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Strength training in treatment of chronic neck pain

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Abstract

Background: Chronic non-specific neck pain is common in modern industrialized countries causing suffering, disability and considerable economical losses for individuals and society. Treatment is commonly advice for stretching and strength exercises in primary health care. However, if improvements are not satisfactory, patients may seek specialist care. The purpose of this study was to evaluate the effectiveness of multimodal rehabilitation in treatment of chronic neck pain.

Methods: The study group comprised of 56 patients with chronic neck pain, who participated rehabilitation for three weeks and one-week follow-up period after eight months at an inpatient rehabilitation facility. The aim was that patients continued exercising at home up to the follow-up. Neck pain, disability indices and neck muscle strength were evaluated at the baseline, after three weeks and at the 8-month follow-up.

Results: Decrease in neck pain and disability amounting 50 % was achieved during three weeks rehabilitation. However, the improvements in these primary outcomes had declined at the follow-up so that the changes were no more clinically significant. Also the results in neck strength tests diminished.

Conclusions: Rehabilitation was clinically effective only in the short-term, although some outcome changes were still significant at the long-term follow-up. It was compared to the best evidence practise, which revealed several common shortcomings in the rehabilitation process.

Keywords: Cervical pain; neck training; strength exercise; muscle stretching; manual therapy; strength test; multimodal rehabilitation.

Introduction

The prevalence of chronic neck pain has been reported to be from 6 to 19 % [1, 2]. Borghouts et al. [3] estimated that of the total costs 50% were derived from disability pensions, with direct medical costs accounting for 23%, which is about 1% of total expenses of the health care. Conventional treatment for chronic neck pain in the primary care setting is known to lead often to only small improvements in function and disability [4, 5]. This means that many patients are left with ongoing complaints. However, several studies which have shown that the rehabilitation using specific neck exercises to be effective treatment in chronic neck pain [6, 7]. Patients with chronic neck pain are first taken care by physiotherapy in primary health care. If neck pain still bothers considerably, patients in Finland may apply institutional rehabilitation and the cost of which is covered by National Social Insurance Institution. The aim of the present study was to evaluate the effects of three weeks rehabilitation courses and home training thereafter on neck strength and neck pain.

Materials and Methods

Participants

The study group comprised of 56 patients; 41 were women and 15 men aged from 29 to 54 years. The mean age was 45

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(SD 5.9) years for the women and 45 (SD 7.5) years for the men. They had received a referral to the rehabilitation due to chronic neck pain from community primary health care, private practitioner or the company physician. Patients were approved to neck rehabilitation courses by the Social Insurance Institution officers due to their primary symptoms in the neck. To meet criteria patients had to be currently working, in vocational training or unemployed. The cost of inpatient rehabilitation period is totally covered by national social insurance institution.

Rehabilitation

Institutional rehabilitation lasted 21 days with the 7 days follow-up after eight months at the Peurunka Rehabilitation Center. Patients carried out multimodal rehabilitation in groups consisting of ten subjects. The rehabilitation program consisted of the traditional neck school; muscle training, relaxation training, aerobic training, behavioural support to reduce fear of pain and improve exercise motivation and lectures and practical exercises in ergonomics. A psychologist and social worker instructed the training groups about demands at work, stress symptoms and possible factors leading to burn-out. The topics dealt with how one could avoid and manage such situations, personal risk factors and mental resources. These were discussed in the group meetings and both sessions lasted about one hour. The rehabilitation also included instruction in the basic anatomy of the neck, ergonomics and exercise physiology provided by medical doctor and physiotherapist. Each subject received three sessions of manual therapy per week during the three-week rehabilitation course. Manual therapy consisted mobilization of the cervical spine, massage and stretching of the neck and shoulder muscles to alleviate neck pain and to enable those with severe neck pain to perform active physical exercises. Hot packs were administered in the neck and shoulder area on the days between the sessions.

Outcomes

Primary outcome measures were pain and disability, which were assessed at the baseline, in the end of three weeks rehabilitation and finally after eight months at the beginning of follow-up course for five days. Secondary outcome measures were maximal isometric neck muscle strength and dynamic upper extremity strength, which were assessed at the same time points. Visual analogue scale (VAS) was used to assess average pain during the previous week [8, 9]. The theoretical range in VAS is from 0 to 100 mm (0 = no pain and 100 = maximal pain). Physical disability was determined by the Oswestry index, which consists of a series of 10 questions on activities relating to daily living [10]. All questions are assessed on a scale from 0 to 5 (0 = no impairment in function and 5 = most severe disability). The maximum disability score would be 50, but the result is multiplied by two so that maximum is 100 and it may thus be expressed in per cents. A strain gauge system (Newtest Ltd., Oulu,) was used to measure isometric neck flexor and extensor muscle strength in the straight standing position [11]. The strain gauge was attached on a leather strap surrounding the head. The upper body was supported above the lower border of the scapula and legs above the upper border of the patella by the adjustable, padded bars of the stand. From the upper bar, a wide strap surrounded the body. After three practice pulls for warm up, the patients then performed three maximal trials in each direction. The greatest strength measure was used in the final analysis in all studies. Adequate testing requires that the measurement device show real values. The calibration of isometric testing devices was checked with controlled standardized weights. The endurance strength of the upper extremities was measured by calculating the repetition maximum of the alternate dumbbell shoulder press, but so that the maximum number of repetitions was set at 50. The repetitive test was assessed by pressing up 5 kg by women and 10 kg by men in the standing position.

Exercise program

The aim of the three weeks rehabilitation courses was to teach and motivate patients to carry out their home training program. Nine group training sessions were conducted i.e every other weekday. Strength training instructions were given by a physiotherapist and the patients received printed information about the exercises to be practised at home. All patients performed specific isometric neck muscle training by using a black rubber band (Theraband, Hygiene Corp., Akron, Ohio, USA) to train the neck muscles in the sitting position. A single series of 15 repetitions was performed directly forward, obliquely toward right and left, and directly backward. Dynamic exercises were performed for the shoulders and upper extremities by doing dumbbell shrugs, presses, curls, bent-over rows, flyes, and pullovers. Individually adjusted single dumbbell was used for one set of each exercise with the highest load possible to perform 15 repetitions. The patients were instructed to perform progressive training by attempting to increase one or two repetitions in a series and, when the patients had attained 15 repetitions they were to increase the weight of the dumbbell by 1-2 kg again. Patients were instructed to perform stretching exercises for the neck, shoulder, upper back and limb muscles after strength training. Each exercise was instructed to be performed by holding the muscle stretch about 30 seconds and repeating 2-3 times with the same interval. All exercises were instructed to be performed three times a week.

Statistical Analyses

Analyses were performed using Statistical packages SPSS 11.0 (SPSS Inc., USA) and STATA 8.0 (Stata corp., USA). Means and standard deviations are given as demographic descriptive statistics. Statistical difference with regards to pain, disability indices and neck muscle strength at baseline and after rehabilitation was analysed using two-tailed paired t-test. Changes were studied with Hodges-Lehmann estimate of median difference with 95% CI.

Results

After the three weeks rehabilitation period, neck pain, headache and pain in upper extremities as well as Oswestry index reduced statistically significantly compared to the baseline values (**Table 1**). At the 8-month follow-up, all these changes had

reduced considerably, but they were still significant in women, but only the change in neck pain was significant in men. Four persons did not participate in the follow-up due to acute illness, being busy at work or for personal reasons. There was significant improvement in neck muscle strength after three weeks of rehabilitation. The maximal isometric neck strength improved in women by 47% in flexion and by 36% in extension compared to the baseline (**Table 2**). In men the strength increases were 35% and 31%, respectively. At the 8-month follow-up, the additional strength changes in women were only 8% and 7% and in men 10% and 1%, respectively. There was a significant improvement in alternate dumbbell shoulder press test results for both genders after three weeks rehabilitation period, but only a minimal additional change could be noted after the home training period.

***Table 1**: Pain measured on visual analogue scale (mm) and disability measured by Oswestry index at baseline and changes at the end of the three weeks rehabilitation and at the follow-up.*

Variables	Baseline	Change from baseline	Change from baseline
	Mean (SD)	to 3 weeks (95 % CI)	to 8 months (95 % CI)
Women (n = 41)			
Neck pain	74 (24)	-35 (-44 to -25)	-25 (-35 to -15)
Headache	43 (33)	-24 (-33 to -15)	-15 (-23 to -6)
Upper extremity pain	42 (35)	-28 (-37 to -20)	-11 (-21 to -1)
Oswestry index	20 (9)	-7 (-9 to -6)	-2 (-5 to 0)
Men (n = 15)			
Neck pain	77 (23)	-35 (-49 to -21)	-19 (-30 to -7)
Headache	61 (31)	-33 (-46 to -19)	-13 (-28 to 3)
Upper extremity pain	45 (41)	-25 (-42 to -7)	0 (-17 to 17)
Oswestry index	22 (12)	-6 (-10 to -1)	-3 (-8 to 1)

***Abbreviation:** CI: Confidence Interval.*

***Table 2**: Isometric neck strength and the number of repetitions in the alternate dumbbell shoulder? press test at the baseline and changes at the end of three weeks rehabilitation and at the follow-up.*

Variables	Baseline	Change/Increase from baseline	Change from baseline
	Mean (SD)	to 3 weeks (95 % CI)	to 8 months (95 % CI)
Women (n = 41)			
Flexion, N	68 (30)	31 (22 to 40)	39 (30 to 48)
Extension, N	140 (51)	51 (39 to 63)	64 (49 to 80)
Upper extremity, right‡	22 (11)	9 (5 to 12)	10 (6 to12)
Upper extremity, left‡	20 (11)	7 (4 to 10)	7 (4 to 10)
Men (n = 15)			
Flexion, N	121 (64)	42 (20 to 65)	59 (35 to 82)
Extension, N	202 (112)	73 (25 to 121)	63 (31 to 95)
Upper extremity, right*	16 (8)	6 (2 to 11)	8 (5 to 11)
Upper extremity, left*	14 (7)	6 (2 to 10)	7 (4 to 11)

***Abbreviation:** N: Newton; CI: confidence interval;*
**Women performed alternate dumbbell press test with 5 kg weights.*
**Men performed alternate dumbbell press test with 10 kg weights.*

Discussion

The present study showed that intensive rehabilitation decreased pain and disability both in women and men, which is according to previous studies, although studies have mainly concerned women [7]. Rehabilitation during three weeks period reduced neck pain over 50 % and thus the change was also clinically significant [13]. However, the results after that were poor. Strength tests were used as secondary outcome measures and these showed that home training had been performed ineffectively. The results suggest that only short-term results can be expected, if currently used methods are followed in rehabilitation.The greater amount of women in the ordinary institutional rehabilitation in study reflects an actual difference between genders as women more commonly experience chronic neck pain and also seek more often treatment for this complaint compared to men [1, 12]. The drop-out rate in the follow-up was small and presumably had no marked influence on the results. The drop-out rate in the institutional rehabilitation is known to be very low as it is free for patients and patients receive a daily allowance for a period of rehabilitation equivalent to a sickness allowance.

Forouzanfar et. al. found in sensitivity and specificity analyses that a cut-off point of 50% relative pain reduction and a 30 mm absolute pain reduction on the VAS have the highest likelihood that patients will report that their treatment has been successful. In the present study the change in neck pain met these criteria after intensive rehabilitation including both pain treatments and exercising. However, this was no longer the case at the 8-month follow-up, where neck pain had reduced by 34% in women and 25% in men compared to the baseline. Both headache and upper extremity pain are commonly associated with neck pain and there was also over 50% reduction in these measures after intensive rehabilitation, but the changes at the 8-month follow-up were small and statistically significant only in women. The effect of rehabilitation period of three weeks was thus transient, although emphasis had been paid to teach proper neck strength training techniques and to motivate patients to train at home in order to achieve long-term results.

The Oswestry index was originally planned to assess patients with back pain, but the questions do not directly refer to back pain. In the present study it was used to evaluate the total disability, because almost 90% of people with neck pain report pain also in other sites [14]. The Oswestry index has been used in studies evaluating different painful conditions and it has been shown to be a prognostic factor for perceived pain at the one-year follow-up in primary care patients with neck pain [15]. However, the sensitivity of the Oswestry index to detect a change due to treatment is low, as the minimal clinically important difference has been reported to be 10 units [16]. The change in the present study was below that level. Thus, we recommend the use of neck specific outcome measures instead.

The rapid increases in neck strength, which took place following intensive muscle training during the three-week period suggest that in everyday life the gravitational load and accelerator movements imposed by the head on these muscles are modest. Strength training studies have shown that the majority of strength increases take place already within the first two

months after the start of regular training. This is mainly due to the neural adaptation [17]. Women exhibited a relatively greater strength increase compared to men. This may be related to the fact that women had significantly lower baseline results compared to the men, as women produced forces, which were only 57% in flexion and 69% in extension of the corresponding values in men. Maximal isometric neck strength in women has been shown to be about 40% lower than in men in previous studies [18, 19]. Relative strength increases are commonly greater when the initial values are very low in untrained subjects [17]. The strength increase was percentually greater in flexor muscles compared to extensor muscles, which may be due to relative weakness of the flexors at the baseline. The response to exercise is greater in weak muscles and less extensive in trained muscles, but the more important reason is probably the difference between the training of flexor and extensor muscles as the ratio between the series for flexor and extensor muscles was 3:1.

Changes in neck strength at the 8-month follow-up were disappointing. The aim of the rehabilitation period was to teach the proper training technique and to motivate patients to exercise regularly at home. Unfortunately, the goal was clearly not achieved. The home training was not intensive enough and/or it was not performed sufficiently frequently. This is common failure that can be found in many intervention studies and has even lead to a conclusion that exercise is not effective treatment in chronic neck pain [20], while the real reason is the lack of proper exercising [7]. Excellent long-term results with regards to diminished neck pain and disability can be obtained with specific resistive exercises for neck muscles [21]. The load of isometric exercise with elastic band was checked to be 80% of maximal strength and it was reassessed at the follow-ups to make the training progressive. In the present study strength tests and exercises were similar, but there was no control of the resistance while teaching to perform exercises, which is one of major flaws in the neck exercise regime. The load in exercise depended thus entirely on the feeling of the patient after some encouragement by the physiotherapist. The increase in neck strength was almost nonexistent after home-training period and there was neither decrease in neck pain nor disability. On the contrary, the effects achieved in primary outcomes after the institutional training period started to vanish. Thus, it is essential to consider the dose-response in the selection of appropriate strength training program.

There is evidence, that untrained participants experience maximal gains by training each muscle group three times per week and trained individuals two times per week [22, 23]. However, in several neck exercise studies the training frequency has been much lower [7]. The patients received apparently similar training program in the present study. However, there were several differences with the rehabilitation regime, which may be important factors accounting for the contrasting results. Patients in the present study did not fill training diaries, which have an important role for reminding them of the importance of training and by incorporating exercising into the normal daily routine. It may be difficult to adhere to the plan, when the environment changes from rehabilitation institution back to that of the home and ordinary work. Moreover, there may not be proper training equipment at home. There were no intermediate follow-ups in the present study, while patients came to two and six intermediate follow-ups in study by Ylinen et. al. [21]. It is important that patients know that their training is being followed, which help motivate and maintain their compliance in home training. Support for training compliance at the intermediate follow-ups was not dependent entirely on the enthusiasm of physiotherapist, who was coaching the training group. Not only was the training frequency checked at every follow-ups, but also the neck strength tests were repeated revealing if the patients had been exercised with sufficient intensity. Patients received objective feedback about their progress at the follow-ups, which helped to maintain compliance for training.

Inevitably the key factor is to identify the correct training methods to produce real physiologic changes and to maintain compliance in the long-term, as mentioned above. It is essential that patients can feel themselves the improvement with training, as we cannot expect that good compliance will be maintained with ineffective training. In the rehabilitation more emphasis should be made on the fact that effects may be transient, if training is stopped and efforts should be made to ensure prolonged compliance to training. The limitation of the present study is that there was no randomised control group. However, there are already several studies which have shown specific neck exercises to be effective treatment in chronic neck pain. Thus the aim of this study was to evaluate the effectiveness of ordinary rehabilitation on neck muscle strength and neck pain [7].

Conclusions

Neck pain and the related disability were shown to decrease clinically significantly during three weeks institutional rehabilitation. However, the effect is not long-lasting in patients with chronic neck pain. This is suggested to be due to poor exercise compliance to home-based training. Thus, a lot of money is wasted on poor rehabilitation in which the current knowledge of effective exercise, motivation and follow-up methods has not been utilized. Moreover, it causes a lot of suffering as chronic pain condition continues in large number of patients.

Conflicts of Interest: The authors declare that there is no conflicts of interest and no source of funding.

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