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Response rate and comparison of clinical features associated with positive or negative responses to a scapular positioning test in patients with neck pain and altered scapular alignment: a cross-sectional study

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ABSTRACT

Objective To investigate the frequency and clinical aspects of patients with neck pain who responded and did not respond to scapular repositioning and to determine the clinical features associated with a positive response.

Design Cross-sectional study.

Setting Research unit, Department of Physical Therapy, Chiang Mai University.

Participants Volunteers with non-specific neck pain aged 18–59 years were recruited between May 2020 and February 2021 from hospitals, clinics, university and community.

Outcome measures Clinical data documented were neck pain (intensity, duration and disability), the presence of headache, type of scapular dysfunction, cervical musculoskeletal impairment (range of motion (ROM), flexion rotation test (FRT) and location of any symptomatic cervical joint dysfunction), upper limb functional limitation and self-reported disability. Manual scapular repositioning was performed on the side of neck pain. Participants were categorised as responsive or non-responsive based on a change in pain and/or cervical rotation range.

Results A total of 219 people with neck pain responded to advertisements, of which 144 were eligible. Of the eligible participants, 107 (74.3%) demonstrated a clinically relevant improvement in either neck pain or rotation range or both following the scapular repositioning and 37 (25.7%) had no relevant improvement. The responsive group had a high incidence of scapular downward rotation, greater neck pain intensity, headache and cervical musculoskeletal impairment (reduced ROM, positive FRT and symptomatic C1-3 dysfunction) compared with the non-responsive group ($p<0.05$). A logistic regression model revealed that features strongly associated with a positive response were the presence of headache (Exp(B)=6.0, 95% CI 2.3 to 15.8), scapular downward rotation (Exp(B)=5.3, 95% CI 2.3 to 12.6) and a positive FRT (Exp(B)=4.0, 95% CI 1.5 to 10.6).

Conclusion Almost 75% of neck pain patients with altered scapular alignment responded to scapular repositioning. The predominance of upper cervical dysfunction with a downwardly rotated scapular in this group suggests a role of poor axioscapular muscle function which might benefit from rehabilitation.

Strengths and limitations of this study

- ► The scapula was repositioned based on the assessment of altered scapular alignment.
- ► Outcome measures were comprehensive addressing clinical features, cervical musculoskeletal impairment, upper limb disability and functional limitations.
- ► Change scores in pain and rotation range were beyond measurement error and represented a clinically meaningful improvement.
- ► Manual scapular repositioning with responses was limited to the more painful side.
- ► The cross-sectional design limits the ability to draw causal inferences.

INTRODUCTION

Altered scapular alignment is considered a clinically relevant feature that may contribute to neck pain and dysfunction.[1–3] The scapula is linked anatomically to the cervical spine through the axioscapular muscles, particularly the levator scapulae and upper trapezius muscles.[4] Changes in axioscapular muscle function may increase mechanical loading and compressive forces on the cervical spine,[5 6] which may adversely affect the neck. Several studies have demonstrated that passive correction of scapular position results in decreased neck pain and/or improved cervical range of motion (CROM).[5 7 8] Likewise, scapular stabilisation exercises can be effective in decreasing pain and disability in patients with neck pain.[9–12]

Scapular positions vary in both healthy individuals and patients with neck pain.[13 14] Assessing the effect of scapular repositioning on neck pain or movement is recommended in the clinical examination.[1 15] Clinical experience suggests that the positive response to scapular repositioning is variable, that is, some patients improve in both pain and range of neck motion but others in either pain or range. Conversely, some patients do not respond or have clinically irrelevant improvement to scapular repositioning.[5] It is currently unknown what proportion of patients with neck pain with altered scapular alignment respond to scapular repositioning and if there is any relevance in improvement in both pain and ROM or either one. Patients present with various clinical features. Identifying features associated with specific aspects of a favourable response may provide a better understanding of the contribution of altered scapular alignment to neck pain and ultimately help to identify patients with neck pain who might benefit from specific rehabilitation strategies directed towards improving scapular position and movement control.

The first aim of this study was to investigate the frequency of positive responses to passive manual repositioning of the scapula in patients with neck pain with altered scapular alignment. The second aim was to determine if there were any differences in clinical presentations between patients who did and did not respond to modification of scapular posture and if there were any differences based on the response (ie, improvement in both pain and cervical range, or improvement in pain or and range only). Lastly, the study aimed to identify any distinctive clinical features associated with positive response to manual scapular repositioning. Overall, it was hypothesised that there would be differences in clinical presentations between those who were responsive and non-responsive to manual scapular repositioning.

METHODS

Study design

A cross-sectional study with patients with non-specific neck pain participating at a research unit at the Department of Physical Therapy, Chiang Mai University, Thailand.

Participants

A sample of convenience of volunteers with non-specific neck pain was recruited between May 2020 and February 2021 from local hospitals, physical therapy clinics, the university and community by advertising through flyers, posters and social networks (eg, Facebook and Instagram). A minimum sample size of 124 was required, considering an analytical cross-sectional study for fixed values of significance level=0.05, power=0.80, coefficient of determination=0.25 and margin of error=10% of variance.

Participants of either gender were eligible if they were: aged between 18 and 59 years; had chronic neck pain (≥3 months); an average pain intensity of ≥3 on a 0–10 cm Visual Analogue Scale (VAS) in the past week; a current Neck Disability Index (NDI) score of at least 10/100 and had altered scapular alignment ipsilateral to the more painful side of neck pain. Participants were excluded if they reported a history of head and neck injury, shoulder problems, neurological conditions and any musculoskeletal problems that could affect the scapular position.

Patient and public involvement

Patients or the public were not involved in the design, conduct and dissemination of this research.

Participant demographics and characteristics related to neck pain

Demographic data were collected from all eligible participants as well as characteristics of their neck pain (intensity, duration, side of pain and associated symptoms for example, headache). Participants also completed the NDI,[16 17] Disability of the Arm, Shoulder and Hand (DASH) questionnaire[18 19] and the Patient-Specific Functional Scale (PSFS).[20] A total score was calculated for the NDI and DASH and expressed as a percentage. The frequency of positive items on the DASH (defined as a score of ≥2 indicating mild or greater difficulty/symptoms) was also derived.[21] For the PSFS, participants were asked to nominate five different activities which they found difficult as a result of their neck pain and rate each activity on an 11-point Numerical Rating Scale (NRS), where 0=unable to perform activity and 10=able to perform activity at the level prior to neck pain.[20] The mean value of the five activities was used for analysis.

Tests of physical impairments

Cervical range of motion

CROM was measured using the CROM instrument (Performance Attainment Associates, USA) in the directions of flexion, extension, lateral flexion and rotation to the left and right. Three trials were performed in each direction and the average value was used in analysis. The use of the CROM was shown to be reliable for this study (Intraclass Corrlation Coefficients (ICCs) for intraexaminer and interexaminer reliability=0.74–0.86 and 0.71–0.91, respectively).

Flexion rotation test

The flexion rotation test (FRT) was conducted according to a standardised protocol[22 23] and the upper cervical rotation range (C1-2) was measured using the CROM device. The FRT was performed bilaterally, three times and the average value was used for analysis. The FRT was interpreted as positive if the range was less than 33° or there was a greater than 10° difference between sides.[23 24]

Cervical manual examination

The presence and location of symptomatic cervical joint dysfunction was determined by manual examination.[25–27] Passive accessory intervertebral movements were performed over cervical facet joints from C0 to 7 bilaterally and pain reproduced during the test was quantified

Figure 1 Manual scapular repositioning.

using the 11-point NRS. The most painful symptomatic cervical joint was identified based on both the presence and amount of (1) pain provoked (≥2/10) and (2) the assessor's rating of abnormal tissue resistance (at least moderate resistance).[28–30]

Manual scapular repositioning

Manual repositioning of the scapula was performed ipsilateral to the most painful side of the neck (figure 1). Participants sat in an upright position with hands on thighs and feet flat on the floor. Neck pain intensity and cervical rotation range to the painful side were measured before (uncorrected) and then in the modified (corrected) scapular position. The examiner (an experienced physiotherapist) first observed and then manually assessed the scapular position. The examiner then performed the corrective movements based on this assessment that is, correction of any rotational (upward/downward, anterior/posterior, internal/external) and translational (superior/inferior, protraction/retraction) positions. During the test, participants were asked to fully relax the muscles of the shoulder girdle and maintain the sitting position without any compensation (eg, thoracic extension and rotation). Two trials were performed and the mean value of the change scores in pain and cervical range between baseline and corrected position was used in the analysis. In preparation for this study, the manual repositioning of the scapula was proven reliable between two examiners (per cent agreement=82.6–84.1, adjusted kappa=0.65–0.68).

Study procedure

Initial screening was conducted by telephone for inclusion/exclusion purposes. An experienced physiotherapist (named the examiner) assessed scapular resting position on the more painful side of the neck for inclusion/exclusion purposes. The assessment was conducted by observation and manual palpation in five different postural planes (scapular, sagittal, transverse, vertical and horizontal) according to a previous study.[31] Altered resting scapular alignment was identified if any obvious abnormalities (upward/downward rotation, anterior/posterior tilting, internal (winging)/external rotation, elevation/depression, protraction/retraction) were observed. The position was documented. Participants were eligible for the study if they met all the eligibility criteria. Appointments were made for the physical examination.

All eligible participants completed all study questionnaires. The physical measures of the neck proceeded in a standard order. An independent assessor (a qualified musculoskeletal physiotherapist) performed the FRT and the manual examination of the cervical segments. The measures of cervical ROM were performed by a second assessor (an experienced physiotherapist). ROM in each plane was first measured in the resting (uncorrected scapular position). Participant were asked to rate any neck pain perceived on an 11-point NRS. Immediately after, the examiner reconfirmed the resting scapular position and performed the manual scapular repositioning on the most painful side of the neck and held the position while the participant repeated the cervical rotation movement to the same side. The second assessor then remeasured the rotation range in the modified (corrected) scapular position and the participant again rated any pain perceived. In both conditions, participants were instructed to rotate their head as far as possible without pain and any compensation, for example, neck lateral flexion and trunk rotation.

Participants were asked to refrain from taking pain medication for at least 6 hours prior to testing. The examiner and the assessors were blinded to each other's findings, the participant's pain rating and their clinical characteristics.

Data management and statistical analysis

Change scores in neck pain intensity and cervical rotation range between the modified and resting scapular positions were calculated and used to define participants who did or did not respond to manual scapular repositioning. Participants with change scores >2 points on NRS and/or ≥7° in cervical rotation range were grouped into a responsive group. The cut-off scores for pain and cervical range were based on the differences that are regarded as clinically important.[32–34] To reduce examiner bias, interpretation of measures to classify the response to scapular repositioning (responsive and non-responsive) were not undertaken until completion of data collection.

Descriptive statistics were used to document participants' demographics and characteristics. Independent sample t-tests were used to compare the change scores in pain intensity and cervical range of rotation following manual scapular repositioning between the responsive and non-responsive groups. Independent sample t-tests and χ^2 test were also used to test for any differences in neck pain-related features, physical impairments, upper limb disability and functional limitations between the groups. Effect sizes were calculated for all tests (Cohen's d for independent t-test 0.2 small, 0.5 medium, 0.8 large and Cohen's w for chi-square 0.1 small, 0.3 medium, 0.5 large).[35]

Participants in the responsive group were then subgrouped according to the outcome of scapular repositioning (group 1: improved in both pain and cervical ROM, group 2: improved in pain only and group 3: improved in ROM only). One-way analysis of variance (ANOVA, version 23) and χ^2 and post hoc tests were used to determine differences in variables tested in the study between the responsive subgroups.

Lastly, logistic regression analysis was used to determine the factors associated with a positive response following manual scapular repositioning. Variables related to the response with a p<0.2 according to a univariate analysis were included in the model. A stepwise selection method was used to identify variables. The goodness-of-fit of the overall model was evaluated by the Hosmer-Lemeshow test.[36]

All data were analysed for a normal distribution using the Shapiro-Wilk test. Statistical analyses were performed using SPSS software. Statistical significance was set at p<0.05.

RESULTS

Participants

A total of 219 people with neck pain responded to advertisements. Of those, 144 were eligible for the study, 69 failed to meet the inclusion criteria (42 had no observable altered scapular alignment, 12 had a VAS score of <3, 10 had shoulder symptoms, and in five, the NDI score was <10). Six declined to participate due to travel distance.

Of the 144 eligible participants, 107 demonstrated a clinically relevant improvement in either neck pain or range of rotation or both, following manual scapular repositioning (responsive group) while 37 had no relevant improvement (non-responsive group). Table 1 presents demographic data for the responsive and non-responsive groups. The change scores in pain and cervical rotation range in the responsive group were 2.7°±1.5° and 11.3°±6.2°, respectively, and in the non-responsive groups 0.9°±0.8° and 3.0°±1.9°, respectively. The change scores were significantly different between the groups (p<0.01).

Table 1 Demographics for the responsive and non-responsive groups

	Responsive (n=107)	Non-responsive (n=37)
Gender (% female)	66.4	62.2
Age (years)	37.8±10.6	36.3±10.3
BMI (kg/m^2)	22.4±3.4	22.1±2.8
Side of neck pain		
Unilateral (% right)	27.1	27.0
Bilateral (% right more painful)	37.4	32.5
Computer work (%)	67.3	70.3

Data are presented as mean±SD unless otherwise indicated.
BMI, body mass index.

Differences in characteristics, physical impairments and upper limb function between the responsive and non-responsive groups

Compared with the non-responsive group, the responsive group had greater neck pain intensity (VAS score), a higher incidence of headache, a shorter duration of neck pain (p<0.05) and a greater frequency of scapular downward rotation (p<0.01) (table 2). The incidence of scapular protraction was less (p<0.01) as was cervical ROM (extension, lateral flexion and rotation to the painful side) and FRT range (p<0.05) (table 2). The presence of painful symptomatic joint dysfunction was more pronounced in the C1-3 segments and less pronounced in the C5-7 segments (p<0.01) (figure 2).

There was no significant difference in the total DASH score between groups (p>0.05) (table 3). For each item of the DASH, eight of 30 items (questions 6–8, 10–12, 18, 19) were scored as positive (>2) by at least 50% of all participants (62.6%–76.6% for the responsive group and 54.1%–81.1% the non-responsive group). The five functional activities reported by participants as being difficult due to neck pain (PSFS) were computer work, lifting, carrying, driving and upper extremity exercise. The average score of five activities nominated in the PSFS were not significantly different between the groups (p>0.05) (table 3).

Subgroup analysis for responsive participants

Of the 107 responsive participants, 39 were allocated into subgroup 1 (improvement in both pain and ROM), 27 into subgroup 2 (improvement in pain only) and 41 into subgroup 3 (improvement in ROM only). Figure 3A presents change scores in pain and cervical rotation range following scapular repositioning. Some between subgroup differences were found for baseline pain intensity (VAS score), FRT (% positive) and cervical ROM (p<0.05) (figure 3B). There were no differences between the subgroups for the other remaining outcomes (p>0.05).

Factors associated with a positive response following manual scapular repositioning

The subgroup analysis revealed that there was no variable that could differentiate the three subgroups. In response, a binary logistic regression was conducted to determine the factors associated with a positive response regardless of whether the response was in relation to pain or cervical rotation range or both. The regression model indicated that six independent variables were related to a positive response to scapular repositioning (ie, pain intensity, headache, scapular downward rotation, positive FRT, painful symptomatic joint dysfunction at C2-3,

Table 2 Neck pain-related features and physical impairments for the responsive and non-responsive groups

Variables	Responsive (n=107)	Non-responsive (n=37)	P value	Effect size (Cohen's d)
Neck pain-related features				
Neck pain intensity (0–10 VAS)	4.5±0.8	3.9±0.4	**<0.01**	0.95
Neck pain duration (months)	27.8±13.8	34.7±17.1	**0.02**	0.44
Neck pain and disability (% NDI)	29.4±10.0	27.1±9.3	0.24	0.24
Headache (%)	80.4	18.9	**<0.01**	0.56†
Physical impairments				
Types of scapular dysfunction (%)			**<0.01**	0.63†
Anterior tilt	2.8	10.8		
Downward rotation (DR)	52.3*	5.4		
Protraction	10.3	46.0*		
Winging	3.7	2.7		
Mixed type with DR	27.1*	8.1		
Mixed type without DR	3.7	27.0*		
FRT (degrees)	32.4±7.3	41.4±9.0	**<0.01**	1.10
FRT (% positive)	68.2	21.6	**<0.01**	0.41†
Cervical range of motion (degrees)				
Flexion	63.1±9.7	62.9±7.0	0.90	0.02
Extension	51.5±12.2	57.4±10.2	**0.01**	0.52
Lateral flexion to painful side	34.9±6.1	37.8±6.1	**0.02**	0.48
Lateral flexion to non-painful side	35.7±6.8	37.9±5.7	0.07	0.35
Rotation to painful side	49.2±5.4	52.9±4.1	**<0.01**	0.77
Rotation to non-painful side	57.9±7.6	60.4±8.6	0.11	0.31

Data are presented as mean±SD unless otherwise indicated.
Bold letters indicate statistical significance.
*P<0.01 post hoc analysis.
†Cohen's d for $\chi 2$ test.
FRT, flexion rotation test; NDI, Neck Disability Index; VAS, Visual Analogue Scale.

and cervical rotation ROM to painful side) (table 4). The model classified 90.3% of the participants correctly. All independent variables were significant factors predictive of a positive response following manual scapular repositioning (p<0.05). The most painful symptomatic joint dysfunction at C2-3 was retained in the model but was not statistically significant (p=0.06).

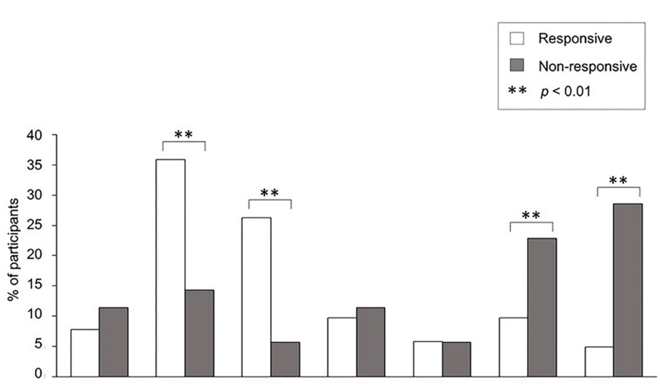

Figure 2 The most painful symptomatic joint dysfunction between the responsive and non-responsive groups.

DISCUSSION

Our results are consistent with previous studies, which demonstrated immediate positive effects of scapular correction on pain and cervical rotation range in patients with neck pain.[5 7 37] In our study, 75% of participants with neck pain and altered scapular alignment responded positively to manual scapular repositioning (either pain or cervical rotation range or both). Conversely 25% did not benefit indicating that the mere presence of altered scapular alignment does not necessarily mean it is pertinent to an individual's neck pain. The positive response would suggest that the scapular position and presumably the attendant change in muscle mechanics are relevant whereas no response might suggest that the scapular position is a 'normal', non-relevant finding.

We questioned whether certain clinical features might identify patients with neck pain whose scapular posture might be contributing to their neck pain disorder. Not unexpectedly, both groups presented with many similar features with respect to neck pain and musculoskeletal impairment (tables 2 and 3). Nevertheless, the responsive group had higher neck pain intensity and reported

Table 3 Upper limb disability and functional limitations associated with neck pain for the responsive and non-responsive groups

Variables	Responsive (n=107)	Non-responsive (n=37)	P value	Effect size (Cohen's d)
Upper limb disability				
DASH score (%)	20.2±10.9	21.4±12.7	0.57	0.10
Functional limitations associated with neck pain				
PSFS score* (0–10)	5.6±1.8	5.3±1.7	0.40	0.17
Top five important activities reported as having difficulty (%)	Computer work 83.2	Computer work 83.8		
	Lifting 70.1	Lifting 64.9		
	Carrying 55.1	Driving 62.2		
	Driving 53.3	Arm exercise 48.6		
	Arm exercise 47.7	Carrying 40.5		

Data are presented as mean±SD unless otherwise indicated.
*Average of top five important activities
DASH, Disability of the Arm, Shoulder and Hand; PSFS, Patient-Specific Functional Scale.

headache far more frequently. The most common scapular position was downward rotation. The FRT was more often positive, movement into extension, rotation and lateral flexion towards the side of pain was more restricted and painful segmental dysfunction was more common in the C1-2 and C2-3 segments. Medium to large effect sizes were revealed for these variables. This combination of symptoms and signs presents as an upper cervical disorder. Interestingly, the non-responsive group presented a different pattern with more painful segmental

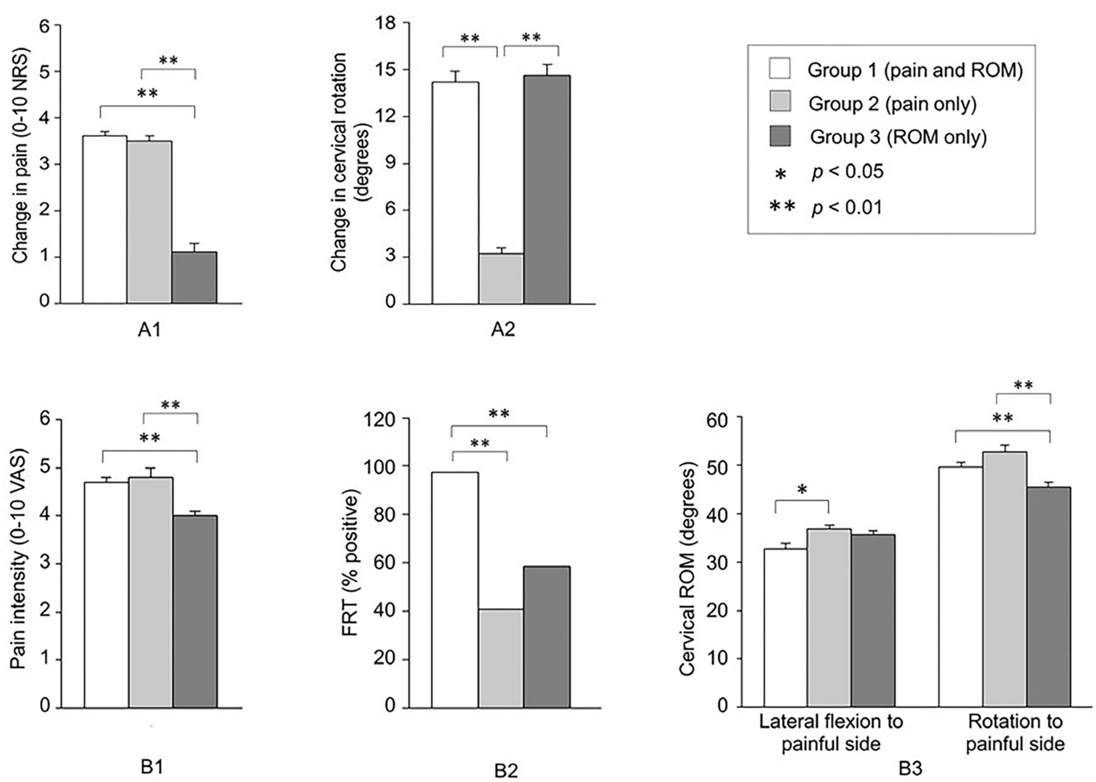

Figure 3 Subgroup analysis for responsive participants. Change scores following manual scapular repositioning: A1 pain intensity and A2 cervical rotation range. Differences in significant variables: B1 neck pain intensity, B2 flexion rotation test and B3 cervical range of motion.

Table 4 Binary logistic regression of factors associated with a positive response (both pain and ROM, pain only or ROM only) following manual scapular correction

Variables	β	SE	Wald test	P value	Exp (B) (95% CI)
Pain intensity (0–10 VAS)	−1.2	0.6	4.3	0.04	0.3 (0.1 to 0.9)
Headache (% yes)	1.8	0.5	13.0	<0.01	6.0 (2.3 to 15.8)
Downward rotation (% yes)	1.7	0.4	14.7	<0.01	5.3 (2.3 to 12.6)
FRT (% positive)	1.4	0.5	7.9	0.01	4.0 (1.5 to 10.6)
C2-3 dysfunction (% yes)	1.4	0.7	3.7	0.06	3.9 (1.0 to 15.5)
Cervical rotation ROM to painful side (degrees)	0.2	0.1	4.4	0.04	1.2 (1.0 to 1.4)

FRT, flexion rotation test; ROM, range of motion; VAS, Visual Analogue Scale.

dysfunction in the lower cervical region (C5-7) and the most common scapular posture was in protraction. The logistic regression confirmed that the presence of headache, scapular downward rotation and a positive FRT were the prominent factors predictive of the likelihood of a positive response to manual scapular repositioning. Combined, the results suggest that altered scapular alignment and especially a downwardly rotated position is most likely to be clinically relevant in patients presenting with an upper cervical disorder and possibly cervicogenic headache.[23 38]

The positive changes in the neck to scapular repositioning could have been in both pain and cervical rotation range or one of these. The precise way these subgroups responded seemed to relate to baseline pain or cervical ROM. The participants who improved in pain only, were more likely to have higher intensity of neck pain whereas those who improved in ROM only were more likely to have less cervical ROM. A greater positive FRT was more pronounced in those improved in both pain and range. However, there were no specific or typical clinical features that could differentiate between the three sub-groups. Thus this differentiation into subgroups did not appear to be of clinical relevance as the degree of responsiveness to scapular repositioning was independent of clinical features.

Likewise, functional difficulties were not useful in differentiating responsive (including the subgroups) and non-responsive groups (table 3). The leading function aggravating neck pain was computer work, reported by 83% of both groups (PSFS), which reflects the long-known association between neck pain and computer work.[39] Interestingly, lifting was the second most frequently nominated activity in both groups. The mean DASH score and activity items scored as positive (>2) by at least 50% of participants were also comparable and in line with other studies reporting the upper limb functional restrictions in neck pain.[21 40] Interestingly, loading from upper limb activities was nominated as provocative regardless of the response to scapular repositioning. This might question the relevance of this clinical test but the difference in response may be explained by the location of the patient's disorder. The responsive group presented more commonly with an upper cervical disorder whereas the non-responsive group presented with a lower cervical disorder. Nevertheless more research is needed to establish reasons for the upper limb functional limitations, whether due to the location of the neck pain disorder, the nature of the scapular dysfunction or other associated factors, such as fear avoidance.

Furthering the proposal that the regional location of the neck pain disorder might be a key feature in the response to scapular repositioning, the combination of an upper cervical location and a downwardly rotated scapula in the responder group points to a potentially provocative contribution of axioscapular activity to neck pain. Several authors have noted that altered scapular alignment has the potential to adversely influence the biomechanics of the cervical spine through the attachments of the axioscapular muscles.[6 41] Levator scapulae attaches directly to the cervical transverse processes of C1-4 and upper trapezius to the occipital bone and indirectly to the cervical spine via the ligamentum nuchae.[4] Scapular downward rotation is often associated with overuse of the levator scapulae, a lengthened upper trapezius muscle and weakness in the tripartite trapezius and serratus anterior muscle which may result in adverse forces, particularly on the upper cervical structures.[5 7 42] Other scapular postures such as protraction, anterior tilting or winging may also contribute to increased mechanical force on the cervical spine but may not be as provocative as a downward rotated scapula.[15 43] Restoring normal alignment of the scapula might take the load/tension of particularly the levator scapulae off the cervical spine, which then reduces pain and/or improves range of cervical rotation.[5 7 44] Some relief might also be attributed to a reduction in tension in the nerve structures which run through the cervical spine.[5] These proposals are supported by findings of recent clinical trials demonstrating that scapular stabilisation was effective in decreasing pain and disability and improving cervical ROM in patients with neck pain with scapular downward rotation.[10 12] However, further investigations are warranted into clinically important benefits of scapular rehabilitation in patients with neck pain with scapular dysfunction. Clinical trials of scapular exercises to date have not considered if the scapular dysfunction was relevant to participants' neck pain (ie, inclusion if the scapular repositioning changed neck pain and or range of motion) or considered specific subgroups of patients. Our study revealed that patients who responded positively to scapular repositioning more likely presented with upper rather lower cervical dysfunction. It is possible that patients with the upper cervical pain have greater improvement from scapular rehabilitation if levator scapulae is key contributor. The threshold for clinically important effects may be substantially different between patient subgroups.

There are some limitations to this study. Manual scapular repositioning was based on the assessment of altered scapular alignment and performed by an experienced physiotherapist, which might limit generalisability to inexperienced clinicians. Manual repositioning of the scapula was performed only on the more painful side. Outcomes of repositioning on the contralateral side were not considered. Additionally, this study did not include patients with neck pain with no altered scapular position to allow comparison.

CONCLUSION

Manual scapular repositioning resulted in decreased pain intensity and increased cervical rotation ROM in 75% of a cohort who presented with altered scapular alignment. Clinically, the presence of headache, scapular downward rotation and upper cervical dysfunction were strong independent clinical features associated with positive response to scapular repositioning, which supports adverse loading on upper cervical structures secondary to scapular position as a probable contributing factor to neck pain. Skilled scapular repositioning in assessment could direct clinicians towards rehabilitation aimed at improving scapular function to improve neck pain and mobility. Well-designed randomised clinical trials with careful consideration of patient characteristics for inclusion are necessary to test this proposal.

Correction notice This article has been corrected since it was first published. Author name has been updated.

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Contributors All authors (NW, JT, GJ and SU) involved in study concept and design. NW and SU involved in data collection and acquisition. All authors involved in data analysis and interpretation. NW and SU drafted the manuscript. JT and GJ critically revised the manuscript for important intellectual content. All authors read and approved the final version of the manuscript. SU is the guarantor.

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Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval The study was approved by the Institution's ethical review committee for research in humans, Faculty of Associated Medical Science, Chiang Mai University (No. AMSEC-62EX-048) and was conducted in accordance with the declaration of Helsinki. All eligible participants signed a written informed consent statement prior to entering the study.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available on reasonable request.

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