Zagazig University Medical Journal
www.zumj.journals.ekb.eg

https://doi.org/10.21608/zumj.2021.79161.2252 Volume 30, Issue 1.1, -January 2024, Supplement Issue

Manuscript ID ZUMJ-2106-2252 (R1)
DOI 10.21608/ZUMJ.2021.79161.2252

ORIGINAL ARTICLE

Arthroscopic Assisted Glenoid Reconstruction for Recurrent Anterior Glenohumeral Instability combined with Glenoid insufficiency.

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Submit Date 2021-06-05
Revise Date 2021-06-13
Accept Date 2021-06-16

ABSTRACT

Background: Anterior recurrent glenohumeral instability is a common clinical entity, particularly among the young athletic patient population with a glenoid defect greater than 20%. Glenoid reconstruction with a bone graft has become the treatment of choice. The aim of this study was to evaluate the role of arthroscopically assisted reconstruction in the management of recurrent anterior glenohumeral instability associated with glenoid insufficiency.

Methods: Our prospective study involved 30 cases of anterior shoulder instability associated with a glenoid defect greater than 20%. All patients were operated on at Zagazig University Hospitals. All cases were surgically managed by arthroscopically assisted reconstruction of the glenoid defect with a bone graft. 15 cases with the coracoid process and 15 cases with the tricortical iliac crest graft.

Results: Thirty patients were followed up on for a year**.** All patients showed significant improvement in their range of motion. No dislocation or subluxation was recorded in any patient. Except for one graft, all the grafts completed bony union. Constant-Murley score and the University of California, Los Angeles scale were highly significant improved postoperatively.

Conclusions: Soft-tissue stabilization procedures for the treatment of anterior shoulder instability have been shown to be less effective, with a high recurrence rate of up to 67% in patients with extensive glenoid bone loss greater than 20%. In the case of extensive glenoid bone loss greater than 20%, bone grafting techniques are used instead of soft tissue stabilization procedures.

Keywords: Bone defect, Shoulder instability, Glenoid bone loss, anterior shoulder dislocation

INTRODUCTION

Recurrent anterior glenohumeral instability is usually associated with disruption of the antero-inferior labrum, or Bankart tear. Patients with recurrent shoulder instability, on the other hand, may present with a glenoid osseous injury [1]. The integrity of the bony arc of the glenoid has recently become one of the most important factors related to the success of surgical repair. A glenoid rim fracture or attritional bone injury may compromise the stability of the glenohumeral joint. This makes further dislocation or subluxation more likely [2].

Preoperative radiology is important for the detection and quantification of bony defects in patients with recurrent shoulder instability. The apical oblique view, the West Point view are recognized as being the most sensitive radiographs for detecting bony abnormalities of the glenoid. Magnetic resonance imaging may be used, but it is primarily used to assess the surrounding soft tissue injury. If any bony lesion is suspected, a computed tomography scan can provide valuable information about the extent of the bone loss. Furthermore, a three-dimensional reconstruction computed tomography scan of the humeral head with digital subtraction provides an en face sagittal oblique view of the glenoid, allowing accurate measurements of glenoid bone loss [3].

Reconstruction of the glenoid concavity using a bone block graft represents an effective option for treatment of glenoid-deficient anterior glenohumeral instability. With the development of arthroscopic techniques, bone block grafting can be assisted arthroscopically [4]. The aim of this study is to evaluate the role of arthroscopically assisted reconstruction in the management of recurrent anterior glenohumeral instability with glenoid insufficiency**.** Our hypothesis is that using an arthroscopically assisted bone block graft will improve glenohumeral joint stability and reduce the risk of wound complications.

METHODS

This is a prospective study of 30 patients who underwent arthroscopically assisted glenoid reconstruction for recurrent anterior glenohumeral instability combined with glenoid insufficiency between 2016 and 2020 **at the** Orthopedic Department, Zagazig University Hospitals. The study was approved by the research ethics committee of the Faculty of Medicine at Zagazig University. The study was done according to the Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans. Written informed consent was obtained from all participants' parents. Patients presenting with anterior shoulder instability with glenoid loss greater than 20% and severe soft tissue loss were enrolled. Patients with a history of previous failed glenohumeral instability surgery and those with a large, engaging Hill-Sachs lesion were also enrolled. High-risk sports (such as martial arts and football) and epilepsy were frequently associated with large bone defects and poor outcomes. Patients with an Instability Severity Score Index (ISIS) greater than 6 were included (Table 1). Patients with instability associated with paresis of the deltoid, rotator cuff, and/or pericapsular musculature were excluded. Exclusion criteria also included voluntary instability, multi-direction instability, and uncontrolled epilepsy.

All patients were evaluated preoperatively using X-ray AP and axillary views. In a CT scan, all patients underwent a glenoid, en-face view made by humeral head subtraction for measurement of the glenoid defect using the Pico method. All patients' MRIs revealed labral tears and Hill-Sachs, the size and depth of which were assessed in the axial cut of the MRI, and no abnormalities in the rotator cuff.

All patients were operated on at Zagazig University Hospitals. Two techniques were used. **In the first technique,** we performed a mini-open laterjet with a coracoid graft in 15 patients with a glenoid defect of 20 to 25%, on-track Hill sacks (non-engaging), and reparable soft tissue involving the anterior labroligamentous structures (Figure 1). **In the second technique, 15** patients with a glenoid defect greater than 25% with off-track Hill sacks (engaging) and irreparable soft tissue loss involving the anterior labroligamentous structures, we did an arthroscopic iliac crest bone graft (Figure 2).

Operative techniques:

Technique no (1): A deltopectoral approach was used. The subcutaneous tissue was bluntly dissected, and the clavipectoral fascia was opened in line with the skin incision. The cephalic vein was protected and retracted laterally with the deltoid musculature. Intervals between the deltoid and pectoralis major were identified.

Step 1: Coracoid osteotomy and preparation

The coracoacromial ligament (CAL) was identified with the aid of shoulder abduction and external rotation. We transect the CAL approximately 1 cm from its insertion on the coracoid process. With the shoulder positioned in adduction and internal rotation, we release the pectoralis minor tendon from its insertion on the medial aspect of the coracoid process sharply with an elevator. Throughout the coracoid exposure, musculocutaneous nerves are identified and protected with digital palpation. Then multiple drills with smooth wires on their superior surfaces were used, followed by a saw, to harvest the coracoid bone graft by performing a medial-to-lateral osteotomy anterior to the insertion of the CC ligaments at the coracoid base. The coracoid graft was next prepared for transfer. Any remaining soft tissue is debrided from the inferior surface of the coracoid to improve conformity between this surface and the glenoid margin with an oscillating saw or high-speed burr.

Step 2: Glenoid exposure and preparation

The shoulder was placed in external rotation to optimize visualization of the subscapularis. The superior and inferior borders of the subscapularis were identified. An L-shaped tenotomy was performed between the junction of the upper one and lower two thirds. A longitudinal capsulotomy was carried out. The anterior-inferior glenoid labrum was next subperiosteally dissected off the glenoid neck by electrocautery. Once exposed, the anterior glenoid neck can be abraded with a high-speed burr to prepare the bed for the later coracoid transfer.

Step 3: Coracoid process transfer

The longitudinal axis of the coracoid graft was positioned superoinferiorly along the glenoid neck flush with the articular surface after the humeral head retractor was placed in the glenohumeral joint to provide visualization of the anterioinferior glenoid articular surface. The optimal position is between the 3 and 5 o'clock positions. Definitive screw fixation was then performed with the lag technique: two bicortical anteroposterior holes, approximately 1 cm apart, perpendicular to the longitudinal axis of the coracoid graft and parallel to the glenoid surface. Two 4.10 mm cannulated screws were used to secure the graft, which was typically 34 to 36 mm long.

Step 4: Repair of the capsule and subscapularis

Capsular repair allows the newly transferred coracoid graft to function as an extra-articular platform and, at the same time, protects the humeral head articular cartilage from the bone block's abrasive effects. The CA ligament stump should be sutured over the capsule for further augmentation. The subscapularis split is next repaired with a high-strength No. 2 suture.

Technique no (2): Arthroscopic reconstruction of the glenoid by a tricortical iliac graft was performed.

Step 1: Diagnostic arthroscopy through the standard posterior portal to evaluate the pathology and identify any concomitant glenohumeral lesions.

Step 2: We create our portals by creating an anteroinferior working portal superior to the subscapularis tendon using an outside-in technique. Then establish the deep anteroinferior to achieve the correct orientation of this portal and insert a spinal needle 6 to 7 cm below the anteroinferior portal, aiming toward the 4 o'clock position. Sometimes we do it inside out.

***Step 3*: Scapular neck preparation** by releasing the capsulolabral complex from the scapular neck, exposing the red fleshy fiber of the subscapularis (creating space for graft insertion), and preparing the glenoid rim and scapular neck with a motorized burr to make a flat surface and enhance healing with the graft. And then relax the rotator interval enough to allow the graft to pass.

***Step 4*: During the arthroscopy, we pass a guide wire from the anterior glenoid rim (subchondral at the anteroinferior part). Where we prefer to insert the graft, on the posterior glenoid rim.** Then we pass Ethibond size 5 on the guide from anterior to posterior.

***Step 5*: Harvesting and preparation of the iliac crest bone block by** taking a tricortical iliac crest bone graft from the ipsilateral side. The size and length of the graft depend on the dimensions of the glenoid defect. Large osseous defects usually require a graft measuring 2 to 3 cm by 1 to 1.5 cm. The soft tissue in the graft is then removed, and a hole is made to allow another Ethibond size 5 to pass through.

***Step 6*: Graft insertion and fixation by** making a loop in the Ethibond pass in the glenoid and using it to guide graft insertion in its anatomical position in the anteroinferior part of the glenoid. Then confirm its position and flushness with the glenoid surface. The graft is then pre-fixed with a guide wire, followed by graft fixation with two cannulated screws and screw positioning under C-arm guidance.

Postoperatively, patients were followed-up for a period of 12 months and evaluated using the University of California, Los Angeles (UCLA) scale and Constant-Murley score.

Statistical analysis:

Data analysis was performed using the software SPSS (statistical package for the social sciences), version 20. Quantitative variables were described using their means and standard deviations. Categorical variations were described using their absolute frequencies, and to compare the proportion of categorical data, the chi square test and Fisher exact test were used when appropriate. The statistical significance level was set at 5% ($p< 0.05$). If $p\leq 0.01$ was used, there was a highly significant difference.

RESULTS

The mean age at the time of operation was 26.10 (ranging from 19–40) years old. 28 male patients and 2 female patients (Table 2). Recurrent glenohumeral instability occurred in 18 patients (14 in the right and 4 in the left dominant arms) and 12 in the nondominant arm (Table 2). One patient suffered from epilepsy controlled with medications and was fit and free for 1 year preoperatively, while another patient was a drug abuser.

The mean number of dislocations was 9.73 (ranging from 5–25), and the mean duration from the first time of dislocation to surgery was 2.33 years (ranging from 1–4.5 years). The average glenoid bone loss measured by CT was 25.46 percent (ranging from 20 to 33 percent), with 15 patients having less than a 25% glenoid defect. Fifteen patients had their first dislocation due to falling on their outstretched hands. Five patients suffered dislocations while participating in a sporting event, four due to a road traffic accident (RTA), three whose first dislocation occurred after falling from a height, one after an attack of convulsions, and two who were involved in a street fight. All the patients had their first dislocation reduced in a hospital under sedation or anesthesia.

Our results revealed a clinically highly significant improvement in the range of the motions (Table 3). Forward elevation improved from 146.16 (ranging from 130 to 165) to reach 166.33 (ranging from 155 to 175) ($p< 0.005$). Abduction improved from 141.50 (ranging from 135 to 150) to reach 162.33 (ranging from 160 to 170) ($p < 0.005$). Internal rotation improved from 57 (ranging from 50 to 60) to reach 71.16 (ranging from 65 to 70), which was significant at $p < 0.005$. External rotation improved from 44.50 (ranging from 40 to 55) to reach 80.66

(ranging from 75 to 85); this was significant at $p < 0.005$. Also noticed was that there was no difference in abduction, external rotation, or forward flexion between the two techniques; however, internal rotation was shown to be significantly worse by 2 to 3 vertebral levels on average after the Latarjet procedure than after ICBGT at 6-, 12-, and 24-months follow-up.

Radiological testing revealed a bony union in 29 patients and one patient with a fibrous union. With only two minor medial displacements, the entire graft was flush with the glenoid edge. The constant score improved from 49.83 (poor) (ranging from 40 to 65) to 89.83 (excellent) (ranging from 80 to 95). Twenty-six patients were excellent, and four patients were good. UCLA score improved from 14.30 (poor) (ranging from 8 to 19) to 31.23 (excellent) (ranging from 26 to 33), with two patients scoring 26, which is a fair result (Table 4). One patient in technique 1 developed a hematoma 5 days after the operation, which was treated by surgical exploration and ligation of the cephalic vein. Two patients showed medialization of the graft in postoperative radiology. In technique 2, superficial infections in one patient with mild serous discharge were treated with broad spectrum antibiotics, and the patient became stable. In one patient, 2 months post-operatively, during physiotherapy, a sudden serous discharge was treated with antibiotics in the culture. Six months later, pain and discharge indicated that the screws had become loose, so the graft fibrous united and the patient was stable following debridement and screw removal

Table 1: Instability Severity Score Index.

Prognostic factors	Points
Age	
<20 year >20 year	2 0
Degree of sport participation	
Competitive None	2 0
Type of sport	
Contact or forced overhead Other	1 0
Shoulder hyperlaxity	
Hyperlaxity None	1 0
Hill sacks lesion on A P x ray	
Visible in external rotation Not	2 0
Glenoid loss of contour AP	
Visible NOT	2 0

Table 2: Age and sex distribution among studied group.

Parameters	Patients (No.:30)
Age	26.1 ± 5.85
Sex (Male/Female)	28/2 (93.3/6.7)
Dominant side:	
• Dominant right	14 (46.7)
• Dominant left	4 (13.3)
• Non right	1 (3.3)
• Non left	11 (36.7)
Affected side:	
• Right	15 (50)
• Left	15 (50)

Data presented as mean ± SD or number (%)

Table 3: outcome assessed by pre- and post-operative comparison among studied group.

	Pre-operative	Post-operative	p
Forward flexion score	146.16±8.57	166.33±5.24	0.001**
Abduction score	141.50±5.27	162.33±3.40	0.001**
Internal rotation score	57.0±4.27	71.16±3.13	0.001**
External rotation score	44.50±3.79	80.66±3.65	0.001**

Data presented as mean ± SD
Statistical significance detected by paired t test
** Significant*

Table 4: UCLA and constant pre and postoperative.

	Pre-operative	Post-operative	p
Constant score	49.83±7.36	89.83±4.25	0.001**
UCLA score	14.30±3.35	31.23±1.77	0.001**

UCLA: University of California, Los Angeles
Data presented as mean ± SD
Statistical significance detected by paired t test
** Significant*

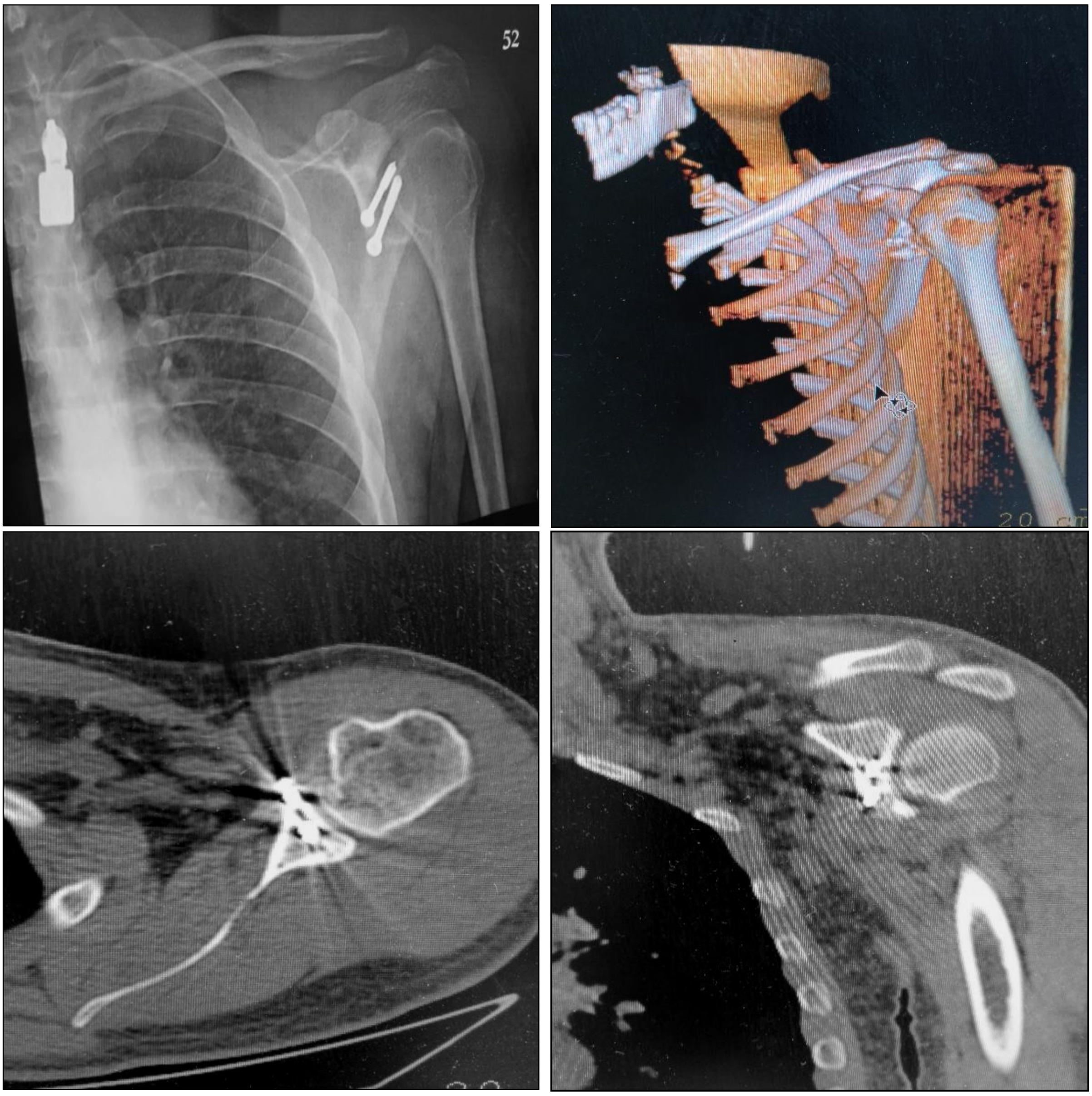

Figure 1: patient with glenoid defect reconstructed with mini open laterjet with coracoid process.

Figure 2: glenoid defect reconstructed with tricortical iliac crest graft

DISCUSSION

Recurrent anterior glenohumeral instability is a major problem in young athletic populations. The incidence of anterior glenohumeral instability in the general United States (US) population is 0.08 per 1000 person-years [5]. Specific at-risk young male athletes, such as football players, have incidence rates as high as 0.51 per 1000 athletes. The incidence in military personnel is estimated to be 1.69 per 1000 person-years [6].

Disruption of the native static and dynamic stabilizers of the glenohumeral joint, leading to dislocation, subluxation, or apprehension with associated pain. The articular conformity, negative intraarticular pressure, glenoid labrum, and glenohumeral ligament complex, specifically the anterior and posterior bands of the inferior glenohumeral ligament (IGHL), are critical to increasing shoulder stability. The rotator cuff and scapular stabilizers are dynamic sources of restraint [7]. The glenoid track concept has aided in the identification of engaging, high-risk lesions. It is well known that glenoid and humeral head bony defects increase the risk of subsequent instability [8].

In the last few years, the failure rate of classic Bankart repair has increased. **Burkhart and De Beer** reported a 67% recurrence rate after arthroscopic treatment of patients with significant bone loss, as compared with just 4% in those without it. Increased interest in glenoid and

humeral bony defects, also known as bipolar bone defects, was detected [9].
The longitudinal recording of range of motions in our study showed all mean postoperative clinical scores were significantly improved compared to the mean preoperative values but inferior to those of the healthy side. **Kraus et al.** [10] did not find significant differences in any of the different elements of postoperative ROM compared to the healthy contralateral side. **Scheibel et al.** [11] found that the mean hand-to-back distance of the affected side (achieved actively during the liftoff test) was significantly inferior to that of the healthy side. In addition, **Anderl et al**. noted that all elements of ROM were significantly improved compared to their respective preoperative values [12]**. Bockmann et al.** reported that their patients achieved full ROM in the abduction and external rotation post-surgery [13], while **Zhao et al.** noted that almost all patients in their cohort had normal postoperative ROM [14]. There was no difference in abduction, external rotation, or forward flexion; however, internal rotation was shown to be significantly worse by 2 to 3 vertebral levels on average after the Latarjet procedure than after ICBGT at 6-, 12-, and 24-months' follow-up. Although the causes thereof remain speculative, a possible explanation is the L-shaped tenotomy of the subscapularis in laterjet. This is consistent with the findings of Moroder P and Schulz E [15]. Also, **Moroder et al.** [16] found similar results.
Regarding postoperative stability, no dislocation or subluxation was recorded. This reflects the results of previous case series reports that showed the high rate of stabilization success of both procedures even in the long term, as described by **Allain *et al.*** [17]. who reported no recurrent dislocation but found subjective subluxation in one (2%) patient. **Hovelius *et al.*** [18] reported a recurrence rate of 4% and a subluxation rate of 9%. This could be due to the relatively short follow up period of our patients as compared to those reported in the literature.
We noticed medialization of grafts in two patients. This is less than Allain et al. [17] reported in the literature, which is likely due to the use of a humeral head retractor against the posterior rim of the glenoid for better visualization. This allowed for accurate positioning of the graft. Although we didn't notice any arthritis due to the smaller follow-up and accurate graft positions.
One patient (6.7%) had a postoperative cephalic vein ligation for acute hematoma. **Kumar and Debuka [19] also reported hematoma in one patient who was treated with reincision, good hemostasis, and cephalic vein ligation.**
Two patients suffered from infections. One patient with a superficial infection requires only antibiotics and a dressing, while another requires screws due to loosening, which could take a long time in early cases. **Malahias and Chytas [20] reported t**wo out of the nine studies (22.2%) that reported a total of four postoperative cases of infection [14, 21] (four patients out of 231, rate 1.7%). Also, the rate of hardware-related complications was 3.9% (9 out of 231 cases). **Bockmann et al**. [21] reported that two out of the 32 patients (6.3% of their patient cohort) experienced mechanical irritation around the screw insertion sites, generating persistent pain. These patients were successfully treated with the removal of the screws.
This study had some limitations. The sample size of this study was small and needs to be larger. The follow up period needs to extend for a long time to assess any complications such as osteoarthritis or dislocation. This study can't compare the two techniques because the size of the defect was different between them.

CONCLUSIONS

A good and precise preoperative evaluation (clinical and radiological) is important in the diagnosis of the glenoid defect with recurrent anterior glenohumeral instability. Soft-tissue stabilization procedures for the treatment of anterior shoulder instability have been shown to be less effective, with a high recurrence rate of up to 67% in patients with extensive glenoid bone loss greater than 20%. When there is more than 20% glenoid bone loss, we recommend bone grafting techniques rather than soft tissue stabilization procedures. There are two competing bone grafting techniques: coracoid transfer techniques and the modern Eden-Hybinette procedure or iliac crest bone graft transfer (ICBGT). ICBG is recommended for larger glenoid defects**.**

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How to cite

Elshaer, A., shalaby, M. S., Megahed, R., abdelsalam, M. Arthroscopic Assisted Glenoid Reconstruction for Recurrent Anterior Glenohumeral Instability combined with Glenoid insufficiency. ***Zagazig University Medical Journal*, 2024; (202-209): -. doi: 10.21608/zumj.2021.79161.2252**