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Reverse Total Shoulder Arthroplasty: Unconventional Indications – A Brief Overview

Abstract

Globally, the proportion of reverse total shoulder arthroplasty (RTSA) is on the rise compared to the anatomic total shoulder replacement and hemiarthroplasty. Historically performed as a salvage surgery for cuff tear arthropathy, the indications for RTSA have now expanded over the years owing to an evolution in implant designs and the application of biomechanics in the shoulder joint. The indications for reverse polarity prosthesis have expanded from the earlier cuff tear arthropathy to included a wide range of noncuff related indications as well. The goal of this brief overview is to walk readers through the growing list of RTSA indications. The indications for RTSA are ever increasing due to its peculiar design, biomechanical advantages, and relatively good functional outcome. Off-label indications are expanding and the avenue is yet to be completely explored.

Keywords: Humeral head fracture, inverse shoulder arthroplasty, massive rotator cuff tear, reverse polarity, reverse shoulder arthroplasty, shoulder arthroplasty

Introduction

Globally, the number of joint replacement surgeries is increasing, irrespective of the site of the joint; whether the hip, knee or shoulder. In the shoulder, the proportion of reverse shoulder arthroplasty is on the rise when compared to the anatomic total shoulder or hemiarthroplasty. Conventionally, a joint replacement surgery involves the anatomical recreation of the exact joint. The shoulder joint is the ball-and-socket type of joint wherein the head of the humerus forms the “ball” and the glenoid of the scapula, the “socket.” The surface area of the “ball” is four times greater than the “socket” cavity, and this size difference has been responsible for the inherent instability of the joint. The stability of the shoulder joint is provided mainly by the soft tissues, especially the rotator cuff, which is a group of four muscles, namely the supraspinatus, infraspinatus, teres minor, and subscapularis. Unpredictable outcomes with anatomic total shoulder and hemiarthroplasty led to the inception of a reverse polarity prosthesis in the shoulder joint. In reverse total shoulder arthroplasty (RTSA), as the name suggests, the normal glenohumeral relationship is

reversed, with the glenoid component redesigned into a hemispherical “ball” component and the humeral stemmed metallic counterpart forming the “socket.” Historically performed as a salvage surgery for cuff tear arthropathy,^[1] the indications for RTSA have now expanded over the years owing to an evolution in implant designs and the application of biomechanics in the shoulder joint. The goal of this brief overview is to walk readers through the growing list of RTSA indications.

As suggested above, the rotator cuff contributed immensely to the stability of the shoulder joint and hence, addressing the osteoarthritis in a cuff-deficient shoulder was challenging with a total shoulder replacement. Early prosthesis failure was often the result with the superior migration of the head of humerus and glenoid loosening from eccentric loading. Hemiarthroplasty was also tried for cuff-deficiency, but unfortunately this surgery was again complicated by instability and progressive bone loss.^[2] The turning point in shoulder arthroplasty was the introduction of the reverse prosthesis in 1985 by Paul Grammont based on four key biomechanics principles: (i) The center

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of rotation shifted medially to decrease the torque at the glenoid component thereby avoiding glenoid loosening; (ii) lowering the humerus to increase tension at the deltoid muscle; the anterior and posterior deltoid then will act as alternative for a deficient rotator cuff; (iii) a constant center of rotation, more distal and medial to the glenoid joint line, for a stable implant; (iv) a semi-constrained implant design with a large glenosphere increasing the arc of motion^[3,4] [Figure 1].

Scope of reverse total shoulder arthroplasty

The indications for RTSA^[5] may be categorized as rotator cuff related and nonrotator cuff related. Eighty percentage of the RTSA currently is being performed for a rotator cuff tear arthropathy.^[6] Cuff tear arthropathy is the Food and Drug Administration (FDA) approved indication for RTSA and the procedure has been found to be associated with a significant improvement in functional outcomes including range of motion, clinical scores,^[7] and implant survivorship.^[8]

Another cuff related indication is pseudoparalysis caused by massive, irreparable rotator cuff tear without arthritis. A massive rotator cuff tear may be defined either by the size of tendon retraction to more than 5 cm, or a complete tear of minimum of two tendons. Total shoulder arthroplasty or hemiarthroplasty for pseudoparalysis has more chances of failure in view of anterosuperior “escape” of the humeral head. Many studies, including a meta-analysis,^[9] have found that among the surgical or palliative interventions, RTSA is an option that can provide a more predictable pain relief and recovery of function for massive cuff tears.

Of the noncuff related indications, RTSA is now growing in popularity for acute comminuted proximal humerus fracture. Conventionally, three- or four-part fractures of the proximal humerus were treated with hemiarthroplasty. Open reduction and internal fixation were also tried,

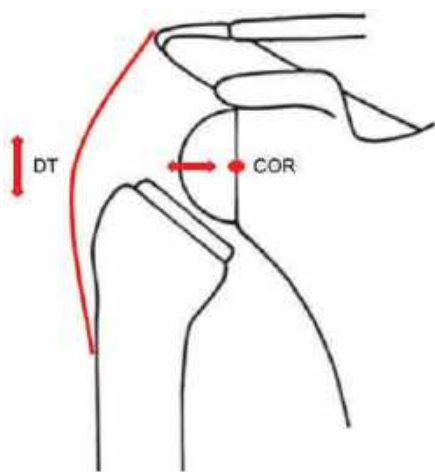


Figure 1: Schematic representation of reverse shoulder prosthesis showing a medial shift of COR and increase in DT due to lowering of humerus. COR: Center of rotation, DT: Deltoid tension

especially for the younger age group. However, with both the above procedures, clinical outcomes depended heavily on achieving tuberosity healing. Problems with hemi replacement in comminuted proximal humeral fractures are progressive decrease in acromiohumeral distance, osteolysis around the humeral head, and tuberosity resorption. RTSA has been found to provide better functional outcomes, greater range of motion, lesser pain, and lower revision rates compared to hemiarthroplasty regardless of the status of greater tuberosity healing.^[10,11] RTSA is also increasingly being identified as a surgical option for malunited or nonunited proximal humeral fractures. Malunited fractures are often characterized by bony asymmetry, fatty atrophy of the rotator cuff and soft-tissue contractures resulting in more failure with a hemi or anatomical replacement. Studies report that RTSA is a good option for type-4 proximal humerus fracture and also possibly for type 3 sequelae but warns about a higher dislocation rate.^[12,13] Fractures of proximal humerus, including the fracture of the humeral head, are FDA approved for certain reverse polarity implants.

RTSA has also been tried for patients with severe glenoid bone loss due to primary osteoarthritis thanks to an inherently strong glenoid component prosthesis design. Design advancements, especially, having a central screw for glenosphere, increases the utility of reverse prosthesis in glenoid bone loss. Promising results have been found for the procedure performed alone,^[14] or with bone grafting of the glenoid, to achieve sufficient bony fixation.^[15] RTSA provided significant improvement in pain and functional outcome in glenoid bone loss, however, long-term implant survivorship is yet to be studied.

Chronic locked glenohumeral dislocation (anterior/posterior) is another condition for which RTSA is applicable.^[16] Literary evidence remains scarce, but since chronic locked dislocations are often complicated by bony deficiencies, soft-tissue contractures, and rotator cuff lesions, anatomic total shoulder arthroplasty have been associated with higher failure rates.

Reverse shoulder arthroplasty has also been used in cases of immunological, especially, Rheumatoid arthritis, with or without associated rotator cuff tears, showing consistent improvements in key outcome measures.^[17]

Revision shoulder arthroplasty is another major indication for RTSA due to the ability of the reverse prosthesis to make up for a deficient rotator cuff and glenoid bone stock. Reverse shoulder for a failed total shoulder replacement due to gross rotator cuff deficiency is FDA approved. RTSA has also been tried off-label for revision in hemiarthroplasty and resurfacing arthroplasty. A reverse design might be the only solution in a failed primary arthroplasty associated with nonreparable rotator cuff deficiency, greater tuberosity malunion, nonunion, or resorption.^[18]

RTSA is also a treatment option for malignant lesions of the proximal humerus, especially where wide resection necessitates the removal of the tuberosities.^[19] A functional deltoid muscle and an intact axillary nerve are a prerequisite for RTSA to be successful in these cases.

Other rarer indications include arthritis secondary to glenoid dysplasia,^[20] avascular necrosis of the humeral head,^[21] and glenohumeral instability in the elderly.^[22] The indications of RTSA are summarized in Table 1.

RTSA has gained immense popularity worldwide since its introduction in the early 2000 s into surgical practice. In the USA, it constitutes almost a third of all shoulder replacement surgery, and RTSA has shown promising results even for younger patients with excellent functional outcomes and long-term implant survivorship.^[23,24]

Conclusion

The indications for RTSA are ever increasing due to its peculiar design, biomechanical advantages, and relatively good functional outcome. Off-label indications are expanding, and the avenue is yet to be completely explored. However, as with any surgical procedure, it has its own set of complications pertaining to the procedure and in common, including scapular notching, implant loosening, acromial fracture, mechanical baseplate failure, instability, neurological injury, infection, and periprosthetic fracture, etc. Increased technical complexity and suboptimal implant designs in the initial era might have contributed to the above. With the latest design modifications, biomechanical evolutions, and the adoption of computer navigation for implant positioning, RTSA has a promising future in satisfactorily addressing multiple shoulder joint pathologies.

Table 1: Scope of reverse total shoulder arthroplasty

Rotator cuff related	Noncuff related
Rotator cuff tear arthropathy*	Acute proximal humerus fracture*
Irreparable rotator cuff tear without glenohumeral arthritis	Malunited/nonunited proximal humerus fracture
	Glenohumeral arthritis with severe glenoid bone loss
	Chronic locked glenohumeral dislocation
	Immunological arthritis
	Revision for failed primary shoulder arthroplasty*
	Malignant bone tumors
	Glenoid dysplasia
	Avascular necrosis of the humeral head
	Gleno-humeral instability

*The given indications are FDA approved for specific reverse total shoulder systems. RTSA: Reverse total shoulder arthroplasty, FDA: Food and Drug Administration

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Conflicts of interest

There are no conflicts of interest.

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