CLINICAL CASE

HEMIARTHROPLASTY IN FOUR-PART DISPLACED FRACTURES

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Abstract

The hemiarthroplasty is the choice of election in the four-part humeral fracture when the glenoid surface is good. It is a relative easy procedure with a short operating time and can be revised to a total shoulder arthroplasty later if necessary. For hemiarthroplasty there are used unconstrained prostheses which are designed to closely replicate the normal anatomy. The general idea is to replace the avascular humeral head with a metal ball in condition of normal glenoid surface.

Keywords*: hemiarthroplasty, prosthesis, displaced fractures*

Introduction

Proximal humeral fractures, as four-part displaced fractures can be treated in many ways depending on the patient status: close reduction for those unwilling to be operated, or with too many comorbidities, close reduction and percutaneous fixation, open reduction and internal fixation, head excision and arthodesis, but the best method is hemiarthroplasty [1-4]. The reason for this choice is that accurate reduction is almost impossible and avascular necrosis of the articular fragment is likely [5].

Contraindications for this procedure include active or recent infection, chronic osteomyelitis and paralysis of the rotator cuff musculature. Debilitating medical status and not a determinate patient are also contraindications for shoulder hemiarthroplasty [6].

Materials and methods

The shoulder joint is a socket-ball joint that allows more mobility than any other joint in the body. There is no inherent stability at this level; it depends on the static and dynamic stabilizers for movement and stability. The rotator cuff is the primary stabilizer of the joint fixing the fulcrum of the upper extremity and allowing the deltoid to contract against it and elevate the humerus. The articular surface of the humeral head is a sphere with an arc of approximately 160 degrees covered by reticular cartilage. The radius curvature is 25 mm. The glenoid curvature is 2-3 mm larger than that of the humeral head. The humeral head thickness is 23 mm. The neck-shaft angle is 45 degrees with an average of 30 to 50 degrees. Between the top of the greater tuberosity and the superior margin of the humeral head articular surface there is a distance of 8-10 mm, very important for functional results. The distance from the lateral margin of the greater tuberosity and the lateral base of the coracoid process is called lateral

humeral offset which is important because it maintains a normal lever arms for deltoid and supraspinatus muscles. Also a malposition of more than 4 mm increases the subacromial contact and decreases the range of motion [7].

During the fracture, the muscles pull the fragments in specific directions which are important to know in order to find them and reattach on the prosthesis shaft. The supraspinatus pulls the greater tuberosity posteriorly and superiorly and subscapularis anteriorly and inferiorly. Usually the articular head is collapsed, or dislocated antero-inferiorly [8].

There are many systems: Neer II (designed to reproduce normal anatomy), Cup arthoplasty, DANA (UCLA) and Monospherical (Gristina), St. Georg, Isoelastic and Bipolar. The current systems are modular with varying humeral head diameters and neck lengths. Stems are available with or without titanium porous coating proximally. Stems can be inserted with press-fit or cemented technique. Stability is increased with cementation versus press-fit. No difference was found between proximal cementation and full cementation on rotational stability. Bipolar prosthesis theoretically offers more motion with less stress on the glenoid.

Preoperative planning

Before hemiarthroplasty, the shoulder must be carefully evaluated. Standard roentgenograms (trauma series) should be obtained (Figure 1). This consist in anteroposterior, Velpeau (because of the fracture, it is difficult to have and axillary view) and scapular Y views. The true anteroposterior view is obtained by the x-ray beam angled 30 to 40 degrees obliquely to the coronal plane of the body. A roentgenogram of the opposite shoulder is also helpful if there is a large humeral deficiency, to aid in the preoperative planning and prosthetic sizing and templating. Also a CT is important to evaluate the surface of the glenoid. MRI evaluates the condition of the rotator cuff. A number of templates are available with adjustments made for magnification.

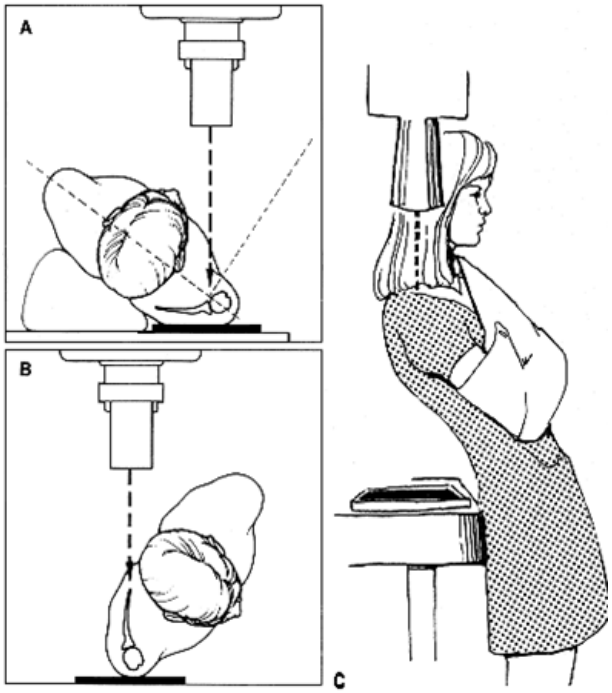

Figure 1 - Trauma series: a) true anteroposterior view, b) scapular Y view, c) Velpeau view (redrawn from Neer CS II: JBone Joint Surg 52 A:1077,1970)

Surgery

1. Patient position

The goal in positioning a patient is to have access to the shoulder. For this, the patient is placed in beach-chair position on the special operating table with cutaway section about shoulder to allow more complete access posteriorly and a small moveable arm board on the operative side of the table (Figure 2). The entire arm is prepped in a sterile fashion and draped. Operative field must include medial clavicle, base of the neck and under the axilla.

2. Approach

For hemiarthroplasty, a long deltopectoral approach (Figure 3) is used. The incision starts just inferior to the clavicle, runs lateral of the coracoid process extending lateral toward the deltoid insertion on the humeral shaft. The cephalic vein is identified and mobilized laterally to minimize bleeding. The proximal 1/3 of the pectoralis insertion can be detached to facilitate the exposure. Sometimes it is necessary to remove the deltoid insertion on the clavicle and acromion. The deltoid muscle is retracted laterally and the long head of the biceps brachii (LHB) is identified. This

structure is a key landmark which can help to orient in identification of individual fracture fragments.

Figure 2 - Patient beach-chair position

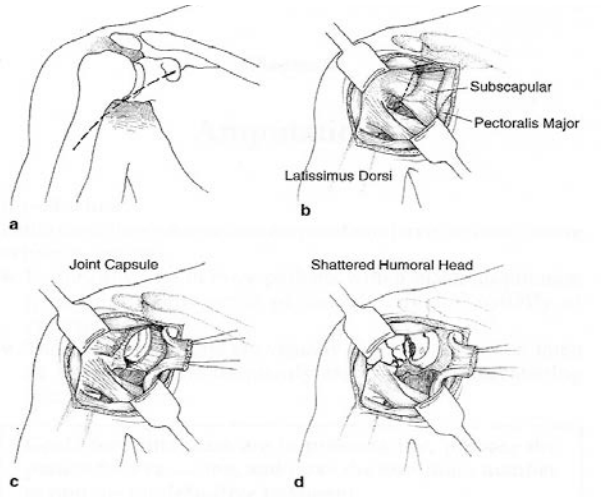

Figure 3 (a, b, c, d) - Deltopectoral approach

3. Exposure of fracture

Using the LBH as landmark, it is possible to differentiate between the lesser and the greater tuberosities. Typically, the lesser tuberosity lies medial to the LHB and the greater lateral, with the head lying between the tuberosities. After the identification of the fragments, each tuberosity is tagged with a no. 2 non-absorbable suture. The suture must be placed in the tendon proximal to the fragment to avoid iatrogenic comminution of them. Retracting the fragment will provide enough space to mobilize the humeral head.

That must be done very carefully to avoid injury of another structure, in particular the neurovascular structure (especially if the humeral head is displaced anteriorly below the coracoid and medial to the strap muscles). Any loose fragment of cancellous bone as well as the humeral head is used for autogenous bone graft. With the rotator cuff intact, the coracoacromial ligament can be excised. If the are osteophytes that impinge on the anterosuperior aspect of the rotator cuff, an anterior acromioplasty is made to permit free movement after surgery. In patients with cuff arthropathy, the acromion and the coracoacromial ligament should be preserved.

4. Shaft preparation and prosthesis placement

If there is a fracture of the shaft, fixation should be performed prior to the implantation of the prosthesis. This can be done with cerclage wires, cables, or heavy non-absorbable sutures. The shaft of the humerus must be mobilized gently to avoid iatrogenic fracture. The humerus canal is exposed by extending and by externally rotating the arm. The medullary canal is prepared with sequential reamers. To determine the proper size of the prosthesis, three aspects should be followed: retroversion, height and head size. Usually, the implant must be placed in 20-30 degrees of retroversion. For that, an intramedullary alignment system is used.

Another way is to position the fins of the prosthesis to the distal aspect of the bicipital groove and to the epicondylar axis of the elbow. Finally the version can be determined after the trial implant has been placed and the prosthesis reduced. The height of the prosthesis is also determined with the help of the trial stem within the canal. The collar of the prosthesis should not be seated very deeply in the canal to allow space for the tuberosities to be placed below the level of the head. The size of the head is selected by templating the radiograph of the uninvolved shoulder, or by using the removed head for comparison. Usually, a smaller head is used to avoid overstuffing the joint which can lead to postoperative stiffness. Also a smaller head facilitates tuberosity closure.

With the trial in the medullary canal, the reduction is made and tuberosities are

mobilized. They must be placed under the head to avoid subacromial impingement and well apposed to the shaft. In neutral position, head should be centered in the glenoid. The stability is checked at 40 to 50 degrees of internal and external rotation. If the prosthesis is instable anteriorly, the retroversion must be increased; if the instability is posteriorly the retroversion is decreased. Also an AP translation and push-pull movement are mare to check the stability in AP plan. A 50% translation in both anterior-to-posterior and superior-to-inferior direction must exist.

After establishing the ideal position of implant, 3-4 holes to allow fixation of the tuberosities are made in the proximal humerus. No. 2 heavy non-absorbable nylon sutures are passed through these holes before cementation. To fix the implant cementation is the best choice. A sized cement restrictor is placed in canal and than irrigated to remove clots and debris. The cement is injected and the component is placed using all previous measurements to establish height and retroversion. The excess of cement should be removed from the superior portion of the humerus to permit contact bone to bone of the tuberosities with the humeral shaft.

5. Tuberosity repair

One cause of failure is inadequate tuberosity repair. They must be placed on the bone of the humeral shaft and not to the prosthesis itself. A no. 5 non-absorbable suture is placed around the lesser tuberosity, through prosthetic fins and around the greater tuberosity, but they are not tied until the lesser and greater tuberosity suture have been tied first. Cancellous bone graft is applied on the humeral shaft, between the shaft and tuberosities, and than they are tied using the sutures from proximal humeral shaft.

Careful attention must be paid to fix properly the greater tuberosity to the shaft because this determines the effective action of the supraspinatus, infraspinatus and teres minor. The greater tuberosity is fixed first and afterwards the lesser. The no. 5 sutures placed around the tuberosities are tied after for compression. The stability of the complex is checked. No movement of the tuberosity repair should be seen with gentle arm movement.

The wound is then closed in a fashion manner with a suction drain placed in the deltopectoral interval for 24 hours to evacuate the hematoma. The insertion of the pectoralis major is repaired with no. 2 non-absorbable suture and after deltopectoral interval with 3-0 absorbable sutures. The skin is closed in a subcuticular fashion with 4-0 suture and Steri-Strips are applied for cosmetic purpose.

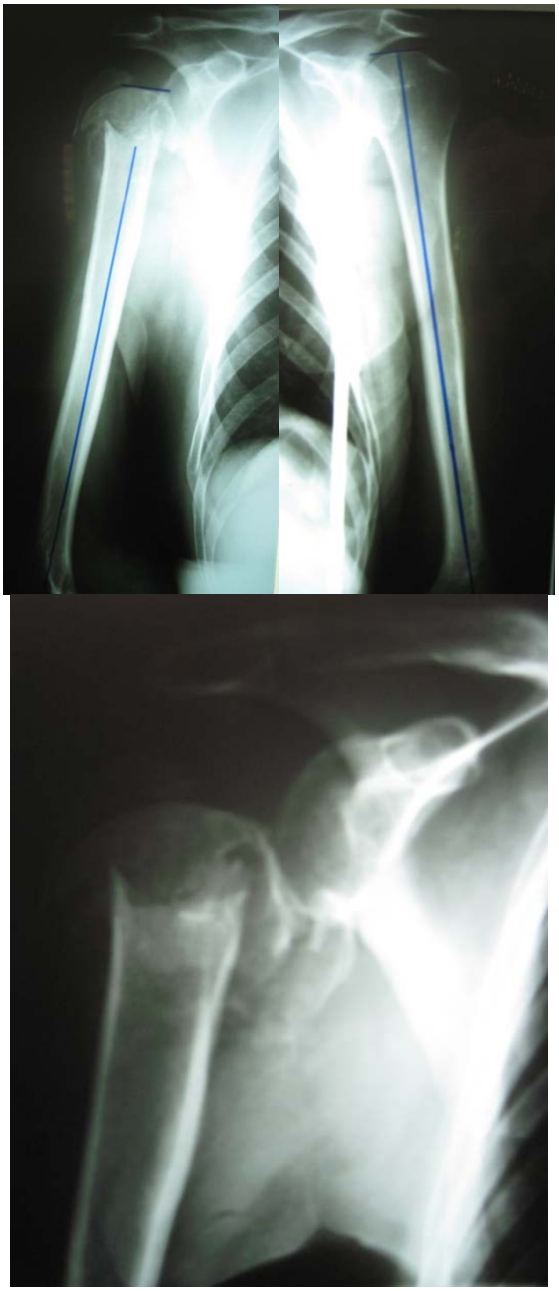

Figure 4 - Four-part fracture of proximal humerus in a 64-year-old patient.

After treatment

The shoulder is immobilized in a sling for a few days. As soon as possible, passive range of motion is allowed until fracture is healed (usually first 6 weeks) and then active range of motion begins. Pendulum exercises and passive elevation of arm in the plane of scapula are made. The patient is discharged from hospital 2-3 days after a control radiograph is obtained. At 2 weeks the patient returns for observation and at 6 weeks, 3 months and at 1 year new radiographs are made to check the healing progress. If progress is satisfactory, exercises to strengthen the anterior deltoid and subscapularis are initiated. Resistive exercises are added as strength improves. The rehabilitation is long (6 months to 1 year) and patient must be aware of this fact.

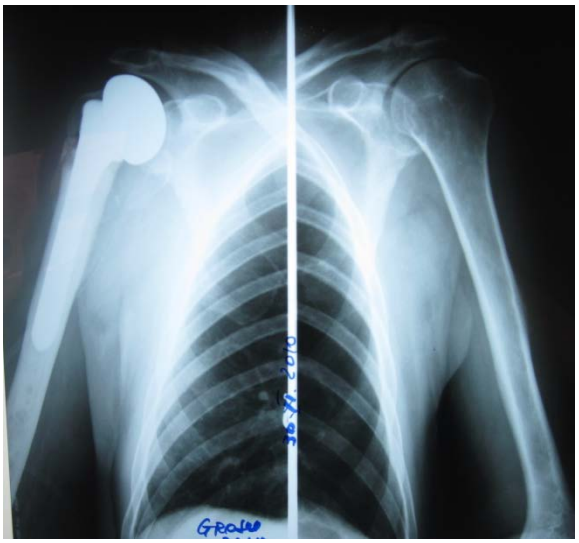

Figure 5 - After treatment with bipolar prosthesis

Discussions

There are many possible complications as: tuberosity failure, prosthesis malposition, instability, infection, poor rehabilitation, neurologic injury, aseptic loosening, glenoid erosion, heterotopic ossification, subacromial impingement. Each of them has specific treatment [9,10].

Conclusions

The final outcome includes many aspects as: pain relief, range of motion, ability to perform activities of daily living, complications and need for further nonsurgical or surgical treatment [11-13]. The outcome is better than in the case of osteosynthesis and the procedure involves less risk of shoulder instability than with total shoulder arthroplasty. The rehabilitation process is prolonged and slow and continuous improvement can be expected for up to 12 to 18 months after the surgery.

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