JAM
Japanese Acupuncture and Moxibustion

Original research

The effect of electroacupuncture stimulation on shoulder flexibility in the elderly

Fukushima Masaya[1)], Watanabe Koichi[2)]

1) Center for Integrative Med., Faculty of Health Sciences, Tsukuba University of Technology
2) Faculty of Health and Sport Sciences, University of Tsukuba

Abstract

[Introduction] As is true for joints generally, shoulder joint flexibility decreases with age. Decreasing shoulder motion is related to a decline in the activities of daily living. Thus, it is beneficial for the elderly to maintain and improve shoulder flexibility. The motion of the scapulothoracic joint is dynamically controlled by muscular attachments, and a dysfunction of these muscles leads to a dysfunction of the shoulder joint. In this study, we investigated the effect of electroacupuncture stimulation of the elevator muscles of the scapulothoracic joint on shoulder flexibility in the elderly to determine whether such treatment improves flexibility.

[Method] Eight elderly women volunteers received electroacupuncture stimulation (EAS) of the elevator muscles of the scapulothoracic joint. As a control, these same women were given a period of bed rest at a later time. Shoulder joint flexibility was assessed with a back scratch test before and after each trial. Statistical analysis was performed using Tukey's multiple comparison test; P values of less than 0.05 were considered statistically significant.

[Results] There was a significant difference between measurements before and after EAS in the downward scratch test (+7.3mm, 95% confidence interval [CI], 0.44 to 14.06; P = 0.033) and upward scratch test (-11.8mm, 95% CI, -21.38 to -2.37; P = 0.009). There were no significant differences among other measurement values.

[Discussion] EAS of the elevator muscles of the scapulothoracic joint improved back scratch test measurements in the elderly. It is supposed that EAS increases muscular extensibility which affects scapula motion and induces improvement in shoulder flexibility. Further study is required to clarify the full effects of acupuncture on joint flexibility.

Key words: *acupuncture, shoulder, flexibility, elderly, back scratch test*

I. Introduction

It is well-known that joint flexibility decreases with age[1,2)]. Such age-related change has been observed in shoulder joints[3,4)].

The shoulder joint plays an important role in the functioning of the upper extremity. In a five-year prospective study, Jette et al. reported that upper extremity functions decreased in individuals aged 65 and older, especially in those older than 80[5)]. Hoeymans et al. reported that there was a significant association between the physical performance of shoulder motion and basic activities of daily living (BADLs)[6)]. These studies show that it is beneficial for the elderly to maintain and improve shoulder function, which includes flexibility.

The shoulder joint is a multi-functional joint involving the conjunct actions of the sternoclavicular, acromioclavicular, glenohumeral and scapulothoracic joints[7)]. There are many difficulties in attempting to evaluate the multiple motions of the shoulder due to the complex actions of these joints[8,9)]. Rikli et al. reported a decrease of flexibility in the elderly using a back scratch test measuring how close the hands can be brought together behind the back[3)]. Apley's scratch test uses a similar method[10)]. In a back scratch test, shoulder abduction and external rotation can be measured by having the patient reach behind the head and touch the superior aspect of the opposite scapula. Internal rotation and adduction of the shoulder can be tested by having the patient reach behind the back and touch the inferior

Corresponding author: Fukushima Masaya, Center for Integrative Med., Faculty of Health Sciences, Tsukuba University of Technology, Ibaraki, Japan.

aspect of the opposite scapula. These tests are not only simple but also useful for clinical evaluation of shoulder flexibility.

The scapulothoracic joint is a sliding junction between the deep aspect of the scapula and the thoracic rib cage; its motion is dynamically controlled by muscular attachments[11]. Therefore, dysfunction of these muscles leads to dysfunction of the shoulder joint[11].

It is reported that myogenic degeneration is the main factor causing limited joint range of motion (ROM) in the early phase of immobility[12]. It is supposed that less physical activity with aging could induce this kind of myogenic degeneration and limitation of joint mobility.

Elevator muscles of the scapulothoracic joint—the upper trapezius, levator scapular, and rhomboideus muscle—act on stabilizing and elevating the scapula[13]. These muscles frequently cause muscular disability in the shoulder girdle region[14]. Lee et al. reported that electroacupuncture-like stimulation of the upper trapezius or levator scapular on patients of myofascial pain syndrome improved shoulder range of motion[14].

The aim of this study is to investigate the effect of electroacupuncture stimulation of the elevator muscles of the scapulothoracic joint on shoulder flexibility in the elderly

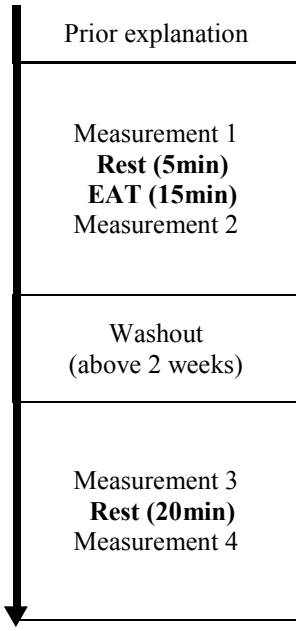

Figure 1. Study procedure

Ⅱ. Materials and methods

1. Participants

Nine elderly women volunteers without upper extremity symptoms, disabilities or pathological dysfunction of the shoulder joint were recruited. Eight completed the study. Participants were informed of the purpose and method of the experiment and agreed to take part in the study according to the principles of the Declaration of Helsinki. This study was approved by the Ethics Committee of the Graduate School of Comprehensive Human Sciences, University of Tsukuba.

2. Intervention

Participants received an acupuncture intervention. After five minutes rest, participants were given an electroacupuncture stimulation (EAS) of the bilateral upper trapezius, levator scapulae and rhomboid major muscles in a prone position. The acupuncturist searched the target muscles by gently palpating and inserted acupunctures into the point not overlapped by other muscles. Pre-sterilized disposable acupuncture needles 50mm in length, 0.2mm in diameter (Seirin Co., Japan) and an electric stimulator (PG-306 pulse generator; Suzuki Iryoki Co., Japan) were used. EAS was applied with a frequency of 1Hz retained for 15 minutes with an intensity that causes muscle twitches without any uncomfortable sensation. The acupuncturist carefully checked that the acupuncture needles were inserted correctly into the muscles by confirming the twitches of each muscle. All EAS was performed by the same acupuncturist.

Control trials consisting of resting on a bed for 20 minutes in a prone position were performed on the same participants two weeks after the acupuncture intervention [Figure 1].

3. Outcome measurement

A bilateral back scratch test was given to participants in a sitting position before and after the intervention in each trial. Each participant was instructed to reach behind the head and touch the spine with her thumb as far as possible (downward scratch test) and to reach behind the back and touch the spine in the same way (upward scratch test) [Figure 2]. The downward scratch test was composed of shoulder abduction and external rotation; the upward scratch was a combined shoulder action of internal rotation and adduction. The distance from the top of the C7 spinous process to the tip of thumb was measured with a tape measure.

4. Statistical analysis

Tukey's multiple comparison test from SPSS 17.0 for Windows (SPSS, Inc., USA) was used to adjust for multiplicity; P values of less than 0.05 were considered statistically significant. All measurement values were expressed as means ± standard deviations.

Figure 2. Back scratch test
Downward scratch test is to reach behind the head and touch the spine with the thumb as far as possible (shown in left figure); upward scratch test is to reach behind the back and touch the spine in the same way (shown in right figure). The distance from top of C7 spinous process to the tip of thumb was measured.

Ⅲ. Results

Data from eight participants (16 shoulders) were obtained. Participant profiles are shown in Table 1. One participant dropped out of the study owing to a shoulder injury that accidentally occurred in routine daily activity. It was confirmed that no significant differences were observed between right and left shoulder active ROM by Student's t-test.

The results of each measurement are reported in Table 2. There was no significant difference between right and left shoulder measurements. No adverse event was observed during the study.

There was a significant difference between measurements before and after EAS in the downward scratch test (+7.3mm, 95% confidence interval [CI], 0.44 to 14.06; P = 0.033) and upward scratch test (-11.8mm, 95% CI, -21.38 to -2.37; P = 0.009). There were no significant differences among the other measurement values.

Table 1. Participant profiles

Age	71.3 ± 6.0 years
Height	154.6 ± 3.0 cm
Weight	52.5 ± 6.1 kg
BMI	22.0 ± 2.4 kg/m^2
Active ROM of shoulder (degrees)*	
Forward flexion	164.6 ± 7.3
Backward extension	25.9 ± 8.5
Abduction	171.3 ± 7.3
External rotation	87.2 ± 12.1
Internal rotation	71.9 ± 14.3
Horizontal flexion	121.9 ± 9.6
Horizontal extension	36.3 ± 7.4

** Bilateral shoulder active ROM was measured by digital goniometer after prior explanation.*

Ⅳ. Discussion and Conclusion

As reported in previous research[14], EAS produced improved flexibility. In the current study, this improvement was considered to be an immediate effect of EAS, as it was evaluated for a uniform group of study participants who received identical acupuncture stimulation.

Shoulder flexibility was evaluated, not with an ROM assessment, but with a back scratch test to assess

Table 2. Measurement values of back scratch test

(n=16, mm, mean±S.D.)

	EAS					Control				
	Before	After	⊿	P value	95% CI	Before	After	⊿	P value	95% CI
Downward scratch	45.0 ± 21.5	52.3 ± 21.2	7.3	0.033*	0.44 to 14.06	48.8 ± 23.6	48.1 ± 22.9	-0.7	0.993	-7.49 to 6.12
Upward scratch	131.4 ± 35.7	119.6 ± 36.6	-11.8	0.009**	-21.38 to -2.37	131.3 ± 36.2	129.9 ± 36.1	-1.4	0.980	-10.88 to 8.13

(*$P < 0.05$, ** $P < 0.01$)

complex shoulder motion related to BADLs—bathing and showering, dressing, grooming and toilet hygiene. Improvements in back scratch test results associated with EAS indicate a likelihood that acupuncture therapy contributes to improving physical functions in the elderly and can be applied to the treatment and rehabilitation of various patients and athletes.

In scapula motion, large upward rotation occurs during shoulder abduction, and large downward rotation occurs during shoulder adduction[13]. In this study, it is supposed that EAS on the muscles that attach to the scapula increased the muscular extensibility that limits scapula motion and induced the improvement in back scratch test measurements. Inoue et al.[15] mentioned a hypothesis of relaxing effect of acupuncture stimulation on muscle. They referred to the involvement of reuptake of calcium, reducing edema, neurological factors (e.g., Ib or γ fibers and α motor neurons) and inhibition of pain. It is probable that these factors involved in the effect of EAS on improving flexibility observed in this study.

However, the study has some limitations. Elderly women were recruited because of joint flexibility differences associated with age and sex. It is necessary to validate the effect on a wider range of subjects. In addition, EAS was applied only to three muscles to avoid interfusing therapeutic effects. However, there are many muscles involved in shoulder motion which are often treated in clinical acupuncture therapy for improving shoulder functions. The effect of acupuncture on these other related muscles should be examined.

Further, the effect of other kinds of acupuncture stimulation or therapy should be compared with EAS. It may be possible to combine acupuncture and other therapies (e.g., stretching exercises) to provide additional benefits.

Back scratch test was used to assess complex shoulder motion related to BADLs in this study. However, to assess the effects on active and passive ROM could provide more information for considering the mechanism of improving shoulder flexibility. This study does not address the details of kinematic alterations or evaluate sustained effects. More detailed analysis and longer-term repeated intervention is required. In addition, it will be necessary to study the effects of acupuncture on skeletal muscle tissue via basic physiological research.

COI

The authors have no conflict of interest associated with this manuscript.

References

1) Gajdosik RL, Vander Linden DW, Williams AK. Influence of age on length and passive elastic stiffness characteristics of the calf muscle-tendon unit of women. Phys Ther. 1999; 79(9): 827-38.
2) Chaparro, Michael Rogers, Jeffrey F A. Range of motion of the wrist: implications for designing computer input devices for the elderly. Disabil Rehabil. 2000; 22(13-14): 633-7.
3) Rikli RE, Jones CJ. Functional fitness normative scores for community-residing older adults, ages 60-94. J Aging Phys Act. 1999; 7(2): 162-81.
4) Barnes CJ, Van Steyn SJ, Fischer RA. The effects of age, sex, and shoulder dominance on range of motion of the shoulder. J Shoulder Elbow Surg. 2001; 10(3): 242-6.
5) Jette AM, Branch LG, Berlin J. Musculoskeletal impairments and physical disablement among the aged. J Gerontol. 1990; 45(6): 203-8.
6) Hoeymans N, Feskens EJM, Van Den Bos GAM, Kromhout D. Measuring functional status: Cross-sectional and longitudinal associations between performance and self-report (Zutphen Elderly Study 1990-1993). J Clin Epidemiol. 1996; 49(10): 1103-10.
7) P. L.Williams and R.Warwick E. Gray's Anatomy. 35th editi. London: Longman; 1973.
8) Tsai N-T, McClure PW, Karduna AR. Effects of muscle fatigue on 3-dimensional scapular kinematics. Arch Phys Med Rehabil. 2003; 84(7): 1000-5.
9) Sheikhzadeh A, Yoon J, Pinto VJ, Kwon YW. Three-dimensional motion of the scapula and shoulder during activities of daily living. J Shoulder Elbow Surg. 2008; 17(6): 936-42.
10) Woodward TW, Best TM. The painful shoulder: part I. Clinical evaluation. Am Fam Physician. 2000; 61(10): 3079-88.
11) Frank RM, Ramirez J, Chalmers PN, McCormick FM, Romeo AA. Scapulothoracic anatomy and

snapping scapula syndrome. Anat Res Int. 2013; 2013: 635628.
12) Trudel G, Uhthoff HK. Contractures secondary to immobility: Is the restriction articular or muscular? An experimental longitudinal study in the rat knee. Arch Phys Med Rehabil. 2000; 81(1): 6-13.
13) Neumann DA, Donald A. Neumann. Kinesiology of the Musculoskeletal System: Foundations for Physical Rehabilitation. 1 edition. St. Louis: Mosby; 2002.
14) Lee S-H, Chen C-C, Lee C-S, Lin T-C, Chan R-C. Effects of Needle Electrical Intramuscular Stimulation on Shoulder and Cervical Myofascial Pain Syndrome and Microcirculation. J Chinese Med Assoc. 2008; 71(4): 200-6.
15) Inoue M, Nakajima M, Itoi M: Relaxing effect of acupuncture stimulation on hypertonic muscle in a rat model. J Jpn Soc Balneol Climatol Phys Med. 2015; 78(3): 187-94.