



Case Study

Effect of the push-up plus guide and resistance device (PPGRD) on the serratus anterior during push-up plus

WON-GYU Yoo¹⁾

¹⁾ Department of Physical Therapy, College of Biomedical Science and Engineering, Inje University: 607 Obangdong, Gimhae, Gyeongsangnam-do 621-749, Republic of Korea

Abstract. [Purpose] This study developed a push-up plus guide and resistance device and investigated the effectiveness of the device. [Subject and Methods] A 39-year-old man presented with moderate pain with left scapular dyskinesia. A newly designed assistance device was used as a push-up plus guide and resistance device (PPGRD). The subject performed the push-up plus exercise without and then with the PPGRD for 2 weeks each. [Results] After performing the push-up plus exercise with the PPGRD for 2 weeks, the serratus anterior muscle power was increased, the pain score was decreased, and the absence of scapular dyskinesia was confirmed. [Conclusion] The PPGRD provided appropriate guidance and prevented excessive trunk flexion during the push-up plus exercise.

Key words: Push-up plus, Scapular dyskinesia, Serratus anterior

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INTRODUCTION

Increasing attention has focused on the role of the scapula in shoulder injuries¹⁾. The mobility of the shoulder joint requires shoulder muscle strength, which depends on a stable base²⁾. The serratus anterior muscle stabilizes the scapula^{1, 2)}. Appropriate rehabilitation exercises are essential for the successful treatment of shoulder muscle disorders²⁾. Closed kinetic chain exercises of the upper limb may increase the stability of articular joints, proprioception, and muscle co-contraction, resulting in enhanced dynamic stabilization of the shoulder girdle in patients with shoulder disorders^{2, 3)}. The push-up plus exercise is a closed kinetic chain exercise used to enhance the serratus anterior muscle selectively in the rehabilitation of shoulder pathologies³⁾. However, there was nothing to assist or guide the direction and resistance of the push-up exercise. Therefore, we developed a device for assisting the push-up plus exercise and investigated its effectiveness.

SUBJECT AND METHODS

A 39-year-old man complained of moderate pain associated with left scapular dyskinesia. The pain had been continuous for 8 months and scored 5/10 on a visual analogue scale (VAS). The study purpose and methods were explained to the participant before his inclusion in the study, and he provided informed consent according to the principles of the Declaration of Helsinki. A physical therapist evaluated the participant for the presence or absence of scapular dyskinesia. The subject was asked to elevate his arms overhead within 3 seconds in a thumbs-up position, and lower them within 3 seconds. Then, a 3-lb cuff was attached to his forearm and the presence of scapular dyskinesia was confirmed (scapular winging and tipping). The height of the dynamometer was adjusted so that the tension line was parallel to the floor and in the sagittal plane. The subject was seated facing away from a wall with his chest against a vertical bench pad. The humerus of his dominant shoulder was elevated to 90° with the scapula in a neutral resting position (midway between maximal protraction and retraction) and

Corresponding author. Won-gyu Yoo (E-mail: won7y@inje.ac.kr)

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the elbow extended. The subject performed four repetitions (two for flexion and two for abduction) that were recorded by a video camera. The initial serratus anterior muscle power was 9.0 kg. Then, the newly designed assistive device was used as a push-up plus guide and resistance device (PPGRD). The PPGRD consists of two sets of tubing bands attached to a wooden frame. Three bands of tubing provide low resistance at the scapular level of the thoracic spine (T2–T6) during the push-up plus in the quadruped position, while another three bands provide high resistance at the lower thoracic spine (T9–L1 level). The PPGRD is designed to provide direct resistance at the scapular level of the thoracic spine and guide the subject during the standard push-up plus exercise, while preventing compensatory motion, such as trunk flexion. The subject performed the push-up plus exercise 50 times per day, without and then with the PPGRD, each for 2 weeks.

RESULTS

The serratus anterior muscle power was 9.0, 11.5, and 15.5 kg at baseline and after 2 weeks of push-up plus exercises without and with the PPGRD, respectively. In addition, the VAS pain scores were 5/10, 3/10, and 1/10 at the corresponding times. Following the push-up plus training with the PPGRD, the absence of scapular dyskinesis was confirmed.

DISCUSSION

The serratus anterior muscle is involved in scapula movement, originating from the lateral aspects of the upper eight ribs and inserting on the anteromedial border and inferior angle of the scapula⁴⁾. It positions the scapula close against the thorax and stabilizes the scapula, preventing the medial border and inferior angle from being projected posteriorly^{2, 4)}. Weakness of the serratus anterior contributes to altered scapular kinematics, such as winging and tipping. Lin et al. found that the activity of the serratus anterior was positively correlated with winging or posterior tilting of the scapula in subjects with mild and severe impingement syndrome⁵⁾. Two physical therapists confirmed that our subject had scapular dyskinesis with scapular winging and tipping. After using our newly designed PPGRD during push-up plus exercises for 2 weeks, the serratus anterior muscle power was greater than at baseline or after training without the PPGRD. The VAS pain score was also lower after training with the PPGRD and the scapular dyskinesis had disappeared. We believe that the PPGRD helps to ensure the effectiveness of standard push-up plus exercises because of the direct resistance and guide it provides to the thorax and scapula, as most patients lack the skill to perform push-up plus exercises correctly. Normally, effective push-up plus exercises require that a therapist provides a cue by using hand palpation at the scapula. The PPGRD improves the proprioception in the scapular area because of the compression by the bands of tubing. During push-up plus exercises, most patients commonly show excessive movement of the trunk and the PPGRD provides appropriate guidance and prevents excessive trunk flexion during the push-up plus exercise.

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