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Case Report

Glenoid hypoplasia

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ABSTRACT

Glenoid hypoplasia, also known as glenoid dysplasia and dysplasia of the scapular neck, is a failure of ossification of the posteroinferior two-thirds of the glenoid. Once thought to be a rare condition, more recent studies have shown that the incidence of glenoid hypoplasia ranges from 18% to 35%. This case report and literature review highlights the typical clinical presentation, the radiologic findings, and the management options for patients with glenoid hypoplasia.

Case report

A 43-year-old Caucasian man presented for evaluation of a multiple year history of shoulder pain and stiffness of insidious onset with no known traumatic event. His active range of motion was reduced on the affected shoulder with some posterior instability noted. The unaffected shoulder demonstrated a normal range of motion with no pain or stiffness. A magnetic resonance imaging (MRI) of the affected shoulder was obtained. Axial imaging shows the deficient posterior glenoid, retroversion and concomitant posterior labral tear, detachment and hypertrophy (Figs. 1A and B). The hypoplastic glenoid may also demonstrate rounding of the posteroinferior glenoid rim and cartilage, labral hypertrophy, and widening of the inferior glenohumeral joint space. [1,2] Retroversion is assessed by obtaining the angle between the glenoid articular surface and a line extending through the long axis of the scapula on axial view (Fig. 1C). Humeral head subluxation often accompanies glenoid hypoplasia and is assessed by calculating the percentage of the humeral head that lies posterior to the long axis of the scapula (Fig. 1D). Additional imaging features may include hypoplasia of the humeral head, hyperplasia of the coracoid process and acromion, and hooking of the distal clavicle [3]. Osteophyte formation along the posteroinferior glenoid rim may be present, indicating accelerated degenerative joint disease [4]. The findings of glenoid hypoplasia can be contrasted to normal glenoid anatomy demonstrated in Figure 1B. The

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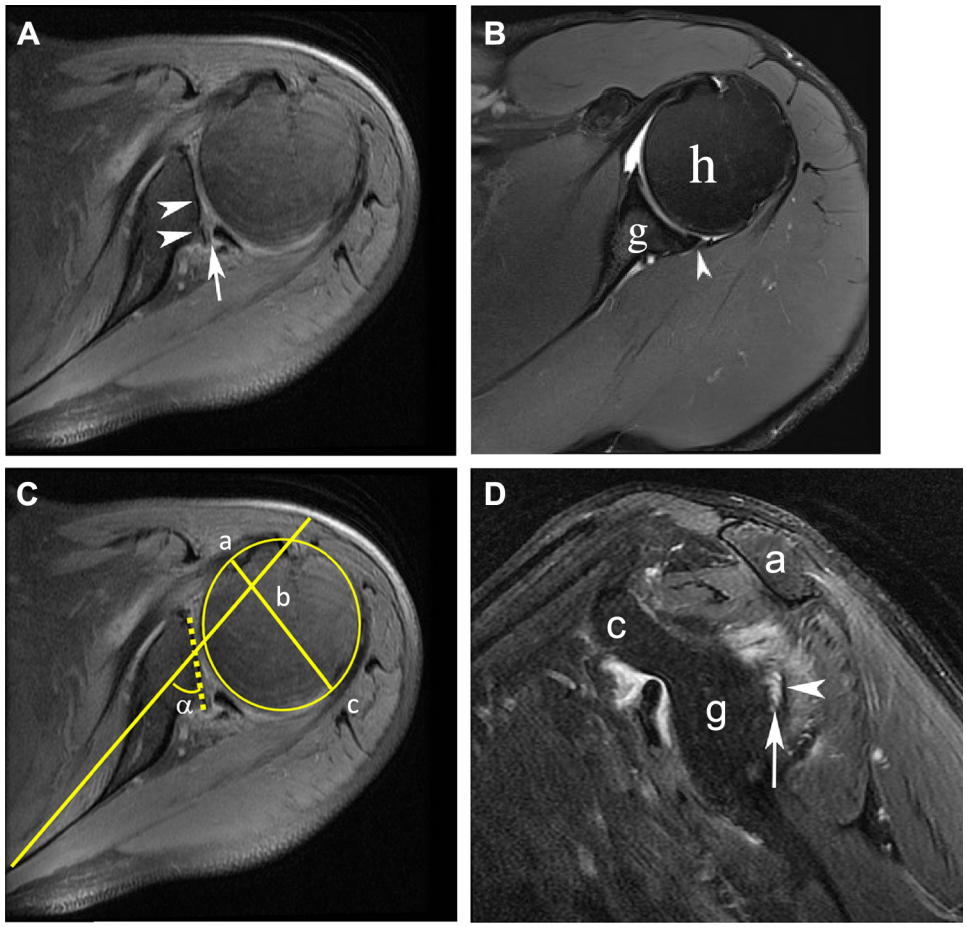

Fig. 1 – MRI of glenoid hypoplasia in a 43-year-old man. (A) Axial fast spin echo (FSE) proton density (PD) fat-suppressed (FS) image shows hypoplasia of the posterior glenoid (arrowheads), retroversion of the glenohumeral joint, and mild posterior humeral head subluxation. Note the concomitant posterior labral tear, detachment (arrow), and enlargement. (B) Normal shoulder in 40-year-old man. Axial FSE PD fat-suppressed image through the midglenohumeral joint shows the normal glenoid version, posterior labrum (arrowhead), and glenohumeral relationship (g = glenoid, h = humeral head). (C) Retroversion is assessed by obtaining the angle (α) between the glenoid articular surface (dotted line) and a line extending through the long axis of the scapula on axial view. Humeral head subluxation is assessed by calculating (ab/ac) × 100%. The conventional method of assessing glenoid version on cross-sectional imaging was described by Friedman et al [5]. Glenoid version is the angle between the glenoid line (the axis along the anterior and posterior glenoid rim) and the line perpendicular to the scapular axis (along the root of the scapular spine and center of the glenoid line). (D) Sagittal FSE T2 FS image shows the deficient portion of the posterior glenoid with complex joint fluid (arrow) extending between the glenoid (g) and imaged portion of the posterior labrum (arrowhead). c = coracoid, a = acromion.

patient's initial radiographs demonstrating glenoid hypoplasia are demonstrated in Figure 2 and are compared with the radiograph findings in an individual with normal glenoid anatomy.

Discussion

Glenoid hypoplasia, also known as glenoid dysplasia and dysplasia of the scapular neck, is a failure of ossification of the posteroinferior two-thirds of the glenoid. The scapula develops through intramembranous ossification at 8 ossification centers, two of which compose the glenoid. Aberrant formation of the inferior glenoid ossification center results in the characteristic findings of hypoplasia of the inferior glenoid promontory with marked hypertrophy of the articular cartilage [1,2]. It was first described by Giongo in 1927 [6]. Multiple etiologies have been described in the literature including idiopathic, familial, and as a part of a clinical syndrome, such as Apert syndrome, Holt-Oram syndrome, and others [2]. Once thought to be a rare condition, more recent studies have shown that the incidence of glenoid hypoplasia ranges from 18% to 35%, depending on the stringency of diagnostic criteria [1,7].

Glenoid hypoplasia is most commonly bilateral and asymptomatic, with the majority of cases discovered incidentally on chest x-ray [8,9]. Symptomatic patients often present with glenohumeral joint instability, pain, stiffness, and restricted range of motion, with abduction most significantly affected [1,3]. In a 2011 literature review, Suryawanshi

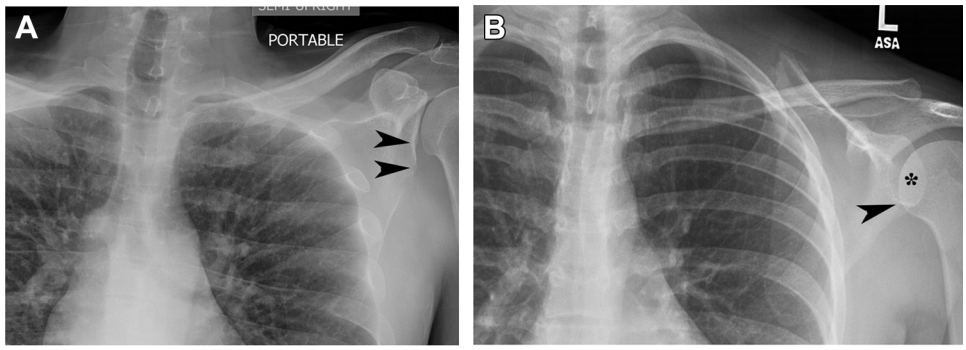

Fig. 2 – Glenoid retroversion and normal version demonstrated on chest radiographs. (A) Coned down frontal view chest radiograph in this patient demonstrates the hypoplastic left glenoid (arrows) and visualization of the glenohumeral joint in profile. The glenoid and humeral head should normally overlap on a chest radiograph since the glenohumeral joint is obliquely oriented to the X-ray beam. (B) Coned down image from a 22-year-old woman shows the normally formed glenoid (arrowhead) and the normal overlapping (asterisk) of the glenoid and humeral head.

et al. [6] reported that 21% of patients had discomfort, 41% had limited range of motion and <2% had glenohumeral instability. Although the natural course of glenoid hypoplasia is not well documented, chronic glenohumeral joint instability predisposes patients to develop accelerated degenerative joint disease and glenoid retroversion, increasing patient susceptibility to posterior labral tears and subluxation or dislocation [1,2,10]. Normal glenoid retroversion ranges from −9° to 13° with an average of 1°. Patients with glenoid hypoplasia have reported glenoid retroversion of greater than 11.5° with some cases exceeding retroversion measurements of 50° [10,11]. The degree of retroversion associated with posterior instability is 7° [12]. Treatment for glenoid hypoplasia is case dependent, with various factors such as patient age, degree of degenerative changes, and level of pain and function influencing the appropriate treatment course.

Diagnostic imaging

The imaging modalities that can evaluate hypoplastic glenoid are radiography, computed tomography (CT) and MRI. Hypoplastic glenoid is usually discovered incidentally on chest x-rays, but 3-view shoulder radiographs provide more diagnostic information. Radiography of the hypoplastic glenoid demonstrates hypoplasia of the scapular neck, an irregularly notched glenoid articular surface, glenoid retroversion, and widening of the inferior glenohumeral joint space [4,9,13]. Elongation of the glenoid and hypoplasia of the humeral head may also be present in severe cases [9]. Osteophyte formation in the inferior glenoid rims may be present, indicating accelerated degenerative joint disease [4].

Axial and 3-dimensional reformatted images CT shoulder imaging of the hypoplastic glenoid shows rounding of the posteroinferior glenoid rim, glenoid retroversion, and widening of the inferior glenohumeral joint space due to the failure of ossification of the glenoid. A smooth concentric articular cartilaginous surface of the glenoid, and hypertrophied articular cartilage inferiorly may be better appreciated when intraarticular contrast is injected with CT arthrography [2]. Additional findings of a downward shifted acromion, a distorted coracoid process, and a hooked distal clavicle may also be apparent on CT [9].

MRI is the gold standard imaging modality for assessing the osseous and soft-tissue abnormalities in patients with glenoid hypoplasia, as demonstrated with this case report.

Management

A conservative approach composed of physician-directed physical therapy and patient education has demonstrated significant reduction in the symptoms of shoulder pain along with improved mobility of the glenohumeral joint in patients who develop symptomatic hypoplastic glenoid before age 40 [4,8]. Patient education consists of counseling against participation in activities that exacerbate shoulder pain, such as overarm shoulder movements and direct contact to the affected shoulder. The physical therapy regimen indicated for glenoid hypoplasia aims to stabilize the scapular muscles and to strengthen the rotator cuff muscles and the deltoid muscle by soft-tissue maneuvers, manipulation of the glenohumeral joint, stretching, and shoulder exercises. [4,14] In a case report detailing the physical therapy management of 2 men, aged 27 and 24 years, Lynch et al. [4] describe the approach to the patient with symptomatic glenoid hypoplasia. Active Release Technique (ART) was performed bilaterally once per week over a 6-7 weeks time frame. ART uses active and passive motions to release adhesions between the soft-tissue planes of healthy and pathologic tissues, thus reestablishing ideal compartments and fascial planes of muscles, ligaments, nerves, and tendons. Daily band exercises consisting of internal and external shoulder rotation with both eccentric and concentric contractions were also a component of the management for the 24-year-old male patient. By the end of the sixth week of physical rehabilitation, both patients had achieved 100% resolution of pain and had regained full range of motion in the affected shoulder. Similarly, in a case report of 16 patients with symptomatic glenoid hypoplasia, Wirth et al. [14] outline considerable improvements in the ratings for pain and the capacity to perform activities in the affected shoulder for 13 patients after conservative management consisting solely of shoulder strengthening and stabilizing exercises,

such as various types of pushups, shoulder shrugs, and internal and external rotation using Therabands.

Surgical intervention should be considered in cases of severe instability, pain and reduced function, and failed conservative treatments [14]. In milder cases, where glenoid retroversion is less than 15°, glenoid reaming remains an option if sufficient subchondral bone can be spared [15,16]. Subchondral bone loss after glenoid reaming may impair implantation strength and may lead to joint line medialization. Reverse total shoulder replacement, bone grafting, and augmented glenoid components are procedures that have been used to treat glenoid bone loss in the setting of significant osteoarthritis, traumatic injury, and glenoid hypoplasia where the degree of retroversion exceeds 15°. Preoperative planning is guided by Walch classification [17]. Overall, shoulder surgeries correcting glenoid bone loss have an increased risk of complications when compared to the normal population [16].

Bone graft repair can be performed with iliac crest, distal tibia, and osteochondral material [18]. This technique is typically employed when the glenoid bone loss is too significant for a glenoid component or glenoid reaming. An allograft bone graft from the iliac crest can be used to extend the articular surface of the glenoid, leading to decreased pain, and normal functioning. In a similar manner, an osteochondral allograft can be used, with the added benefit that the cartilage surface is restored. Glenoid bone graft can also be achieved with curved bone from the lateral aspect of the distal third tibia, which closely resembles the natural convexity of the glenoid. Complications of bone graft repair include resorption, nonunion, and subsidence of the graft, radiolucencies and instability. However, literature-regarding bone graft outcomes are limited with mixed findings. It is advised that patients can return to normal recreational activities after 6 months of recovery and rehabilitation.

Augmented glenoid components are possible treatments for glenoid retroversion exceeding 15° [16]. The use of these implants can spare the glenoid subchondral bone, but the installation procedure may be more technically challenging than others [16]. Suggested use of these devices has been determined by a range of posterior glenoid bone loss from 3 mm to 9 mm on axial view [19]. Augmented components have been shown to decrease joint medialization when compared to standard glenoid components [19]. However, with design variance, not all augmented glenoid components share equal efficacy in restoring version. The stepped design augmented glenoid component has been shown to minimize anterior glenoid liftoff and improve component fixation [20]. Improper installation can cause component movement, ultimately leading to loosening. Studies on long-term follow-ups are lacking.

Reverse total shoulder replacement for primary glenoid hypoplasia is the best evaluated in the setting of sufficient rotator cuff function. Mizuno et al. described 27 cases where reverse shoulder replacements were performed on patients with glenoid retroversion and functional rotator cuffs. The average glenoid retroversion angle for the patients was 32°; they had an average age of above 70 years old. All surgeries resulted in the elimination of posterior shoulder instability without the occurrence of radiolucent lines. Only 10 patients required additional bone grafting to decrease the glenoid angle below 10°. At 54-month follow-up, there were 4 complications: 3 had neurologic sequelae and 1 had glenoid loosening. The authors concluded that reverse total shoulder replacement was a viable option for those with chronic shoulder instability and a severe degree of glenoid retroversion [21].

In summary, standard treatment for glenoid hypoplasia has not been determined across all patient populations. Patient symptomatology, age, activity, and other relative indications, as well as clinical judgment and surgical skill, should be used to guide patient treatment options as there are limited studies on preferred treatments.

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