Immediate Effects of Breathing Re-Education on Respiratory Function and Range of Motion in Chronic Neck Pain

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Objective: *Neck pain is associated with certain breathing patterns and may lead to altered respiratory function. Moreover, the altered breathing patterns may cause neck pain symptoms. This study has determined the effects of respiratory muscle re-education on neck pain symptoms and respiratory function.*

Material and Method: *Subjects with chronic neck pain (n = 36) were re-educated with three breathing patterns for 30 min. The pain intensity at rest and at the end-of-range of each neck movement, the cervical range of motion (CROM) measured from photographic images and the chest expansion during full inhalation and exhalation recorded using videography were evaluated before and after breathing re-education. Upper trapezius, anterior scalene, and sternocleidomastoid activity were evaluated during normal and deep breathing using surface electromyography, and the respiratory function measured by a spirometer was also evaluated during the same period.*

Results: *The pain intensity and the muscle activity were significantly decreased after re-education. The CROM and chest expansion at lower rib cage were significantly increased after re-education.*

Conclusion: *Breathing re-education can change breathing patterns and increase chest expansion. This change leads to an improvement in CROM. Positive consequences may result from the improvement in diaphragm contraction or reduced activity of accessory muscles.*

Keywords: *Breathing, Neck pain, Re-education, Respiratory function*

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Neck pain can lead to a decrease in the strength of deep neck muscles, while the superficial neck flexor muscles are compensated by greater activation and cause fatigability(1). In addition, neck pain results in a decrease in the cervical range of motion (CROM). Moreover, neck pain is also related with breathing patterns. Several studies have shown that patients with neck or back pain have poor breathing patterns(2-5). The use of accessory respiratory muscles, especially the sternocleidomastoid (SCM), anterior scalene (AS) and upper trapezius (UT) in every breathing cycle leads to shallow breathing and results in hypomobility of the rib cage, especially at the 4th-6th thoracic levels(2,3). Constant contraction of these muscles tends to cause hypertonia and a shortening of these muscles and eventually sets them into a forward head posture. One study has shown a strong association between increased forward head posture and decreased respiratory muscle strength in patients with neck pain(6). Diaphragmatic breathing is a relaxation technique that may lead to a decrease in the activity of the accessory muscles of respiration. Moreover, changing to a proper breathing pattern by motor relearning techniques may alter neck pain symptoms and the ventilatory pump. Therefore, this study aimed to determine the effects of breathing re-education on neck pain symptoms, CROM and respiratory function.

Material and Method

All subjects who voluntarily participated in the study were recruited with an internet announcement or from the Physical Therapy Clinic of the Faculty of Physical Therapy in Mahidol University. All subjects used self-management to relieve neck pain and were included with non-specific chronic neck pain (more than six months), mild to moderate pain, and aged 18-45 years. All subjects provided written inform consent before

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participating in the study. The protocol for the study was approved by the MU-IRB (COA. No. MU-IRB 2011/078.3103) before being applied to subjects.

Study measurements

Pain intensity

The neck pain intensity was rated with a visual analog pain rating scale at rest and while performing functional movement.

Cervical range of motion (CROM)

Front, lateral, and top view pictures were obtained to assess the CROM in the sitting position. Markers were placed at the tragus of the ear, the 7th cervical (C7) spinous process, the base and tip of the nose and the acromion processes. The subjects were asked to sit with their backs straight and leaning on the backrest of the chair, place hands on their thighs and look straight ahead. The CROM in flexion, extension, right and left lateral flexion and right and left rotation were obtained at the end range of each movement. Then the CROM was determined by digitizing the markers using Scion Image Software, version 4.0.3.2, written by the National Institute of Health.

Neck muscles activity

Neck muscle activity (left and right SCM, AS, and UT) were evaluated using a surface EMG while lying in a supine position and deep breathing through an incentive spirometer in a sitting position. The electrodes were placed on all of these muscles with the standard EMG electrode placement technique[7-9]. EMG activities were recorded while the subjects laid in a supine position for one minute and performed deep breathing through an incentive spirometer for five repetitions. The root-mean-square (RMS) amplitudes of the EMG signal pattern were computed with the band-pass filter set at 20 Hz and 300 Hz to reduce the noise level[7-9].

Ventilatory pump measurement

The ventilatory pump was indicated by respiratory function and chest expansion. Respiratory function was measured with a spirometer (Vmax Encore 29, VIASYS Healthcare Inc., USA). The spirometry test was applied to all subjects in a standardized fashion according to the American Thoracic Society (ATS) guidelines[10]. The three levels of chest expansion (4th rib, xiphoid process and costal cartilage of the 10th rib) in terms of anterior-posterior (AP) and lateral displacement were measured using two video cameras. The markers were placed at the anterior and lateral sides of each level. Synchronization between subjects and video was determined by the subjects pressing a hand switch to turn the light on and off when full inhalation or exhalation was reached.

Breathing re-education

Three breathing patterns (upper rib, diaphragmatic, and lower costal breathing) were provided to all subjects. All subjects learned the correct breathing patterns with verbal guidance to help perform the movement. Then all three breathing patterns were applied to all subjects with relaxed and smooth movement guidance. Each type of breathing pattern was performed for five cycles with a rest of at least one minute until 15 cycles were completed.

Procedures

All previously mentioned measurements were assigned to all subjects. Then, they received breathing re-education as mentioned for 30 minutes. After that, all previously mentioned measurements were assigned to all subjects immediately.

Statistical analysis

The Wilcoxon signed-ranks test was used to compare the differences in pain intensity between the periods before and after re-education. The dependent t-test was used to compare the differences in CROM, EMG of neck muscles, and ventilatory pump between the periods before and after re-education.

Results

Thirty-six subjects (8 males and 28 females) with non-specific chronic neck pain were enrolled. The subjects were aged 18-45 years (mean: 28.26$\pm$5.81) and had mild to moderate neck pain intensity (mean: 3.55$\pm$1.68). The pain intensity at rest and at the end-of-range of neck movement significantly decreased after re-education (Fig. 1A). In addition, the CROM was significantly increased in all directions after re-education (Fig. 1B). The neck muscle activities in the supine position also significantly decreased after re-education (Fig. 2A). Similarly, during deep breathing through an incentive spirometer, the activities of all neck muscles, except right UT, were significantly decreased after re-education (Fig. 2B). However, from video recording data, two subjects elevated the trunk and shoulder when taking deep breaths through the incentive spirometer. Therefore, the researcher removed the data of the two subjects and re-analyzed it. The

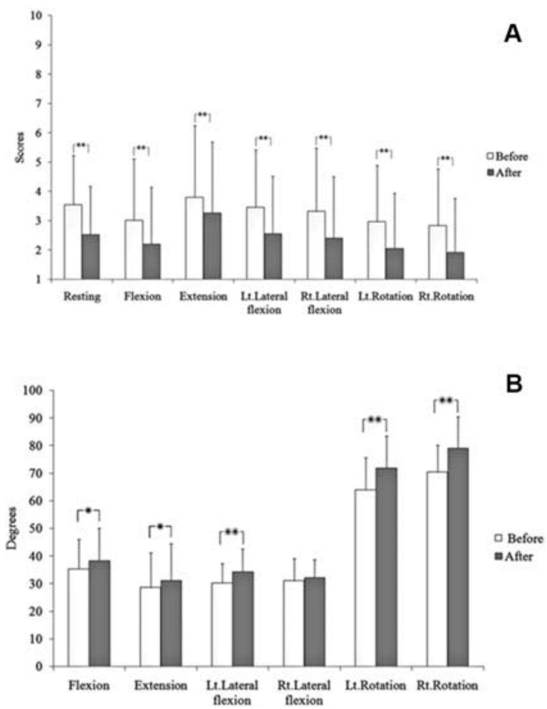

Fig. 1 Comparisons of pain intensity (A), and CROM (B) between before and after re-education (* = $p \leq 0.05$, ** = $p \leq 0.01$).

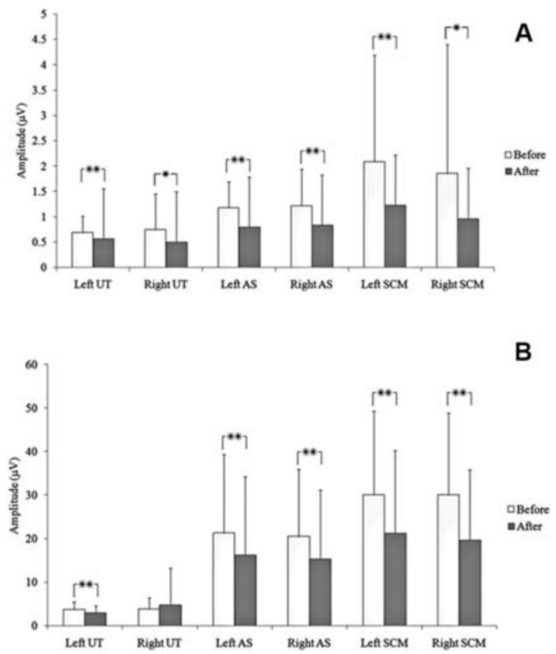

Fig. 2 Comparisons of neck muscle activity while lying in the supine position (2A) and deep breathing (2B) between before and after breathing re-education (* = $p<0.05$, ** = $p<0.01$).

results (n = 34) revealed a significant decrease in activity in the right UT after re-education. Moreover, the lower level of chest expansion in the lateral direction was significantly increased after re-education, whereas not all levels of chest expansion in the AP direction and upper and middle levels of chest expansion in the lateral direction differed from the values before re-education (Fig. 3A, B). However, the respiratory function parameters were not significantly different between the periods before and after re-education.

Discussion

The decrease in pain intensity at both rest and end-of-range of each neck movement after re-education may be a result of muscle relaxation, which could be observed in the decrease in neck muscle activity after re-education in the present study. Two other studies also indicated that pain intensity may also decrease after long-term breathing training[4,5]. Most of the directions of CROM were increased after re-education. Hyperactivity of the neck muscles was found in subjects with neck pain, leading to the limitation of CROM[1,2,4-6,11]. A decrease in pain intensity and muscle hyperactivity resulted from muscle relaxation. When the subjects relaxed and had no pain during movement, CROM also increased. The results indicate that only the lower costal level of chest expansion in the lateral direction increased after re-education. As mentioned above, the results imply that subjects with neck pain greatly recruited the diaphragm after breathing re-education. This change resulted in an increase in chest expansion, especially at the lower costal level. On the contrary, at other levels, chest expansion did not differ from before re-education. The results suggest that modifying chest expansion may require an improvement in ribcage mobility, and 30 minutes of re-education might not be sufficient to improve ribcage mobility. Therefore, other modalities such as ribcage mobilization may be necessary. In the same way, respiratory function may require a long period of training to realize improvements[12]. Thus, 30 minutes of re-education were sufficient to improve muscle function but not respiratory function.

Conclusion

Breathing re-education can decrease pain intensity and neck muscle activity and can improve CROM and chest expansion in subjects with chronic neck pain. Moreover, re-education should be assigned

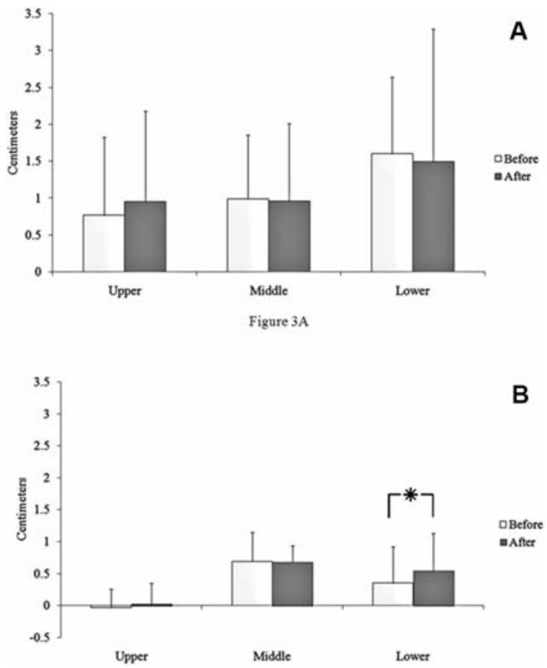

Fig. 3 Comparisons of chest expansion in the AP (A), and lateral directions (B) between before and after breathing re-education (* = $p \leq 0.05$).

particularly for those neck pain patients with abnormal chest expansion and breathing patterns as one of several treatment choices or as part of a home program.

What is already known on this topic?

Previous studies concluded that chronic neck pain in patients was related to the respiratory function. Moreover, breathing training such as deep breathing can reduce pain intensity in patients with musculoskeletal pain.

What this study adds?

Apart from using pain intensity as a main outcome, this research determined the effect of breathing training on other aspects of outcome such as neck muscle activity, CROM and chest expansion. In addition, this breathing training technique can improve symptoms of chronic neck pain and change in chest expansion.

Acknowledgment

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Potential conflict of interest

None.

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ผลของการฝึกหายใจต่อการทำงานของระบบทางเดินหายใจและองศาการเคลื่อนไหวของคอในผู้ที่มีอาการปวดคอเรื้อรัง

อวรวรรณ เยี่ยมพัฒนพร, คีรินท์ เมฆโหรา, วรรธนะ ชลายนเดชะ, จตุพร วงศ์สาธิตกุล

ภูมิหลัง: *อาการปวดคอเกี่ยวข้องกับรูปแบบการหายใจและก่อให้เกิดการเปลี่ยนแปลงการทำงานของระบบทางเดินหายใจ โดยเฉพาะอย่างยิ่งการเปลี่ยนแปลงของรูปแบบการหายใจอาจก่อให้เกิดการเปลี่ยนแปลงของอาการปวดคอร่วมด้วย*

วัตถุประสงค์: *เพื่อศึกษาผลของการฝึกหายใจต่ออาการปวดคอ*

วัสดุและวิธีการ: *ผู้เข้าร่วมศึกษาที่มีอาการปวดคอเรื้อรังจำนวน 36 ราย ได้รับการฝึกรูปแบบการหายใจที่ถูกต้องเป็นเวลา 30 นาที ระดับความเจ็บปวดถูกวัดในขณะพักและเมื่อเคลื่อนไหวคอจนสุดองศาการเคลื่อนไหว ค่ามุมการเคลื่อนไหวคอวัดจากภาพถ่าย การขยายตัวของทรวงอกขณะหายใจเข้าและออกเต็มที่ถูกบันทึกด้วยกล้องถ่ายภาพเคลื่อนไหว การทำงานของกล้ามเนื้อ upper trapezius กล้ามเนื้อ anterior scalene และกล้ามเนื้อ sternocleidomastoid ขณะหายใจปกติและหายใจลึกเต็มที่ถูกวัดโดยเครื่องวัดคลื่นไฟฟ้ากล้ามเนื้อ (electromyography) และการทำงานของระบบทางเดินหายใจวัดโดยเครื่อง spirometer ถูกนำมาใช้วัดก่อนและหลังการฝึกหายใจ*

ผลการศึกษา: *หลังการฝึกหายใจพบว่าระดับความเจ็บปวดและการทำงานของกล้ามเนื้อมีค่าลดลงอย่างมีนัยสำคัญทางสถิติ ค่ามุมการเคลื่อนไหวคอและการขยายตัวของทรวงอกส่วนล่างมีค่าเพิ่มขึ้นอย่างมีนัยสำคัญทางสถิติ*

สรุป: *การฝึกหายใจสามารถเปลี่ยนแปลงรูปแบบการหายใจและเพิ่มการขยายตัวของทรวงอก การเปลี่ยนแปลงนี้นำไปสู่การเพิ่มมุมการเคลื่อนไหวคอซึ่งอาจเกิดจากการทำงานของกล้ามเนื้อกระบังลมที่ดีขึ้นและการทำงานของกล้ามเนื้อช่วยหายใจที่ลดลง*