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Influences of Chronic Shoulder Pain on Muscle Tone Changes in Trunk Muscles

The purpose of this study was to examine the influences of chronic shoulder pain on the muscle tone in trunk muscles. The study's subjects were 40 men and women in their 30 to 50s, which were divided into two groups. A chronic shoulder pain group consisted of 20 subjects who had been diagnosed with chronic shoulder pain by doctors, and a painless group consisted of 20 subjects who had experienced no such pain. An analysis was performed using electromyography on the muscle tone in the rectus abdominalis, external oblique, internal oblique, and erector spinae muscles under the same conditions between the two groups. The analysis results were as follows.
The chronic shoulder pain group exhibited an overall high level of trunk muscle tone than the painless group, along with a statistically significant difference in the rectus abdominalis($p < .05$). Moreover, the chronic shoulder pain group showed differences in the trunk muscle tone depending on the affected side. The chronic left shoulder pain group yielded higher levels of muscle tone in the right-side trunk muscles. In particular, the group revealed statistically significant differences in the rectus abdominalis and internal oblique($p < .05$).
The chronic right shoulder pain group exhibited higher levels of muscle tone in the left-side trunk muscles with a statistically significant difference in the internal oblique($p < .05$). The above results suggested that chronic shoulder pain influences increases in the muscle tone in the trunk muscles on the opposite side to the affected shoulder.

Key words: *Chronic Shoulder Pain; Trunk Muscle; Muscle Tone Change*

Hye Mi Jeon[a], Yoo Rim Choi[b], Si Eun Park[c], Ho Jung An[d], Sang Bin Lee[e], Wan Suk Choi[f], Nyeon Jun Kim[g], Hee Kyoung Kim[h], Mi Jung Kim[c], Soon Hee Kim[c]

[a]Lohas Hospital, Yongin; [b]Daegu Science University, Daegu; [c]Yongin University, Yongin; [d]Dongnam Health College, Suwon; [e]Namseoul University, Cheonan; [f]International University of Korea, Jinju; [g]Pohang College, Pohang; [h]Sungmo Hospital, Chungju, Korea

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Address for correspondence
Soon Hee Kim, PT, Ph.D
Department of Physical Therapy, Yongin University, 470 Samga-dong, Cheoin-gu, Yongin, Korea
Tel: 82-31-8020-2774
E-mail: shkim@yongin.ac.kr

INTRODUCTION

Chronic shoulder pain is one of musculoskeletal disorders, which has symptoms such as shoulder pain, limited range of motion(ROM), and functional disorders(1, 2, 3). Korea's chronic shoulder pain patients have recently increased by 8.9% year on year. In addition, 4.3% of the country's total population is reported to have chronic shoulder pain.

The general causes of chronic shoulder pain include subacromial impingement syndrome, rotator cuff tears, frozen shoulder, shoulder arthritis, subacromial bursa and inflammation in tendons, and degenerative changes(4, 5). The incidence rate of shoulder pain is 10 to 20%, and a study reported that over 20% of the total population experience shoulder pain at least once in their lifetime(6).
Shoulder lesions are mainly the actions to avoid pain due to the degree of pain, limited ROM, and the fear of pain, and cause dysfunctions in muscles or ligaments(7, 8).

Patients with constant pain in their body regions exhibit the pattern of defensive motions due to postural imbalance and stiffening in the affected regions as the defensive actions to avoid pain. They also exhibit increases in unbalanced muscle tone in the trunk muscles(9, 10).

Among trunk muscles, the rectus abdominalis and external oblique provide the overall stability of the trunk, and the internal oblique offers direct stability by being attached to the lumbar spinal segments. The co-contraction of the external oblique, internal oblique, and transversus abdominis plays the role of improving trunk stability by increasing the overall trunk stiffness through increased muscle tone and abdomen pressures(11, 12). As this shows, trunk muscles are a highly important element in maintaining various postures during daily life, and trunk stability should be fully supported to produce large arm and leg forces(13).

In recent years, a number of studies related to trunk exercises have been reported in various fields such as physical therapy, dancing, and sports(14, 15). In particular, while many studies have been presented on postural and balance changes corresponding to low back pain(16, 17, 18), a limited number of studies are available regarding the effects of shoulder pain on trunk muscle changes.

Therefore, this study considered that studies will be necessary on secondary physical changes resulting from chronic shoulder pain, and thus, intended to identify the effects of chronic shoulder pain on changes in the trunk muscle tone.

METHODS

Subjects

This study was performed on 20 patients who had visited L Hospital located in Yongin, Gyeonggi-do and had been diagnosed with chronic shoulder pain and 20 people who had experienced no shoulder or other musculoskeletal pain over the last three years. The selection criteria for the study subjects were as follows: 1) Those who have no neurological disease symptoms or history, vestibular disorders, visual impairment, mental diseases and cognitive impairment, spinal operations, and orthopedic diseases in the legs, and 2) those who understand the study's purpose and consent to participate in the study.

Study Procedures

To measure the trunk muscle tone, the regions in which surface electrodes would be attached were lightly wiped out with alcohol swabs to reduce skin resistance before the attachment, and then the electrodes were applied.

Ag-AgCl bipolar surface electrodes which was 10㎜ in diameter and had a cognitive gel spread were attached to the rectus abdominalis(hereafter, RA), external oblique(EO), internal oblique(IO), and erector spinae(ES).

The electrodes were attached to the point 3㎝ away from the navel on both sides in the RA, the point 15 cm away from the navel at an angle of 40° toward the ribs in the EO, the median point of the line that horizontally connected the anterior superior iliac spine(ASIS) and the navel centerline in the IO, and the point 2㎝ lateral to the scalids of the second lumbar vertebra. Each recording electrode and reference electrode were attached parallel to the muscle fibers.

To normalize the action potential of each muscle, the subjects performed volitional maximum isometric contraction. Each movement was performed for 10 seconds through its division into three parts which consisted of a warm-up for two seconds, the expression of the movement for three seconds, and the maintenance of the final position for five seconds. A one-minute break was given between the movements, and each movement was repeated three times for measurements.

The measured values were standardized by converting the amount of EMG signals in the measured muscles during the maintenance of the final position into the variable of %MVC. The average of %MVC values obtained from three repeated measurements was used for analyses, and a higher value indicated a higher level of muscle tone.

Data Analysis

All the data collected in this study were encoded, and then analyzed using a computer-based statistical processing program(SPSS 18.0). Averages and standard deviations were calculated for the variables of the collected data, and descriptive statistics were used to identify the general characteristics of the subjects.

An independent t-test was conducted to compare the chronic shoulder pain group and the painless groups in terms of the muscle tone, balance, and the movement of the spinal segments. In addition, paired t-tests were performed to compare differences in the muscle tone, balance during standing on one foot, and the movements of the left and right spinal segments according to the affected side. The statistical significance level for all analyses was set at .05.

RESULTS

Differences in the Trunk Muscle Tone between the Chronic Shoulder Pain Group and the Painless Group

The analysis results on differences in the trunk muscle tone between the chronic shoulder pain and painless groups exhibited that the chronic shoulder pain group yielded higher levels of trunk muscle tone in the left and right-side RA, EO, IO, and ES, compared to the painless group. In particular, the right-side RA revealed a statistically significant difference($p<.05$)(Table 2).

Table 1. The differences of trunk muscles tone between groups

Classification		PG	NG	t	p
RA	Rt	63.73±23.17	47.11±23.54	2.250	.030*
	Lt	65.10±30.86	48.72±26.14	1.811	.078
EO	Rt	56.82±26.30	52.64±32.55	.447	.658
	Lt	58.73±27.17	43.63±24.16	1.858	.071
IO	Rt	55.34±22.99	41.00±21.96	2.017	.051
	Lt	63.28±29.22	46.08±25.87	1.970	.056
ES	Rt	44.21±32.35	42.05±23.69	.241	.810
	Lt	36.32±27.58	25.18±17.61	1.523	.136

* $p<.05$
PG: chronic shoulder pain group, NG: no pain group
RA: rectus abdominalis, EO: external oblique
IO: internal oblique, ES: erector spinae

Differences in the Trunk Muscle Tone of the Chronic Shoulder Pain Group according to the Affected Side

Differences in the trunk muscle tone of the chronic left shoulder pain group corresponding to the affected side

The analysis results on differences in the trunk muscle tone of the chronic left shoulder pain group corresponding to the affected side showed that the trunk muscles in the right-side RA, EO, IO, and ES had higher levels of muscle tone. In particular, the RA and IO revealed statistically significant differences($p<.05$)(Table 2).

Table 2. The differences of left.right trunk muscles tone in chronic left shoulder pain group

Classification	LPG		t	p
	Rt	Lt		
RA	68.86±22.97	59.60±19.38	2.797	.021*
EO	62.19±32.11	50.45±19.75	1.195	.263
IO	58.17±23.27	48.80±22.01	2.695	.025*
ES	39.69±25.28	25.98±14.51	2.127	.062

* $p<.05$
LPG: chronic left shoulder pain group
RA: rectus abdominalis, EO: external oblique
IO: internal oblique, ES: erector spinae

Differences in the trunk muscle tone of the chronic right shoulder pain group corresponding to the affected side

The analysis results on differences in the trunk muscle tone of the chronic right shoulder pain group corresponding to the affected side exhibited that the trunk muscles in the left-side RA, EO, and IO, and the right-side ES yielded higher levels of muscle tone. In particular, the IO revealed a statistically significant difference($p<.05$)(Table 3).

Table 3. The differences of left·right trunk muscles tone in chronic right shoulder pain group

Classification	RPG		t	p
	Rt	Lt		
RA	58.59±23.40	70.60±39.59	−1.473	.175
EO	51.44±19.10	67.01±31.87	−1.214	.256
IO	52.50±23.59	77.75±29.19	−2.620	.028*
ES	48.73±39.06	46.66±34.02	.177	.863

* $p<.05$
RPG: chronic right shoulder pain group
RA: rectus abdominalis, EO: external oblique
IO: internal oblique, ES: erector spinae

DISCUSSION

The occurrence of chronic shoulder pain reduces physical functions and activated body regions in daily life(19). Shoulder pain reduces the ROM of shoulder joints, which subsequently restricts movements such as flexion, abduction, internal rotation, and external rotation, and reduces normal physical functions by causing changes in the location of shoulder bones during rest and movement changes due to joint function disorders(2). Therefore, shoulder pain becomes the cause for the imbalance of the muscles around the shoulders and reduction in shoulder joint stability(20, 21).

Continued shoulder pain affects the movements of the muscles and shoulder joints in which the pain occur, and results in compensatory actions in the trunk and the inclination of the center of mass(COM) toward the opposite side to the region with pain(22, 23). Chronic shoulder pain affects not only physical functions, but also usual daily activities due to depression and sleep disturbance(24).

Skolimowski et al. performed a study to examine the trunk muscle tone in patients with pain(23). They reported that the measurement of the postures of the patients with shoulder impingement syndrome resulted in increases in the angle of trunk movements in all variables of flexion, extension, and lateral flexion due to the compensatory actions toward the arms. Moreover, the shoulders and lumbar triangles exhibited asymmetries, and thus, the flexor muscle exhibited a higher level of muscle tone than the extensor muscle as a compensation for the body side that developed instability.

Bertoft et al. reported in their study findings that shoulder impingement syndrome patients exhibited a lower placement of the humeral head and the inclination of the trunk toward the affected side, which become the cause of declines in the muscle tone of pectoralis major and latissimus dorsi muscles(25).

In this study, the chronic shoulder pain group showed a higher level of trunk muscle tone than the painless group. In particular, the group exhibited a statistically significant difference in the RA($p<.05$). Moreover, the chronic left shoulder pain group showed higher levels of trunk muscle tone in the right-side RA, EO, IO, and ES, along with statistically significant differences in the RA and IO($p<.05$). On the other hand, the chronic right shoulder pain group exhibited higher levels of muscle tone in the left-side RA, EO, and IO, and the right-side ES. The group also revealed a statistically significant difference in the IO($p<.05$).

Such results coincide with the previous studies which suggested that shoulder pain changes the trunk muscle tone. Consequently, chronic shoulder pain may increase the overall trunk muscle tone and the muscle tone of the trunk flexor on the opposite side to the affected shoulder, thereby influencing postures and movements.

Therefore, when evaluating and treating patients with chronic shoulder pain. along with the observation of affected regions, changes in the trunk muscle tone should be taken into account. Moreover, structural and functional changes of the human body following chronic shoulder pain should be researched in a concrete manner through consistent future studies.

CONCLUSION

This study was performed to identify the effects of chronic shoulder pain on the trunk muscle tone. The study's subjects were men and women in their 30 to 50s, comprising the chronic shoulder group of 20 patients who had been diagnosed with chronic shoulder pain and the painless group of 20 people who had experienced no pain.

The subjects were measured in terms of the muscle tone in the rectus abdominalis, external oblique, internal oblique, and erector spinae, using eletromyography under the same conditions between the two groups.

The chronic shoulder pain group exhibited an over-all high level of trunk muscle tone than the painless group, along with a statistically significant difference in the RA($p<.05$). The chronic shoulder pain group also revealed differences in the trunk muscle tone according to the affected side. The chronic left shoulder pain group yielded higher levels of muscle tone in the right-side trunk muscles with statistically significant differences in the RA and IO($p<.05$). On the other hand, the chronic right shoulder pain group exhibited higher levels of muscle tone in the left-side trunk muscles with a statistically significant in the IO($p<.05$).

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