

## Reverse Shoulder Arthroplasty for Displaced Proximal Humeral Fractures in the Geriatric Population: A Literature Review of Clinical Efficacy and Safety

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### ABSTRACT

**Background:** Proximal humerus fractures are among the most common fractures in the elderly population, particularly due to osteoporosis and low-energy trauma. Management of displaced three-part and four-part fractures remains controversial, with treatment options including open reduction and internal fixation (ORIF), hemiarthroplasty (HA), and reverse shoulder arthroplasty (RSA). In recent years, RSA has gained increasing acceptance due to its biomechanical advantages and more predictable functional outcomes.

**Objective:** To evaluate the role of reverse shoulder arthroplasty in comparison to other surgical modalities in the management of displaced proximal humerus fractures in the elderly population, with emphasis on functional outcomes, complication profile, and surgical decision-making.

**Methods:** This study is a narrative review based on previously published indexed literature focusing on elderly patients with proximal humerus fractures. Relevant studies comparing ORIF, HA, and RSA were analysed to assess indications, surgical techniques, outcomes, and complications. Emphasis was placed on recent evidence supporting the use of reverse shoulder arthroplasty.

**Results:** Open reduction and internal fixation, although widely used, is associated with higher complication rates in osteoporotic bone, including fixation failure and avascular necrosis. Hemiarthroplasty outcomes are largely dependent on tuberosity healing and rotator cuff integrity, leading to variable functional results. Reverse shoulder arthroplasty, on the other hand, provides more reliable improvement in forward flexion and abduction, as it relies on deltoid function rather than the rotator cuff. Although complications such as instability, infection, and scapular notching may occur, overall complication and revision rates are comparable or lower than other surgical options. Recent trends indicate a shift towards RSA as the preferred treatment modality in elderly patients with complex fractures.

**Conclusion:** Reverse shoulder arthroplasty has emerged as a dependable and effective treatment option for displaced proximal humerus fractures in the elderly population. It offers superior and more consistent functional outcomes compared to ORIF and hemiarthroplasty, particularly in patients with poor bone quality and rotator cuff deficiency. Careful patient selection and surgical technique remain essential to optimise outcomes and minimise complications.

**Keywords:** Proximal humerus fracture; reverse shoulder arthroplasty; hemiarthroplasty; open reduction internal fixation; elderly; functional outcome

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### 1. INTRODUCTION

Among the elderly population, proximal humeral fractures represent the third most common fracture, following fractures of the neck of femur and distal radius [1–4]. These fractures are increasingly encountered in clinical practice due to the rising ageing population and associated osteoporosis, which predisposes individuals to fragility fractures. The incidence is significantly higher in females, mainly due to reduced bone mineral density, while a smaller proportion occurs in males. In addition to low-energy falls in the elderly, high-energy mechanisms such as sports injuries and road traffic

accidents also contribute to the occurrence of these fractures [5,6].

Classification of proximal humerus fractures plays an important role in guiding management. The Neer classification and AO/OTA classification systems are the most commonly used in clinical practice [7]. According to the Neer classification, operative management is generally recommended for displaced three-part and four-part fractures [8]. Although the AO classification provides a more detailed fracture description, it is often considered relatively complex and less practical for routine clinical use [1].

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Epidemiological studies have demonstrated a marked female predominance, with a reported sex ratio of 0.18, where the mean age of affected females is around 79 years and that of males is approximately 76 years [9]. Proper assessment of proximal humerus fractures requires careful clinical as well as radiological evaluation. Standard imaging includes plain radiographs with anteroposterior and lateral views, along with computed tomography (CT) scans to better delineate the fracture configuration and assist in planning appropriate management [7].

Multiple surgical options are available for the management of proximal humerus fractures, including open reduction and internal fixation (ORIF), hemiarthroplasty (HA), and reverse shoulder arthroplasty (RSA) [10,11]. ORIF has traditionally been the most commonly employed technique; however, in elderly patients with osteoporotic bone, it is associated with a higher rate of complications such as fixation failure, screw cut-out, and avascular necrosis [12–14]. Due to these limitations, arthroplasty procedures, particularly hemiarthroplasty and reverse shoulder arthroplasty, have gained increasing acceptance among surgeons for the management of complex fractures [15]. Reverse shoulder arthroplasty represents a biomechanical modification of the conventional ball-and-socket joint, wherein the centre of rotation is altered to improve deltoid muscle efficiency [16]. This design allows shoulder elevation even in the presence of rotator cuff deficiency. RSA is particularly indicated in elderly patients with comminuted three-part and four-part fractures, poor bone quality, and compromised rotator cuff integrity. In such cases, it provides more predictable stability and functional outcomes compared to other treatment modalities. Studies have shown that RSA is associated with lower complication rates and a reduced need for revision surgery in comparison to other surgical options in this patient group [10].

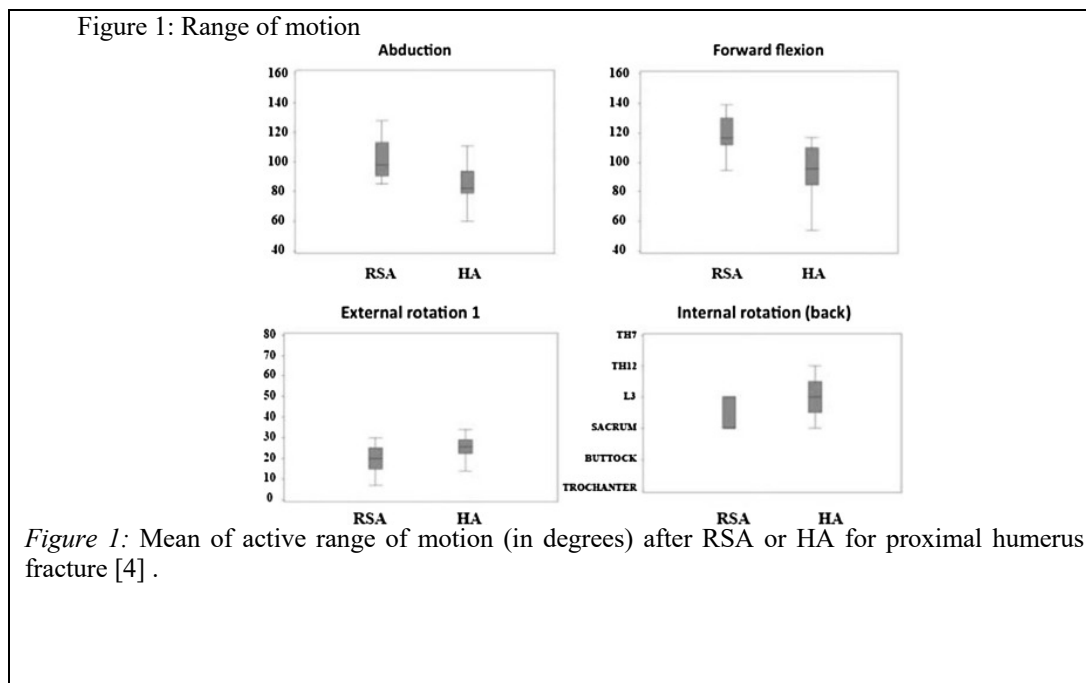
Furthermore, reverse shoulder arthroplasty has demonstrated superior and more consistent functional outcomes, especially in terms of forward flexion and

abduction, thereby allowing elderly patients to achieve earlier and more reliable recovery [17,18]. Hence, RSA has emerged as a preferred surgical option for managing displaced proximal humerus fractures in the elderly population.

## 2. ROLE OF SURGICAL TREATMENT

### 2.1 Surgeon decision

For better pre-operative decision-making, the surgeon must first decide whether the humeral head should be repaired or removed [1]. Along with this, the choice of procedure for the patient has to be made carefully. The operative plan depends on the type of fracture, the surgical time required, the expected post-operative complications, and the anticipated shoulder function [2]. Open reduction and internal fixation with a locking plate has been reported to have a higher complication rate [3]. When a patient presents with a displaced proximal humeral fracture or a complex fracture of the humeral head, the surgeon usually has three main treatment options: first, open reduction and internal fixation; second, hemiarthroplasty; and third, reverse shoulder arthroplasty [4]. However, in many elderly patients, ORIF becomes less suitable because of poor bone quality, higher risk of fixation failure, and less predictable functional recovery. For this reason, arthroplasty is often considered a better option in complex proximal humeral fractures. In recent years, shoulder arthroplasty has gained more importance, and a major controversy remains between hemiarthroplasty and reverse total shoulder arthroplasty. Recent literature has shown that hemiarthroplasty has gradually been surpassed by reverse total shoulder arthroplasty in many such cases [5]. Surgery is usually performed in the beach-chair position under general anaesthesia [6]. Reverse shoulder arthroplasty is more strongly recommended in elderly patients with severe three-part and four-part fractures, because the risk of complications and revision is lower when compared with hemiarthroplasty [1].



## 2.2 Open reduction-internal fixation (ORIF)

Open reduction and internal fixation is commonly used for unstable displaced fractures, especially in the elderly population [7]. In the study by Kulkarni et al., the authors treated patients through both anterior and posterior approaches, although the anterior approach remains the standard for proximal humerus fractures [2]. While performing ORIF, the surgeon must be careful in maintaining hemostasis and in dissecting the muscular layers and nerve supply before exposing the bone. A systematic review by Howard et al. on 514 displaced proximal humerus fractures treated with locking plate fixation reported an overall healing rate of 96.6%, but the overall complication rate was still high at 48.8% [8]. In contrast, other studies have also shown that ORIF with a locking plate is associated with a high complication rate, particularly in osteoporotic bone [3]. Because of these concerns, ORIF is now being replaced in many elderly patients by arthroplasty-based treatment.

## 2.3 Hemiarthroplasty (HA) vs reverse shoulder arthroplasty (RSA)

Hemiarthroplasty has traditionally been used for third- and fourth-part fractures of the proximal humerus [9]. Functional outcome after hemiarthroplasty and reverse shoulder arthroplasty mainly depends on the range of motion. Reverse shoulder arthroplasty generally gives better results than hemiarthroplasty in forward flexion and abduction. On the other hand, internal and external rotation may sometimes be better after hemiarthroplasty than after reverse shoulder arthroplasty [4]. Figure 1 shows the mean active range of motion after RSA and HA in proximal humerus fractures [4]. Because of these functional advantages, reverse shoulder arthroplasty is gradually replacing hemiarthroplasty in the treatment of elderly patients with displaced proximal humerus fractures [9].

Surgical approaches for reverse shoulder arthroplasty commonly include the deltopectoral and superolateral approaches, while hemiarthroplasty is usually performed through the deltopectoral approach [9]. Lack of tuberosity reattachment or imperfect anatomical healing around reverse shoulder arthroplasty does not usually produce the same degree of functional deficiency seen in some hemiarthroplasty cases, because forward flexion and abduction in RSA are mainly performed by the deltoid muscle [10–13]. When the tuberosities are reattached in RSA, anatomical healing improves and there is gradual improvement in internal and external rotation of the shoulder [10]. Therefore, the surgeon should pay careful attention during tuberosity repair in reverse shoulder arthroplasty. Humeral bone grafting also improves tuberosity healing and shoulder motion [14]. Earlier reports had shown that hemiarthroplasty was still being widely used, but with the increasing success of RSA, this trend has now changed in favour of reverse shoulder arthroplasty in many centres [5].

## 2.4 Complications

A review by Tepass et al. reported that out of 200 studies, a total of 5402 complications were documented [21]. Among these, 158 complications (2.9%) were severe, including 145 neurological lesions and 13 vascular injuries. The overall post-operative clinical and radiological complication rate was 55.9%. The most common complications included fracture displacement, malunion, humeral head necrosis, and malreduction.

### 2.4.1 Complications after open reduction internal fixation

Klug et al. reported two major complications after open reduction and internal fixation, namely shoulder stiffness and avascular necrosis of the humeral head, often associated with screw cut-out or complete loss of fixation [1]. The blood supply of the humeral head is mainly through the anterior humeral circumflex artery

and posterior humeral circumflex artery, and disruption of this blood supply may contribute to avascular necrosis [22]. Laux et al. reported avascular necrosis rates ranging from 3% to 68% [22]. The dominant nutrient artery may be disrupted during fracture and fixation, making the humeral head vulnerable to necrosis. Risk factors for complications after ORIF include varus impaction, multifragmentary greater tuberosity fracture, and posteromedial metaphyseal extension of less than 8 mm [1]. Varus deformity changes the pretension of the rotator cuff and also decreases the force of the supraspinatus muscle, which then requires more effort to elevate the arm [1].

#### 2.4.2 Complications after hemiarthroplasty

The most serious complication after hemiarthroplasty is malunion or nonunion of the greater tuberosity [9]. Other complications include shoulder stiffness, scapular notching, hematoma, postoperative infection, glenoid loosening, and persistent instability. The functional result after hemiarthroplasty is therefore highly dependent on correct tuberosity healing and stable implant positioning.

#### 2.4.3 Complications after reverse shoulder arthroplasty

The most common complications after reverse shoulder arthroplasty are instability and shoulder stiffness [1]. Scapular notching is also seen, although it does not always affect the range of motion significantly. Barco et al. reported that instability may occur due to multiple factors, and some authors have suggested that dislocation of the humeral head occurs during abduction and extension, particularly when the deltoid force is not balanced properly [15]. Recurrent instability may lead to revision surgery and may also increase the risk of infection [15]. *Propionibacterium acnes* has been associated with positive cultures in shoulder surgery, although its true clinical significance in patients with mild symptoms remains uncertain [16]. Neurological injury may also occur, with the axillary nerve being the most commonly affected; radial, ulnar, and musculocutaneous nerve palsies have also been reported [17]. However, spontaneous recovery is seen in many cases [18]. Partial recovery of the axillary nerve improves deltoid strength [19]. Excessive deltoid tension may weaken the acromion and increase the risk of fracture after RSA [20]. Even with these complications, reverse shoulder arthroplasty generally provides a more predictable range of motion and better functional outcome than hemiarthroplasty and open reduction internal fixation in elderly patients with proximal humeral fractures [1].

### 3. CONCLUSIONS

Treatment of third- and fourth-part proximal humerus fractures in the elderly remains challenging for surgeons, as the final decision has to be made between open reduction and internal fixation, hemiarthroplasty, and reverse shoulder arthroplasty. Open reduction internal fixation with locking plates was commonly used earlier, but in many elderly patients it has now been replaced by hemiarthroplasty or reverse shoulder arthroplasty

because of the high complication rate, the poor quality of osteoporotic bone, and the less predictable functional outcome. At present, there are still no clear universal guidelines that can justify one procedure over the other in every situation. Although the complication rate after reverse shoulder arthroplasty may be higher than after hemiarthroplasty in some series, the reoperation rate is similar and the revision rate is lower.

At present, surgeons tend to reserve reverse shoulder arthroplasty for elderly patients and hemiarthroplasty for selected younger patients. In the older population, RSA provides better results because it depends more on a functioning deltoid and less on perfect tuberosity healing or rotator cuff integrity. The range of motion of the shoulder, especially forward flexion and abduction, is usually better after reverse shoulder arthroplasty than after hemiarthroplasty in elderly patients. Therefore, reverse shoulder arthroplasty is more likely to improve clinical performance and reduce the need for additional procedures in displaced proximal humerus fractures. Figure citation

Figure 1. Mean active range of motion after reverse shoulder arthroplasty and hemiarthroplasty in proximal humerus fracture [4].

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