

Reverse shoulder arthroplasty for non-traumatic problems

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Abstract

Reverse shoulder arthroplasty (RSA) was developed by Grammont to address cuff tear arthropathy (CTA) in the elderly. RSA facilitates centring of the humeral head within the glenoid, such that deltoid function is maintained. CTA remains the main indication for RSA but observed improvements in postoperative outcomes have driven an expansion of indications. This review explores the broadening role of RSA, with emphasis on non-traumatic indications. In addition, the biomechanical principles, evolution of reverse polarity prostheses and complications are discussed.

Keywords cuff deficient; cuff tear arthropathy; pseudoparalysis; reverse polarity; reverse shoulder arthroplasty; RSA; shoulder replacement

Introduction

Arthroplasty options in the shoulder include hemi-arthroplasty, anatomical total shoulder arthroplasty (TSA) or reverse shoulder arthroplasty (RSA), the latter being the newest concept. The UK National Joint Registry (NJR) demonstrates an increasing volume of RSA being undertaken, with such operations accounting for 50.7% (3015 cases) of primary shoulder arthroplasties performed in the UK in 2016, compared with 31.7% (806 cases) in 2012.¹ The principal indication for RSA has traditionally been cuff tear arthropathy (CTA) but indications have expanded as surgical outcomes and implant design have improved. Indications now include irreparable cuff tear without glenohumeral osteoarthritis (OA), primary OA with glenoid erosion, revision shoulder arthroplasty, tumour resection and inflammatory

arthritis. In the trauma setting, RSA can be used to treat acute proximal humeral fractures, post-traumatic sequelae and chronic shoulder dislocations. The remit of this article is to review the theory behind RSA with emphasis on the use of RSA for non-traumatic indications. Finally, the complications following RSA are briefly discussed.

Evolution of the reverse polarity concept

The rotator cuff consists of subscapularis anteriorly, supraspinatus superiorly and infraspinatus with teres minor posteriorly. Due to the bony geometry of the glenohumeral joint, centring of the head relies on soft tissue balance within the cuff. The cuff produces a stable fulcrum by centring the humeral head within the glenoid, facilitating deltoid function. Superior migration of the humeral head due to the pull of deltoid is prevented by supraspinatus, whilst anteroposterior stability is achieved by subscapularis working against infraspinatus and teres minor (Figure 1). When these force couples are lost, the ability to maintain a centred humeral head is compromised. This results in superior migration of the head due to the unopposed action of deltoid. Neer coined the term ‘cuff tear arthropathy’ to describe cuff deficiency with proximal migration of the humeral head, ‘acetabularization’ of the acromion and glenohumeral joint degeneration (Figure 2). Such patients may develop ‘pseudoparalysis’ of the shoulder, whereby active forward elevation and abduction are lost but passive range of movement is maintained.

The reverse polarity concept was developed in several institutions simultaneously in the 1970s to manage patients with CTA. Paul Grammont popularized RSA, in 1987, with the publication of his series, which re-evaluated the key principles as follows:

- 1) Medialization of the glenohumeral joint centre of rotation (COR) increases the deltoid lever arm. This effect has been shown to improve deltoid efficiency by 25%² (Figure 3).
- 2) Positioning the COR inferiorly tensions the deltoid and thus improves deltoid efficiency.
- 3) Semi-constraining the implant provides a fixed, stable fulcrum to allow the deltoid to exert rotational torque.

Grammont’s initial design consisted of a monoblock metal glenosphere and a polyethylene humeral component. Variable degrees of active forward elevation were reported at 6 months of follow-up.³ Whilst modern implants vary somewhat from Grammont’s original prosthesis, his principles still underpin the RSA concept.

Newer implants now often utilise a modular, or ‘platform’, system with separate ‘metaglenoid’ (baseplate) and glenosphere (Figure 4). These systems include a standardized humeral stem, onto which reverse or anatomic components may be mounted. Therefore, the humeral stem does not require revision to convert between standard or reverse polarity components. Additionally, platform systems facilitate accurate retroversion, of up to 30°. Retroverting the humeral component shifts the arc of movement in favour of external rotation at the expense of reduced internal rotation. Systems that incorporate a lateralized glenosphere with an anatomical neck-shaft angle have been shown to improve active external rotation by an average of 9.9° ($p = 0.0007$)⁴. Lateralizing the glenosphere is achieved with either bone graft or the implant itself. A high neck-shaft angle of 155° was

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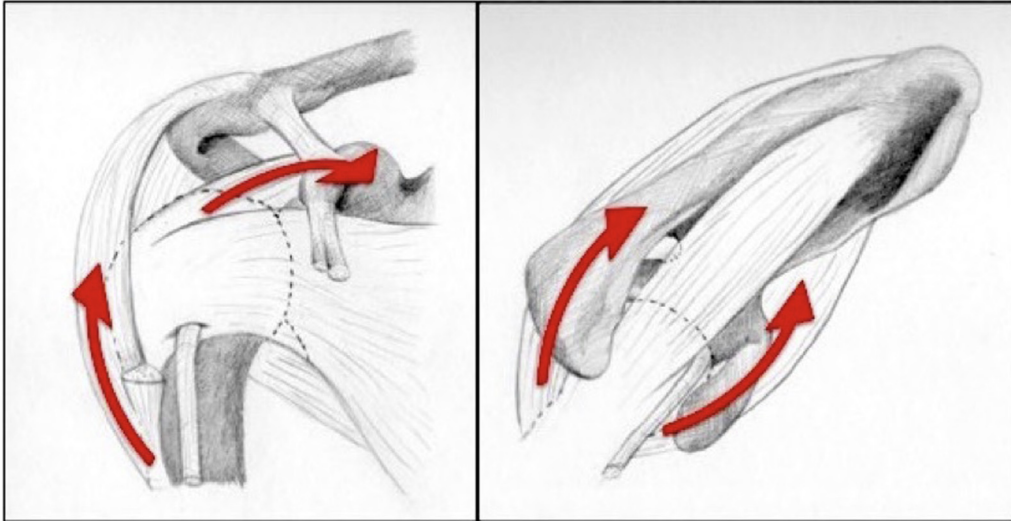


Figure 1 Force couples of the rotator cuff.



Figure 2 Typical radiographic features of cuff tear arthropathy.

traditionally used to distalize the deltoid insertion and thus increase deltoid muscle tension (Figure 3).⁵ However, excessive deltoid tension over a prolonged period may also precipitate 'deltoid fatigue'. This phenomenon may occur many years post-operatively and results in progressive deltoid weakness with loss of active forward elevation. Baseplate designs have moved towards a central compression screw for initial fixation, which is augmented by peripheral locking and non-locking screw options.

Non-traumatic indications for reverse shoulder arthroplasty

RSA was originally intended for use exclusively in patients with CTA. All the patients in Grammont's original series had irreparable cuff tears combined with glenohumeral joint pathology. More recently, indications have expanded considerably. The proportion of primary RSAs performed in the UK for each indication between 2012 and 2016 is summarized in Table 1¹. The NJR data highlight that cuff tear arthropathy remains the most

common indication but almost 40% of cases are currently performed for other reasons. The role of RSA in various non-traumatic shoulder pathologies is discussed below. The comparative outcomes for each indication are summarized in Table 2⁶.

Cuff tear arthropathy

About 2% of patients over 80 years of age will present with CTA (Figure 2).⁷ Such patients frequently complain of pain and loss of active forward elevation. The exact aetiology of CTA is unknown but theories include a crystal mediated pathway, involving calcium-phosphate, and a cuff tear theory, involving mechanical and cartilage nutritional factors.⁸

CTA remains the principal indication for RSA and also produces, after surgery, the highest levels of function and patient satisfaction.⁹ A systematic review of clinical and functional outcomes, performed by Samitier et al in 2015, showed 90% patient satisfaction for all indications. However, it was noted that RSA performed for CTA resulted in better outcomes than for other indications; with 95.7% patient satisfaction and an increase in Constant score from 30.5 to 68.1. Petrillo et al presented a systematic review of outcomes for RSA performed in cuff deficient shoulders. They reported significant improvement in function at a mean follow-up of 35.3 months, with 124.4° forward elevation, 115.4° abduction and 27.7° external rotation.¹⁰

Cuff et al reported a 90.7% RSA survivorship with a minimum 10-year clinical follow-up on 42 shoulders.¹¹ Their patients continued to maintain improved outcome scores and range of motion. Bacle et al also reported improved long-term clinical outcomes following RSA performed for CTA. The preoperative mean Constant score and minimum 10-year follow-up Constant score was 22 and 63 respectively.¹² However, the long-term scores were significantly less than the medium-term score (minimum 2-year follow-up). They suggested the cause of this decrease was related to patient age coupled with bone erosion and deltoid impairment over time. Within the CTA sub-group, the overall complication rate is 19.5%.¹³ Complications are discussed later.

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