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Stress radiography for clinical evaluation of anterior shoulder instability

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Background: The purpose of this study was to examine the validity of stress radiography using the Telos GA-IIE as a clinical methodology to evaluate shoulder instability.
Methods: On 36 anterior shoulder dislocators and 23 uninjured volunteers, 4 types of stress radiographs were captured while applying 15 daN of force anteriorly (AER0 and AER60) and posteriorly (PER0 and PER60) at 2 different positions: (1) 90° of abduction combined with 0° external rotation and (2) 90° of abduction combined with 60° external rotation. The results of the anterior drawer test and of the same test under anesthesia were correlated.
Results: AER0 and AER60 from the affected shoulder revealed significantly larger displacement than on the normal side ($P < .05$), and all 4 radiographs from the affected joints demonstrated significantly larger displacement ($P < .05$) than in the volunteers. Among the 4 types of radiographs, AER0 and AER60 showed significantly higher displacement in the patients ($P < .001$), whereas there were no differences in the volunteers ($P = .167$). The results of the anterior drawer test positively correlated to AER60 (Pearson correlation coefficient [PCC] = 0.453; $P = .005$) and AER0 (PCC = 0.529; $P = .001$), and those of examination under anesthesia weakly correlated to AER60 (PCC = 0.287; $P = .264$) but highly correlated to AER0 (PCC = 0.695; $P = .002$).
Conclusion: Stress radiographs on the affected shoulder frequently correlated with physical examinations, and the displacement of >3 mm on AER0 suggests anterior instability.
Level of evidence: Level III; Diagnostic Study

Keywords: Shoulder; instability; stress radiography; Telos GA-IIE; shoulder positioning device; validity

The shoulder joint has an extensive range of motion and necessarily exhibits unique inherent instability. The shoulder's bone structure and ligaments, muscles, labrum, and other diverse factors contribute to its stability. Disease of these structures results in diverse types of instability. Although several quantitative measurements for the evaluation of instability have

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been introduced and receive the most attention from orthopedists, there is no clear standard measurement discriminating biomechanical characteristics of normal laxity from pathologic instability, and there are no objective measurement tools or instruments to assess the instability of the shoulder. Therefore, diagnosis and treatment of shoulder instability are dependent on the patient's symptoms and the clinician's subjective physical examinations.

To date, various researchers, using diverse methods, have attempted objective and quantitative assessment of the shoulder joint's normal laxity and instability. There have been continuous efforts to incorporate these methods into clinical evaluations,[1,8,10,12,18,20,22] but no standard assessment exists. As standardized laxometers are applied for diagnosis and treatment of knee and ankle joint instability, additional research is now needed regarding shoulder joints.[7,26] Therefore, we applied the Telos GA-IIE stress radiography device (Telos, Weiterstadt, Germany) and the Telos shoulder positioning device designed by Georgousis and Ring[10] on patients with anterior instability to evaluate its validity. Georgousis and Ring reported that the normal cutoff point for humeral displacement is <3 mm in normal shoulders.[10] However, no studies have focused on patients with instability afterward. Therefore, it is expected that this study will contribute significantly to the evaluation of its clinical application and describe a quantitative and objective method for evaluating shoulder instability.

Materials and methods

This is a retrospective case-control study of stress radiography using the Telos GA-IIE stress radiography device and shoulder positioning device designed by Georgousis and Ring[10] (Fig. 1) in the anterior instability patient group and the normal uninjured volunteer group.

From March 2012 to April 2014, among patients admitted with the chief complaint of anterior instability, 36 who experienced anterior dislocation were selected as subjects. The group included 28 male and 8 female patients, with an average age of 26.1 years (15-57 years). Among this group, 27 patients were diagnosed with anterior instability and 9 with multidirectional instability with anterior dislocation as a main component. Diagnoses were made by examining the patients' histories of anterior dislocation events documented on the radiograph; physical examinations confirming anterior instability, including anterior apprehension tests, relocation tests, and anterior drawer tests conducted by a senior physician (J.Y.P.); intra-articular enhancement on magnetic resonance imaging; and arthroscopic findings. This definition was restricted to confirmation of apparent positive findings on the physical examinations or apparent anterior subluxation/dislocation during the tests and confirmation of anatomic lesions. Even in cases with clear signs of instability, patients who had received related operations in the past, who had reported symptoms consistent with instability but without anatomic lesions related to anterior instability on radiographic images or operative findings, who had bony Bankart lesion involving >10% of the anterior glenoid margin in width, or who had poor and unclear contour of bone landmarks on the stress radiographs were excluded. Subjects for whom stress loading on the shoulder did not occur accurately were excluded. Patients complaining of bilateral shoulder symptoms were also excluded for the purpose of comparison between the affected and normal sides.

In addition, for a more accurate comparison, 23 volunteers without abnormal symptoms were recruited and underwent the same radiographic tests and examination as a control. This group included 4 women and 19 men, with an average age of 19.7 years (14-25 years).

The shoulder joints of all subjects were filmed for stress radiography using the Telos GA-IIE stress radiography device and shoulder positioning device designed by Georgousis and Ring[10] (Fig. 1) according to the original authors' protocol.

The shoulder joint was fixed in 90° abduction and placed on the positioning device, adjusting the external rotation only to 0° and 60°. A stress force of 15 daN was applied without any prior administration of analgesics or narcotics. In both positions, with the same force, loading was applied in the anterior direction first, then in the posterior direction, and images were captured (Fig. 2). Four types of axillary view radiographic images from each shoulder were obtained. For convenience, anterior drawer stress radiography with 0° external rotation was designated AER0, posterior drawer stress radiography with 0° external rotation was designated PER0, anterior drawer stress radiography with 60° external rotation was designated AER60, and posterior drawer stress radiography with 60° external rotation was designated PER60. On the axillary view radiograph, the rotation center in the head of the humerus was determined and marked by using a concentric circle ruler. A parallel line with the articular surface passing through both ends of the glenoid and a perpendicular line to the joint surface that bisected the glenoid articular surface length were drawn (Fig. 3). To

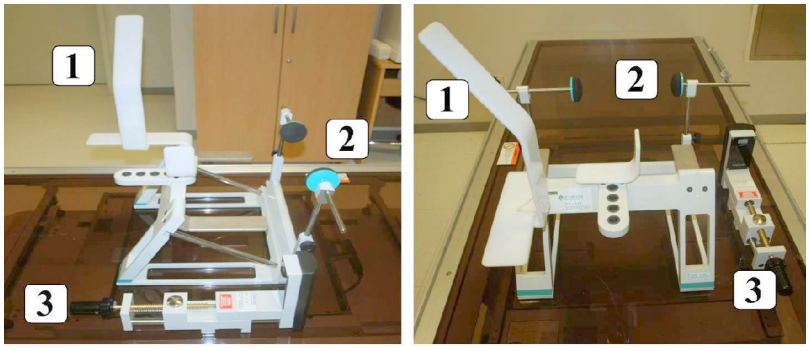

Figure 1 The Telos device mainly consists of a lower arm positioner for external rotation (*1*), shoulder fixation pads (*2*), and a pressure support (*3*).