

(ii) Hemiarthroplasty of the glenohumeral joint

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Abstract

Hemiarthroplasty of the humeral head is indicated for glenohumeral arthritis unresponsive to conservative measures and for some acute fractures of the proximal humerus. Regardless of indication, the functional result relies upon recreation of normal anatomy.

In the elective setting, stemmed, stemless and surface replacement prostheses are available. Significant controversy exists regarding implant choice, and a longstanding debate concerning the choice of hemiarthroplasty versus total shoulder replacement continues.

Complex fractures of the proximal humerus may not be reconstructable or may place the humeral head at excessive risk of avascular necrosis. Stemmed prosthetic replacement is often performed for such indications. This is a technically challenging procedure for which results are related to the healing of the bony tuberosities which in turn provides best rotator cuff function. Tuberosity healing is thought to be related to good surgical technique.

This article aims to review the history, indications, technique and results of prosthetic hemiarthroplasty of the shoulder. Where available, comparison of results is made with alternative prosthesis designs and with other available forms of glenohumeral arthroplasty for each indication.

Keywords arthroplasty; fracture; hemiarthroplasty; humeral head; replacement; shoulder

Introduction

Jules Emile Péan (1830–1898) is widely recognized for performing the first shoulder replacement in Paris in 1893. He used this prosthesis, made of rubber and platinum to treat the late effects of tuberculosis. However, in his original report, Péan credited Romanian surgeon Themistocles Gluck (1853–1942) with providing the inspiration for his shoulder prosthesis as Gluck had described the design and surgical technique in his article of 1891, although specific detail as to whether any were implanted in a living patient is not recorded.¹

Modern day shoulder arthroplasty became popular following the publication in 1955 of Charles Neer's classic work on

prosthetic replacement for unreconstructable fractures of the proximal humerus.² The same concepts have been applied to the treatment of degenerative joint disease and an ever-expanding range of stemmed, stemless and resurfacing implants is now available for use in the elective situation. However, stemmed prostheses continue to be the mainstay for acute trauma.

Indications

Shoulder hemiarthroplasty (HA) continues to be used for the acute unfixable fracture of the proximal humerus as well as for other pathologies which include:

- Osteoarthritis
- Rheumatoid arthritis
- Avascular necrosis
- Cuff tear arthropathy
- Trauma/Fracture sequelae
 - Fracture malunion
 - Post-traumatic arthropathy
 - Arthritis of recurrent dislocation
 - Fixed anterior or posterior dislocation
 - Osteochondral injury

Degenerative osteoarthritis (OA) of the glenohumeral joint in the older patient with a concentric shoulder and functioning rotator cuff remains the classic indication for HA. Avascular necrosis, rheumatoid arthritis and post-traumatic arthritis are often seen in younger patients (<50 years old).

Anatomical considerations

Anatomical shoulder HA should aim to reproduce normal (1) bone morphology (2) capsular tension (3) stability for muscle function. Normal range values for important parameters to be considered are presented in Table 1.³

In the pathological situation the spherical shape of the head is often distorted, making determination of exact head diameter difficult. The height of the prosthetic hemisphere has a broadly linear relationship with diameter and can be a useful guide. If the radius of humeral head curvature changes by 6 mm the shoulder range of motion may decrease by 20–30°.⁴ Sizing error of the humeral head may result in eccentric loading of the glenoid, causing glenoid erosion and pain. However this also depends upon other factors, in particular soft tissue balancing and glenoid morphology. According to the classification of glenoid morphology proposed by Walch et al.,⁵ inferior results have been reported in B2 and C types (posterior deficiency) when using stemmed and surface hemiarthroplasty.^{6,7} The superior edge of the head should protrude 2–5 mm above the superior edge of the greater tuberosity.⁸ If the tuberosity protrudes above the head, painful subacromial impingement may occur. Conversely, if the head protrudes excessively above there will be increased tension on the cuff ('overstuffing').

Excessive retroversion of the humeral head may induce posterior instability and cause excessive tension on the posterior cuff, whereas insufficient retroversion may cause subscapularis impingement anteriorly. Excess medial offset will overstuff the joint and may result in stiffness, but too small an offset will not tension the capsuloligamentous complex sufficiently.

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Variables characterizing normal proximal humerus anatomy³

Parameter	Mean value (range)
Neck inclination (degrees)	129.6 (123.2–135.8)
Humeral head diameter/diameter of curvature (mm)	46.2 (37.1–56.9)
Retroversion – transepicondylar axis (degrees)	17.9 (–6.7 to 47.5)
Medial offset (mm)	6.9 (2.9–10.8)
Posterior offset (mm)	2.6 (–0.8 to 6.1)

Table 1

Hemiarthroplasty for glenohumeral osteoarthritis

Glenohumeral hemiarthroplasty (HA) differs from total shoulder replacement (TSR) in that the glenoid is not replaced. One of the most debated topics in shoulder surgery is whether to do a hemiarthroplasty or total replacement. There are advocates for both. The argument surrounding hemiarthroplasty versus total shoulder replacement is that of potential painful glenoid erosion following the former as opposed to possible glenoid wear and implant loosening with the latter. Implant loosening is a problematic issue in shoulder arthroplasty and may require technically-demanding revision surgery. The total prevalence of loosening is less for HA than TSR as it is the glenoid implant that is more commonly affected.⁹ Additionally, humeral stem loosening is less common in HA as polyethylene wear particles are not produced.¹⁰ However, in a systematic review of 236 HA procedures, it was reported that 8.1% of stemmed hemiarthroplasties required conversion to TSR due to pain, suggesting the glenoid progressively erodes over time resulting in worsening outcomes.⁶

Stemmed implants

Stemmed implants may be monoblock but more modern designs comprise modular components to provide greater surgeon choice with a view to recreating normal anatomy. Prostheses are usually designed with a fixed cervicodiaphyseal angle of around 130° and instrumentation to perform osteotomy of the humeral neck at this angle is provided. Modular heads with a wide range of offset diameters are now available and this is often combined with the ability to ‘dial’ the head around the prosthesis neck to adjust height and offset. Both cemented and proximally coated cementless designs are available. Although uncemented stems have the potential to shorten operative time and simplify revision procedures, level 1 evidence suggests that cemented stems provide better quality of life, strength and range of motion at 2 years for TSR.¹¹

Stemmed hemiarthroplasties have been reported as providing sustained good to excellent results for function and pain relief at 5–10 years in a single non-comparative series of selected patients. Their selection criteria included shoulders with either a concentric eburnated glenoid or a non-concentric glenoid that could be made concentric and a humeral head centred within the glenoid after soft-tissue balancing.¹²

Regarding the controversial issue of HA versus TSR, the largest and best quality comparison studies have contrasted stemmed implants with or without glenoid replacement. Edwards et al. (2003) conducted a multi-centre non-randomized study comparing 601 TSRs to 89 HAs. At a minimum follow-up of two years the TSR group displayed significantly greater average active forward flexion (144.5 vs 129.6°) and external rotation (41.5 vs 35.5°). Constant–Murley score was also significantly greater in the TSR group (70.3 vs 64.1 points) but it is unclear whether this is clinically significant as the minimum clinically important difference pertaining to arthroplasty for this score is not known. No significant difference in pain scores was found between the two groups. There was a substantially higher revision rate at 7 years in the TSR group (30% vs 4%), however this was explained by the authors as being due to the use of metal-backed glenoid components in 238 patients.¹³

A systematic review by Singh et al. (2013) pooled level 1 data from two small randomized controlled trials comparing HA with TSR comprising a total of 88 patients with primary osteoarthritis of the shoulder. Follow-up was 24–36 months. TSR demonstrated significantly greater American Shoulder and Elbow Surgeons Shoulder Scores (ASES-S; 10.05 points difference, 95% CI 1.13 to 18.97), however the confidence intervals reported fell within the lowest minimum clinically important difference for this score (6.4 points), which in turn is not based on arthroplasty. There was no significant difference found in pain scores, quality of life scores or adverse events between the two groups.¹⁴

Resurfacing hemiarthroplasty

Surface replacement arthroplasty (SRA) of the glenohumeral joint for the treatment of arthritic conditions was developed by a number of surgeons. In the 1970s Zippel in Germany implanted two surface replacements fixed to the proximal humerus by a transosseous screw. Steffee and Moore implanted small hip resurfacing prostheses. In the early 1980s, surgeons in Sweden used the (Scandinavian) SCAN cup as a cemented implant in rheumatoid patients.

SRA may be performed as a total (TSRA) or hemiarthroplasty (HSRA). Whilst some humeral head surface implants may be cemented, most are uncemented press-fit with a central small stem or peg to aid initial fixation (Figure 1). A greater numbers of size and offset options have become available over time to facilitate replication of normal anatomy. In cases of bony deformity of humeral head erosion, it is recommended that 60% of the subchondral surface is available for implant support.¹⁵

HSRA has many perceived advantages over a stemmed implant. Retaining the humeral head makes it easier to recreate the geometric centre of the normal joint by maintaining correct version, offset and head diameter and leaving the cervicodiaphyseal angle undisturbed.¹⁶ From this it is inferred that HSRA may limit eccentric wear of the glenoid through more balanced biomechanics. Further, bone stock is preserved and this is useful for younger patients who may require revision. Operative time is somewhat quicker and the risks of excess bleeding and fracture associated with instrumentation of the humeral canal are negated. In addition, HSRA is a viable option for patients with deformity of the proximal humerus (e.g. fracture malunion) in whom a conventional stemmed implant would be difficult.

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