J Shoulder Elbow Surg (2018) ■■, ■■–■■

ELSEVIER

Journal of Shoulder and Elbow Surgery

www.elsevier.com/locate/ymse

ORIGINAL ARTICLE

A preliminary exploration of plain-film radiography in scapular dyskinesis evaluation

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Background: Evaluation of scapular dyskinesis is of clinical interest because it is believed to be associated with pathologies of the shoulder. This study investigated the feasibility of plain-film radiography in evaluating scapular dyskinesis.

Methods: Subjects with unilateral disorders of the shoulder (n = 186) who underwent plain-film radiography of bilateral scapulae were divided into 4 categories of scapular dyskinesis patterns according to the Kibler classification and analyzed. Coracoid upward shift distance (CUSD), length of the scapular spine line (LSS), and scapular upward rotation angle (SURA) were measured on the radiographs. Intrarater and inter-rater reliability were tested, and the characteristics of these parameters in each type were analyzed. The differences (d) between bilateral scapulae (d-CUSD, d-LSS, and d-SURA) among the 4 categories were compared.

Results: Intrarater and inter-rater reliability were excellent for all parameters. Significant differences between the scapulae were observed in CUSD in type I and in LSS in type II categories. No significant difference in any of the parameters was found in type III. Compared with the other categories, d-CUSD in type I and d-LSS in type II were significantly larger. The cutoff values of d-CUSD and d-LSS were 1.1 mm and 1.2 mm, respectively. No significant difference in d-SURA was found among the 4 categories.

Conclusions: The measurement of CUSD, LSS, and SURA on plain-film radiography had excellent reliability. d-CUSD and d-LSS were characteristic parameters of type I and type II, respectively; however, type III had no distinguishing characteristics among the parameters.

Level of evidence: Level III; Diagnostic Study

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Keywords: Scapular dyskinesis; plain-film radiography; coracoid upward shift distance; length of the scapular spine line; scapular upward rotation angle; Kibler classification

Abnormalities in the positions of the scapulae at rest and during movements have been collectively termed scapular dyskinesis,[15,20,27] which is associated with many shoulder disorders.[8,11,17-19,25] Management of scapular dyskinesis is one of the strategies of physiotherapy in disorders of the shoulder; therefore, appropriate evaluation is important in the management of scapular dyskinesis.

Kibler et al[20] introduced a classification system involving 4 categories for scapular dyskinesis according to the abnormal movements of the scapula in 3 planes:

Type I: abnormal scapular movements in the sagittal plane with anterior and posterior tilts
Type II: abnormal scapular movements in the transverse plane with internal and external rotations

The Shanghai Jiao Tong University Affiliated Sixth People's Hospital Ethics Committee approved the study: Approval No. 2015-43-(1).

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1058-2746/$ - see front matter © 2018 Journal of Shoulder and Elbow Surgery Board of Trustees. All rights reserved.
https://doi.org/10.1016/j.jse.2017.12.032

Type III: elevation of the scapula and abnormal movements in the coronal plane with upward and downward rotations
Type IV: symmetrical bilateral scapula

This classification system is widely used in clinical settings[15,16,20-22] but is based on visual observations.[20] In many cases, the soft tissues overlying the scapulae, such as adipose tissue and muscles, may make the identification difficult,[30] and this method cannot quantify the severity of scapular dyskinesis.

Laboratory instruments, such as inclinometers and electromagnetic or optoelectronic tracking systems, can quantify scapular kinematics in the 3 dimensions.[3,8,10,24,28] These methods allow for accurate measurements; however, the technical difficulties and requirements of the equipment render them unavailable in the clinical settings.

Three-dimensional (3D) wing computed tomography (CT) and magnetic resonance imaging (MRI) have been explored in evaluating scapular dyskinesis.[21-23] However, CT and MRI are both performed in the decubitus position, which relieves the scapula of gravity and the resulting movements. Whether scapular kinematics in decubitus are the same as those in the erect position is unclear.

Endo et al[6,7] introduced 3 parameters on plain-film radiography to represent 3 kinds of scapular rotational tilts. The length of the scapular spine line (LSS) represents internal and external rotations, coracoid upward shift distance (CUSD) represents anterior and posterior tilts, and the scapular upward rotation angle (SURA) represents upward and downward rotations. Plain film is advantageous because of lower radiation, fewer technical requirements, and inexpensive and easily available equipment. We hypothesized that LSS, CUSD, and SURA can be used to evaluate scapular dyskinesis. Therefore, the purpose of this study was to investigate the characteristics of radiographic parameters in the 4 patterns of scapular dyskinesis and the feasibility of plain-film radiography in evaluating scapular dyskinesis.

Materials and methods

Subjects and demographics

This was a prospective, diagnostic case series involving repeated measurements. All subjects received information regarding the objectives of the study and provided their written consent for participation. Subjects who had unilateral shoulder disorders were recruited from the Department of Rehabilitation Medicine by 1 investigator (K.C.).

Exclusion criteria were (1) a history of fracture or deformity of the scapula, clavicle, humerus, or ribs; (2) scoliosis or kyphosis with visible rib hump in neutral erect posture; (3) unequal lengths of lower extremities; (4) stature >1.8 m or body mass index >26 kg/m^2;[12] (5) subjects whose scapular pattern could not be determined by 3 raters; and (6) obvious variations or bony spurs of the coracoid and acromion as seen on x-ray images.

We enrolled 205 subjects who underwent radiographic examination and clinical classification of scapular dyskinesis. After the radiographic examination, 19 individuals were excluded for the following reasons: (1) obvious acromion spurs in 8 and morphologically variable coracoid processes in 2; (2) mild thoracic scoliosis in 3; and (3) the quality of imaging was inadequate in 6. Finally, 186 individuals were included, and their demographic data are summarized in Tables I and II.

Table I Demographic data of subjects

Variable	No. or mean ± SD (range) (N = 186)
Sex	
Women	115
Men	71
Age, yr	45.74 ± 10.20 (22-68)
Mass, kg	59.60 ± 6.94 (46-80)
Height, m	1.64 ± 0.07 (1.50-1.80)
BMI, kg/m^2	22.14 ± 1.93 (17.47-25.96)
Affected side	
Left	73
Right	113
Dominant side	
Left	15
Right	171
Dominant side	
Affected	110
Unaffected	76
Duration, weeks	16.82 ± 13.22 (1-48)

SD, standard deviation; *BMI*, body mass index.

Table II Main disorders in the affected shoulders

Main disorder of affected side	No. (N = 186)
Subacromial impingement syndrome	59
Partial-thickness rotator cuff tear	56
Adhesive capsulitis of shoulder	23
Long head of biceps tendon tendinitis	15
Shoulder osteoarthritis	13
Rotator cuff tendonitis	10
Superior labrum anterior posterior tear	10

Clinical evaluation for scapular dyskinesis

Scapular patterns were identified based on visual palpation because it has the advantages of identification of bony landmarks and reliability.[15] To expose both the scapulae, men bared to the waist and women wore halter tops. The raters stood behind the subject and documented the initial rating by visual inspection. Then they placed their hands on the subject's scapulae for further identification

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