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ORIGINAL ARTICLE

Time to peak torque and acceleration time are altered in male patients following traumatic shoulder instability

Jin Hyuck Lee, PT, MS^{a,1}, Ji Soon Park, MD^{b,c,1}, Hyun Jung Hwang, MD^d,
 Woong Kyo Jeong, MD, PhD^{a,e,*}

^aDepartment of Sports Medical Center, Korea University, Anam Hospital, Seoul, Republic of Korea

^bDepartment of Orthopaedic Surgery, Seoul National University Hospital, Seoul, Republic of Korea

^cSheikh Khalifa Specialty Hospital, North Ras Al Khaimah, United Arab Emirates

^dDepartment of Orthopaedic Surgery, Burteam Hospital, Seoul, Republic of Korea

^eDepartment of Orthopaedic Surgery, College of Medicine, Korea University, Seoul, Republic of Korea

Background: Numerous authors have evaluated the strength of the rotator cuff muscles in patients with shoulder instability. However, only limited data are available with regard to neuromuscular control in patients with traumatic anterior shoulder instability, in particular at 90° of abduction. This study was designed to assess muscle strength and neuromuscular control ability using time to peak torque and acceleration time in nonathletic patients with traumatic anterior shoulder instability.

Methods: Isokinetic muscle performance testing was performed in 20 male nonathletic anterior shoulder instability patients compared with 20 side-matched asymptomatic volunteers. Isokinetic muscle performance testing was performed at an angular velocity of 180°/s with 90° of shoulder abduction. Muscle strength and neuromuscular control (time to peak torque and acceleration time) of the internal rotators (IRs) and external rotators (ERs) were measured.

Results: There were no significant differences in muscle strength of the IRs and ERs between the 2 groups. The injured shoulder showed delayed neuromuscular control in both the IRs and ERs in the instability patients compared with the normal control subjects (time to peak torque, $P = .023$ for IRs and $P = .020$ for ERs; acceleration time, $P = .035$ for IRs and $P = .021$ for ERs).

Conclusion: The neuromuscular control of both the IRs and ERs was decreased in male nonathletic patients with traumatic anterior shoulder instability even though muscle strength was not altered. Therefore, clinicians and therapists should implement exercises that aim to restore neuromuscular control in the rehabilitation of nonathletic patients with anterior shoulder instability.

Level of evidence: Basic Science Study; Kinetics

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Keywords: Anterior instability; muscle strength; neuromuscular control; rotator cuff; isokinetic; rehabilitation

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¹These authors contributed equally to this work.

*Reprint requests: Woong Kyo Jeong, MD, PhD, Department of Orthopaedic Surgery, College of Medicine, Korea University, 73 Incheon-ro, Seongbuk-gu, Seoul 02841, Republic of Korea.

E-mail address: drshoulder@korea.ac.kr (W.K. Jeong).

Shoulder instability can be caused by a disability or defect of the static or dynamic stabilizers, such as the ligaments, glenoid labrum, rotator cuff, and periscapular musculature.^{7,11,34,35,43,46} The transverse force couple mechanism of the rotator cuff muscles plays an important role

in shoulder stability following disruption of the capsuloligamentous structures.^{20,38} It has been shown to protect against excessive translation and to provide compression of the humeral head onto the glenoid in the apprehension position.^{23,28}

Previous researchers have described the association of anterior shoulder instability with weakness of the internal rotators (IRs) or external rotators (ERs),^{12,26} while others have described deficits in proprioception or muscular coordination in patients with anterior shoulder instability.^{3,30,41} Injuries of the capsuloligamentous complex may cause alteration of the afferent sensory signals to the central nervous system.²⁴ This alteration can be expressed as altered muscle recruitment patterns, including decreased muscle activity or delayed muscle activation timing. Some recent research has been focused on neuromuscular control in patients with shoulder instability and restoration of rotator cuff activity, such as neuromuscular control, strength, and muscle activation time, as important in shoulder instability.^{9,33,37} In contrast, a systematic review reported that activation time of the scapulothoracic muscles is not changed in anterior shoulder instability.⁴³ Likewise, there are conflicting opinions on many other issues because of differences in participants, measurement methods, parameters, testing positions, and so on. It is important to note that most authors have focused on patients with multidirectional instability (MDI) and throwing athletes, and specific data on nonathletic patients with traumatic anterior shoulder instability are lacking.^{5,21}

The purpose of this study was to analyze muscle strength and neuromuscular control of the rotator cuff muscles using

an isokinetic device between patients with traumatic anterior or shoulder instability and normal controls. We hypothesized that muscle strength and neuromuscular control would be altered in both the IRs and ERs of the injured shoulder in male nonathletic traumatic anterior shoulder instability patients compared with normal subjects.

Materials and methods

Patient enrollment

This was a retrospective case-control study. Among 66 patients with shoulder instability diagnosed at our institution between 2011 and 2014, 20 male nonathletic patients with traumatic anterior shoulder instability were enrolled. All patients showed a positive anterior apprehension sign, sulcus sign, and load-and-shift test (more than grade II) on the physical examination, and anteroinferior labral detachment, following traumatic dislocation, was confirmed using magnetic resonance imaging. We excluded 46 patients for the following reasons (Fig. 1): posterior instability, bilateral instability, superior labrum anterior-to-posterior lesion, MDI, involvement of the nondominant shoulder, and no history of traumatic injury. Patients with prior testing or training experience with an isokinetic device were excluded to prevent possible differences in strength testing as the result of experience.³⁹ In addition, patients who were unable to complete the isokinetic test without pain or apprehension during the test were excluded. Twenty normal control subjects were selected from our database of volunteers with no history of shoulder trauma or instability symptoms and agreed to participate in this study. Sports and activity levels were categorized as low or high. High sports and

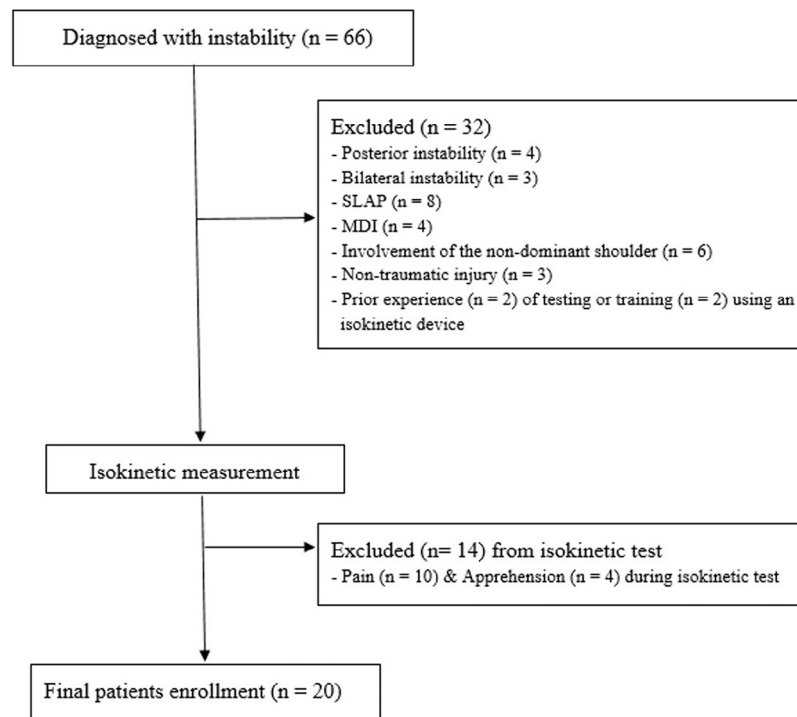


Figure 1 Flowchart of patients with traumatic anterior shoulder instability. *SLAP*, superior labrum anterior-to-posterior lesion; *MDI*, multidirectional instability.

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