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Cervical and scapula-focused resistance exercise program versus trapezius massage in patients with chronic neck pain
A randomized controlled trial

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Abstract

Objective: The purpose of this study was to investigate the effects of resistance exercise in comparison with those of common exercise on chronic neck pain (CNP) to provide useful clinical guidelines for reducing pain or increasing cervical range of motion (ROM), upper trapezius tone, disability level, and quality of life (QOL).

Methods: The subjects were randomized into a cervical and scapula-focused resistance exercise group (CSREG, n = 21) or trapezius massage group (TMG, n = 20). All groups received a 4-week, five times per week CSRE or TM program for CNP. The visual analogue scale (VAS) score, cervical ROM, myotonometer measures (upper trapezius tone, stiffness, and elasticity), neck disability index (NDI), and short form-36 (SF-36) were identified as the primary outcomes.

Results: Within-group changes in VAS, cervical ROM, myotonometer measures, NDI, and SF-36 were significant in the CSREG and TMG ($P < .05$). The between-group changes in VAS, cervical rotation, myotonometer (upper trapezius tone and stiffness), NDI, and SF-36 after intervention showed significant differences between the CSREG and TMG ($P < .05$).

Conclusion: These results suggest that the CSRE program is effective in improving pain, cervical ROM, upper trapezius tone, disability level, and QOL in patients with CNP. More comprehensive studies with longer follow-up durations are needed to better understand the potential effects of the CSRE program in patients with CNP.

Abbreviations: CNP = chronic neck pain, CSRE = cervical and scapula-focused resistance exercise, NDI = neck disability index, QOL = quality of life, ROM = range of motion, SF-36 = short form-36, TM = trapezius massage, VAS = visual analogue scale.

Keywords: chronic neck pain, disability, musculoskeletal disorders, quality of life, resistance exercise, trapezius tone

1. Introduction

Neck pain (NP) is a disorder that affects individuals and society worldwide.[1] The prevalence of NP over 12 months is 30% to 50%, and the prevalence of activity-limiting NP is 11%.[2] Poor physical condition, as well as a lack of exercise, can be possible causes of NP development because of poor posture.[3] If the NP persists for more than 3 months, it is considered chronic NP (CNP); head forward protraction is the main cause of NP, causing increased lordosis in the cervical region and weakness in the muscles.[4] CNP may include physical dysfunction, such as neuromuscular dysfunction, decreased cervical mobility, and reduced quality of life (QOL).[5–7]

Interventions for functional disorders in patients with CNP primarily involve physical agents, manual therapy, and therapeutic exercise; however, surgical methods may be required to treat severe damage.[8–10] Some studies have suggested that progressive resistance exercise is beneficial for CNP.[11,12] However, a recent Cochrane Review suggested that although resistance exercise is beneficial in the treatment of CNP, there is insufficient evidence to make clear recommendations.[13] Thus, the current guidelines for the management of CNP deliver unclear recommendations regarding the variety of exercises that should be favored.[14] Therapeutic exercise plays an important role in the restoration of muscular imbalance.[15,16] Some interventional studies in patients with CNP have focused only on neck exercise.[17,18] However, the trapezius muscle is important.

The trapezius muscle has a supporting and stabilizing function on the movement of the upper extremities, such as in many everyday work tasks (computer work, cleaning, eating).[19,20] The trapezius muscle is involved in many activities related to

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the high prevalence of NP. This muscle participates in long-term low-level activity, which is typically appreciated by office workers.[21] Weakness of the middle and lower trapezius and tightness of the upper trapezius lead to muscle imbalance in the scapulothoracic region, leading to NP and cervicogenic headaches.[22,23] Many methods exist for treating the tightness of the upper trapezius, including the muscle energy technique, ischemic compression, static stretching, and massage therapy.[24,25] Among these methods, massage therapy can secure flexibility by effectively reducing tightness without affecting the joints. Sherman et al[26] reported that massage therapy is safe and has a clinical benefit in treating CNP in the short term. Domingo et al[27] reported a decrease in muscle activity after massaging the upper trapezius in healthy subjects. Saavedra et al[28] reported a decrease in pain and muscle activity in subjects with myofascial trigger points in the upper trapezius. Massaging the upper trapezius safely reduces tightness and solves the scapulothoracic imbalance. Alternatively, resistance exercise in the trapezius can reduce NP by resolving scapulothoracic imbalances.[29] Bae et al[30] reported a decrease in neck muscle imbalance by applying middle and lower trapezius resistance exercises and levator scapulae and upper trapezius stretching. Kim and Kim[31] reported that lower trapezius resistance exercise could be used in patients with unilateral NP to reduce pain and disability level and increase cervical range of motion (ROM). In this way, resistance exercises affecting the middle and lower trapezius is a method of resolving scapulothoracic imbalance by reducing weakness.

Therefore, the purpose of this study was to investigate the effects of cervical and scapula-focused resistance exercise (CSRE) in comparison with those of trapezius massage (TM) on CNP and to provide useful clinical guidelines for reducing pain and/or increasing cervical ROM, upper trapezius tone, disability level, and QOL. The research hypothesis was that the CSRE would better than TM at reducing pain and disability level, and improving cervical ROM, upper trapezius tone, and QOL in participants with CNP.

2. Methods

2.1. Trial design

This study was a single-blind, randomized clinical trial. After screening, participants were randomized into two groups (CSRE group [CSREG] and TM group [TMG]) through central allocation and consecutively treated for 4-weeks. Block randomization was performed using a computer-generated random number list prepared by a researcher with no clinical involvement in the trial. Other additional interventions (e.g., oriental medicine, medications, acupuncture, surgical procedure, surgery) not specified in the protocol were not allowed during the 4-week period. The visual analogue scale (VAS) score, cervical ROM, myotonometer measures (upper trapezius tone, stiffness, and elasticity), neck disability index (NDI), and short form-36 (SF-36) were identified as the primary outcomes. A flowchart of the trial design is shown in Figure 1. The study was conducted in accordance with the rules of the Declaration of Woosuk University. Written informed consent was obtained from all participants. This study was approved by the Ethics Committee of Woosuk University (approval number WS-2020-03).

2.2. Subjects

Pilot testing was performed in six volunteers (n = 3 each in the CSREG and TMG) to determine the number of subjects required in this study. A power analysis based on the pilot study results was completed for a significance level of 0.05, power of 0.80, and effect size of 1.63. The power analysis performed using G-power software (version 3.1.2; Franz Faul, University of Kiel, Kiel, Germany) showed that this study required eight subjects in each group. Patients with CNP by physicians who were referred to the rehabilitation clinic were included in the study. Patients with CNP who had substantial activity limitation and restriction of participation were included according to the clinical practice guidelines on NP, linked to the International Classification of Functioning, Disability, and Health (ICF): NP with mobility deficits, headaches, movement coordination impairments, and radiating pain.[14] NDI and QOL were used for activity and participation limitations. The inclusion criteria were as follows: volunteers aged 29 to 66 years, limited cervical spine activity or NP as the main complaint, having pain for more than 3 months, and having a baseline NDI score of at least 20% (10 points).[32] The exclusion criteria were as follows: stenosis, traumatic injury history, previous surgery related to the cervical spine, history of cervical spine fracture, hypermobility, cancer, inflammatory rheumatologic disease, severe psychological disorder, and pregnancy. A summary of the clinical information of the participants is presented in Table 1.

2.3. Assessments

Prior to randomization, demographic data, namely age, height, weight, sex, smoking, and exercise habits, were collected via an assessment form specifically designed for this study by an experienced researcher. Before and after the intervention, evaluations related to pain, cervical ROM, upper trapezius tone, disability level, and QOL were conducted by a physical therapist.

The average NP intensity was indicated by placing a mark on a 10-cm VAS anchored with one end representing “no pain” and the other end representing the “worst pain.”[33] A minimal clinically important change was defined as a difference of at least 2.5 cm between successive recordings of self-reported pain.[34] This is a highly reliable tool with good test–retest reliability (intraclass correlation coefficient [ICC] = 0.85–0.95).[35]

The cervical ROM was measured using a goniometer and always conducted in the same order: flexion, extension, lateral flexion, and rotation, with the subject sitting with the head and trunk held erect. The universal goniometer is frequently used to quantify limitations in ROM.[36] Physical therapists use the ROM measurement to quantify limitations at the beginning of intervention and to quantify the effects of intervention.[37] This is a reliable tool with inter-rater reliability (ICC = 0.88–0.78).[38]

Muscle tone was measured using a myotonometer. Muscle tone in the upper trapezius muscle was measured using a Myoton PRO (Myoton AS, Tallinn, Estonia). The myotonometer can measure muscle tone simply and noninvasively. It provides results with an intra-rater correlation coefficient as high as 0.94 to 0.99.[39] The subjects were positioned in a sitting posture on a chair with a back. The myotonometer was positioned vertically on the most sensitive parts (along trigger points) of the upper trapezius muscle. In this way, tone (Hz), elasticity (log decrement), and stiffness (N/m) were measured. To obtain a measurement, the skin was pressured with a force of 0.18 N followed by five impulses of 0.4 N at 15-seconds intervals.[40] The value of the mechanical variable was checked by measuring the vibration on the surface of the skin with a myotonometer. The trigger points were measured on either side three times at 15-seconds intervals, and the average value of the result was recorded.

The NDI measured disability in the neck. The NDI is a self-report instrument for the assessment of disability in subjects with NP. Each item is scored from 0 to 5.[41] Scoring of the NDI is as follows: 0 to 4 = no disability, 5 to 14 = mild, 15 to 24 = moderate, 25 to 34 = severe, and >34 = complete. A 5-point change is required to be clinically meaningful.[42] This instrument has been shown to have a high degree of test–retest reliability, internal consistency, acceptable level of validity, sensitivity to severity levels, and changes in severity over time.[41,43] This is a highly reliable tool with test–retest reliability (ICC = 0.93).[44]

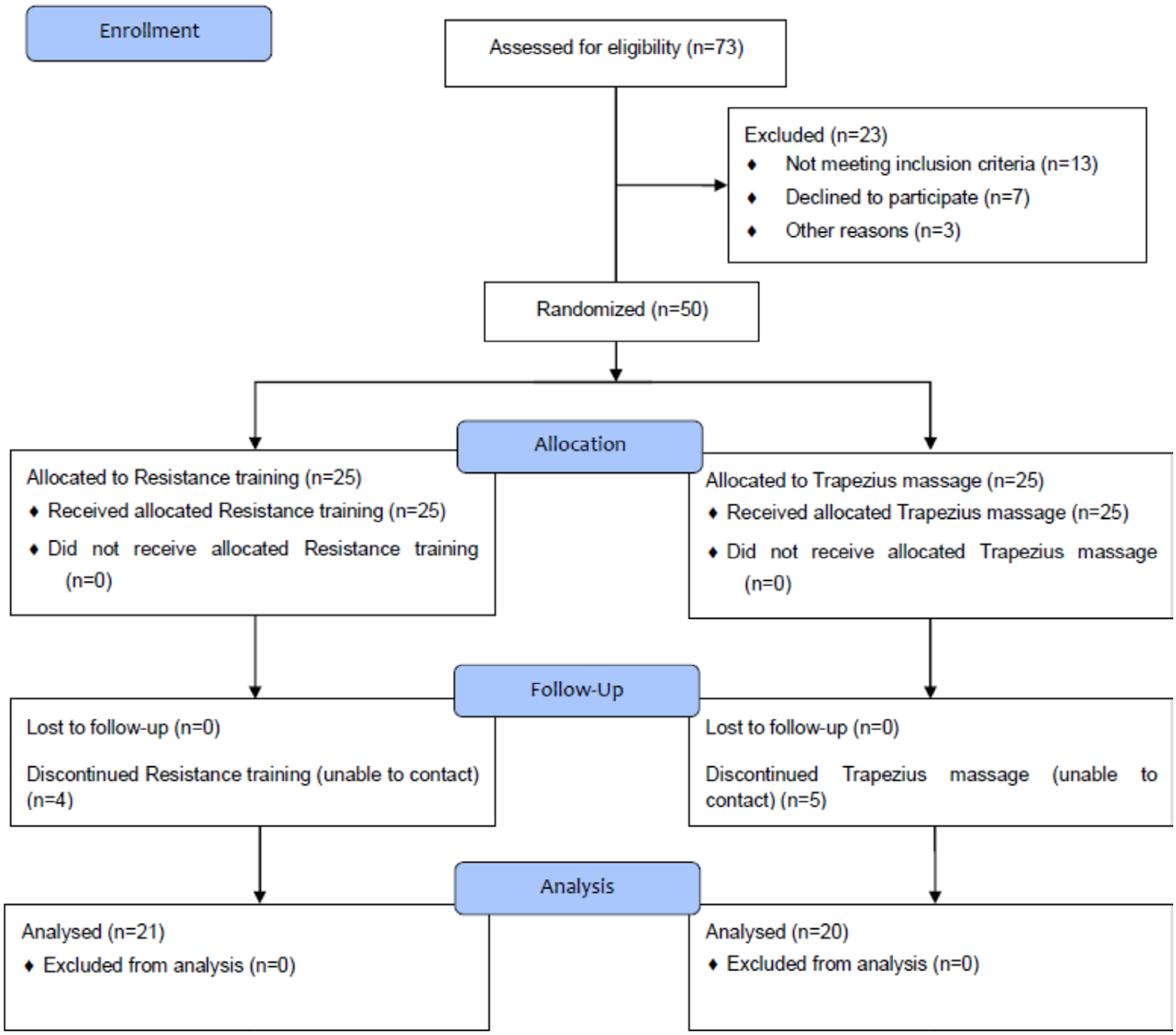

Figure 1. Flowchart of the trial design.

QOL was evaluated using the Medical Outcome Study SF-36-Item Health Survey.[45] The Korean version, the reliability and validity of which was established by Han et al[46] was used. It includes eight different fields: physical function, physical role limitations, bodily pain, general medical health, vitality, social function, emotional role limitations, and mental health. The eight fields can be joined using the physical component score (PCS) and mental component score (MCS), which reflects physical and mental health. Scores range from a maximum of 100 to a minimum of 0, with higher scores indicate better functioning. This is a reliable tool with good inter-rater reliability (ICC = 0.71–0.89).[46]

2.4. Intervention

The subjects were randomized into two groups: CSREG (n = 21) and TMG (n = 20). Both groups participated in a routine physical therapy program consisting of a hot pack, electronic therapy, and microwaves. The CSREG received a 4-week resistance exercise program for CNP. The program was managed by professionals working in clinics. Subjects in the CSREG performed resistance exercise using a Thera-Band Elastic Band (color: green) five times per week. They were also given door anchors and handles to use with the elastic bands and were instructed to record all training sessions in a diary. The CSRE program was used by modifying that reported by Iversen et al[47] The CSRE program consisted of the following exercises: chin tuck, seated row in long sitting, bent-over row, scapular retraction, standing row, seated row when sitting on chair, letting full down, and standing chest press (Fig. 2). In this study, the CSRE consisted of 5-minutes warm-up, 20-minutes main, and 5-minutes cool-down exercises. Damage from the exercise program was prevented by utilizing a 5-minutes stretching protocol during the warm-up and cool-down exercises. The exercise was repeated 10 to 20 times per set for three sets following the exercise sessions with a 30-seconds rest between each set. The number of repetitions in the CSRE program progressively increased during the 4-week exercise program. The subjects were asked to perform three sets of 10 to 15 repetitions during the first and second week, progressing to three sets of 15 to 20 repetitions during each session in the third and fourth weeks.

The TMG received a 4-week, five times per week TM program for CNP. The program was managed by professionals working in clinics. A standardized 20-minute TM program was followed at each session after the subjects laid down prone on the massage table. Five min of myofascial release was applied to warm soft tissues of the upper back and neck; 10 minutes of trigger point release was applied bilaterally

Table 1

General characteristics of the participants (n = 41).

Variables	All patients	Resistance training group	Trapezius massage group	P†
Number of patients	41	21	20	–
Sex (male/female)	22/19	12/9	10/10	.65
Age (yr)	47.88 (10.41)	47.90 (9.75)	47.85 (11.32)	.99
Height (cm)	168.58 (7.53)	168.00 (7.76)	169.20 (7.42)	.62
Body weight (kg)	63.58 (10.66)	63.90 (10.72)	63.25 (10.87)	.85
Body mass index (kg/cm^2)	22.18 (1.86)	22.44 (1.84)	21.90 (1.88)	.36
Exercise habits (yes/no)	15/26	7/14	8/12	.66
Smoking (yes/no)	10/31	4/17	6/14	.41
Visual analogue scale (score)	4.78 (1.38)	4.81 (1.49)	4.75 (1.28)	.89
Neck range of motion				
Flexion (degree)	43.68 (4.63)	44.19 (4.65)	43.15 (4.66)	.48
Extension(degree)	62.27 (5.99)	61.71 (5.44)	62.85 (6.60)	.55
Lateral bending (right, degree)	37.36 (5.08)	37.19 (4.92)	37.55 (5.36)	.82
Lateral bending (left, degree)	37.34 (4.88)	37.28 (4.63)	37.40 (5.24)	.94
Rotation (right, degree)	65.32 (5.76)	65.28 (5.47)	65.35 (6.19)	.97
Rotation (left, degree)	65.76 (5.47)	65.76 (5.79)	65.75 (5.26)	.99
Upper trapezius				
Tone (right, Hz)	13.95 (1.42)	14.07 (1.49)	13.83 (1.35)	.59
Tone (left, Hz)	14.29 (1.77)	14.39 (1.78)	14.17 (1.81)	.70
Stiffness (right, N/m)	228.61 (39.90)	231.86 (42.27)	225.20 (38.04)	.60
Stiffness (left, N/m)	229.24 (40.46)	230.14 (42.70)	228.30 (39.07)	.89
Elasticity (right, D Log)	1.31 (0.37)	1.32 (0.36)	1.29 (0.39)	.83
Elasticity (left, D Log)	1.30 (0.34)	1.32 (0.35)	1.28 (0.33)	.71
Neck disability index(score)	22.22 (4.52)	21.67 (4.75)	22.80 (4.31)	.43
Short form-physical component (score)	29.17 (3.30)	29.38 (3.16)	28.96 (3.50)	.69
Short form-mental component(score)	45.41 (7.12)	45.25 (7.70)	45.58 (6.65)	.88

Values are presented as mean (standard deviation).
†Independent *t* test.

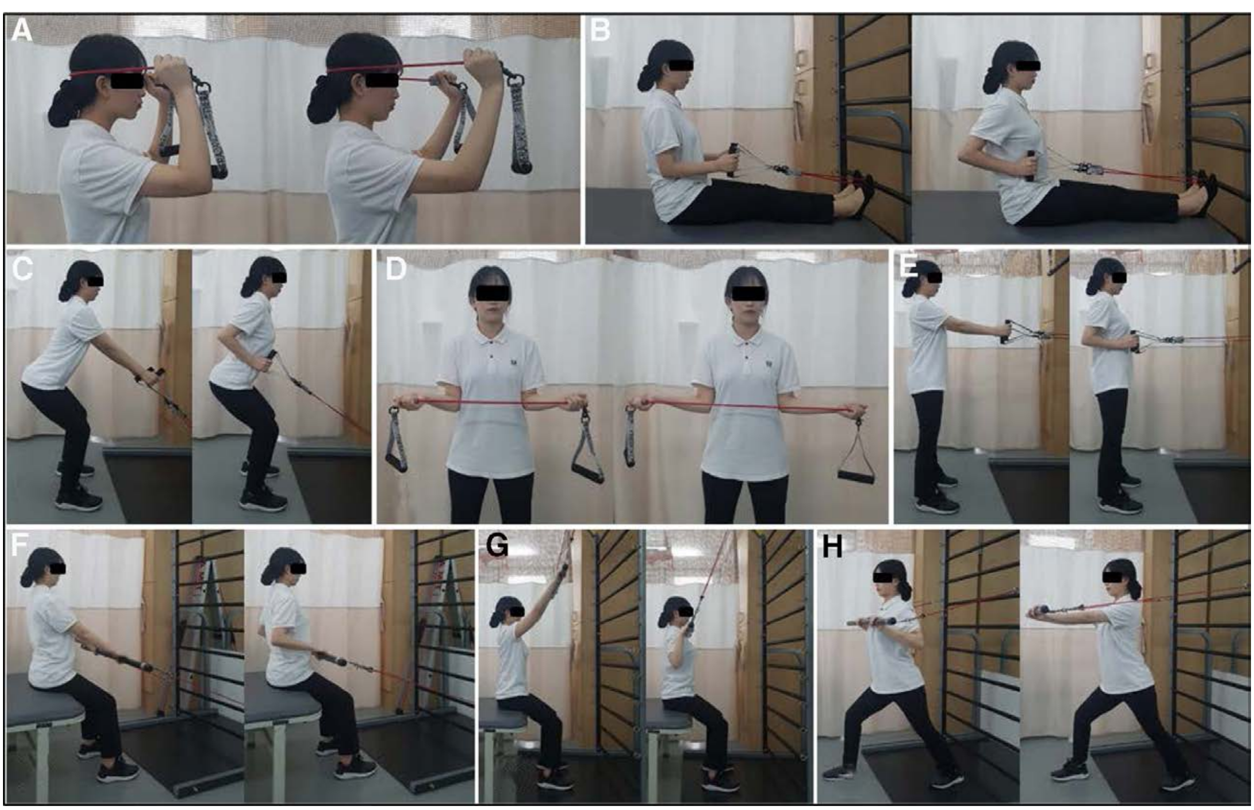

Figure 2. Resistance training program: (A) chin in, (B) seated row in long sitting, (C) bent over row, (D) scapular retraction, (E) standing row, (F) seated row in sitting on chair, (G) let full down, and (H) standing chest press.

to myofascial trigger points in the suboccipital muscles and upper trapezius; the final 5 minutes consisted of circular or cross-fiber friction on the suboccipital muscles and upper trapezius, and ended with gentle effleurage and petrissage of the upper back and neck.[48]

2.5. Statistical analysis

PASW statistics software (version 23.0; SPSS, Chicago, IL) was used to perform all statistical analyses. Descriptive and analytical statistics are presented. Data are presented as mean ± standard deviation (SD). Normality was examined using a one-sample Kolmogorov–Smirnov test. Paired t tests were performed to examine within-group changes in variables after CSRE. Independent t tests were conducted to compare between-group differences between the CSREG and TMG. Statistical significance was set at $P < .05$. The P value alone is insufficient to determine the effect of the intervention. Thus, we also calculated the effect size using Cohen's d to determine meaningful between-group changes. Cohen's d was defined as the difference in the mean baseline values in the CSREG and TMG divided by the SD. An effect size ≤ 0.20 indicates a small change; 0.50, a moderate change; and 0.80, a large change.[49] Therefore, treatment results with a large effect size represent more significant outcomes than those with a small effect size.

3. Results

3.1. Comparison of neck pain, disability level, and QOL changes

Within-group changes in the VAS score were significant in the CSREG (t = 26.77, $P < .05$) and TMG (t = 20.68, $P < .05$). The between-group changes in VAS score after intervention showed significant differences between the CSREG and TMG (t = 2.46; $P < .05$; 95% confidence interval [CI], 0.06–0.67).

Within-group changes in NDI were significant in the CSREG (t = 31.25, $P < .05$) and TMG (t = 30.15, $P < .05$). The between-group changes in NDI after intervention showed significant differences between CSREG and TMG (t = 2.14; $P < .05$; 95% CI, 0.05–1.97).

Within-group changes in SF-PCS were significant in the CSREG (t = –14.96, $P < .05$) and TMG (t = –15.84, $P < .05$). The between-group changes in SF-PCS after intervention showed significant differences between the CSREG and TMG (t = –2.15; $P < .05$; 95% CI, –6.50 to –0.20). Within-group changes in SF-MCS were significant in the CSREG (t = –53.25, $P < .05$) and TMG (t = –39.96, $P < .05$). The between-group changes in SF-MCS after intervention were significantly different between the CSREG and TMG (t = –5.25; $P < .05$; 95% CI, –4.01 to –1.78) (Table 2).

3.2. Comparison of cervical ROM changes

Within-group changes in cervical flexion were significant in the CSREG (t = –12.45, $P < .05$) and TMG (t = –17.54, $P < .05$). The between-group changes in cervical flexion after the intervention showed no significant differences between the CSREG and TMG.

Within-group changes in cervical extension were significant in the CSREG (t = –8.11, $P < .05$) and TMG (t = –6.76, $P < .05$). The between-group changes in cervical extension after the intervention showed no significant differences between the CSREG and TMG.

Within-group changes in cervical right lateral bending were significant in the CSREG (t = –13.51, $P < .05$) and TMG (t = –18.65, $P < .05$). The between-group changes in cervical right lateral bending after the intervention showed no significant differences between the CSREG and TMG. Within-group changes in cervical left lateral bending were significantly different between the CSREG (t = –12.31, $P < .05$) and TMG (t = –11.57, $P < .05$). The between-group changes in cervical left lateral bending after the intervention showed no significant differences between the CSREG and TMG.

Within-group changes in right cervical rotation were significant in the CSREG (t = –32.19, $P < .05$) and TMG (t = –22.58, $P < .05$). The between-group changes in right cervical rotation after the intervention showed significant differences between

Table 2

Comparison of neck pain, disability, and quality of life within and between groups.

Variables		Resistance training group (n = 21)	Trapezius massage group (n = 20)	Difference (post-pre) Resistance training group	Difference (post-pre) Trapezius massage group	95% CI	t	P‡
Visual analogue scale (score)	Pre	4.81 (1.49)	4.75 (1.28)	2.67 (0.46)	2.30 (0.50)	0.06 to 0.67	2.46	.02*
	Post	2.14 (1.31)	2.45 (1.28)					
	t	26.77	20.68					
	P†	0.00*	0.00*					
Neck disability index (score)	Pre	21.67 (4.75)	22.80 (4.31)	10.76 (1.58)	9.75 (1.45)	0.05 to 1.97	2.14	.04*
	Post	10.90 (3.48)	13.05 (3.35)					
	t	31.25	30.15					
	P†	0.00*	0.00*					
Short form-physical component (score)	Pre	29.38 (3.16)	28.96 (3.50)	–18.31 (5.61)	–14.96 (4.22)	–6.50 to –0.20	–2.15	.04*
	Post	47.69 (8.71)	43.92 (7.46)					
	t	–14.96	–15.84					
	P†	0.00*	0.00*					
Short form-mental component (score)	Pre	45.25 (7.70)	45.58 (6.65)	–19.51 (1.67)	–16.61 (1.86)	–4.01 to –1.78	–5.25	.00*
	Post	64.76 (6.70)	62.19 (6.24)					
	t	–53.25	–39.96					
	P†	0.00*	0.00*					

Values are presented as mean ± standard deviation.
CI = confidence interval.
†Paired t test.
‡Independent t test.
*$P < .05$.

the CSREG and TMG ($t = -4.92$; $P < .05$; 95% CI, –3.06 to –1.28). Within-group changes in cervical left rotation showed significant differences between the CSREG ($t = -32.30$, $P < .05$) and TMG ($t = -24.28$, $P < .05$). The between-group changes in cervical left rotation after the intervention showed significant differences between the CSREG and TMG ($t = -2.40$; $P < .05$; 95% CI, –1.86 to –0.16) (Table 3).

3.3. Comparison of upper trapezius tone, stiffness, and elasticity changes

Within-group changes in right upper trapezius tone were significant in the CSREG ($t = 7.68$, $P < .05$) and TMG ($t = 5.33$, $P < .05$). The between-group changes in right upper trapezius tone after the intervention showed significant differences between the CSREG and TMG groups ($t = 3.60$; $P < .05$; 95% CI, 0.25–0.89). Within-group changes in left upper trapezius tone were significant in the CSREG ($t = 5.81$, $P < .05$) and TMG ($t = 4.49$, $P < .05$). The between-group changes in left upper trapezius tone after intervention showed significant differences between the CSREG and TMG ($t = 2.24$; $P < .05$; 95% CI, 0.06–1.20).

Within-group changes in right upper trapezius stiffness were significant in the CSREG ($t = 6.38$, $P < .05$) and TMG ($t = 5.25$, $P < .05$). The between-group changes in upper trapezius right stiffness after the intervention showed significant differences between CSREG and TMG ($t = 2.90$, $P < .05$, 95% CI, 5.11–28.79). Within-group changes in upper trapezius left stiffness were significant in the CSREG ($t = 6.56$, $P < .05$) and TMG ($t = 5.35$, $P < .05$). The between-group changes in upper trapezius left stiffness after the intervention showed significant differences between CSREG and TMG ($t = 3.03$, $P < .05$, 95% CI, 5.75–28.92).

Within-group changes in upper trapezius right elasticity were significant in the CSREG ($t = 4.25$, $P < .05$) and TMG ($t = 3.51$, $P < .05$). The between-group changes in right upper trapezius elasticity after the intervention were not significantly different between the CSREG and TMG. Within-group changes in upper trapezius left elasticity were significant in the CSREG ($t = 4.53$, $P < .05$) and TMG ($t = 3.56$, $P < .05$). The between-group changes in left upper trapezius elasticity after the intervention were not significantly different between CSREG and TMG (Table 4).

4. Discussion

This study was conducted to investigate to compare how a 4-week CSRE or TM protocol affects pain, cervical ROM, upper trapezius tone, disability level, and QOL in participants with CNP. After the 4-week intervention, both groups showed significant differences in pain, cervical ROM, upper trapezius tone, disability level, and QOL compared with those at baseline. Between the post-test values, CSREG demonstrated significant improvement in pain, cervical ROM, upper trapezius tone, disability level, and QOL compared with the TMG. The findings supported our research hypothesis that CSREG would improve pain, cervical ROM, upper trapezius tone, disability level, and QOL compared with TMG. To the best of our knowledge, this is the first study to demonstrate the beneficial effects of CSREG on pain, cervical ROM, upper trapezius tone, disability level, and QOL compared with the TMG in participants with CNP.

Patients with cervical spine disorders often have upper crossed syndrome. Patients with upper crossed syndrome show weakness and inhibition of the deep neck flexor, serratus anterior, trapezius (middle, lower), and rhomboid. On the other hand, the upper trapezius, levator scapula, suboccipital

Table 3

Comparison of neck range of motion within and between groups.

Variables		Resistance training group (n = 21)	Trapezius massage group (n = 20)	Difference (post-pre): Resistance training group	Difference (post-pre): Trapezius massage group	95% CI	t	P‡
Flexion (degree)	Pre	44.19 (4.65)	43.15 (4.66)	–5.48 (2.01)	–4.50 (1.15)	–2.02 to 0.07	–1.89	.07
	Post	49.67 (3.18)	47.65 (4.99)					
	t	–12.45	–17.54					
	P†	0.00*	0.00*					
Extension (degree)	Pre	61.71 (5.44)	62.85 (6.60)	–2.90 (1.64)	–2.05 (1.36)	–1.81 to 0.10	–1.81	.08
	Post	64.62 (6.58)	64.90 (5.74)					
	t	–8.11	–6.76					
	P†	0.00*	0.00*					
Lateral bending (right, degree)	Pre	37.19 (4.92)	37.55 (5.36)	–4.28 (1.45)	–3.65 (0.87)	–1.40 to 0.13	–1.68	.10
	Post	41.47 (5.94)	41.20 (4.75)					
	t	–13.51	–18.65					
	P†	0.00*	0.00*					
Lateral bending (left, degree)	Pre	37.28 (4.63)	37.40 (5.24)	–4.24 (1.58)	–3.60 (1.39)	–1.58 to 0.30	–1.37	.18
	Post	41.52 (5.78)	41.00 (5.12)					
	T	–12.31	–11.57					
	P†	0.00*	0.00*					
Rotation (right, degree)	Pre	65.28 (5.47)	65.35 (6.19)	–9.57 (1.36)	–7.40 (1.46)	–3.06 to –1.28	–4.92	.00*
	Post	74.86 (5.65)	72.75 (6.20)					
	t	–32.19	–22.58					
	P†	0.00*	0.00*					
Rotation (left, degree)	Pre	65.76 (5.79)	65.75 (5.26)	–8.81 (1.25)	–7.80 (1.44)	–1.86 to –0.16	–2.40	.02*
	Post	74.57 (5.90)	73.55 (5.93)					
	t	–32.30	–24.28					
	P†	0.00*	0.00*					

Values are presented as mean ± standard deviation.
CI = confidence interval.
†Paired *t* test.
‡Independent *t* test.
*$P < .05$.

Table 4

Comparison of upper trapezius tone, stiffness, and elasticity within and between groups.

Variables		Resistance training group (n = 21)	Trapezius massage group (n = 20)	Difference (post-pre)		95% CI	t	P‡
				Resistance training group	Trapezius massage group			
Tone (right, Hz)	Pre	14.07 (1.49)	13.83 (1.35)	1.01 (0.60)	0.44 (0.37)	0.25–0.89	3.60	.00*
	Post	13.06 (1.19)	13.38 (1.33)					
	t	7.68	5.33					
	P†	0.00*	0.00*					
Tone (left, Hz)	Pre	14.39 (1.78)	14.17 (1.81)	1.33 (1.05)	0.70 (0.70)	0.06–1.20	2.24	.03*
	Post	13.06 (1.19)	13.47 (1.41)					
	t	5.81	4.49					
	P†	0.00*	0.00*					
Stiffness (right, N/m)	Pre	231.86 (42.27)	225.20 (38.04)	32.00 (22.98)	15.05 (12.81)	5.11–28.79	2.90	.01*
	Post	199.86 (44.26)	210.15 (39.21)					
	t	6.38	5.25					
	P†	0.00*	0.00*					
Stiffness (left, N/m)	Pre	230.14 (42.70)	228.30 (39.07)	32.24 (22.53)	14.90 (12.45)	5.75–28.92	3.03	.00*
	Post	197.90 (44.22)	213.40 (37.28)					
	t	6.56	5.35					
	P†	0.00*	0.00*					
Elasticity (right, D Log)	Pre	1.32 (0.36)	1.29 (0.39)	0.22 (0.23)	0.12 (0.16)	−0.03 to 0.22	1.49	.14
	Post	1.10 (0.21)	1.17 (0.26)					
	t	4.25	3.51					
	P†	0.00*	0.00*					
Elasticity (left, D Log)	Pre	1.32 (0.35)	1.28 (0.33)	0.22 (0.22)	0.12 (0.15)	−0.02 to 0.22	1.66	.11
	Post	1.10 (0.21)	1.16 (0.20)					
	t	4.53	3.56					
	P†	0.00*	0.00*					

Values are presented as mean ± standard deviation.
CI = confidence interval.
†Paired *t* test.
‡Independent *t* test.
$^*P < .05$.

muscle, sternocleidomastoid, and pectoralis major and minor tend to be facilitated and shortened.[50] The imbalance of muscles around the scapulothoracic region may contribute to the initiation or persistence of NP. In addition, the development of NP may contribute to the impaired control of the muscles around the scapulothoracic region.[51] Function of muscles around the scapulothoracic regions is very important in the clinical management of patients with NP.[52] Clinically, muscle imbalance around the scapulothoracic region is recognized to occur when the upper trapezius is shortened, and the lower trapezius is weak. In patients with NP, it has been clinically shown that the strength and endurance of the lower trapezius muscle are reduced.[50] Kim and Park[53] suggested that muscle weakness and NP are related. Petersen and Wyatt[29] found that the muscle strength of the lower trapezius compared to that of the contralateral side in patients with NP was 3.9 N lower, which was statistically significant. Strengthening exercises targeting the scapulothoracic muscles led to increased muscle strength in weakened scapulothoracic muscles, reduced muscle imbalance, and improved scapulothoracic posture.[54] However, there have been few studies on interventions targeting the imbalance of scapulothoracic muscles to increase muscle strength of weakened scapulothoracic muscles in patients with NP. Therefore, in this study, resistance exercises using elastic bands were performed for muscles that showed inhibition and weakness.

The protocols were reported to reduce pain and disability level, and improve cervical ROM, upper trapezius tone, and QOL. Chin exercises were performed to strengthen the deep neck flexor muscles. A standing chest press was used to strengthen the serratus anterior. Seated row when long sitting, bent-over row, scapular retraction, standing row, seated row while sitting on a chair, and letting full down were performed to strengthen the rhomboid and trapezius (middle, lower) muscles. The chin tuck exercise in CSRE is thought to leaf to increased cervical ROM and decreased pain by reducing the strain on the sternocleidomastoid muscle due to forward head posture and improving neck alignment by activating the longus coli (deep neck flexor).[10,55] Patients with scapulothoracic dysfunction and NP show weakening of the serratus anterior,[56] and the standing chest press exercise in our study activated the serratus anterior, thereby reducing scapulothoracic dysfunction and NP. A high level of activity in the upper trapezius increases scapulothoracic dysfunction and NP.[57] In our study, it is considered that the tone and stiffness of the upper trapezius are reduced by activating the middle and lower trapezius optionally through seated row when long sitting, bent-over row, scapular retraction, standing row, seated row in sitting on chair, and letting full down exercises. Therefore, the disability level and QOL in patients with CNP is thought to have improved due to decreased pain, increased cervical ROM, and decreased tone and stiffness of the upper trapezius.

CNP reduces muscle strength and health-related QOL associated with the neck[58]; increases costs for both individuals and society; and can lead to reduced work capacity, work disability, and decreased productivity.[59] Andersen et al[60] reported that the application of resistance exercise using elastic bands reduced pain in healthy adults who complained of neck and shoulder pain. Li et al[61] reported that neck resistance exercise reduced NP and disability levels in women with CNP. In this study, NP, disability level, and QOL significantly changed after the intervention in the CSREG and TMG. In addition, the results of the between-group comparisons showed better results in the CSREG. In patients with CNP, repetitive micro-injuries and pain result in decreased contractility of the muscles around the neck and changes in the motor and sensory systems.[62] This impairment of motor and sensory function leads to inhibition of the contraction of the muscles around the neck, in addition to muscle atrophy and weakness.[63] The intervention program in this study was thought to improve NP, disability level, and QOL by strengthening muscles.

The main clinical symptoms of NP include pain and dysfunction, limitation of motion, and weakness of the neck muscles. ROM is a representative measure of the mobility of the neck joint and soft tissue. Limitation of rotation leads to more severe level dysfunction than that with limitations of other movements.[64] In this study, cervical flexion, extension, lateral flexion, and rotational movements in the CSREG and TMG changed significantly after the intervention. In addition, cross-group comparisons showed better results in the CSREG only for rotation. Therefore, CSRE is considered a solution for severe cervical rotation dysfunction. There were no statistically significant differences in cervical flexion, extension, or lateral flexion. In conclusion, the cervical rotational ROM after intervention was improved significantly more in the CSREG than in the TMG, but there was no significant difference in the improvement in flexion, extension, or lateral flexion. This study showed similar results to those reported in Kim and Kim[31]'s study, which found that the rotation of the cervical increased significantly compared to that in the control group after the lower back muscle strengthening exercise, but there was no significant difference in flexion, extension, or lateral flexion. According to a study by Johnston et al,[65] the increase in cervical rotation was significantly higher in patients with NP than in those without NP. Clinically, this may be associated with alleviation of NP symptoms.

Patients with NP complain of pain and subjective symptoms such as stiffness and tension in the upper trapezius muscle.[64] Chronic whiplash injury patients have increased tension in the upper trapezius and subscapularis compared to that in healthy subjects during repeated arm tasks.[66] In addition, when shoulder stability is poor, the activity of the upper trapezius muscle is increased to promote stability. This leads to increased shoulder elevation, resulting in greater stress on the upper trapezius.[50] As such, patients with NP experience increased tension of the upper trapezius due to deterioration of the stability of the shoulder and performance of the task. In this study, the tone and stiffness of the upper trapezius muscle in the CSREG and TMG showed significant changes after the intervention. In addition, the between-group comparison showed better results in the CSREG. These results suggest that the muscles involved in shoulder stability are strengthened to reduce the stress on the upper trapezius during repetitive arm-related tasks.

This study has a few limitations. First, our findings should not be generalized to all patients with NP. Second, the results of follow-up measures were not performed; thus, the carry-over effect of the intervention could not be determined. Third, the muscle strength of scapulothoracic muscles weakened by NP was not evaluated. Therefore, to generalize the results of this study, it is necessary to measure strength variables, and further studies to supplement these limitations will be conducted.

5. Conclusion

In this study, 41 patients with CNP with muscle imbalance around the scapulothoracic region were trained for 4 weeks. There were statistically significant differences in pain, cervical ROM, upper trapezius tone, disability level, and QOL. It was found that CSRE for weakened scapulothoracic muscles positively affected pain, disability level, and QOL in NP patients, and increased cervical ROM and decreased upper trapezius tone. Based on these results, it may be necessary to consider physical therapy in NP patients. Therefore, it is suggested to refer to the muscle strength of the weakened scapulothoracic muscles in clinical interventions for patients with NP and to apply the appropriate CSRE in parallel.

Author contributions

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