

The Effects of Sitting Questionmark Exercise and Brugger's Relief Exercise on Pain, ROM, Proprioception, NDI in Patients with Chronic Cervical Pain

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Abstract

Purpose : This study aimed to evaluate the effects of sitting questionmark exercise (SQE) and brugger's relief exercise (BRE) on pain, ROM, proprioception, NDI in 60 Patients with Chronic Cervical Pain (CCP).

Methods : In this study the VAS and NDI were used to investigate changes in pain and disability with SQE and BRE. The pre and post intervention intra group differences were analysed with a paired t-test for mean values, and the inter group differences were analyzed with an independent t-test for mean values.

Results : The pain of both of groups was lowered with statistical significance. Pain of SQE group is lower than that of BRE group with statistical significance. ROM in both groups was improved, but there is no significant difference between two groups. NDI in both of groups were significantly decreased after the intervention, but there was no significant difference between groups. there was NDI ratio (%) significant difference between each groups.

Conclusion : SQE intervention may be considered a more effective clinical approach for reducing pain and restoring proprioception in patients with CCP.

Key Words : chronic cervical pain, neck disability index, visual analogue scale, sitting questionmark exercise, brugger's relief exercise

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I. Introduction

1. Background

Statistically, 30 % of the total population experiences cervical pain, and 14 % of them end up developing Chronic cervical pain (CCP) that lasted longer than 6 months (Borghouts et al., 1999). Among the causes of CCP, the lack of physical activity is coupled with repetitive or excessive work that involves unstable postures, triggering muscle spasm and structural imbalance around the cervical spine. In particular, the sitting position is reported as a risk factor for musculoskeletal disorders (Szczygiel et al., 2017).

Cervical pain radiates along the myotomes that belong to the spinal segments into surrounding structures, even in the absence of nerve compression and stimulation, causing pain over a wide area, including the posterior scapular region, posterior occipital region, upper extremity, and upper thoracic region. A steep rise in the number of individuals with CCP has been reported amid widespread use of computers and smartphones (Ye et al., 2017).

However, it is not easy to maintain a good sitting position with the natural curvature of the spine preserved. As a poor posture causes pain, the sitting position is critical for spine health (Drza-Grabiec et al., 2016). A dynamic analysis of the sitting position revealed that the pelvis is tilted further posteriorly, while providing a base to support the upper body, thereby causing the lumbar lordotic curvature to disappear and making the spine flat, compared with the standing position. These posture changes in the lower spine eventually influence the proximal upper segments.

Different kinds of therapeutic approaches for the treatment of CCP have been suggested in previous studies. Some studies stated that upper cervical and upper thoracic manipulations are more effective than mobilization and exercise (Dunning et al., 2016) and that training the deep cervical flexor muscles is an effective therapeutic approach (Bobos et al., 2016). Thoracic mobilization and self-stretching were effective for

patients with CCP. However, opinion on the best therapeutic method for CCP is divided among researchers (Hudson & Ryan, 2010). In other previous studies, Woo and Kim (2016) stated that the exercise program turned out to be more effective when it was applied with thoracic extension exercise. The strengthening and endurance exercises for the scapulothoracic joint of patients with CCP are known to affect the mobility of the thoracic spine directly and reduce pain significantly.

2. Purpose of study

In these studies, postural correction mainly focused on improving the movement of the thoracic curvature in the direction of total extension. Such attempts could not avoid a reversal phenomenon in which the curvature of the thoracic segments became much flatter than normal without an appropriate kyphosis. Since no study has explored the difference in the exercises for total and partial thoracic extensions, we sought to determine the effects of SQE as an exercise for partial thoracic extension and BRE as an exercise for total thoracic extension.

II. Methods

1. Subjects

A total of 70 subjects among the visitors of Y hospital in Daejeon, Korea, were recruited on the basis of the following inclusion criteria: presence of recurring or persistent CCP that lasted longer than 6 months from the onset, NDI of 4~15 or 15~29, and ability to perform the required intervention exercises with ease. Subjects were excluded if they had a medical history in orthopedics or neurology, infection, car accident over the last year, and surgical procedure in the spine and extremity joints and if they were pregnant. A total of 60 subjects participated in this study.

Sixty subjects underwent tests to measure the pain intensity, ROM, proprioception, and NDI before the experiment and were randomly assigned to the following two groups: the SQE group (n=30) and the BRE group (n=30). Before the experiment, all the subjects received a full explanation of the experimental method based on the contents of the Helsinki Declaration, and conducted the subjects who fully understood and voluntarily agreed the contents and purpose of the experiment. The subjects completed four sets of 12 reps for each exercise and underwent the measurement tests again after the experiment.

2. Intervention

Exercises were divided into sitting questionmark exercise groups and Brugger's relief exercise groups.

Sitting questionmark exercise is to perform the SQE easily without the risk for pelvic deformity, the subjects were instructed to place their feet on the floor completely and keep their knee joints 10 cm below the hip joints in 45° of abduction. The subjects sat with their ischial tuberosity touching the chair, maintained their physiological curvature for the TL spine, and then placed both forearms tightly against the stool bars. While holding that position, SQE was performed by breathing in between the medial borders of the scapula on both sides and breathing out while still maintaining the physiological TL curvature and creating thoracic kyphosis (Lehnert-Schroth & Christ, 2007).

Brugger's relief exercise is to perform the BRE easily without the risk for pelvic deformity, the subjects were instructed to place their feet on the floor completely and keep their knee joints 10 cm below the hip joints in 45 ° of abduction. The subjects sat hitting their ischial tuberosity on the chair and maintained their physiological curvature for the TL spine. Following external rotation of the glenohumeral joints, tension was relaxed with each inhalation, and depression and retraction of the shoulder girdle were performed with each exhalation (Liebenson, 2002).

1) Visual Analog Scale

VAS was used to measure the intensity of pain perceived by the subjects before and after the interventions. VAS is a line marked in units from 0 to 10, where 0 indicates "no pain" on the left and 10 indicates "unbearable pain" on the right side of the scale (Boonstra et al., 2008).

2) Range of motion

An electro-goniometer (Mobee med, SportMed, Germany) was used to measure the ROM. This instrument is used to measure angle of joint and ROM, such as flexion, extension, and right and left side bending, through a computer-aided analysis.

3) Proprioception

The electro-goniometer was also used to measure the reposition errors for the TL joints. In the standing and resting positions, the electro-goniometer was set to 0, and the blinded subjects were instructed to perceive a position for 3 seconds at 30 %, 60 %, and 90 % positions, preset between the resting position and the maximum ROM positions and to repeat it five times. The subjects were provided a 5-minute rest period to eliminate the learning effects, and joint reposition sense was measured. Each target angle was measured three times (Yang et al., 2015a).

4) Neck disability index

To measure the abilities of the patients with CCP to perform activities of daily living, a 10-item Korean version of the NDI for cultural adaptation, modified from the original NDI, was used (Lee et al., 2011).

2. Statistical Analysis

Data were analyzed using the SPSS version 18.0 for windows. A paired t-test was used to compare the difference before and after the interventions in each group, and an

independent t-test was used to compare the differences between the groups. A statistically significant level was set at $p < .05$.

III. Results

General characteristics of the subjects the 60 participants were divided into the SQE and BRE groups those are shown no significant difference ($p > .05$).

1. Comparison of the pain, ROM, NDI between the two groups

The effects of SQE and BRE on cervical pain were studied.

There was no difference between the two groups before the interventions. however, the pain scores of both groups decreased significantly ($p < .05$) after the interventions. The pain score of the SQE group was significantly lower than that of the BRE group ($p < .05$)(Table 1).

The effects of SQE and BRE on the TL joint ROM of the patients with CCP were studied. Both groups a statistically significant increase in pre and post-ROM comparisons for intervention ($p > .05$), with no significant difference in ROM between the two groups ($p < .05$).

The effects of SQE and BRE on the NDI were studied. Before the interventions, there was no difference between the two groups. After the interventions, the NDI of both groups significantly decreased ($p < .05$). however, there was no significant difference between the groups (Table 1).

Table 1. Comparison of the pain between the two groups

		SQE group (n=30)	BRE group (n=30)	t
VAS	Pre	6.37±1.33 ^a	6.37±1.33	0.000
	Post	2.87±1.30	3.70±1.58	-2.227 [†]
	t	18.394 [*]	20.538 [*]	
NDI	Pre	18.07±4.04 ^a	17.43±3.81	0.624
	Post	11.27±3.66	11.90±3.73	-0.664
	t	21.28 [*]	19.87 [*]	

^amean ± standard deviation. Abbreviations: SQE = Sitting Question Mark Exercise; BRE = Brugger’s Relief Exercise. ^{*}Significant differences between the pretest and posttest ($p < .05$)

[†]Significant differences between each group ($p < .05$)

2. Comparison of the proprioception (flexion, extension) between the two groups

The effects on flexion reposition error of the TL joint in the patients with CCP were studied there was no significant between the two groups. After the interventions, the flexion reposition errors in the SQE group (flexion 30 %, 60 %, and 90 %) and BRE group (flexion 30 % and 60 %) significantly decreased (both $p < .05$). There was no significant difference between the two groups.

The effects on extension reposition error of the TL joint in the patients with CCP were studied there was no significant between the two groups. After the interventions, the extension reposition error in the SQE group (30 % and 90 %) significantly decreased ($p < .05$); only the extension reposition error of the SQE group at 60 % had no significant difference ($p > .05$). Further, the extension reposition error in the BRE group (30 %) significantly decreased ($p < .05$). There was also no significant between the two groups.

3. Comparison of the proprioception (right, left side bending) between the two groups

The effects on the right side bending reposition error of the TL joint in the patients with CCP were studied there was no significant between the two groups. After the interventions, the reposition error in both groups decreased. The active TL right side bending (30 %, 60 %, and 90 %) proprioception in both groups significantly decreased ($p<.05$). There was a significant difference ($p<.05$) in the right side bending

proprioception at post 30% and 90% between each group (Table 2).

The effects on the left side bending reposition error of the TL joint in the patients with CCP were studied. there was no significant between the two groups. After the interventions, the left side bending reposition error in the SQE group (30 %, 60 %, and 90 %) significantly decreased ($p<.05$). The left side bending reposition error in the BRE group (30 % and 90 %) also significantly decreased ($p<.05$)(Table 2).

Table 2. Comparison of the proprioception between the two groups

		SQE group (n=30)	BRE group (n=30)	t
RSB	Pre 30 %	3.46±1.83 ^a	3.41±1.07	0.121
	Post 30 %	1.66±0.84	2.76±0.93	-4.806 [†]
	t	5.019 [*]	2.679 [*]	
	Pre 60 %	4.49±2.26	3.77±1.16	1.567
	Post 60 %	4.49±2.26	2.98±1.31	-1.057
	t	3.963 [*]	2.709 [*]	
	Pre 90 %	4.38±2.46	4.33±1.87	0.089
	Post 90 %	2.61±1.12	3.27±1.26	-2.151 [†]
	t	4.115 [*]	3.031	
LSB	Pre 30 %	3.37±1.68 ^a	3.18±1.34	0.485
	Post 30 %	1.89±1.11	2.45±1.09	-1.996
	t	4.759 [*]	2.520 [*]	
	Pre 60 %	3.64±1.28	3.40±1.44	0.678
	Post 60 %	2.47±1.41	3.09±1.34	-1.726
	t	3.796 [*]	1.251	
	Pre 90 %	3.68±1.26	3.84±1.48	-0.460
	Post 90 %	2.73±1.09	3.04±1.17	-1.075
	t	3.149 [*]	3.409 [*]	

RSB = right side bending; LSB = left side bending

IV. Discussion

A poor sitting posture is one of the most common causes of functional limitations experienced by patients with CCP. Poor postures cause functional problems particularly in the

cervical and lumbar spines (Drza-Grabiec et al., 2016). If a dynamic approach is applied to address these issues, the improvement in thoracic extension would be emphasized for the thoracic spine. Meanwhile, clinicians have applied therapeutic exercises in a bid to promote thoracic mobility in patients with CCP and reported effective results in previous

studies (Lee & Lee, 2017). However, no study has been conducted yet to compare the exercises for total and partial thoracic extensions. Therefore, this study aimed to determine the effects of SQE and BRE as intervention exercises for partial and total thoracic extensions, respectively, on pain, ROM, proprioception, and NDI in randomly assigned patients with CCP and to provide clinical evidence on this topic.

Patients with CCP experience physical changes, such as reduced joint mobility, weakened strength and endurance, and muscle fiber contraction and adhesions in the joint (Hanten et al., 2000). Progression to the chronic phase may further disrupt the cervical proprioception and sensorimotor function (Sjolander et al., 2008), leading to limitations in activities of daily living and inconvenience (Hakkinen et al., 2007). In this study, the difference in the VAS scores was statistically significant before and after the interventions (SQE : -55 % and BRE : -42 %). In particular, the 13% decrease in the VAS scores was prominent in the SQE group compared with in the BRE group. This result is attributable to the fact that SQE mainly focused on restoring the normal position of the spine that an increased functional activity of the serratus anterior muscles improved scapular stability and reduced pain significantly (Castelein et al., 2016).

A previous study also reported reduced pain in patients with CCP after Petersen et al. (2016) interventions aimed at improving thoracic mobility and strengthening the scapulothoracic muscles. Celenay et al. (2016) also reported reduced VAS score -57 % after exercises for cervical and scapulothoracic stabilizations. Scapulothoracic strengthening exercises instantly reduced cervical pain in office workers and mentioned that self-interest and effort to exercise whenever time permits, even in workplaces, are important elements for pain management. Both SQE and BRE are easy to perform for everyone, making them excellent self-management techniques (Andersen et al., 2012).

Concerning the effects of SQE and BRE on ROM, SQE group demonstrated statistically significant increase in flexion 3 %, extension 9 %, right side bending 5 %, and left side bending 6% after the intervention. and BRE group

demonstrated statistically significant increase in flexion 4 %, extension 9 %, right side bending 5 %, and left side bending 5 % after the intervention.

A previous study interestingly claimed that an elevated sagittal mobility can improve side bending motions. In this study, the gliding mobilization during exercise sessions might have occurred among segments that have minimal mobility among facet joints. The combination of exercise and breathing techniques appears to have additionally helped in increasing thoracic and rib mobilities. Hur (2006) reported a more significant increase in the thoracic mobility exercise group, and its close relationship with ROM increased when subjects completed exercises for 3~6 month periods in the thoracic mobility and lumbar stability groups. In their study, ROM was measured while the subjects held their arms straight up as high as possible. According to Ko et al. (2009) thoracic mobilization is critical in promoting spinal mobility and securing ROM as well in patients with cervical pain as the thoracic spine contains relatively many hypermobile segments. Woo and Kim (2016) stated that thoracic extension exercise has positive effects on the movements of lordotic and lumbosacral angles.

Proprioception plays an essential role in normal motor control by distinguishing between joint movement and joint position based on sensory input and feedback (Riemann & Lephart, 2002). This test was used in this study to measure the control of TL joint movement.

With respect to the effects of SQE and BRE on proprioception the changes in the flexion of the BRE group varied, showing a statistically significant difference at 30 % and 60 % and a statistically insignificant difference at 90 %; the post-intervention changes in flexion in the SQE group were statistically significant. In extension measurements, the SQE group showed statistically significant changes after the intervention at 30 %, 90 %, the extension reposition error of the SQE group at 60 % had no significant difference. However, the BRE group showed a statistically significant post-intervention change at 30 % only, and the changes at 60 % and 90 % were not statistically significant. The

post-intervention changes in right side bending were statistically significant at all preset angles. The difference in right side bending between the groups was statistically significant at 30 % and 90 %. In left side bending, the SQE group demonstrated statistically significant changes after the intervention at all preset angles. However, the BRE group showed statistically significant changes at 30 % and 90 %, and the change at 60 % was not significant.

These results suggest that the exercise program, designed to provide stability for the pelvic girdle and shoulder girdle and mobility for the TL joint, and the breathing technique effectively improved joint movement control by stimulating joint mechanoreceptors and activating local muscles involved in stability and movement. The SQE group outperformed the BRE group, albeit not in all items, and the underlying reason can be explained by the nature of the exercise. The SQE requires tight placement of the forearms against the stool bars, allowing the shoulder girdle to be firmly fixed, which helped the subjects control the movement of their TL joint more efficiently than the BRE group who controlled their TL joint through the depression and retraction of the shoulder girdle (Hidalgo-Perez et al., 2015).

In this study, the reposition errors were used to assess proprioception. Similarly, Humphreys and Irgens (2002) used a craniocervical movement training program to induce the eye-head-cervical coordination in patients with CCP and the consequent improvement in cervical coordination. Jull et al. (2007) reported that a training program aimed for active movements, including flexion, extension, side bending, and rotation, improved the active reposition sense. Yang et al. (2015b) investigated the changes in reposition errors before and after interventions in patients with CCP divided into the cervical stability training group and the upper thoracic manipulation group and reported more positive results in the latter. Baek (2015) reported that TL reposition errors significantly decreased in the thoracic mobilization group, compared with the lumbar stability training group.

The post-intervention NDI significantly decreased in the SQE and BRE groups; however, no difference between the

groups was observed. This finding confirms that both exercises are safe and effective for patients with CCP as a means of pain relief and stress management. Kjellman and Oberg (2002) also reported that general therapeutic exercises combined with McKenzie exercise were effective in reducing NDI.

In this study, the subjects were limited to a young population (20s and 30s) showing minimal variations in age. As we compared the immediate effects of the exercises, the application was immediately. Hence, the results of the study cannot be generalized to long-term outcomes. Another limitation is that ROM and proprioception reposition errors can vary depending on the subject's ability to concentrate. Further studies are necessary to overcome the aforementioned limitations and to provide more objective assessments and study results.

V. Conclusion

The aim of this study was to compare the effects of SQE and BRE on pain, ROM, proprioception, and NDI in patients with CCP and to suggest effective exercise options for clinical purposes. In conclusion, I suggest to use SQE to clinically because SQE may be considered a more effective clinical approach for reducing pain, ROM, restoring proprioception and NDI in patients with CCP.

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