Effect of the application of local vibration in scaption on joint stability

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Abstract. [Purpose] The aim of this study was to determine the initial effect of local vibration on the stability of the shoulder joints by applying local vibration to the shoulder joints. [Subjects and Methods] For the test, the subjects held a FlexBar with one hand, at about 10 cm from one end, and performed the oscillation movement with the shoulder at 90° flexion and the elbow in the full-extension position in scaption; the vibration stimulus was set to 5 Hz. Then, the subjects underwent the Upper Quarter Y Balance Test to evaluate the stability of the shoulder joints. [Results] The moving distances in the left, right, and upper directions after the oscillation movement were increased significantly compared with the results before the oscillation movement. [Conclusion] A vibration stimulus is effective as an exercise method to increase the stability of the shoulder joints.

Key words: Local vibration, Shoulder joint, Stability

INTRODUCTION

The stability of the shoulder joints is the result of the combination of static-dynamic balance and the interaction between various joints1, 2). In addition, coordination around the shoulder joints plays an important role in stabilization of the shoulder joints3). Thus, strengthening exercise programs for these muscles can help with recovery from instability in the shoulder joints or help prevent instability from occurring4). Moreover, vibration is regarded as an effective exercise method to improve muscle strength and endurance. According to Bosco et al., applying dynamic vibration to arm flexor muscles increased the muscle power significantly5, 6). In addition, it has been shown that vibration stimuli in the lower extremity improved balance ability7). Furthermore, Han et al. reported that vibration stimuli decreased knee joint reposition error8). In order to apply vibration more safely and effectively, low frequency vibration has been widely used. The FlexBar is a resistance tool that can be applied to the upper extremity. It has been used to apply a low frequency vibration stimulus to a local area while performing an oscillating movement9). In addition, the Upper Quarter Y Balance Test is a method for examining shoulder stability by measuring the distance a fingertip can reach while in a closed-chain position, which is known to be highly reliable.

SUBJECTS AND METHODS

Twenty-one male and female young adults voluntarily participated in this test. They were chosen because they had a suitable range of motion and muscle strength to perform the exercises required in this test and had no problems or diseases related to the shoulder joints in the past. The mean age, height, and weight of the subjects were 24.2±2.7 years, 165.4±7.9 cm, and 62.2±13.5 kg, respectively. The procedures of this study were harmless to the human body. All subjects read and signed a written consent form. Also, this study was approved by the Daegu University Faculty of Rehabilitation Sciences Human Ethics Committee. To apply the local vibration to the subjects, a FlexBar (Hygenic Corporation, Akron, OH, USA) was used11). A FlexBar is an oscillating device that weighs 0.59 kg and is 0.3 m long. For the test, the subjects held a FlexBar with one hand, at about 10 cm from one end, and performed the oscillation movement with the shoulder at 90° flexion and the elbow in the full-extension position in scaption; the vibration stimulus was set to 5 Hz11, 12). In total, three sets of the oscillation movement were completed, with each set consisting of three exercises lasting three minutes each. About 10 minutes of rest was provided to the subjects between the sets to minimize muscle fatigue. Once all exercise sets were complete,
the subjects underwent the Upper Quarter Y Balance Test to evaluate the stability of the shoulder joints. The mean value of the three test results was used for the Upper Quarter Y Balance Test, and the distance a subject could reach with a fingertip was divided by the arm length of the subject to find the percentage value, as this removed the bias due to the physical structure differences between the subjects. For the data analysis, SPSS for Windows (ver. 18.0) was used, and a paired t-test was employed to compare the results before and after the oscillation movement. Significance was accepted for values of \( p < 0.05 \).

RESULTS

The moving distances in the left, right, and upper directions after the oscillation movement were 95.5±9.3, 85.1±11.9, and 63.8±14.8 cm, respectively; all increased significantly compared with the results before the oscillation movement (82.9±9.2, 75.7±11.4, and 52.5±11.5 cm, respectively) \( (p<0.05) \). The total moving distance also increased significantly after the oscillation movement, rising from 211.1±26.8 cm to 244.3±30.1 cm \( (p<0.05) \).

DISCUSSION

The objective of this study was to determine the initial effect of the vibration stimulus on the stability of the shoulder joint. The results showed that the vibration stimulus improved the shoulder joint’s stability.

Scaption is an ideal exercise plane that is used to strengthen various muscles around the shoulders, as these muscles are required to lift the arms in daily life. Furthermore, the rotator cuff and deltoid are two dynamic stabilizers that surround the shoulder, and they press the humeral head toward the glenoid fossa or offset the superior gliding of the humeral head during shoulder movement, thereby preventing impingement.

In the present study, the vibration stimulus in scaption effectively strengthened these muscles, thereby increasing the stability of the shoulder joints.

Vibration has normally been used in resistance exercises to improve muscle strength and power by strengthening the neuromuscular performance, but different effects have been identified depending on the vibration characteristics. According to Bongiovanni, a suppression effect was displayed if the duration and strength of vibration continued to increase gradually. The suppression effect was a reduction in motor output during maximum muscle contraction. Therefore, if a vibration stimulus is applied using a suitable amplitude and frequency, highly effective resistance training will be achieved.

In conclusion, a vibration stimulus is effective as an exercise method to increase the stability of the shoulder joints. Furthermore, application of a vibration stimulus for patients with impaired shoulder joints can help support effective rehabilitation programs.

REFERENCES

1) Hayes K, Callanan M, Walton J, et al.: Shoulder instability: management and rehabilitation. J Orthop Sports Phys Ther, 2002, 32: 497–509. [Medline] [CrossRef]
2) Hess SA: Functional stability of the glenohumeral joint. Man Ther, 2000, 5: 63–71. [Medline] [CrossRef]
3) Kronberg M, Németh G, Broström LA: Muscle activity and coordination in the normal shoulder. An electromyographic study. Clin Orthop Relat Res, 1990, (257): 76–85. [Medline]
4) Burkhead WZ Jr, Rockwood CA Jr: Treatment of instability of the shoulder with an exercise program. J Bone Joint Surg Am, 1992, 74: 890–896. [Medline]
5) Bosco C, Colli R, Intinki E, et al.: Adaptive responses of human skeletal muscle to vibration exposure. Clin Physiol, 1999, 19: 183–187. [Medline] [CrossRef]
6) Bosco C, Cardinale M, Tsarpela O: Influence of vibration on mechanical power and electromyogram activity in human arm flexor muscles. Eur J Appl Physiol Occup Physiol, 1999, 79: 306–311. [Medline] [CrossRef]
7) Han JT, Lee MH, Lee KH: Effects of local muscle vibration on the displacement of center of pressure during quiet standing. J Phys Ther Sci, 2013, 25: 1643–1645. [Medline] [CrossRef]
8) Han JT, Jung JM, Lee JH, et al.: Effects of vibration stimuli on the knee joint reposition error of elderly women. J Phys Ther Sci, 2013, 25: 93–95. [CrossRef]
9) Theraband Website: www.theraband.com, 2013.
10) Gorman PP, Butler RJ, Plisky PJ, et al.: Upper quarter Y balance test: reliability and performance comparison between genders in active adults. J Strength Cond Res, 2012, 26: 3043–3048. [Medline] [CrossRef]
11) Mileva KN, Kadr M, Amin N, et al.: Acute effects of Flexi-bar vs. Sham-bar exercise on muscle electromyography activity and performance. J Strength Cond Res, 2010, 24: 737–748. [Medline] [CrossRef]
12) Luo J, McNamara B, Moran K: The use of vibration training to enhance muscle strength and power. Sports Med, 2005, 35: 23–41. [Medline] [CrossRef]
13) Sciascia A, Kuschinsky N, Nitz AJ, et al.: Electromyographical comparison of four common shoulder exercises in unstable and stable shoulders. Rehabil Res Pract, 2012, 2012: 783824. [Medline]
14) Chen SK, Simonian PT, Wickiewicz TL, et al.: Radiographic evaluation of glenohumeral kinematics: a muscle fatigue model. J Shoulder Elbow Surg, 1999, 8: 49–52. [Medline] [CrossRef]
15) Bongiovanni LG, Hagbarth KE, Stjernberg L: Prolonged muscle vibration reducing motor output in maximal voluntary contractions in man. J Physiol, 1990, 243: 15–26. [Medline]