weeks, Irnich et al. (35) reported better effects on pain and active neck mobility (the degree of change was not reported) by acupuncture than by conventional massage; however the improvements had disappeared at the 3 month-follow-up. Thus, neck mobility can be improved by neck training although some of the improvement in neck function may be attributable to reduced neck pain.

Both manual therapy and stretching, which were used in the present study, were equally effective in decreasing neck pain in the short term. Earlier studies have not found evidence for the long-term effectiveness of passive physical therapies in the treatment of chronic neck pain (21). The reason may be that passive therapies do not increase tolerance to strain and thus do not induce long-lasting increases in neck muscle strength and endurance. Although neck pain may diminish with therapy, it has been shown to return soon after the end of the intervention (30, 35). Thus, it seems to be important that to achieve long-term results, passive therapies are not used exclusively to treat chronic neck pain but are accompanied by active neck muscle training.

A limitation of this study is that the patients investigated were local residents and volunteered their participation in the study. Thus, they are suggested to represent well patients attending a primary healthcare centre, but the study group may also include persons who would not normally actively seek help for neck pain. We knew that all of the patients had chronic neck pain. However, as impaired neck function was not as an inclusion criterion, in some of the subjects neck function was normal even at baseline. This will have affected the results somewhat as the changes in neck extension strength and ROMs were set against baseline values. Another limitation is that data on stretching frequency was not collected after the first 4 weeks. Group 2, which had excellent short-time stretching adherence, reported considerable relief from symptoms. Unfortunately we do not have exact data on how group 1 was motivated to continue stretching exercises after 4 weeks of manual therapy and some alleviation of symptoms. However, it was emphasized to them that stretching could help them to maintain the results achieved by passive manual therapy. It is, of course, likely that information about the benign nature of pain may have removed some of the fear of pain.

In conclusion, manual therapy and stretching were equally as effective as short-term treatments for chronic neck pain. The significant decrease in pain reported by the patients in this study may have reduced inhibition of the motor system and thus, in part, improved neck function. However, the changes in neck muscle strength were minor, showing that these treatments alone are not effective methods of improving muscle strength.

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