Effect of dynamic humeral centring (DHC) treatment on painful active elevation of the arm in subacromial impingement syndrome. Secondary analysis of data from an RCT

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ABSTRACT

Background The physiotherapy dynamic humeral centring (DHC) aims to prevent subacromial impingement of rotator cuff tendons during elevation of the arm. The objective of the study was to determine whether DHC acts via an effect on subacromial impingement mechanism by assessing its effect on painful elevation of the arm in subacromial impingement syndrome.

Methods This is a secondary analysis of results of a randomised controlled trial of the effectiveness of DHC. Sixty-nine patients with subacromial impingement syndrome were prospectively included. Patients and the assessor were blinded to the study hypothesis and treatment, respectively. Patients underwent DHC or non-specific mobilisation as a control for 6 weeks in 15 supervised individual outpatient sessions with home exercises. Outcomes were pain-free range of motion and presence of painful arc of the shoulder, both in active flexion and abduction of the arm at 3 months.

Results At 3 months, pain-free range of motion, both flexion and abduction, was greater in the DHC group than in the mobilisation group. The number of patients with painful arc during flexion was decreased in the DHC group.

Conclusions DHC improves painful active elevation of the arm. We suggest that DHC may act via a specific effect on subacromial impingement mechanism.

INTRODUCTION

Degenerative rotator cuff disease ranks first in frequency of shoulder disorders.[1] Its pathogenesis involves subacromial impingement of rotator cuff tendons, which appears during active elevation of the arm and is therefore a movement of key importance in the development of degenerative rotator cuff disease.[2] MRI and in vivo measurements of pressure have revealed subacromial impingement with flexion or abduction of the arm $60°–90°$.[3] [4] Duration of activity with the arm in an elevated position is associated with degenerative rotator cuff disease in workers.[5] [6] Clinical tests, including Neer, Hawkins and Yocum, involve shoulder pain induction during elevation of the arm, and are thus used to detect subacromial impingement of rotator cuff tendons.[7] Active elevation of the arm is also of key importance because of its functional utility in daily and occupational activities. Arm elevation is found as one or several items in all of the scales most used for shoulder functional assessment.[8] [9]

Dynamic humeral centring (DHC) is a modality of physiotherapy that aims to prevent subacromial impingement of rotator cuff tendons.[10] We reported that DHC improves shoulder pain at 3 months in patients with subacromial impingement syndrome.[11] DHC was more effective than non-specific mobilisation. We sought to further determine whether the pain improvement we found with DHC is due to an effect on subacromial impingement itself, as we previously supposed, or to independent mechanisms. We wondered whether DHC specifically ameliorates pain during active elevation of the arm, a movement associated with subacromial impingement mechanism. We therefore conducted an ancillary study of our published data[11] to assess the effect of DHC on painful active elevation of the arm in subacromial impingement syndrome. Since the effect of DHC was previously shown at 3 months, we chose 3 months for the secondary analysis.

METHODS
Design
This study is a secondary analysis of data from a single-centre randomised controlled trial with blinded assessment.

Patients
Patients consulting in our department were considered for inclusion. Criteria for inclusion were age >30 years, shoulder pain duration >1 month, presence of at least two positive impingement results from Neer, Yocum and Hawkins tests[7] and total Constant score <80.[8] Patients were excluded if they had the following shoulder conditions: limited passive range of motion (ROM), instability, tendon calcification, corticosteroids injection within the previous 30 days, previous surgery, humeral fracture, inflammatory joint disease or neoplastic disorders.

Randomisation and allocation
Patients were randomised to DHC physiotherapy or non-specific mobilisation (control) programmes. Allocations were sealed in opaque and consecutively numbered envelopes. Envelopes were opened by an independent investigator who was not involved in the eligibility assessment, outcome assessment or treatment. Allocation was revealed to the physiotherapist before the patients presented for treatment. Two physiotherapists were involved

in the trial. If both were available at the time of patient inclusion, patients were also randomised to physiotherapist 1 or 2 to undergo the allocated treatment.

Interventions

Standardised DHC physiotherapy and mobilisation therapy were performed for 6 weeks, in 15 supervised individual outpatient sessions (table 1). Daily home exercises according to DHC or non-specific mobilisation principles completed each supervised programme. The DHC consisted in learning the lowering of the humeral head first during passive abduction of the shoulder and then during active abduction by cocontraction of the pectoralis major and latissimus dorsi. The mobilisation programme consisted in passive and active mobilisation of the shoulder with painless ROM.

Outcomes assessment

Outcomes were assessed before and 3 months after patients began the physiotherapy programmes by the same assessor. Outcomes were pain-free ROM and presence of painful arc of the shoulder, both in active elevation of the arm. Flexion and abduction in the frontal plane were separately considered for each outcome by the use of goniometry. Painful arc of the shoulder was defined as shoulder pain between 61° and 90° of active elevation of the arm, a range associated with subacromial impingement.[3] The movement plane (frontal for abduction and sagittal for flexion), arm rotation and forearm position were supervised and verified by the assessor. Patients were asked to slowly perform abduction and flexion of the arm. The abduction started with the upper limb in the neutral position from 0° to 90° and continued in lateral rotation. The flexion started with the upper limb in the neutral position from 0° to 90° and continued in medial rotation. The elbow of the patients remained in extension. Pain-free ROM of the shoulder was defined as the maximum ROM without pain during active elevation of the arm. The ROM was graded as 0, 0°–30°; 2, 31°–60°; 4, 61°–90°; 6, 91°–120°; 8, 121°–150°; and 10, ≥151°.[8]

Blinding

Patients were blinded to the study hypothesis. The assessor of all outcomes was blinded to the interventions.

Statistical analysis

Quantitative data are described with mean±SD; semiquantitative data with median, mean, 95% CI; and nominal data with number and percentage. We tested the error of measurement ($2 \times SEM$) in a previous sample of 26 patients with goniometry. This was 0.94 for flexion and 0.86 for abduction. Comparisons involved Mann-Whitney and χ^2 tests as required. Statistical analysis involved use of Statview V.4.5 (Abacus Concepts, Berkeley, California, USA). A $p<0.05$ was considered statistically significant.

Table 1 Description of the physiotherapy interventions

Dynamic humeral centring programme		Mobilisation programme	
Part 1: number of sessions as required, up to 15		Part 1: sessions 1–5	
Step 1: 10 min	Lying on side or sitting. Massage of soft tissue of the neck and shoulder region	Step 1: 10 min	Lying on side or sitting. Soft tissue massage of the neck and shoulder region
Step 2: as required, up to 20 min	Lying on side or sitting. Muscular stabilisation of the scapula: contraction of the adductors of the scapula, arm passively positioned in progressive abduction	Step 2: 20 min	Lying on back, stomach or side. Passive mobilisation of the scapula and the glenohumeral joint in a painless range of motion: abduction, flexion, extension, lateral and medial rotations, 10 movements for each
Step 3: as required, up to 20 min	Sitting position. Perception of the lowering of the humeral head in glenohumeral joint during passively pulling down the arm	Home exercises	10 Passive pendular movements of the shoulder 3 times a day
Step 4: as required, up to 20 min	Sitting. Perception and control of the isometric contraction of the pectoralis major and latissimus dorsi	Part 2: sessions 6–10	
Step 5: as required, up to 20 min	Sitting. Active lowering of the humeral head by co-contraction of pectoralis major and latissimus dorsi during passive abduction of the arm in painless range of motion	Step 1: 10 min	Lying on side or sitting. Massage of soft tissue of the neck and shoulder region
Home exercises	10 Lowerings of the humeral head by co-contraction of the pectoralis major and latissimus dorsi, arm by the side, 3 times a day	Step 2: 20 min	Lying on side or sitting. Active mobilisation of the scapula and the gleno-humeral joint in a painless range of motion: abduction, flexion, extension, lateral and medial rotations, 10 movements for each
Part 2: after controlling part 1, up to 15 sessions part 1 included		Home exercises	10 active flexions of the arm positioned in lateral rotation in a painless range of motion, 3 times a day
Step 1: 10 min	Lying on side or sitting. Soft tissue massage of the neck and shoulder region	Part 3: sessions 11–15	
Step 2: as required, up to 20 min	Sitting. Active lowering of the humeral head by co-contraction of the pectoralis major and latissimus dorsi during active abduction of the arm, up to 90°, the elbow in 90° flexed position	Step 1: 10 min	Lying on side or sitting. Soft tissue massage of the neck and shoulder region
Step 3: as required, up to 20 min	Sitting. Active lowering of the humeral head by co-contraction of the pectoralis major and latissimus dorsi during active abduction of the arm, up to 90°, the elbow in extension	Step 2: 20 min	Sitting. Mobilisation against light resistance of the scapula and of the glenohumeral joint in a painless range of motion: abduction, flexion, extension, lateral and medial rotations, 10 movements for each
Step 4: as required, up to 20 min	Sitting. Active lowering of the humeral head by co-contraction of the pectoralis major and latissimus dorsi during full active abduction of the arm, the elbow in extension. Light resistance allowed	Home exercises	10 Active antepulsions of the arm positioned in lateral rotation in a painless range of motion, 3 times a day
Home exercises	10 Lowerings of the humeral head by co-contraction of the pectoralis major and latissimus dorsi during active abduction of the arm up to 110°, 3 times a day		

Table 2 Baseline characteristics of patients randomised to undergo dynamic humeral centring physiotherapy or non-specific mobilisation control therapy for subacromial impingement syndrome

	DHC (n=34)	Control (n=35)	p Value
Age, years (SD)	57.9 (10.7)	59.4 (10.0)	0.54
Women (%)	21 (61.8)	26 (74.3)	0.23
Dominant shoulder (%)	20 (58.8)	24 (68.6)	0.63
Pain duration, months (SD, range)	35.7 (81.6, 1–360)	20.9 (27.6, 2–120)	0.15

DHC, dynamic humeral centring.

RESULTS

We included 69 patients; data for 62 (90%) were available at 3 months. The two treatment groups did not differ in baseline characteristics (table 2).

At 3 months, pain-free ROM of the shoulder in active movement of the arm, both flexion and abduction, was higher in the DHC (median: 8 corresponding to the range 121°–150°) than mobilisation group (median: 6 corresponding to the range 91°–120°; table 3). These changes were greater than the error of measurement. Fewer patients in the DHC (sixfolds less) than mobilisation group showed painful arc of the shoulder during active flexion of the arm. The groups did not differ in painful arc of the shoulder during active abduction.

DISCUSSION

In this analysis of a randomised study of DHC physiotherapy or non-specific mobilisation control therapy for subacromial impingement syndrome, DHC improved painful active elevation of the arm. The pain-free ROM in active flexion and abduction in the frontal plane was increased and the number of patients with painful arc in active flexion was lower after DHC than mobilisation therapy at 3 months. DHC had an impact on symptoms at 3 months, but not at 12 months. DHC may act via a specific as yet undetermined effect on the symptoms of subacromial impingement.

The pathogenic model of the subacromial impingement involves the abrasion of the bursal side of the rotator cuff by the acromion or the coracohumeral ligament.[2] The acromion or the coracohumeral structures are often considered as actors in the pathogenic process, yet dynamic factors contributing to the vertical stabilisation of the humeral head should not be ignored. Failure of the inferior components of the rotator cuff could result in a slight superior translation of the humeral head during the flexion or abduction of the arm. DHC may be able to counteract the process by acting on other depressors of the humeral head that are the pectoralis major and latissimus dorsi. Indeed, DHC consists in early activation of the pectoralis major and latissimus dorsi during flexion and abduction of the arm.[10] Our results are in accordance with the subacromial impingement pathogenic model, while emphasising the importance of the muscular stabilisation of the humeral head.

Few studies have investigated the effect of DHC in degenerative rotator cuff disease.[12 13] To our knowledge, the trial we recently reported is the first randomised trial assessing the effectiveness of such DHC programme.[11] Comparison of the presented study with others studies is limited. Randomised trials have shown short-term effectiveness of exercise in rotator cuff disorders.[14] They also indicate equal long-term effectiveness of physiotherapy as compared with surgery, namely acromioplasty, for impingement syndrome. Closer to our study, a three-dimensional analysis of elevation of the arm in patients with rotator cuff tears demonstrated that DHC could reduce the displacement of the rotation centre of the shoulder.[12] One retrospective study reported clinical improvement during a 4-month follow-up in patients with full-thickness tear of the rotator cuff after a 2-week period of DHC as compared with no physiotherapy[13]: the clinical improvement involved pain and function. Our findings reinforce these results. In our first study we showed an effect on pain but no difference for total Constant score, activity, mobility and strength. We showed less pain during active mobilisation of the arm after DHC. Pain during active mobilisation of the arm may be a source of functional limitation. The fact that we did not find any difference in total Constant score between the groups in the previous study, may be due to the type of measurement.[11] Indeed, Constant scale, which is composed of subscales for pain, activity, mobility and strength, may be less specific than our present outcome criteria considering the effect and mechanism of action of DHC. We only showed positive effect on pain and pain-free movement, and these results call for further investigation of functional impact of DHC.

Several methodological points of our study strengthen our findings.[15 16] We defined the selection of the study population, the modalities of the randomisation and allocation to treatment, and the description and application of standardised physiotherapy programmes. The assessor was blinded to the treatments. The rate of patients lost to follow-up reasonable. The randomisation involved the physiotherapy programmes and also the physiotherapists. This procedure has not been used in other trials about physiotherapy in subacromial impingement syndrome. The control we used was an exercise programme. Both conditions, double randomisation and active physical treatment as a control, allowed for direct assessment of DHC, excluding

Table 3 Results of dynamic humeral centring physiotherapy or non-specific mobilisation control therapy for subacromial impingement syndrome at baseline and 3 months

	Baseline			3 months		
	DHC (n=33)	Control (n=35)	p Value	DHC (n=30)	Control (n=32)	p Value
Pain-free range of motion of the shoulder, median (mean, 95% CI)						
Active flexion (0–10)	6 (5.6, 4.9 to 6.3)	4 (5.1, 4.6 to 5.6)	0.22	8 (7.9, 7.1 to 8.6)	6 (6.4, 5.6 to 7.2)	0.011
Active abduction (0–10)	4 (5, 4.4 to 5.6)	4 (4.5, 3.9 to 5.1)	0.14	8 (7.5, 6.7 to 8.3)	6 (6.1, 5.2 to 7)	0.04
Painful arc of the shoulder, number (%, 95% CI)						
Active flexion	11 (33.3, 17.3 to 49.3)	16 (45.7, 29.2 to 62.2)	0.30	2 (6.7, −2.4 to 15.8)	13 (40.6, 23.6 to 57.6)	0.002
Active abduction	15 (45.5, 28.5 to 62.5)	19 (54.3, 37.8 to 70.8)	0.47	6 (20, 5.7 to 34.3)	12 (37.5, 20.8 to 54.2)	0.13

DHC, dynamic humeral centring.

non-specific effects, due to, for example, contact with the physiotherapist, the environment and beliefs of the patient.[17] Active exercise as a control also allowed patients to be blinded to the study hypothesis. Patients were informed that two physiotherapy programmes were being evaluated, with no further information on the superiority of one treatment over the other.

Our study has also some limitations. The two physiotherapists involved in the study were not blinded to treatment. We cannot exclude the effect of their beliefs about the physiotherapy programmes. However, they were asked to strictly apply the two standardised physiotherapy programmes. Furthermore, both treatment groups showed improvement over time, so the effect of the beliefs of the physiotherapists was probably marginal. The study was conducted in a single centre with selected patients and with two trained musculoskeletal physiotherapists. These conditions should not be representative of current practice. To allow for its diffusion in current practice, the DHC programme has been described in detail.[11]

In summary, we further explored the effect on pain of DHC for impingement syndrome we had previously reported. DHC improved painful active elevation of the arm as compared with non-specific mobilisation physiotherapy. Thus, DHC may have an impact on impingement syndrome. DHC may act on pain by altering the pathogenic process through its specific effect on subacromial impingement of the rotator cuff tendons.

What this paper adds

- ▶ Dynamic humeral centring improves pain and active painful elevation of the arm in subacromial impingement syndrome.
- ▶ Dynamic humeral centring may have an impact on subacromial impingement syndrome.
- ▶ Dynamic humeral centring may act on pain by altering the pathogenic process through its specific effect on subacromial impingement of the rotator cuff tendons.

What are the clinical implications

- ▶ Dynamic humeral centring is an effective modality of physiotherapy.
- ▶ Dynamic humeral centring should be used in patients with subacromial impingement syndrome.

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