Case Study

Effects of diagonal shoulder training in a closed kinematic chain for secondary impingement syndrome: a case study

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Abstract. [Purpose] This study examined the effects of diagonal shoulder training on an individual with secondary impingement due to scapular dyskinesis. [Subject] A 54 year-old female with secondary impingement participated in this study. [Methods] The patient performed diagonal shoulder training in 4-point kneeling, 3 times per day for 20 minutes over a period of 6 weeks. Evaluations of shoulder pain, range of motion, upper trapezius/lower serratus anterior ratio, and impingement were performed before training and at 2, 4, and 6 weeks. [Results] The patient's parameters improved gradually. All parameters returned to normal ranges at 4 weeks. [Conclusion] Diagonal shoulder training is effective for improving dysfunction in individuals with secondary impingement. In addition, this training should be applied for more than 4 weeks.

Key words: Diagonal shoulder training, Closed kinematic chain, Secondary impingement syndrome

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INTRODUCTION

Shoulder impingement is a common musculoskeletal problem. Its primary cause is internal degeneration of the rotator cuff muscles; this can be caused externally by a deformity of the acromion and coracoacromial ligament¹⁾. Meanwhile, secondary impingement is caused by problems in muscle dynamics or incomplete combination of the scapula and glenohumeral joint. This is specifically caused by injuries of the joint capsule and ligament or muscle weakness and scapular dyskinesis²⁾.

The trapezius and serratus anterior (SA) are the most important muscles in scapular kinesis; they are coupled, resulting in upward rotation of the scapula during the elevation of the arm above the head³⁾. These muscles contribute to the movement and stabilization of the scapula when performing overhead work⁴⁾. However, some people with shoulder problems exhibit scapular dyskinesis in which SA activity is diminished and upper trapezius (UT) activity is excessive during arm elevation⁵⁾. The scapular dysfunction that can cause secondary impingement is due to excessive activity of the UT to compensate for the lack of SA activity. The ratio of the activation of the upper trapezius to the lower serratus anterior (UT/LSA) has been used to represent effects of shoulder training^{6, 7)}.

A recent study demonstrates diagonal shoulder training is more effective for improving the UT/LSA activity ratio than push-up plus exercise⁷⁾. However, the effects of diagonal shoulder training on people with shoulder problems in clinical practice remain unknown, because the previous study⁷⁾ only examined normal subjects. Therefore, this case study examined the effects of diagonal shoulder training on an individual with secondary impingement due to scapular dyskinesis.

SUBJECT AND METHODS

This is a case study of a 54-year-old woman with shoulder impingement syndrome who was referred to the Department of Physical Therapy, Busan ST. Mary's Hospital because of pain and limitation of range of motion (ROM) in her right shoulder joint. On the basis of radiography and Hawkins-Kennedy test, she was diagnosed with secondary impingement syndrome without injury of the rotator cuff or shoulder ligament by an orthopedic specialist. In particular, the Hawkins-Kennedy test, which evaluates supraspinatus tendonitis or secondary impingement syndrome⁸⁾, showed abnormalities related to supraspinatus tendinitis, which can cause secondary impingement. Her scapular dyskinesis, which can cause secondary impingement, was examined.

Scapular dyskinesis was examined as follows. The patient performed arm abduction to 90° for 3 seconds. The UT/LSA activity ratio, pain, and ROM were evaluated during the overhead work task. Shoulder pain and ROM were measured using a visual analogue scale and goniometer (Plastic goniometer, Baseline Inc., USA). Surface electromyography (MP150, BIOPAC Systems Inc., USA) was used to determine muscles activities. The signals were amplified

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Table 1. Changes in shoulder pain (VAS), ROM, the UT/LSA activity ratio, and impingement (Hawkins-Kennedy test) during training

	Baseline	2 weeks	4 weeks	6 weeks
VAS	7	5	2	1
ROM	112	130	157	168
UT/LSA activity ratio	1.31	1.18	0.92	0.81
Hawkins–Kennedy test	(+)	(+)	(–)	(–)

Values are means; VAS: visual analogue scale; ROM: range of motion; UT/LSA: upper trapezius/lower serratus anterior

and band-pass filtered (20–450 Hz) before being digitally recorded at 1,000 Hz. Two surface electrodes were placed on the affected side (right): on the UT at approximately half the distance between the 7th cervical spinal process and acromion and LSA on the belly of the muscle branching to the 7th rib^{6, 7)}.

Electromyography amplitudes were normalized according to the reference voluntary isometric contraction (RVIC). RVIC was measured at 90° shoulder abduction in scapular plane elevation, which is used to evaluate individuals with impingement. On the basis of her shoulder condition, she wore a 5-lb sandbag on the right forearm; previous studies used a 15-lb sandbag^{6, 7)}. Finally, RVIC was measured at 90° of scapular plane elevation for 3 seconds. This study conformed to the ethical principles of the Declaration of Helsinki, and the patient provided written informed consent for the treatment and use of the case data for scientific purposes and publication.

The patient performed diagonal shoulder training in 4-point kneeling with her hands and knees placed vertically below her shoulder and hip joints, respectively. She then lowered her right ischial tuberosity diagonally towards the opposite heel (left heel) while fixing her arms on the floor. While she moved her trunk diagonally backward, she applied a proprioceptive neuromuscular facilitation (PNF) pattern by pressing the right arm toward the floor in flexion, abduction, and external rotation directions. She performed diagonal shoulder training in 4-point kneeling for 20 minutes 3 times per week for 6 weeks. Evaluations were performed repeated 2 times before training and after 2, 4, and 6 weeks.

RESULTS

Pain, ROM, the UT/LSA activity ratio, and shoulder impingement improved gradually during training (Table 1).

DISCUSSION

Shoulder pain and ROM improved dramatically at 6 weeks. Shoulder pain decreased approximately 86%, ROM increased approximately 50%. These improvements are likely because of the application of an upper-extremity PNF pattern in a closed kinematic chain, which can be controlled

by shoulder motion itself without pain. In shoulder rehabilitation, closed kinematic chain may effectively diminish the weight of the arm and decrease the demand on the weakened rotator cuff¹⁰⁾. In addition, the patient's improved impingement and ROM corroborate the findings of previous studies⁷⁾ in that PNF training provides traction to the shoulder.

The normal UT/LSA activity ratio is less than 1 during shoulder abduction beyond 90°⁹⁾. Although she had an abnormal UT/LSA activity ratio of 1.31, this returned to the normal range at 4 weeks, indicating recovery of scapular kinesiology. Therefore, the results indicate diagonal shoulder training is effective for improving shoulder pain, ROM, scapular dyskinesis, and impingement in individuals with secondary impingement due to scapular dyskinesis. In addition, this training should be applied for more than 4 weeks to individuals with secondary impingement. Future research is required to confirm the effects of PNF training for various shoulder problems.

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