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The Evidence for Exercise Therapy in Cervical Dysfunction

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경추장애에서 운동치료의 효과

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-국문 요약-

운동치료는 환자가 자기 자신의 치료에 직접 참여한다는 측면에서 다른 수동적인 치료보다 더 효과적이라고 생각된다. 이 논문의 목적은 관련문헌을 찾아내어 경추의 장애를 치료하는데 운동치료가 효과적이라는 것을 입증하는 증거를 찾아내기 위한 것이다.

경추 장애를 치료하기 위한 여러 가지 형태의 운동치료를 포함하는 연구를 찾아내기 위하여 7가지의 컴퓨터 문헌탐색을 수행하였고 출판된 전문을 아들레이드 내에서 구할 수 있는 것만 검토하였다. 문헌 평가도구를 사용하여 연구의 질을 평가하였고 그 결과를 표로 제시하였다.

111개의 문헌 중 34개가 포함 기준에 합당하였으며 이 중 18개의 임상실험연구를 수집하여 운동치료의 효과를 조사하기 위하여 그 질을 분석하였다. 임상실험연구의 전체적인 질은 "우수"였다.

도수치료와 운동치료를 병행하여 치료를 실시한 5개의 "탁월"한 질의 임상실험연구에서 근력의 증가와 통증의 감소를 보였다. 3개의 임상연구에서 근력강화운동이 증상의 경감에 효과가 있다고 하였다. 2개의 "우수"와 "중등도"의 질의 문헌에서 집단운동이 개별적인 물리치료만큼 효과가 있다고 하였다. 고유수용성 운동과 다른 형태의 운동 또한 경추의 장애의 치료에 효과가 있는 것으로 나타났다.

이 글의 소견은 경추 장애의 치료에 운동이 효과적이라는 이전의 연구결과를 지지한다. 또한 경추 장애의 치료에 다른 형태의 운동의 상대적인 효과를 확인하기 위한 훌륭한 질의 연구가 더 행해질 필요가 있다고 본다.

Background

Neck pain is commonly reported in the literature; Gross et al.(1999) reported that between 26 to 71% of the adult population will probably experience an episode of neck symptoms in their life time; similarly Cote et al.(1998) noted that 70 % of the adult individuals will be affected by a neck related problem during a lifetime.

Pain arising from the cervical spine is often difficult to diagnose clinically, often because of a multifactorial aetiology(Bogduk 1984), therefore the term cervical dysfunction is often used in clinical practice. Chronic forms of neck pain can require a lengthy treatment period and be costly for the individual in terms of suffering, time loss from work, social and leisure activities(Jordan et al. 1998). Such problems are also very costly for the society in terms of health care provision and compensation issues (Borghouts et al. 1999).

Exercise has been suggested to be effective in restoring function and strength of neck muscles which often appear to be weakened(Berg et al. 1994). Manual therapy treatment including joint mobilization and manipulation is also often used in the treatment of cervical dysfunction(Hoving et al. 2002). The author holds the belief that exercise is superior to passive manual therapy treatments mainly because of the involvement of the patient in their own recovery or treatment. In addition to that, exercise may have a psychological benefit in terms of increasing the patients' confidence in their ability to change or avoid symptoms, such as pain and instability related problems. The type of exercise can differ considerably and depend on the therapist's perception with regards to ef-

fective elements in an exercise program.

While many exercise regimes may be equally effect it is worthwhile looking at the effectiveness of specific exercises to determine the relative efficacy of exercise components, such knowledge will eventually assist the therapist in optimizing the effect of a given exercise program for neck pain, and supporting the decision making with evidence based knowledge.

The effectiveness of the different exercise types or programs is often debated in clinical practice; opinions in the literature appear to be divided into supporting certain forms of exercise therapy(Nelson et al. 1999; Kjellman & berg 2002) and the less supportive literature(Hoving 2002 Takala et al. 1994). The purpose of this review is to identify relevant literature and determine the evidence of using exercise therapy in treatment of cervical dysfunction.

Method

Inclusion criteria

Type of studies: comparative clinical trial.

The intervention type: must include specific cervical exercises such as: stretching / strengthening / endurance exercises, dynamic / static exercises, isometric / isotonic / isokinetic exercises, flexion / extension exercises, aerobic / aquatic / sling exercises as the treatment regimen.

Or any type of intervention used as an adjunct to exercise therapy.

Published in English.

Exclusion criteria

If the trial included patients with a specific spinal diagnosis, such as infection, tumour, osteoporosis, rheumatoid arthritis, fracture, or any inflammatory condition.

Exercise for the non-symptomatic subjects.

Comments, letters or expert's opinions.

Search strategy

Evidence for the effectiveness of exercise was sought from allied health, medical, nursing and sports science databases available at the Library of the University of South Australia.

The following data bases were searched during the period from 25th of June to 5th of July 2003: AMED, Cumulative Index of Allied Health Literature, Current Contents, Medline, Sports Discuss, PEDro and The Cochrane Library.

The terms "neck", "cervical" combined with "exercise", "exercise therapy" were

applied to search in the fields of journal titles, abstracts as key words in the electronic databases. Searches were not restricted by date, but limited to English language only. The topics which were similar to the key words but not relevant, such as femoral neck, were identified and excluded using "not" to screen.

Each type of article was then searched using the terms of CCT(nonrandomised controlled trial) or RCT(randomised controlled trials) or "random allocation and clinical trials or controlled trials.

All hits were screened manually for inclusion and exclusion criteria.

Lists of references of identified articles were searched as well to identify additional relevant studies.

Data synthesis

Determination of relevance to this review was done in the following order: title, abstract, and the method section given that the article was obtainable. Then relevant citations were filtered for duplicates.

Type of intervention: 1. Strengthening exercise. 2. Group exercise. 3. Proprioceptive exercise. 4. Other exercise. 5. Exercise combined with other intervention.

Determination of quality: PEDro scale was applied to determine the quality of comparative clinical trials. It has been developed by physiotherapist, for quality evaluation of physiotherapy trials and has been endorsed by the Cochrane Collaboration, the Australian Physiotherapy at the University of Sydney. A PEDro score was calculated by adding up all 'yes' answers from the 11 criteria(see appendix B).

Comparative clinical trials scoring less than 5/11 on the PEDro scale were excluded; the scores were then rated as follows:

Moderate quality: 5, 6

Good quality: 7, 8

Excellent quality: 9, 10, 11

Results

Search process

Although the same key words were used, the number of hits differed among the various databases. 111 articles were searched by key words from seven databases. Manual screening through the abstracts narrowed the number of references significantly(Table 1). Some relevant references were unavailable in Adelaide, and some were excluded as non-relevant after reading the whole articles.

Eighteen comparative trials were re-

Table 1. The search process

Databa	Number of hi	Number of manual screening	Final number of extracted
AMED	25	19	13
CINAHL	12	9	7
CURRENT CONTENTS FULL	36	16	10
MEDLINE	43	27	16
SPORTS DISCUS	5	5	3
COCHRANE LIBRARY	102	31	12
PEDro	12	6	3
TOTAL(after removal of duplicates)	111	34	18

viewed and accumulated with 7 average PEDro score, representing good quality(see evaluation of comparative clinical trials).

Recent progression of search

Time was not limited for a specific period when the search was conducted. But most of the studies identified in this search were published after 1990; this may indicate that active intervention for cervical disorder became interesting for researchers after 1990.

Among selected articles, the earliest study was McKinney(1989), and the most recent ones were Hoving et al.(2002), Jull et al.(2002), Allison et al.(2002), Evans et al.(2002), Kjellman & berg(2002). There were many trials that investigated the effectiveness of exercise in 1990's and early 2000's.

It appears, from reviewing the literature that many trials attempted to study the cost effective options for treatment of neck pain; this is evident by the choice of preventative programs or group based programs(Jordan et al. 1998; Randolov et al. 1998; Vasseljen et al. 1995; Takala et al. 1994; Kamwendo & Linton 1991). Most of the studies were designed for sedentary workers and group exercises were conducted in work places.

Recently many studies were conducted on exercise combined with manual therapy rather than exercise alone. Four studies in early 2000's(Jull et al. 2002; Allison et al. 2002; Evans et al. 2002; Bronfort et al. 2001) were conducted on exercise combined with manual therapy.

Table 2. PEDro scores of comparative clinical trial

	Criteria											
Author	A	B	C	D	E	F	G	H	U	J	K	T
Hoving et al.(2002)	y	y	y	y	y	n	n	y	y	y	y	T
AuthorJull et al.(2002)	Ay	By	Cy	Dy	En	Fn	Gy	Hy	Iy	Jy	Ky	9
Allison et al.(2002)	y	y	y	y	n	n	y	y	y	y	y	9
Bronfort et al.(2001)	y	y	y	y	n	n	y	y	y	y	y	9
Evans et al.(2002)	y	y	y	y	n	n	y	n	y	y	y	9
Fitz-Ritson(1995)	y	y	y	y	y	y	n	y	y	n	n	8
Taimela et al.(2000)	y	y	n	y	n	n	y	y	n	y	y	8
Friedrich et al.(1996)	y	y	n	y	n	n	y	y	n	y	y	7
Vasseljen et al.(1995)	y	y	n	y	n	n	n	y	y	y	y	7
McKinney(1989)	y	y	y	y	n	n	y	n	n	y	y	7
Kamwendo & Linton(1991)	y	y	n	y	n	n	n	y	y	y	y	7
Kjellman & berg(2002)	y	y	n	n	n	n	n	y	y	y	y	7
Jordan et al.(1998)	y	y	n	y	n	n	n	y	n	y	y	6
Takala et al.(1994)	n	y	n	y	n	n	y	y	n	y	y	6
Levoska & Keinnen-Kiukaanniemi(1993)	y	y	n	y	n	n	n	y	n	y	y	6
Randlov et al.(1998)	y	y	n	y	n	n	n	y	n	y	y	6
Waling et al.(2000)	y	y	n	y	n	n	n	n	n	y	y	6
Sderlund et al.(2000)	y	y	n	y	n	n	n	n	n	y	y	5
Mean												5
Standard deviation												7.06
												1.35

Key: A: Eligibility, B: Random allocation, C: Concealed allocation, D: Baseline comparability, E: Blind Subjects, F: Blind Therapists, G: Blind Assessors, H: Adequate follow-up, I: Intention-to-treat analysis, J: Between-group Comparisons, K: Point Estimates and Variability, T: Total score(out of 11), y: yes, n: no.

The results of quality analysis

Eighteen comparative clinical trials were included in this review.

PEDro scores of comparative clinical trial were distributed from 5 to 9(table 2). Four trials were of excellent quality, eight of good quality, six of moderate quality. The studies were classified according to the type of intervention; four strengthening exercise studies, five group exercise studies, two proprioceptive exercise studies, two other type of exercise studies, and

Table 3: Summary of strengthening exercise studies

Study	Participants	Interventions	Outcome measures	Reported results
Levoska & Keinnen Kiukaanni emi (1993)	169 subjects F. Age: 20-59 Worked mainly at personal computers. Neck & shoulder symptoms > 1/wk . Feeling of disturbance of neck-shoulde r symptoms M spasm & tenderness in neck & shoulder regions on palpation. G1: n=22 G2: n=22 G3: n=14	G1) Passive PT: Surface heat, massage, light stretching & physical Ex of neck & shoulder m. No home Ex. 3/wk for 15 times G2) Active PT: Stretching & dynamic m training of neck & shoulder regions. No surface heat or massage. Resistance provided via an omnikinetic training machine. Daily home Ex program. 60 min. 3/wk, for 15 times. G3) no Rx group	1) Maximal isometric neck m strength: a dynamometer for Cx E, LF 2) Maximal isometric grip test: dynamometer 3) Endurance forces of shoulder m: arm lifting & elbow F test with 5kg weight. 3) M tone in neck, shoulder & scapular areas: manual palpation. 4) Tender points in supraspinatus & scapula areas: tenderness 5) Tender points in trapezius & levator scapulae: a pressure threshold meter. 6) Neck & shoulder symptom: questionnaire standardized for this purpose.	Both active & passive PT relieved neck & shoulder symptoms effectively. Occurrence of symptoms was significantly lower after active than after passive PT. Both interventions resulted in a decrease of m tone and of tender palpated points in neck region. M tone decreased significantly only in passive group. Maximal isometric & endurance forces were improved by active training

Study	Participants	Interventions	Outcome measures	Reported results
Friedrich et al.(1996)	87 subjects(33F, 54M). Age: 20-70 Neck or low back pain by muscular factors > 6 wks. G1: n=47 G2: n=40	G1) Ex: instructed strengthening & stretching Ex individually by a physiotherapist in 8 Rx sessions & home Ex 20min 1/day with brochure describing the Ex to carry out. G2) Instruction only: given a brochure. Ex for 20min 1/day. All patients received one of three different brochures.	1) Pain: VAS. 2) M force: deep Cx flexor, rhomboideus, abdominal m, gluteus maximus & medius by a manual examination(0-5 scale). 3) M length: Upper trapezius, pectoralis major, iliopsoas, quadratus lumborum. & ischiocrurale m assessed(0-3 scale). 4) Performance of Ex: 3 grade quality scale.	The supervised group was better than the brochure group with regard to the quality of Ex performance, m statue, & pain relief. The quality of Ex performance was correlated both with m status & with pain relief.
Waling et al.(2000)	103 Subjects, F Age: 38.2.5.8 work-related neckshoulder pain. At least 1 yr history, decreased Cx ROM, & one	G1) Strength training: concentric resisted Ex including latissimus pull down, triceps press, shoulder F & scapular retraction. 3x10 reps. G2) Endurance training: arm cycling 3 min +	1) Pain: 3 VAS scales: One for pain in general, one for pain at worst, one for pain at present. 2) Pressure pain threshold: 3 trigger points in the trapezius m using a pressure algometer.	The Ex groups reported significantly larger pain reduction on both the VAS for pain at present & for pain at worst compared to the control group($P<0.05$). Pain thresholds were significantly

Study	Participants	Interventions	Outcome measures	Reported results
	or more trigger points tender in the trapezius m. G1: n=29 G2: n=28 G3: n=25 G4: n=21	arm Ex using rubber expanders 3 min. G3) Co-ordination training: Body awareness therapy. G4) Control group: study & discuss stress management for 2 h, 1/wk. No Ex. All Ex 3/wk for 10 wks	3) The effect of training: 5 graded categorical scale. 4) Satisfaction regarding effect of training: 5 graded categorical scale. 3 & 4 were performed with 3 Ex groups	reduced in the three trigger points in the total Ex groups compared to the controls($P<0.05$). No significant differences in comparisons between Ex groups.
Sderlund et al.(2000)	59 subjects (35F, 24M) Age: 34(18-60). acute whiplash injury. G1: n=29 G2: n=30	G1) Regular Ex: instructions for self-care & three Ex of looking over each shoulder in turn 3-5 times, moving the arms up & down 2-3 times, taking a deep breath & lifting the shoulders upward. > 3/day G2) Additional Ex: the same programme with an additional Ex, pressing the corners of an	1) Disability: Pain disability index. 2) ADL: Self-Efficacy Scale. 3) Cognitive or behavioural coping strategies: Coping strategies questionnaire. 4) Cervicothoracic posture: manual goniometer. 5) Cx rot ROM: Lic Rehab Care Svetsary goniometer 6 wks and 3- & 6-ms follow-ups	Significant positive effects for the merged group(G1 & G2) over time regarding self-efficacy, disability, & in pain intensity. No significant interaction effects or group differences in the self-rated variables. No significant interaction effects or group differences in physical measures.

Study	Participants	Interventions	Outcome measures	Reported results
		imaginative quadrangle under the head against the floor, 3 reps, > 3/day. Ex program carried for 6 wks.		

five exercise combined with other treatments. A summary of each type of exercise is illustrated in table 3, 4, 5 and 6. Distribution of each type of exercise in the comparative clinical trial is shown in Figure 1.

Table 4. Summary of group exercise studies

Study	Participants	Interventions	Outcome measures	Reported results
Jordan et al.(1998)	119 Subjects, (88F, 31M) Age: 20-60 Neck pain =3 ms, non-radicular extremity pain. G1: n = 40 G2: n = 39	G1) Intensive Ex: stationary bicycling 5-6 min, neck stretching 10 min, intensive training of neck m using device(Neck Ex unit, Follo, Norway), 30% of maximal power, 12 repetitions/1 set, 1 set for F, 3 sets for E, LF. Bicycle 5-6 min for cool-down + home training of	1) Patient's perceived effect & blinded physician's global assessment 2) Self-reporting disability scale involving 15 questions. 3) Self reported pain(11-point box scales). 4) Maximal isometric voluntary contraction in F & E & isometric	Patients in all groups showed decrease pain & increases in maximal isometric strength in E & isometric endurance. There was no significant difference between groups(p = 0.44) at Rx.

Study	Participants	Interventions	Outcome measures	Reported results
	G3: n = 40	five strengthening Ex for neck shoulder & 3 m stretching-Ex. 2/wk for 6 wks.	endurance of extensors of Cx spine in E.	
			Follow up at 4, 12 ms.	
		G2) Individual PT: passive elements: hot pack, massage, US, traction, mobilization, PNF, active elements: same home Ex given to G1. 2/wk for 6 wks.		
		G3) High-velocity, low amplitude spinal manip of Cx spine, traction, same home program. 2/wk for 6 wks.		
		All patients participated in a single "neck school" session		
Vasseljen et al. (1995)	24 subjects, F Office workers, Shoulder & neck pain. =3 pain rating scale in 0-6 pain scale system, =3 days continuously during last 2	G1) Individual PT: massage 5-10 min, strength & flexibility Ex 20-30 min, stretching 3-4 min, weight training 5-10 min, passive neck mobilisation, ergonomic advice, home Ex	1) Trapezius m activity: surface EMG. 2) Pain: VAS 3) Perceived general tension: VAS. 4) Trigger points: algometer & palpation. 5) Maximal shoulder elevation strength:	Pain & perceived general tension were significantly reduced in all groups, no difference between the two intervention groups. Upper trapezius m activity levels were mostly

Study	Participants	Interventions	Outcome measures	Reported results
	wks. G1: n = 12 G2: n = 12 G3: n = 9 additional group recruited from local PT, the patients with more severe symptoms, pain in upper trapezius region daily for the past 2 wks.	instruction. 2/wk total 10 Rxs G2) Group Ex: 30 min. Ex in the working place, 1.1 kg dumb-bell in both hand 10 times x 3, Shoulder & neck stretching 5 min. 3/wk for 6 wks. G3) Individual PT: PT for the shoulder & neck myalgia, average of 12 Rx times	only G3.	unchanged. Improvement were similar in all three Rx groups, but individual-based therapies were rated more beneficial on subjective measures. The improvement was maintained better in PT group than in group Ex group at 6 ms follow up.
Takala et al.(1994)	44 subjects F. Age 20-55 Sedentary worker. Frequent neck symptoms but no signs of Cx nerve root compression or tendonitis of shoulder. G1: n = 22 G2: n = 22	2 groups were matched according to work task, frequency of pain, & age. Cross over design: Rx group & the control group in the spring were reversed in the autumn. G1) Group gymnastics during working hours: trained whole body of 10 min walking, 10 min stretching & dynamic Ex, 5 min walking, 10	1) Pain & disability: VAS. 2) Pressure pain threshold(PPT): mean value of bilateral 4 m(upper trapezius, levator scapula, rhomboideus, infraspinatus)	No clear effects of the group gymnastics program. No significant reduction in pain occurred during the second intervention.

Study	Participants	Interventions	Outcome measures	Reported results
		min dynamic & coordination Ex, 10 min stretching & relaxation. 1/wk, for 10 wks. G2) Control group.		
Kamwendo & Linton(1991)	79 subjects, F. Age 39.4 10.7. Secretaries, symptoms >5 hours sitting/day, >30 hours/wk, No medical Rx. Pain in either neck or shoulder during the previous yr. G1: n = 25 G2: n = 28 G3: n = 26:	G1) Traditional neck school: Lecture about self-care. Ex of active & stretching for neck & shoulder m & relaxation. Demonstrate of proper use of equipment 1 hr, 4 sessions 2) Neck school + physiotherapist's observation in their working places. Written instructions for a pause gymnastics programme Written list of measures agreed upon. 1 hr, 4 sessions. Follow up contacts . 3) Control = no intervention. 4 wks of Rx. Follow-up: 6 ms.	1) Expectancy: 4 questions adapted from Borkovec & Nau 2) Ergonomical knowledge: 13 questions 3) Daily ratings of muscular fatigue & pain: VAS 4) Daily ratings workload: VAS 5) ROM: A Myrin goniometer 6) Headache & low back pain: VAS 7) Sick leave: number of days	No significant group differences was found. Neck schools appear to be of limited clinical value for prevention of neck & shoulder disorders.

Study	Participants	Interventions	Outcome measures	Reported results
Randlov et al.(1998)	77 25 drop out = 52 subjects, F Age: 18-65 neck/ shoulder pain(> 6ms), residence within short distance to the hospital. G1: n = 41 G2: n = 36	G1) Light training: hot pack 14 min, stationary bicycling & stretching 15 min, 6 Ex for the neck & shoulder, each 20 reps. G2) Intensive training: bicycling & stretching 10 min, 7 Ex for the neck & shoulder, each 20 reps, 5 rounds, resistance increased. Group sessions of 1.5 hours, 3/wk, total 36 sessions.	1) Pain: 11 point scale 2) Pain relieving medication: intake or not. 3) ADL: disability scale(demonstrated good reliability & validity) 4) Maximal voluntary isometric contraction of flexors & extensors of the Cx spine: strain-gauge equipment. Pain & ADL questionnaires were filled out at baseline, after 3ms & 12ms	Both groups improved significantly with regards to objective measurements, but no significant difference between groups could be demonstrated. Pain scores were only significantly improved in the intensive group at 12 ms follow-up

Table 5. Summary of proprioceptive exercise studies

Study	Participants	Interventions	Outcome measures	Reported results
Fitz-Ritson(1995)	30 subjects, 19M, 11F age 377yr. G1: n=15 G2: n=15 12 wks after a vehicle accident, Cx pain/soreness/stiffness with sports or activities.	G1) Chiropractic Rx + Ex: ROM, stretching, isometric-toning, isokinetic strengthening. G2) Chiropractic Rx + Phasic Ex: eye-head-neck-arm, eye-head-neck-trunk coordinated pattern 5/wk for 8 wks.	Pre & post Neck Pain: Disability Index	G1 improved by 7.4% which was significant($p<0.05$), G2 improved remarkably by 48.3% which was significant($p<0.001$). Minimal improvement of group 1 & the remarkable results of group 2
Taimela et al.(2000)	76 Patients (54F, 22M,) Age: 30-60 Non-specific recurrent or chronic neck pain >3 ms. G1: n=25 G2: n=25 G3: n=26	G1) Active group: cervicothoracic stabilization, relaxation, behavioural support to reduce anxiety & fear of pain, eye fixation Ex, seated wobble board training to improve postural control. 45-min sessions 2/wk for 12 wks. G2) Home group: one lecture & written information + practical training for home Ex. Small group practical training	1) Subjective pain & disability: A questionnaire inquired about above & included a VAS. 2) Cx mobility: ROM with a measurement helmet equipped with a goniometer. 3) Pressure pain threshold in the upper trapezius & levator scapula m: a mechanical force gauge. All the above were measured at	Subjective measurements differed significantly in favour of the active group($P < 0.01$ 0.03) that emphasized Ex. No significant differences were shown in objective measurements of Cx function among the three groups.

Study	Participants	Interventions	Outcome measures	Reported results
		Twice with a 1-wk interval G3) Control group: one lecture & written information about neck Ex	baseline, at 3 ms, & at 12 ms.	

Table 6. Summary of other exercise studies

Study	Participants	Interventions	Outcome measures	Reported results
McKinn-ey(1989)	247 77drop out=170 subjects (82 F, 88 M) within 48 hrs after sustaining a non-contract F-E sprain of neck in a shunting road traffic accident. G1: n=33 G2: n=71 G3: n=66	G1) Rest: general advice to mobilize after an initial rest period of 10-14 days. G2) PT: Hot & cold, pulsed short wave diathermy, hydrotherapy, traction & active & passive repetitive movements. 10 hrs PT over 6wks G3) Advice on self mobilization: verbal & reinforcing written instruction on correction of posture, use of analgesia & collar, use of heat sources & m relaxation, encouraged mobilizing Ex. Instruction session lasted 30 min.	1) Pain(VAS). 2) Recovery time. Monthly follow up, for 12 ms. Examined initially & monthly interval for 3ms, questionnaire after 2yrs	Recovery was significantly better in the patients given advice on mobilization Ex to do at home than in the other patients. The time to recovery was not different. The time of using a collar was shorter in the advice & PT groups. Early mobilization program improves long term outcome, reducing the incidence of persistent symptoms at 2yrs.
Kjellman & berg (2002)	77 subjects Age: 18-65	G1) General Ex: Ex of neck & shoulders intended to increase Cx	1) Pain intensity: VAS 2) Pain frequency: 5 point scale	Better outcome with the two active alternatives compared with the

Study	Participants	Interventions	Outcome measures	Reported results
	presenting with neck complaints G1: n=23 G2: n=28 G3: n=26	movement & the endurance & strength of Cx m through active movements G2) McKenzie Rx: physiotherapist follow the McKenzie protocol but choose the type of Ex, the number of Rx sessions & home Ex to suit the individual patients. Rx 8 wks. G3) Control group: ultrasound to the trapezius	3) Use of painkillers: 4 point scale 4) Function: sick leave, Neck Disability Index General health: 6 point scale, VAS 5) Psychosomatic & depressive symptom: Modified Somatic Questionnaire, Modified Zung Depression Index 6 & 12 ms follow-up	control group. McKenzie Rx was more favourable than general Ex & the control group, with a more rapid improvement in pain intensity during the first 3 wks. There were no differences between the three groups at 12 ms follow-up.

Table 7. Summary of exercise combined with other treatments studies

Study	Participants	Interventions	Outcome measures	Reported results
Jull et al. (2002)	200 subjects Age: 18-60 Cervicogenic headache, headache associated with neck pain & aggravated by neck postures or movement, at least one of the upper three Cx joint tenderness, headache frequency of at least 1/wk(>2ms) G1: n=51 G2: n=52 G3: n=49 G4: n=48	G1) Manual therapy: both low-velocity Cx joint mobilization or high-velocity manip techniques. G2) Ex therapy: Craniocervical F Ex in supine aimed totarget the deep neck flexor m & the longus capitus & colli, hold progressively increasing ranges of craniocervical F using feedback from an air-filled pressure sensor. Serratus anterior & lower trapezius were trained using inner range holding Ex. 2/day of those two Ex. Postural correction in sitting. Tightened m lengthening Ex. G3) Combined therapy: combination of manipulative & Ex therapy applied on	1) Headache frequency 2) Number of headache days, Neck pain & disability: Northwick Park Neck Pain Questionnaire. 1. Pain 2. Neck movement 3. Upper cervical joint tenderness 4. Craniocervical F m test 5. Photographic measure of posture Baseline, wk immediately after Rx(wk7), 3, 6, 12 ms after the intervention.	Manipulative therapy & specific Ex had significantly reduced headache frequency & intensity, & neck pain and effects were maintained. Combined therapies was 10 % better than the single therapy.

Study	Participants	Interventions	Outcome measures	Reported results
		the same day G4) Control: no physical therapy		
Allison et al.(2002)	30 subjects. (20 F, 10 M) Age: 18-75 cervicobrachial pain for greater than 3 ms G1: n=10 G2: n=10 G3: n=10	G1) NT group mobilizing the tissues surrounding the nerves. Cervical lateral glide, shoulder girdle oscillation, contract-relax techniques for the shoulder, home Ex of cervical spine side F & active shoulder movements. G2) AT group manual therapy Rx. G/H mobilization, thoracic mobilization, home Ex of shoulder mobilizing, stretching & strengthening. G3) Control group No PT Rx.	1) Pain: short-form McGill Pain Questionnaire(SF-MGP), VAS 2) Function: Northwick Park Questionnaire(NPQ). Tested at 4-wk intervals for the 8-wk intervention period	1) Short-form McGill pain questionnaire -a significant improvement for both groups. No significant differences between the groups. 2) Northwick Park questionnaire -a significant improvement for both groups. No statistical differences between groups. 3) Visual analogue scale - significant improvements in both Rx groups. Lower pain scores in the NT group significantly than the AT group at the end of the treatment period .
Hoving et al. (2002)	183 subject, Age: 18-70 Non specific neck pain, pain or stiffness in the	G1) Manual therapy: mobilization, coordination or stabilization techniques 45 min session 1/wk	Primary outcome measures 1) Perceived recovery: 6-point ordinal transition scale. 2) Spinal mobility,	Significant differences in pain intensity with manual therapy compared with continued care or physical therapy.

Study	Participants	Interventions	Outcome measures	Reported results
	neck(> 2wks), neck symptoms reproducible during physical examination. G1: n=60 G2: n=59 G3: n=64	for 6 wks G2) Physical therapy: active Ex therapy(active ex, postural, stretching, relaxation, functional ex.). Manual traction, stretch, massage, physical therapy methods(interferential current, heat) could precede the Ex therapy. 30 min session 2/wk for 6wks G3) Continued Care by general practitioner: Advice on prognosis, advice on psychosocial issues, advice on self-care(heat application, home ex), advice on ergonomics & encouragement to await further recovery.	palpation & pain: numeric 11 point scale 3) functional disability: Neck Disability Index(10 ADL on a scale of 0-5) Secondary outcome measures 1) Severity of the most important functional limitation: 11 point scale. 2) ROM of cervical spine: Cybex Electronic Digital Inclinometer 320 3) General Health: self-rated health index(scale 0-100) of the Euro Quality of Life scale.	Disability scores favoured manual therapy, but the differences among group were small. Manual therapy scored consistently better than other two interventions on most outcome measures. Physical therapy scored better than continued card on some outcome measures, but the differences were not statistically significant
Bronfort et al.(2001)	191 21 drop out=170 subjects, Age: 20-65	G1) Spinal manip & low-technology Ex: 15-min manip by a chiropractor, followed	Questionnaires: (1) Neck pain: 11 box scale. (2) Disability: Neck	No significant differences between groups in subjective measures except for

Study	Participants	Interventions	Outcome measures	Reported results
	Chronic mechanical neck pain persisted more than 12 wks. Completed Rx phase G1: n=58 G2: n=56 G3: n=62 Available at 1 yr follow up G1: n=58 G2: n=52 G3: n=60	by a 45-min supervised Ex including progressive strengthening Ex for the neck & upper body, preceded by a short aerobic warm up of upper body & light stretching. G2) MedX Ex : dynamic progressive Ex on MedX cervical E & rot machines. 20 reps of each Ex. One-on-one supervision by a physical therapist. Began with upper body strengthening, 15 20 min of aerobic Ex using a dual-action stationary bike. G3) Spinal Manip alone: 15 min chiropractic Rx as described in G1. 45 min detuned(sham) micro-current therapy. All patients attended	Disability Index. (3) Functional health status: SF-36D. (4) Rated improvement: 9 point ordinal scale. (5) Medication use: 5 point scale. (6) Satisfaction with care: 7 point scale. Neck performance: (1) Cervical Isometric m strength: maximal voluntary contraction for F, E, & rot measured by computerized load-cell transducer dynamometer. (2) Static endurance: in supine by elevating head just free of support with 60% maximal voluntary contraction. (3) Dynamic endurance : number of reps with 25% weight of the maximal voluntary contraction. (4) Cervical ROM: A6000 Spine	patient satisfaction where spinal manipulative therapy & Ex were superior to spinal manip. Manip with Ex group showed greater gains in all objective measures of strength, endurance, & ROM than the spinal manip group. The spinal manip with Ex group also demonstrated more improvement in F endurance & in F & rot strength than the MedX group. Ex group had better improvement in E strength & F-E ROM than manip group.

Study	Participants	Interventions	Outcome measures	Reported results
		20 one-hour visits during the 11 wk study period.	Motion Analyzer.	
Evans et al.(2002)	191 46 drop out=145 subjects 20-65 years of age. Chronic mechanical neck pain persisted more than 12 wk. G1: n=64 G2: n=63 G3: n=64	G1) Spinal manip & low-technology Ex: 15-min manip by a chiropractor, followed by a 45-min supervised Ex including progressive strengthening Exfor the neck & upper body, preceded by a short aerobic warm up of upper body & light stretching. G2) MedX Ex : dynamic progressive Ex on MedX Cx E & rot machines. 20 reps of each Ex. One-on-one supervision by a physical therapist. Began with upper body strengthening, 15 20 min of aerobic Ex using a dual-action stationary bike. G3) Spinal Manip alone: 15 min	Questionnaires: (1) Neck pain: 11 box scale. (2) Disability: Neck Disability Index. (3) Functional health status: SF-36D. (4) Rated improvement: 9 point ordinal scale. (5) Medication use: 5 point scale. (6) Satisfaction with care: 7 point scale.	A two years follow up of the study by Bronfort(2001) confirmed the results, favouring the Ex groups; The magnitude of change was also similar. Spinal manip combined with low-tech rehabilitative Ex superior to Med X rehabilitative Ex(P=0.02) & spinal manip alone(P<0.001). No significant group differences for neck disability, general health status, improvement, & OTC medication use.

Study	Participants	Interventions	Outcome measures	Reported results
		chiropractic Rx as described in G1. 45 min detuned(sham) micro-current therapy. All patients attended 20 one-hour visits during the 11 wk study period. 2 year follow up		

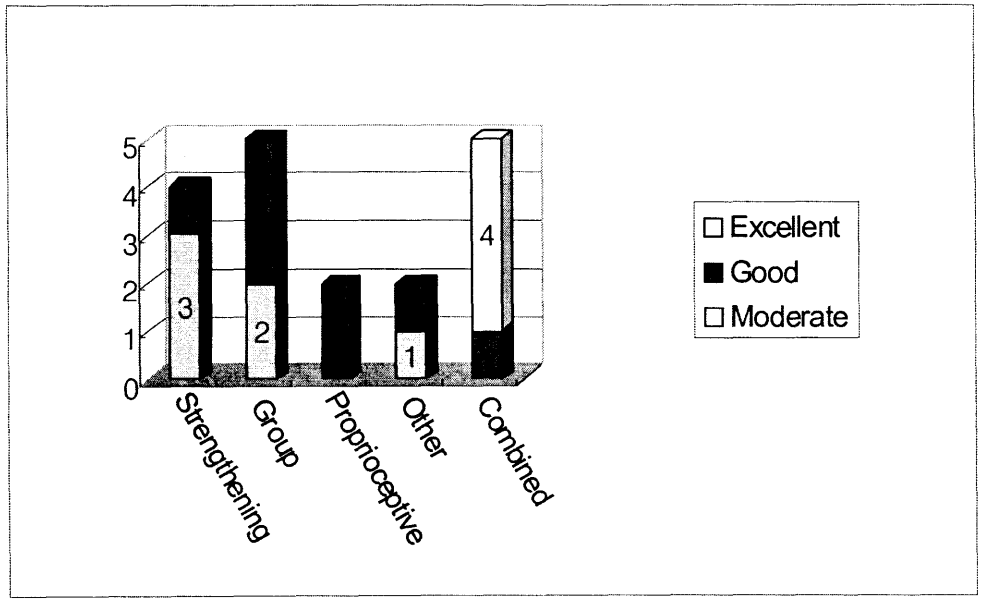

Figure 1 Distribution of each excise group in comparative clinical trials

Strengthening exercises

This category included four comparative clinical trials dealing with strengthening exercises(Sderlund et al. 2001; Waling et al. 2000; Friedrich et al. 1996; Levoska & Keinnen-Kiukaanniemi 1993).

The average PEDro score of the four comparative trials was 5.75 ranging from five to seven, representing moderate quality.

All studies, with the exception of the lowest scoring study(Sderlund et al. 2001), reported significant effects of their strengthening training programs. The study of Sderlund et al.(2001) did not find any advantage in adding isometric exercise to range of motion exercise.

Duration of training program varied in studies from 5 to 11 weeks. Frequency varied from three times a day to once a week.

Group exercises

Five comparative clinical trials(Jordan et al. 1998; Randolov et al. 1998; Vasseljen et al. 1995; Takala et al. 1994; Kamwendo & Linton 1991) were identified in relation to group exercise for mechanical neck disorders. The average PEDro score of the five trials was 6.6. All trials revealed no significant difference in group exercise compared with individual training.

Two trials investigated group exercise compared with individual physiotherapy (Jordan et al. 1996; Vasseljen et al. 1995) and reported significant improvement in all treatment groups but no significant difference between groups.

Kamwendo & Linton(1991) studied neck school which was not found to be effective. The main diverse opinion was that of Takala et al.(1994) who found group exercise to be ineffective in the long term. However, whole body exercise regime(Takal et al. 1994) was different to that of other studies that focused on the neck only, in addition to that, the whole body exercise was only applied for once a week while other studies applied exercises with higher frequencies.

Proprioceptive exercises

Two comparative clinical trials dealt with the interesting concept of proprioceptive exercises(Taimela et al. 2000; Fitz-Ritson 1995). Taimela et al. (2000) which scored 7 on PEDro score showed significant difference in the subjective outcome measures; Fitz-Ritson (1995) which scored 8 on PEDro scale revealed remarkable results.

Other exercise studies

Two comparative clinical trials (Kjellman & berg 2002; McKinney 1989)

were included in this category. The PEDro score of the two trials were 6 and 7, representing moderate and good quality respectively. McKinney(1989) was the largest study with 247 subjects, but with a very high dropout rate(32%).

Both trials revealed significant change in the intervention groups compared the control groups.

Combined exercise studies

There were five comparative clinical trials(Hoving et al. 2002; Jull et al. 2002; Allison et al. 2002; Evans et al. 2002; Bronfort et al. 2001) in this category. All comparative clinical trials scored 9 on the PEDro scale with exception of Evans et al.(2002) scoring 8 due to the high drop out rate(24%); all studies except Hoving et al.(2002) investigated the effect of manual therapy combined with exercise. Hoving et al.(2002) compared manual therapy to general physiotherapy including exercise.

Discussion

It is possible that the search strategy applied in this review could have been refined, thus resulting in identification of other relevant studies. However, the author believes that most relevant studies has been identified and processed in this review.

The discussion section has been organized by type of exercise in the following text:

Strengthening Exercises(Isometric/ Dynamic)

Three comparative clinical trials support the effect of strengthening exercise.

Two moderate quality comparative clinical trials(Levoska & Keinanen-Kjukaanniemi 1993; Waling et al. 2000) favoured active treatment; the first mentioned favoured strengthening exercise in comparison with passive treatment while the second mentioned found that strength, endurance, co-ordination exercises were equally superior to no treatment. A good quality comparative clinical trial in this category(Fredrich et al. 1996) favoured supervised exercise.

A moderate quality comparative clinical trial(Sderlund et al. 2001) found no benefit in adding isometric exercise to range of motion exercise.

Overall, the above mentioned studies do support the use of strengthening exercise as a treatment or a preventative measure. However the author could not differentiate the relative advantage of the different forms of exercise.

Group exercises

Group exercise was as effective as individual physiotherapy according to a good and a moderate quality comparative clinical trials(Jordan et al. 1996; Vasseljen et al. 1995). Both studies aimed at finding the effects of group exercise.

Jordan et al.(1998) compared intensive group exercise training, individual physiotherapy, and manipulation in a randomized study involving patients with chronic neck pain and found that all groups showed decrease pain and increase in maximal isometric strength in extension, and isometric endurance and these improvements were maintained at 12 month follow-up, with no differences between the groups. The home exercise which was given to all three groups might have increased the initial effects.

Vasseljen et al.(1995) divided office workers who suffered from neck pain in two groups a. group exercise b. individual physiotherapy and a third group was patients recruited from local physiotherapy clinics. Reduction in pain and perceived general tension was found in all groups; individually based outpatient physiotherapy and group exercise at the workplace was approximately equally effective. However, at six month follow up, the results favoured the individual physiotherapy group; these were also more satisfied with the treatment.

The result of these studies showed the possibility of well designed group exercise and home program may be substituted the individual physiotherapy for the cervical dysfunction.

There was no evidence that group exercise for the sedentary workers was effective. Two trials of moderate and good quality respectively(Takala et al. 1994; Kamwendo & Linton 1991) tried group exercise in the working place using no intervention control group.

Takala et al.(1994) applied group gymnastics for the sedentary worker during working hours and Kamwendo & Linton(1991) applied Neck school for the secretaries in their walking places. They could not find any significant group differences in those two studies. Takala et al.(1991) applied group gymnastics of the whole body once a week for 10 weeks but Kamwendo & Linton(1991) focused of the education counselling but less on physical exercise. It can be argued that a frequency of once a week is insufficient to produce statistically observable change and that counselling and education benefits may first be detectable in the longer term; for that reason the results of these studies may be underestimated.

A good quality comparative clinical trial(Randlov et al. 1998) was the only study

that compared intensive and light exercise programs. It was found that both exercise forms to be effective but found no statistical difference between groups at three months follow up but the results favoured the intensive exercise at twelve months follow up with regards to pain scores.

Overall the above mentioned studies, Frequency and correct implication rather than the intensity of exercise should be considered in the group exercise.

Proprioceptive exercises

Good evidence exist in support the use of proprioceptive exercise for neck pain. The support for this type treatment is based on two trials of good quality(Taimela et al. 2000; Fitz-Ritson 1995).

Taimela et al.(2000) demonstrated that patients receiving 24 sessions of multimodal treatment including proprioceptive exercises faired better than those who exercised at home, or just receiving advice; they experienced significantly fewer neck symptoms, greater general health, and improved working ability at 3 and 12 months follow-up.

Fitz-Ritson(1995) compared the chiropractic plus phasic exercises to chiropractic plus standard exercises and found a remarkably significant difference favouring the phasic exercises(48.3%) in comparison with for the standard exercise group(7.4%). However, this study did not apply adequate statistical analysis in comparing groups.

This area of research is interesting, given that proprioceptive exercise can be used in combination with other physiotherapy modalities; however, more studies of this kind would be needed to determine the effectiveness of such training concepts.

Other exercises

In this category, all studies supported an active intervention in form of exercise or early mobilisation; the good quality study of McKinney(1989) supported home instruction in early mobilisation and reduced reliance on neck collar while the study of a moderate quality(Kjellman & berg 2002) supported the use of McKenzie exercise rather than general exercise. It can be concluded on the basis of these studies that different forms of active exercise may be effective in treatment of neck pain but more studies are needed to define the optimal forms of exercise or exercise combinations in treatment of neck pain.

Exercise combined with other treatments

Exercise can increase or maintain the effects of manual therapy. It is supported by four comparative clinical trials of excellent quality(Jull et al. 2002; Allison et al. 2002; Evans et al. 2002; Bronfort et al.

2001).

Jull et al.(2002) compared the effects of manipulative therapy and exercise therapy and combined both therapies for cervicogenic headache; The authors applied a new low-load exercise program emphasizing muscle control to correct head posture, all three treatments were effective in reducing headache and neck pain and this was maintained over a follow up period of 12 months. The participants who received combined treatment of manipulative and exercise therapy were 10% better than the participants who received single therapy.

There is evidence that the upper and deep cervical flexors lose their endurance capacity in patients with neck pain. There is preliminary evidence that restoration of the supporting capacity of the upper and deep cervical flexor muscles parallels a reduction in neck pain and headache(Beeton & Jull 1994).

Bronfort et al.(2001) showed that manipulation plus low-tech exercise was superior to manipulation alone at one year follow-up for the cumulative advantage of pain intensity. The treatment duration was 11 weeks or 20 sessions of treatment for mechanical neck disorder. Evans et al.(2002) continued two years follow up for the study of Bronfort et al.(2001) with similar findings; the findings of Evans et al.(2002) were impaired by a high loss to follow up(24%).

Allison et al.(2002) studied the mobilisation based on neural stretch and manual therapy based on articular mobilisation for the cervicobrachial pain patients. Each group was conducted home exercise based on neural and articular mobilisation respectively. They found significant improvement in both exercise groups but they could not find any differences between the two intervention groups.

An excellent quality comparative clinical trial(Hoving et al. 2002) favored manual therapy than exercise combined with other physical treatments such as traction, massage, or interferential current. Hoving et al.(2002) compared general physiotherapy including exercise, manual therapy and continued care by a general practitioner; they found significant change in pain intensity with manual therapy compared with continued care or physical therapy, even though physical therapy scored better than continued care on some outcome measures. Their findings supported the use of manual therapy rather than physiotherapy(with exercise included) or continued care by a general practitioner. However, the study did not focuse on exercise interventions, the dosage of exercise was not clear and each patient did not receive same exercise program.

In general, determining the effects of exercise was hampered because the trials used exercise often in combination with other treatment modalities; other types of design isolating exercise would have improved the ability to analyse the effects of exercise directly. The different opinions of the different studies do reflect the diversity in combining different modalities with exercise.

Future studies could benefit from designs that explicitly address the effects of exercise as a single modality and from general improvements in methodological quality. Especially, blinding should be applied whenever possible to strengthen the reliability of the findings. While many studies failed to include functional outcome measures, it is advisable that such measures should be included to clarify a broader meaning of any treatment modality.

This review has inherent limitations which may have affected the findings with regards to the effect of exercise on cervical dysfunctions. The following limitations where among major limitations of this study:

- Language was limited to English.
- Reference collection was limited geographically to those available in Adelaide libraries.
- Very few studies were analyzed.
- There was limitation to categorize the studies and interpret with same tool because each study had different approach with different purpose.
- Although huge effort was done by the author to interpret the reviewed studies, the author acknowledges that potential misinterpretations may have occurred due to English language limitations.
- Being a single reviewer limited the ability to control selection bias, or quality evaluation bias. Having more reviewers could allow inter-raters analysis of quality and prevention of subjective bias.

Conclusion

Before drawing definite conclusions, the reader should be mindful of the previously mentioned limitations of this review.

The findings of previous review were mainly in agreement with the findings of this review.

Exercise combined with other treatment was found to be the most effective treatment for cervical dysfunction. This is supported by four comparative clinical trials of excellent quality(Jull et al. 2002; Allison et al. 2002; Evans et al. 2002; Bronfort et al. 2001).

There is evidence that strengthening ex-

ercise is effective in treatment of cervical dysfunction based on one good quality comparative clinical trial(Fredrich et al. 1996) and two moderate comparative clinical trials(Levoska & Keinanen-Kjukaanniemi 1993; Waling et al. 2000).

There is evidence that group exercise is as effective as individual physiotherapy based on a good quality comparative clinical trial(Jordan et al. 1996) and a moderate quality comparative clinical trial(Vasseljen et al. 1995).

There is evidence that proprioceptive exercise is effective for treatment of cervical dysfunction based on two good quality comparative clinical trials(Taimela et al. 2000; Fitz-Ritson 1995).

There is evidence that McKenzie exercise was more effective than general exercise based on a moderate quality comparative clinical trial(Kjellman & berg 2002); similarly there is evidence that active intervention was better than use of neck collar based on a good quality comparative clinical trial(McKinney 1989). In summary of this category, there appears to be evidence that active treatment is superior to passive treatment or general exercise.

This review did not base its conclusion on consideration such as cost effectiveness and applicability but limited its conclusion to the findings of identified studies.

Based on the above, this review concludes that there is evidence in the literature in support of using exercise in treatment of cervical dysfunction.

In addition to that, the relative effectiveness of specific types of exercise is less definite, there is some indication that exercise combined with other treatments is superior to exercise alone.

More research is needed to specify elements of effectiveness in exercise programs designed for treatment of cervical dysfunction. Further emphasis on methodological issues in future studies is desirable.

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Appendix A: List of Abbreviations in Tables

Abbreviation	Full meaning
Age x y	Mean age standard deviation
CCT, CCTs	Non-randomised controlled trial, Non-randomised controlled trials
Cx	Cervical
E	Extension
Ex	Exercise
F	Female
F	Flexion
G	Group eg G1 = Group 1, G2 = Group 2 etc.
G/H	Glenohumeral
LF	Lateral flexion
Lx	Lumba
M	Male
M	Muscle
Manip	Manipulation
MND	Mechanical neck disorder
Ms	Month, Months
Movt	Movement
N	Numbers of subject
Physiotherapy	PT
pt, pts	Patient, patients
RCT, RCTs	Randomised controlled trial, Randomised controlled trials
Reps	Repetitions
ROM	Range Of Motion
Rot	Rotation
Rx	Treatment
S	second
Thx	Thoracic
US	Ultra Sound
VAS	Visual Analogue Scale
Wk, Wks	Week, Weeks
x1/wk, x2/wk	Once a week, Twice a week
Yr, Yrs	Year, Years

Appendix B: PEDro Scale

1. Eligibility criteria were specified	no ☐ yes ☐ where:
2. Subjects were randomly allocated to groups (in a crossover study, subjects were randomly allocated an order in which treatments were received)	no ☐ yes ☐ where:
3. Allocation was concealed	no ☐ yes ☐ where:
4. The groups were similar at baseline regarding the most important prognostic indicators	no ☐ yes ☐ where:
5. There was blinding of all subjects	no ☐ yes ☐ where:
6. There was blinding of all therapists who administered the therapy	no ☐ yes ☐ where:
7. There was blinding of all assessors who measured at least one key outcome	no ☐ yes ☐ where:
8. Measures of at least one key outcome were obtained from more than 85% of the subjects initially allocated to groups	no ☐ yes ☐ where:
9. All subjects for whom outcome measures were available received the treatment or control condition as allocated or, where this was not the case, data for at least one key outcome was analysed by "intention to treat"	no ☐ yes ☐ where:
10. The results of between-group statistical comparisons are reported for at least one key outcome	no ☐ yes ☐ where:
11. The study provides both point measures and measures of variability for at least one key outcome	no ☐ yes ☐ where:

The PEDro scale is based on the Delphi list developed by Verhagen and colleagues at the Department of Epidemiology, University of Maastricht(Verhagen AP et al. (1998). The Delphi list: a criteria list for quality assessment of randomised clin-

ical trials for conducting systematic reviews developed by Delphi consensus. Journal of Clinical Epidemiology, 51(12):1235-41). The list is based on expert consensus not, for the most part, on empirical data. Two additional items not on the Delphi list(PEDro scale items 8 and 10) have been included in the PEDro scale. As more empirical data comes to hand it may become possible to weight scale items so that the PEDro score reflects the importance of individual scale items.

The purpose of the PEDro scale is to help the users of the PEDro database rapidly identify which of the known or suspected randomised clinical trials(ie RCTs or CCTs) archived on the PEDro database are likely to be internally valid (criteria 2-9), and could have sufficient statistical information to make their results interpretable(criteria 10-11). An additional criterion(criterion 1) that relates to the external validity(or generalisability or applicability of the trial) has been retained so that the Delphi list is complete, but this criterion will not be used to calculate the PEDro score reported on the PEDro web site.

The PEDro scale should not be used as a measure of the validity of a study's conclusions. In particular, we caution users of the PEDro scale that studies which show significant treatment effects and which score highly on the PEDro scale do not necessarily provide evidence that the treatment is clinically useful. Additional considerations include whether the treatment effect was big enough to be clinically worthwhile, whether the positive effects of the treatment outweigh its negative effects, and the cost-effectiveness of the treatment. The scale should not be used to compare the quality of trials performed in different areas of therapy, primarily because it is not possible to satisfy all scale items in some areas of physiotherapy practice.