Clinical Rehabilitation 2008; **22:** 592–600

Strength training and stretching versus stretching only in the treatment of patients with chronic neck pain: a randomized one-year follow-up study

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Received 3rd July 2007; returned for revisions 31st October 2007; revised manuscript accepted 21st November 2007.

Objective: To compare the effectiveness of a 12-month home-based combined strength training and stretching programme against stretching alone in the treatment of chronic neck pain.
Design: A randomized follow-up study.
Participants: One hundred and one patients with chronic non-specific neck pain were randomized in two groups.
Intervention: The strength training and stretching group was supported by 10 group training sessions and the stretching group was instructed to perform stretching exercises only as instructed in one group session.
Main outcome measurements: Neck pain, disability, neck muscle strength and mobility of cervical spine were measured before and after the intervention.
Results: No significant differences in improvement in neck pain and disability were found between the two training groups. Mean (SD) pain decreased from 64 (17) mm by 37 (95% confidence interval (CI) 44 to 30) mm in the strength training and stretching group, and from 60 (17) mm by 32 (39 to 25) mm in the stretching group. The improvements in disability were significant in both groups ($P<0.001$), while the changes in neck strength and mobility were minor. Training adherence decreased over time from the targeted three sessions a week, ending up at 1.1 (0.7) times a week for strength training and stretching group and 1.4 (0.8) times a week for stretching group.
Conclusions: No statistically significant differences in neck pain and disability were observed between the two home-based training regimens. Combined strength training and stretching or stretching only were probably as effective in achieving a long-term improvement although the training adherence was rather low most of the time.

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10.1177/0269215507087486

Introduction

The aetiology of chronic neck pain is multimodal.[1] Prevalence reportedly varies from 5% to 10%.[1–3] Although the complaint is not life-threatening, neck pain and stiffness may considerably affect patients' physical and social functioning. Neck pain is also often a cause of absence from work.[4] Further, patients with chronic neck pain use health care services twice as much as the general population.[5]

Systematic meta-analyses of randomized studies show that passive physical therapies are ineffective treatment of chronic neck pain in the long term.[6] The authors of the latest systematic review conclude that the role of active training in chronic neck disorders is unclear.[7] Various studies indicate that benefits are achieved initially by short training periods from two to three months, but that the gains disappear at long-term follow-ups.[8,9] However, a 12-month neck muscle strength training and stretching period was found to reduce neck pain more efficiently than the stretching exercises alone in women with chronic neck pain.[10] In that study rehabilitation began with a 12-day institutional training period during which the patients were instructed on a specific training programme and motivated for long-term home-based training. The aim of the present study was to evaluate whether long-term combined neck strength and stretching training would also show greater gains than stretching-only exercises, when the rehabilitation is implemented in outpatient clinics.

Participants and methods

The major occupational health care centres in the district were informed about the intervention study and asked to tell their clients about it. A screening questionnaire regarding current health and symptoms was mailed to 262 volunteers to confirm their status with regard the study criteria (Figure 1). The inclusion criteria were: age 25–53 years and duration of non-specific neck pain for more than six months. Exclusion criteria were specific disorders of the cervical spine, such as disk prolapse, spinal stenosis, post-operative conditions, severe trauma, hypermobility, spasmodic torticollis, frequent migraine, peripheral nerve entrapment, fibromyalgia, shoulder diseases, inflammatory rheumatic diseases, severe psychiatric illness or other conditions preventing physical loading, and pregnancy.

Of those who responded, 127 were excluded on the basis of the returned questionnaire (42 other on-going therapies in process, 42 neck pain less than 30 mm, 26 neck pain duration less than six months, 17 specific diseases, two older than 53 years). Of the 135 subjects who attended the study-related medical examination, 21 were excluded: 10 specific diseases, seven mild neck pain (<30 mm), three other on-going therapies in process, one moving out of the catchment area. In addition, 13 withdrew for personal reasons; busy at work, lack of time for exercise, expectations of receiving personal treatment, interest only in having a specialist examination. Finally, 101 patients were included in the study (Table 1). All the patients gave their written consent before entering the study.

The patients were assessed at the baseline and at 2 and 12 months. Baseline variables included date of birth, sex, weight, height, duration of symptoms, use of analgesics and smoking. Subjectively perceived neck pain was assessed on a visual analogue scale (VAS)[11] and disability by the modified Neck and Shoulder Pain and Disability Index[12] and the Neck Disability Index.[13] The participants were also asked to describe how the intervention affected their neck pain on a 6-point scale (1 indicating much more pain and 6 indicating complete relief from pain). In addition, visits to a physician, therapies received and number of days on sick leave during the follow-up were collected. Other outcome measures were maximal isometric neck strength[14] and neck range of motion (ROM).[15] Assessments were carried out by an experienced physiotherapist blinded to the patient's group assignment.

Randomization and treatments

Patients were stratified by gender and catchment area (four study centres) and then in the order of enrolment randomized pair-wise into either the strength training group or stretching group. A staff member, who was not otherwise

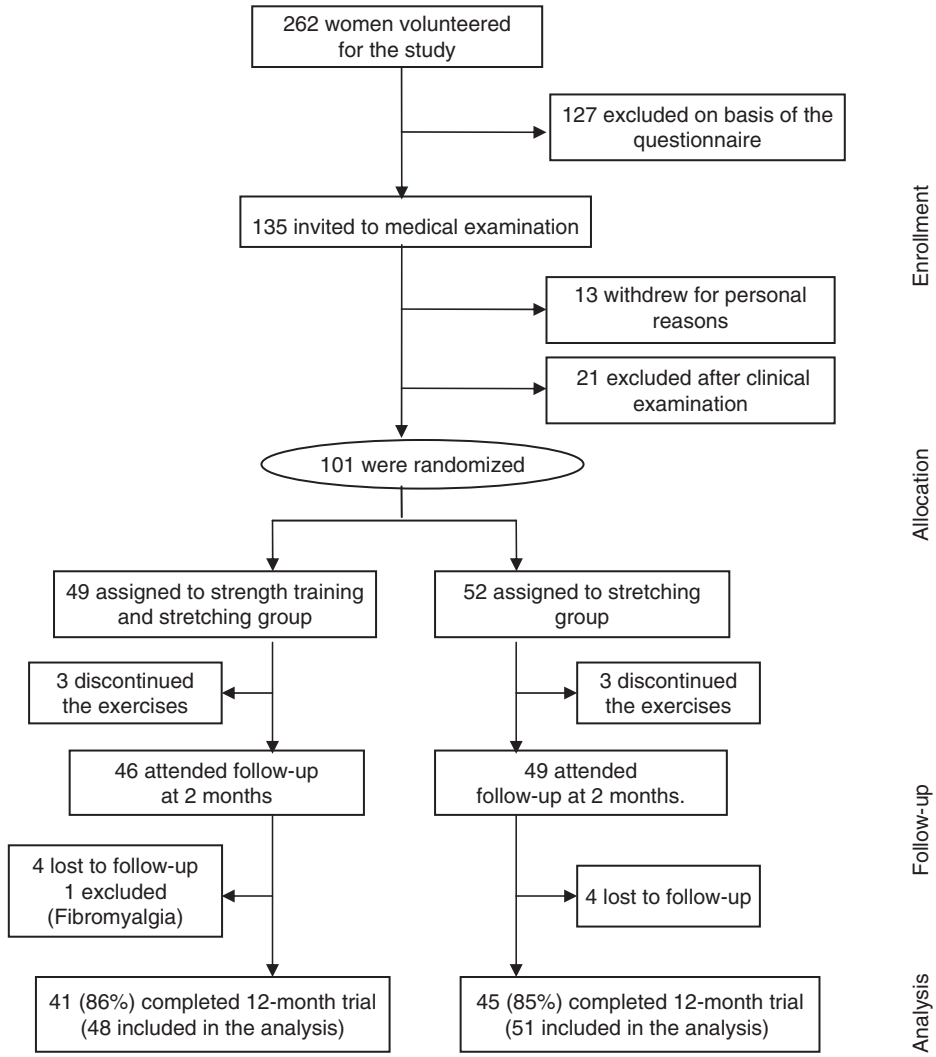

Figure 1 Participant flowchart.

involved in the study, did the randomization by flipping a coin.

The strength training programme was planned to improve in particular the stability, strength and posture of the neck. Patients used elastic rubber bands (Rehband, X-hard Solletuna, Sweden) attached to a leather strap worn around the head for the isometric neck exercises. During each session they performed three series of 15 repetitions for the neck flexor muscles; one series directly forwards and one series each obliquely towards the right and towards the left. For neck extensor muscles a single series of 15 repetitions was performed backwards.[10] The aim was to maintain the level of resistance at 80% of the patient's maximum isometric strength as recorded at the baseline and at the follow-up assessments. The load was checked with hand-held digital scales (Rapala, China) during the supervised group training sessions. The shoulders and upper

Table 1 Demographic and clinical data at the baseline

	Treatment groups	
	Stretching ($n=52$)	Strength training and stretching ($n=49$)
Demographic		
Females, no. (%)	44 (90)	47 (90)
Age, mean (SD), years	40 (10)	41 (9)
Height, mean (SD), cm	168 (6)	168 (7)
Weight, mean (SD), kg	68 (13)	71 (12)
Body mass index (kg/m^2), mean (SD)	24.3 (4.2)	25.1 (3.4)
Clinical		
Duration of neck pain, mean (SD), years	5.8 (5.7)	5.5 (5.2)
Short depression inventory score, mean (SD)	5 (4)	4 (3)
Smoking, no. (%)	4 (8)	5 (10)

extremities were trained with dumbbell shrugs, presses, curls, bent-over rows, flyers, and pullovers using each in a single series of 15-repetition with the highest load possible. The training programme also contained one series of a dynamic abdominal exercise against body weight while lying supine, a back exercise while lying prone and a leg exercise in which squats were performed until tiredness. The supervised strength training sessions were organized for 6–8 patients in each group, once a week for six weeks at the beginning of the training period and thereafter one session every second month.

Both groups were instructed on how to stretch the muscles in the region of the neck, shoulders and upper extremities. The stretching group had instructions in a single group session, while strength and endurance group had instructions during strength training group sessions.

All the patients were encouraged to perform the home training regimen three times a week and to keep a weekly exercise diary throughout the training year. The training instructions were given by specially trained physical therapists in four study centres. In addition all patients were given verbal instructions and written material on self-treatment, including the basic anatomy and function of the neck, benign nature of neck pain, use of heat/cold packs, good posture, ergonomics and the exercises to be performed in their group.

Sample size estimation and statistical analysis

The intended sample size was based on the primary hypothesis (neck pain). The target sample size of about 100 (50 in each group) was calculated to ensure at least 90% power to detect a 30% difference in change of neck pain between the treatment groups using two-side $\alpha = 0.05$. The estimation is based on that used in a previous study by Ylinen *et al.*[10]

Clinical outcome variables were analysed by the intention-to-treat principle with the last observation carried forward (LOCF). The results were expressed as means and standard deviations (SD). The most important descriptive values were expressed with a 95% confidence interval (95% CI). The normality of variables was evaluated by the Shapiro–Wilk statistic. Statistical comparison among the groups was done using the chi-square test, Fisher's exact test, and *t*-test or analysis of covariance (ANCOVA) taking baseline values as covariates. Effect size ('*d*') was calculated by using the method of Cohen[16] for paired samples (mean baseline scores minus mean follow-up scores, divided by the pooled standard deviation). Effect size of 0.20 was considered small, 0.50 was medium, and 0.80 was large. 95% CI values for the effect sizes were obtained by bias-corrected bootstrapping (5000 replications).

Results

The baseline demographic and clinical data between the groups were similar (Table 1). Only one patient, a woman in the strength and stretching group who was diagnosed with fibromyalgia at the beginning of the study, was excluded from the analyses. Three patients in both groups withdrew from the study after the first group meeting as they had expected more individual treatment. Four patients in both groups dropped out after the two-month check-up (in the strength training group one was involved in an accident and died, one moved out of the catchment area and two discontinued the exercise, while in the stretching group one moved, one was referred to orthopaedics owing to serious back pain, one discontinued for personal reasons and one when the symptoms disappeared). Finally, 86% in the strength training

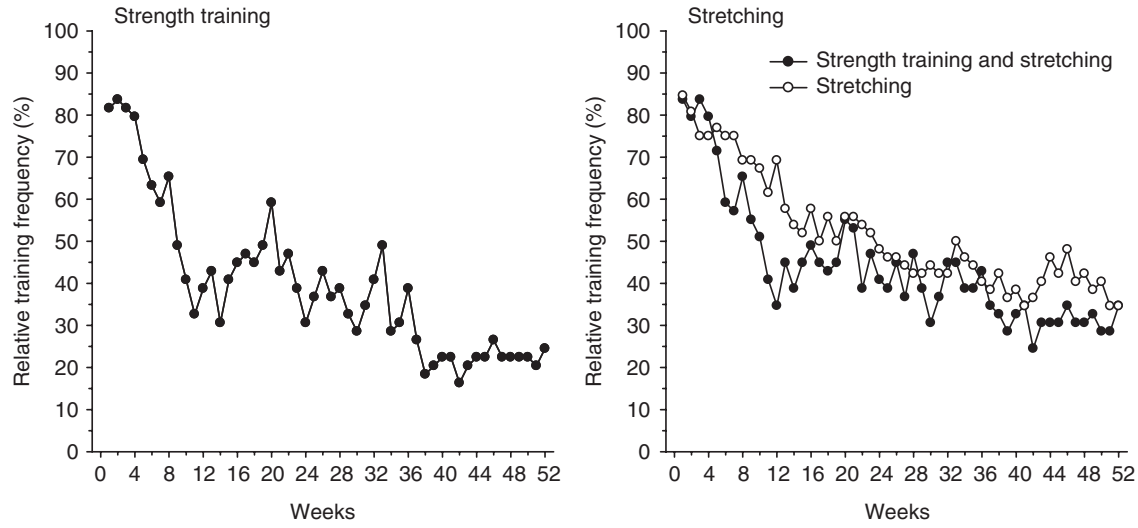

Figure 2 Relative training frequencies against target level (three times a week).

group and 85% in the stretching group attended the 12-month follow-up.

According to the exercise diaries the mean (SD) strength training frequency was 2.1 (0.6) times a week during the first two months and 1.1 (0.7) times a week during months 3–12 (Figure 2). The initial stretching frequency per week was 2.1 (0.7) in the strength training group and 2.4 (0.8) in the stretching group. The respective frequencies during months 3–12 were 1.3 (0.7) and 1.4 (0.8) times a week of the target 3 times/week. The adherence to group meetings was 8 (2) times out of 10 in the strength training group.

Neck pain decreased by 37 (−44 to −30) mm in the strength training and stretching group and by −32 (−39 to −25) mm in the stretching alone group (Table 2). Most of the decrease in pain occurred during the first two months in both groups (Figure 3). Considerable or complete relief from pain was obtained by 51% and 42% of the patients in the strength training and stretching or stretching alone groups, respectively, while 6% and 2% reported that pain had become worse due to training. Neck disability indices were significantly lower at the 12-month follow-up in both groups ($P<0.001$) with no statistically discernible difference in change between the two training groups (Table 2). Figure 4 shows magnitude of change in pain and disability over time. Isometric neck muscle strength and ROM towards flexion-extension and lateral flexion improved significantly in both groups (Table 2). Neck extension strength in the strength training and stretching group increased slightly more than in the stretching only group.

At the baseline the percentages of patients using analgesics for neck pain either on demand or on a daily basis were 45% and 41% in the strength training and 56% and 29% in the stretching group. The use of analgesics decreased considerably in both groups during the follow-up (Table 3). The percentage of patients visiting a physician or using other therapies owing to neck pain was similar between the groups during the 12-month follow-up.

Discussion

A considerable reduction in average pain and disability was observed after one-year follow-up period in all patients regardless whether they were randomized either to the combined strength training and stretching or stretching only groups, although the training adherence was rather low

Table 2 Disability and pain ratings at the baseline and changes at the follow-up

Variables	Baseline		Change at months12		Treatment effect[a]	*P*-value[b]
	Stretching Mean (SD)	Strength training and stretching Mean (SD)	Stretching Mean (95% CI)	Strength training and stretching Mean (95% CI)	Mean (95% CI)	
Neck pain, VAS, (0–100 mm)	60 (17)	64 (17)	−32 (−39 to −25)	−37 (−44 to −30)	−5 (−15 to 5)	0.53
NSPD (scale 0–100)	32 (14)	33 (14)	−14 (−19 to −10)	−14 (−19 to −9)	0 (−6 to 7)	0.76
Vernon (scale 0–100)	26 (10)	25 (10)	−8 (−11 to −5)	−8 (−11 to −5)	0 (−4 to 5)	0.79
Neck ROM (degrees)						
Flexion to extension	134 (23)	133 (20)	5 (1 to 10)	8 (3 to 12)	2 (−4 to 9)	0.53
Lateral flexion	81 (16)	76 (14)	5 (2 to 7)	9 (6 to 12)	4 (0 to 8)	0.53
Rotation	169 (60)	156 (17)	0 (−6 to 6)	3 (−1 to 8)	3 (−4 to 11)	0.097
Isometric neck strength (N):						
Flexion	75 (32)	80 (29)	9 (3 to 15)	9 (3 to 14)	0 (−7 to 7)	0.88
Extension	169 (60)	165 (59)	17 (8 to 26)	34 (22 to 56)	17 (3 to 32)	0.019

[a]Difference of the changes between groups.
[b]Analysis of covariance, baseline value as covariate.
NPSD, Neck and Shoulder Pain and Disability Index; Vernon, Vernon Neck Disability Index; ROM, range of motion.

Figure 3 Improvement of neck pain during the 12-month follow-up.

most of the time. The training was conducted in four different centres under the guidance of four physiotherapists, but no difference in the results between the centres was observed. Pain was reduced by over 50%, which may be regarded as clinically significant.[17] The results are consistent with the outcomes of other neck training studies.[9,18] The improvement in neck symptoms was comparable to that after 12-month home-based neck muscle strength or endurance training preceded by a two-weeks period of institutional rehabilitation.[10] On the other hand, the decrease of the neck pain was higher in the present stretching group than that of the earlier stretching

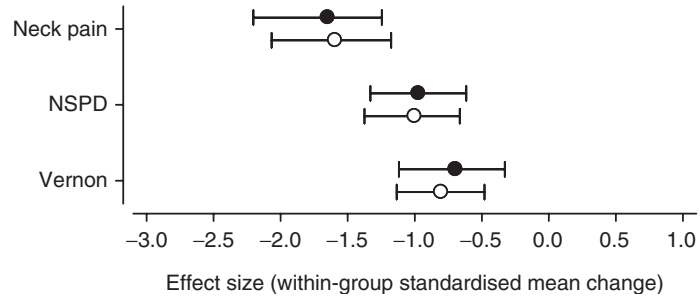

Figure 4 Magnitude of change (baseline minus 12 months) in neck pain, Neck and Shoulder Pain and Disability Index (NSPD) and in Vernon Neck Disability Index (Vernon). Solid dots show strength training and stretching group and open dots show stretching group.

Table 3 Number of patients seeking treatment due to neck pain during the 12-month follow-up

	Stretching ($n=45$)	Strength training and stretching ($n=41$)	*P*-value
Use of analgesics, *n* (%)			0.30
No	26 (58)	29 (71)	
On demand	14 (31)	10 (24)	
Daily	5 (11)	2 (5)	
Visits to physician, *n* (%)	5 (12)	8 (18)	0.59
Receiving therapies, *n* (%)	17 (38)	17 (41)	0.47
Sick leave due to neck pain, *n* (%)	3 (7)	5 (11)	0.32

Data received from only those participants who completed the follow-up.

controls (decrease of neck pain was 27% and that of the neck disability index was 14%).[10] However, the proportion of spontaneous recovery of the observed improvements in the present study setting cannot be estimated.

Although the duration of neck pain before the intervention and exercise programmes was similar in both studies, the recruitment of the patients was different. In the study by Ylinen *et al.*[10] doctors in occupational health care centres in southern and eastern Finland selected the patients for institutional rehabilitation. In the present study the subjects, who were local residents, volunteered themselves directly. Thus, they can be supposed to reasonably well represent patients visiting a primary health care but may also include individuals who would not normally bother actively to seek help for the neck pain.

The systematic reviews find only limited evidence for the benefit of active strengthening or range-of-motion exercises for neck disorders.[6,7] This may be due to the heterogeneity of the interventions as the length, amount and intensity of the training as well as the target (neck muscles, upper body, upper extremities) of the exercises vary considerably. In some studies significant improvements in neck function were reported after rather short rehabilitation periods of 5–11 weeks; however the results achieved usually disappear in a few months.[8,9,19] Viljanen *et al.*[20] found no increase in dynamic strength following dynamic muscle training of the shoulders and upper extremities for 12 months with mean training adherence of once a week. The same neck strengthening exercises as those used in the present study led to significant increases in neck muscle strength (69–110%), in which the participants continued to exercise almost twice a week for 12 months.[10] In the present study the mean strength training frequency decreased rapidly from about twice a week to once a week and the increase in neck

strength was about 10–20%. As increases of about 10% in neck muscle strength due to repeated testing have been observed, the actual training-induced increases in neck muscle strength remain rather small. Also in the present study the increases of neck mobility were marginal. In earlier short-term studies, the changes in the cervical range of motion were temporary and minor,[9,18] while with intensive strength training combined with stretching the improvements in neck mobility at 12-month follow-up were considerable.[10]

Decreased neck strength in patients with chronic neck pain may be related to pain-induced inhibition of the motor system as well as structural changes in neck muscles.[21–23] These reports suggest that the strengthening exercises should lead to morphological changes in the muscles. Although the elastic band applied as the training equipment in the present study is inexpensive and feasible to conduct, it has the disadvantage that controlling its resistance is difficult.[24] It is possible that the observed small increases in strength and ROM in strength training group cases were not entirely related to poor compliance, but partly due to our inability to transfer effective self-training outside the study centres. However, in the present study, despite the marginal nature of the increases in neck strength and mobility, a considerable reduction in pain and disability was reported, showing that even low load long-term training may be effective in the majority of subjects.

Rising health care costs have led to greater awareness of the importance of low-cost rehabilitation programmes. In our previous study[10] the direct costs of the initial 12-day institutional rehabilitation period were 1680 euros per patient while indoor rehabilitation requiring absence from work would increase the indirect costs of rehabilitation by about 827 euros per patient (estimated according to the mean wages of female office workers in Finland). In the present intervention the costs of 10 outpatient clinic group meetings for the strength training and stretching group were 270 euros per patient. The stretching group had a single group meeting at a cost of 27 euros per participant. Further, the group meetings were organized after working hours, causing practically no absence from work. Given the costs of clinical rehabilitation, a home exercise programme should be the first resort, only more severe cases being referred for institutional rehabilitation, which in Finland is mostly provided by the Social Insurance Institution.

Clinical messages

- Even with rather low training frequency, effects on chronic neck pain could be achieved by strength and stretching training or stretching alone, when the training was continued for 12 months.
- Home-based programmes supported with group meetings are low-cost and feasible.
- Self-management of chronic neck pain should be encouraged together with brief interventions.

Competing interests

There is no competing interest.

Funding source

Medical Research Foundation from Jyväskylä Central Hospital.

Acknowledgements

We thank the physiotherapists at the four study centres (health care centres of Jyväskylä, Jämsä and Keuruu, and Jyväskylä Central Hospital) for their contribution.

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