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Assessment of Anterior Shoulder Instability by CT Arthrography

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Computed tomography (CT) immediately after double-contrast shoulder arthrography was taken in twenty-two young male patients with anterior shoulder instability including recurrent dislocation and subluxation. This recently developed technique called CT arthrography can provide significant information about patients with glenohumeral instability which is difficult to obtain by conventional arthrography. Information about glenoid labrum pathology is useful for proper management of the shoulder with instability. Lesions identified in this study include anterior labral defects (attenuation, tear, displacement), anterior capsular distension and/or detachment, Hill-Sachs lesion, anterior glenoid rim compression fracture, and fracture of scapula. This article describes the method used in CT arthrography of the glenohumeral joint, reviews the normal cross-sectional anatomy, and emphasizes the importance of the application of CT arthrography in the shoulder disorder with instability. CT arthrography of the glenohumeral joint is easy to perform, is accurate, and has lower radiation dose than arthrotomography.

Key Words: *CT arthrography, shoulder, instability, glenohumeral*

INTRODUCTION

Recurrent anterior shoulder dislocation is generally considered to be the major type of instability with surgical significances (Protzman, 1980), and can be diagnosed on physical examination and confirmed by radiographic studies (Kessel, 1982). But defect in the posterolateral surface of the humeral head caused by compression from the anterior glenoid rim (Hill-Sachs defect) and anterior labral defect including capsular lesion and fracture of the anterior glenoid rim are difficult to be demonstrated on plain films. While standard arthrography has been successful in a number of shoulder abnormalities (Freiberger et al., 1979; Goldman & Ghelman, 1978; Mink et al., 1979; Jang et al., 1984; Calvert et al., 1986), it has limitations in its application for patients with glenohumeral instability. Conventional arthrotomography has been used to enhance delineation of the internal joint structures, but in this imaging technique it is hard to properly position the patient (El-Khoury et al., 1979, 1986; Braunstein & O'Connor, 1982; Kleinman et al., 1984). Recently computed tomographic (CT) arthrography is used to define the labral lesion and surrounding abnormalities in the patients having shoulder instability (Shuman et al.,

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1983; Deutsch et al., 1984; Rafii et al., 1986, 1987).

Since there is no good clinical means to quantitate labral damage except invasive methods such as arthroscopy and arthrotomy, radiologic imaging of the glenoid labrum is crucial not only in documenting the pathology but also in planning surgical repair. We present our experience with CT arthrography of the shoulder in 22 patients with instability. In this report, it is aimed for defining the normal cross-sectional anatomy and various lesions of the glenoid labrum and abnormalities contributing to shoulder instability which are useful in preoperative planning for reconstructive surgery.

MATERIALS AND METHODS

Twenty-two patients with anterior shoulder dislocation and subluxation underwent CT arthrography between April 1985 and June 1987. All were young males ranging from 20 to 25 years of age. All had a history of trauma that had resulted in recurrent shoulder dislocation or subluxation from 3 to 30 times during recreational sports activities. In 17 patients, lesion was in right shoulder and all were unilateral. As a normal control, bilateral shoulder injection in 9 patients for obtaining normal CT arthrographic findings was performed.

After sterile preparation and local anesthesia, the shoulder joint was entered anteriorly with a 20-gauge spinal needle and 2-3 ml of contrast material (Hypaque 50%) and 0.3 ml of 1:1,000 epinephrine and 12-14 ml of room air were injected into the glenohumeral joint through the needle. After removal of the needle and gentle shoulder motion, double-contrast arthrography was made which was immediately followed by CT examination. With the patient supine and the arm in neutral position, contiguous 5-mm-thick slices with 3-mm or 5-mm table incrementation were obtained covering the region of the glenoid fossa using the large-body mode on a Technicare 2020. Each scanning was done with the static position to reduce respiratory artifacts and images were viewed and recorded on film with an extended scale at a window of 2,000 H or 1,000 H,respectively.

CT arthrographic abnormalities of the glenoid labrum, the bony glenoid rim, and the joint capsule were studied. Surgery was performed in 8 selected cases with mainly Bristow and Putti-Platt procedures.

RESULTS

Contrast injection into the glenohumeral joint was successful in 20 patients, and radiologic analysis of the two failed cases was impossible. The cross-sectional appearance of the humeral head varies with the level of section. It is essentially round and smooth on superior section taken at the level of the coracoid process (Fig. 1,a), which is the appropriate level for the evaluation of Hill-Sachs lesion (Deutsch et al., 1985). The glenoid labrum is an oval disk of dense fibrous tissue and its shape varies somewhat in relation to the state of rotation of the humerus and patient's age (Shuman et al., 1983). The cross-sectional appearance of the anterior portion of the glenoid labrum commonly demonstrates a triangular

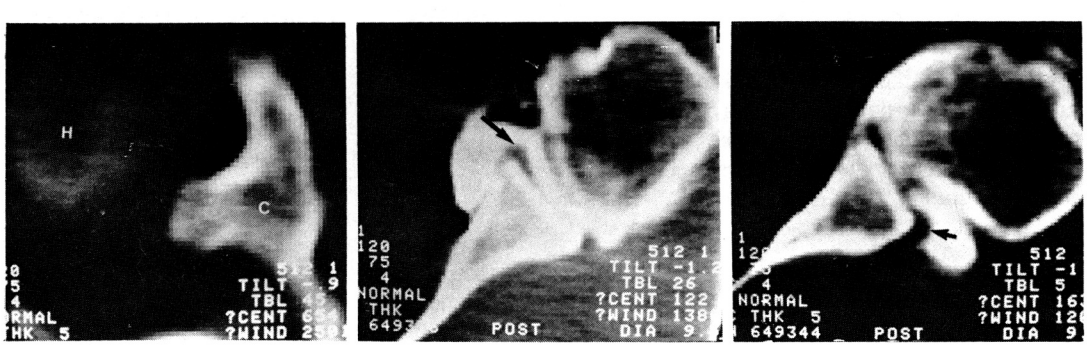

Fig. 1. a. Normal rounded appearance of the humeral head (H) at the level of the coracoid process (C). b. During internal rotation, the anterior capsule is maximally distended and the anterior labrum (arrow) with a triangular shape is well visualized. c. With the arm in external rotation, the posterior capsule is then distended. This allows optimal visualization of the posterior portion of the glenoid labrum (arrow) with more rounded appearance than anterior portion.

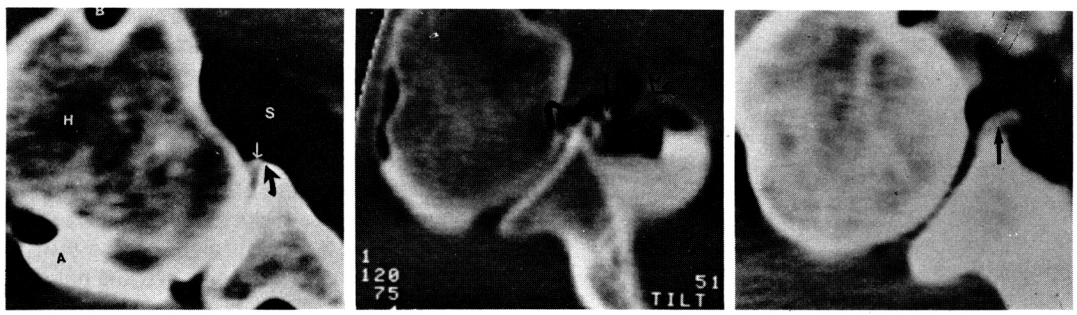

Fig. 2. a. Blunting and attenuation of the anterior labrum (thin white arrow) and minimal spur change of the anterior glenoid rim (black arrow). B=bicipital tendon sheath; H=humerus: A=axillary recess; S=distended subscapularis recess. b. Anterior glenoid labrum is irregularly torn (curved arrow) and scapular insertion of the anterior capsule is thickened (straight arrow). Open arrow=midglenohumeral ligament visualized as a band of soft tissue. c. Torn fragment of the anterior labrum is displaced superomedially (arrow). Note convex distended anterior joint capsule.

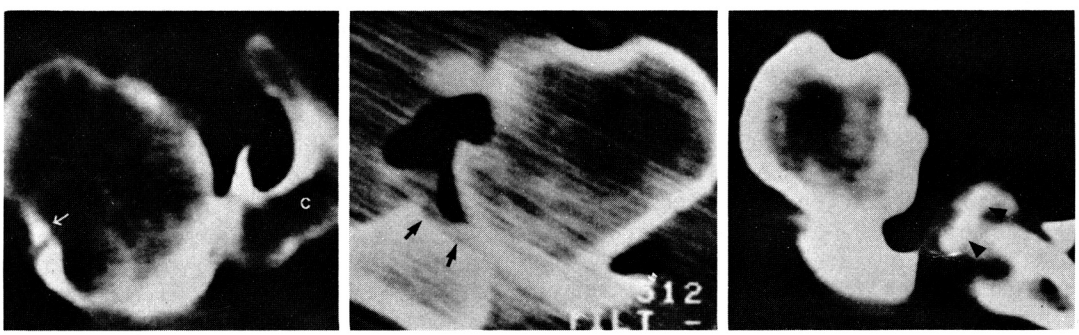

Fig. 3. a. Depression along the posterolateral aspect of the humeral head (white arrow) called a Hill-Sachs lesion at the level of the coracoid process (C). b. Compression fracture of the anterior glenoid rim (arrows) as seen on a section through the level of the inferior portion of the labrum. The labrum is completely avulsed anteriorly. c. One case of scapular body fracture is seen (arrowheads). Note stretching of the entire capsule.

shape with a smoothly rounded apex (Fig. 1, b). Visualization of the more rounded posteriod portion of the labrum is often easy on CT arthrography when scans are obtained with the shoulder in external rotation which allows the posterior capsular distension (Fig. 1,c).

Abnormalities of the glenoid labrum were detected with CT arthrography in 18 patients and involved the anterior portion in all and both anterior and posterior portion in one patient. This determination was based on the distorted appearance of the normally triangular shaped smooth labrum, and its abnormalities were classified into attenuation, tear, and displacement (Fig. 2,a-c).

CT arthrographic findings about the capsule of the joint were corroborative of the diagnosis of the glenohumeral instability. Enlarged capsule was diagnosed on the basis of comparison with the normal side. In three patients, the anterior capsule was stripped from the scapula. In 2 patients with normal labrum, the capsule was distended. Actual capsular tear with extravasation of contrast material was not demonstrated in our cases. Other associated CT arthrographic findings included a Hill-Sachs lesion in 12 patients (Fig. 3,a), compression fracture of the glenoid rim in 2 patients (Fig. 3, b), and a minute scapular fracture in one patient (Fig. 3, c). (Table 1)

These abnormalities were surgically confirmed in 8 patients.

Table 1. CT Arthrographic Findings (N=20*)

Findings	No.	%
• Anterior labral defect	18	90
attenuation	10	
tear	4	
displacement	4	
• Capsular distention	16	80
without labral defect	2	
with stripping	3	
• Hill-Sachs lesion	12	60
• Anterior glenoid rim compression	2	10
• Central pit at glenoid fossa	1	5
• Scapular fracture	1	5
• Posterior labral attenuation	1	5

*Two cases of inadequte study were excluded.

DISCUSSION

Acute traumatic dislocation damages the anatomy that provides the stability of the shoulder joint. As the humeral head dislocates, it my tear or crush the labrum, stretch and strip the joint capsule off the bony glenoid, separate the capsule from the labrum, fracture the rim of the glenoid, and impact fracture onto the glenoid rim (Rowe et al., 1984). These abnormalities in various combination can result in instability that leads to repetitive shoulder dislocation (Shuman et al., 1983).

The clinical diagnosis of labral or capsular damage may be difficult. Imaging of the glenohumeral joint id-entifies the presence of shoulder joint pathology; this may be particularly helpful if previous episodes of dislocation have not been documented and also useful in preoperative planning for reconstructive procedures.

A number of publications have recently described the assessment of the unstable shoulder by CT arthrography (Shuman et al., 1983; Deutsch et al., 1984, 1985; Rafii et al., 1986, 1987). CT arthrography of the glenohumeral joint provides cross-sectional images and the potential for image reformatting in the coronal and sagittal planes. Technique of direct sagittal CT arthrography has developed for the evaluation of rotator cuff lesions which were not discernible in this series (Beltran et al., 1986). And new technologic innovation with Magnetic resonance imaging (MRI) gives promise of utterly noninvasive assessment of the shoulder joint (Kieft et al., 1986; Seeger et al., 1987), although its clinical application is limited. CT arthrographic findings associated with the glenohumeral instability are well-established including the anterior labral defect, stripping and stretching of the anterior shoulder joint capsule, glenoid rim fracture, and Hill-Sachs lesion. Of 32 shoulders which were treated by reoperation due to recurrent anterior dislocation after initial surgical repair reported by Rowe et al., avulsion of the capsule and labrum from the anterior glenoid rim (Bankart lesion) was present in 84% and capsular laxity in 83% and a Hill-Sachs lesion in 76%. This finding is relatively consistent with our CT arthrographic findings (Table 1).

The advantages of CT arthrography at this point are plentiful including feasibility of positioning, use of small amount of contrast material (2-3ml), excellent visualization of the labrum, and simultaneous examination of the both shoulders without increasing either the dose or examination time. Two demerits are relative high cost compared with other conventional studies and some implicating technical limitation. Extra-articular injection and the presence of joint effusion may diminish optimal evaluation. We experienced two cases of exra-articular injection at the earlier time of this study. Otherwise the labral and capsular elements are clearly visualized; and with the knowledge of normal cross-sectional anatomy, one can often readily recognize abnormal lesions on CT arthrography.

Since CT arthrography is easier to perform, more comprehensive, requires less technical expertise and radiation exposure, and is tolerated better by patients in pain, we believe that CT arthrography may become the procedure of choice for imaging the glenoid region among the active orthopedic surgeons who are interested in shoulder reconstructive surgery until the era of MRI.

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