

# M.O.R.E. Journal

S U P P L E M E N T

MEDACTA SHOULDER SYSTEM  
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RESEARCH AND EDUCATION

**MEDACTA SHOULDER** SYSTEM

# MEDACTA SHOULDER SYSTEM



# Complete Convertible Innovative

# Introduction

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Designed by a group of expert surgeons from Europe, Australia and the United States, the Medacta Shoulder System is a modular solution that features a broad range of options, wide-ranging sizes, adjustable offsets and innovative outlines both in the anatomic and reverse configuration.

From its inception, it has been clear that the Medacta Shoulder System has potential to provide relevant clinical advantages.

The Medacta Shoulder System offers flexibility to move from a total to reverse arthroplasty without the need to revise all the components. The aim is to have conversions rather than revisions of all prosthesis components.

When attempting a new procedure or working with innovative product and technologies, there is always a challenge of the learning curve. The M.O.R.E. Institute has created a comprehensive Shoulder Education Program to support surgeons through this learning curve. With extensive experience delivering surgical education and a variety of opportunities available, the M.O.R.E. program can be tailored to suit surgeon's needs.

The main purpose of this document is to review a collection of available published studies regarding the state of art in shoulder arthroplasty, to support design choices and benefits when selecting the Medacta Shoulder System as the product of choice for the treatment of shoulder pathologies.

The major findings of each study serve as rationale to support Medacta Shoulder System features. This document is divided into three sections:

- Review of Modular System benefits
- Review of Total Anatomic Shoulder Arthroplasty components
- Review of Reverse Shoulder Arthroplasty components

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## INDEX

1. MODULAR SYSTEMS	1
2. TOTAL ANATOMIC SHOULDER ARTHROPLASTY	6
Anatomic Humeral Metaphysis	6
Eccentricity	7
Highly Cross - Linked Polyethylene	8
Glenoid Humeral Mismatch	9
Cemented and Cementless Glenoid	10
Metal Back and Cemented Glenoid	11
3. REVERSE SHOULDER ARTHROPLASTY	12
Reverse Neck Angle	12
Onlay versus Inlay	15
Scapular Notching	17
Subscapularis Repair in Reverse Arthroplasty	18
Glenosphere Sizing	20
Ancillary Glenosphere Fixation	21
Glenosphere Lateralization	22
Glenosphere Dissociation	23
Humeral Lateralization	24
Numbers of Screws and Baseplate Fixation	25

## I. Modular Systems

### Platform Shoulder Arthroplasty: a systematic review.

KIRSCH, J. M., KHAN, M., THORNLEY, P., GICHURU, M., FREEHILL, M. T., NEVIASER, A., MORAVEK, J., MILLER, B.S., & BEDI, A. - JSES 2018. 27(4), 756-763. DOI: 10.1016/J.JSE.2017.08.020

#### BACKGROUND

Platform shoulder arthroplasty systems may allow conversion to a reverse total shoulder arthroplasty (RTSA) without removing a well-fixed, well-positioned humeral stem. We sought to evaluate the complications associated with humeral stem exchange versus retention in patients undergoing conversion shoulder arthroplasty with a platform shoulder arthroplasty system.

#### METHODS

PubMed, MEDLINE, CINAHL (Cumulative Index to Nursing and Allied Health Literature), and Embase were searched from database inception through October 9, 2016, for all articles comparing humeral stem retention versus exchange during conversion RTSA or that pertained to conversion RTSA with stem retention alone. All studies were screened in duplicate for eligibility. A methodologic quality assessment was completed for included studies. Pooled outcomes assessing complications, operative time, blood loss, and reoperations were determined.

#### RESULTS

We included 7 studies (236 shoulders), including 1 level III and 6 level IV studies. Pooled analysis demonstrated significantly higher overall complications (odds ratio, 6.89; 95% confidence interval [CI], 2.48-19.13;  $P = .0002$ ), fractures (odds ratio, 4.62; 95% CI, 1.14-18.67;  $P = .03$ ), operative time (mean difference, 62.09 minutes; 95% CI, 51.17-73.01 minutes;  $P < .00001$ ), and blood loss (mean difference, 260.06 mL; 95% CI, 165.30-354.83 mL;  $P < .00001$ ) with humeral stem exchange. Stem exchange was also associated with increased risk of reoperation ( $P = .0437$ ).

#### CONCLUSION

Conversion arthroplasty with retention of the humeral stem is associated with lower overall complications, blood loss, operative time, and reoperations in comparison with stem exchange.



According to the study, roughly 78% of stem retention occurred as result of sufficient stability, proper stem positioning, and height. **Medacta Shoulder System** features unparalleled modularity and provides solutions to issues identified in current non-convertible systems. **The Medacta Diaphysis** combines Mectagrip with HA providing multiple means for stability. The +20° left/-20° right e +20° right/-20° left reverse humeral metaphyses were designed to address positioning concerns during conversion. The 150° stem was designed to accommodate both the anatomical metaphysis and the reverse metaphysis without the need to revise the diaphysis component during a revision surgery.



## Revision of total shoulder arthroplasty.

FAVARD, L. - ORTHOPAEDICS & TRAUMATOLOGY: SURGERY & RESEARCH 2013. 99(1), 12-21. DOI: 10.1016/J.OTSR.2012.11.010.

### BACKGROUND

In France, the number of revisions for total shoulder arthroplasty (TSA) has increased by 29% between 2006 and 2010. Published studies have reported a revision rate of approximately 11% for hemi-arthroplasty and total anatomical implants, and 10% for reversed implants. Revision decisions must be based on stability, wear, loosening, infection and rotator cuff evaluation. Whether or not the humeral stem is loose, it must often be removed. However, its removal is very difficult, risky and it often causes complications, with humerus fracture being the most common.

### METHOD

The author takes in consideration the actions to be taken depending on five factors: (1) stability, (2) wear, (3) loosening, (4) infection and (5) rotator cuff condition. Different treatment indications are analyzed: revision without implant change, revision with implant change or conversion to total arthroplasty. Loosened glenoid component and stem are also assessed and the revision technique is described.

### RESULTS

Revisions of shoulder arthroplasty has three possible pitfalls: (1) diagnosis error, (2) underestimating the risk of a latent infection and (3) poor preparation for surgical procedure.

### CONCLUSION

The possibility of reconstruction depends on the quality of the remaining bone stock.



This descriptive study analyzes the decision-making process behind a revision of total shoulder arthroplasty defining the steps to follow depending on the type of surgery and issue. A highly modular system as **Medacta Shoulder System** provides multiple options and assures several strategies in case of shoulder revisions.

## The use of a modular system to convert an anatomical total shoulder arthroplasty to a reverse shoulder arthroplasty: clinical and radiological results.

WEBER-SPICKSCHEN, T. S., ALFKE, D., & AGNESKIRCHNER, J. D. - *THE BONE & JOINT JOURNAL* 2015. 97B(12), 1662-1667. DOI: 10.1302/0301-620X.97B12.35176

### BACKGROUND

If a modular convertible total shoulder system is used as a primary implant for an anatomical total shoulder arthroplasty, failure of the prosthesis or the rotator cuff can be addressed by converting it to a reverse shoulder arthroplasty (RSA), with retention of the humeral stem and glenoid baseplate. This has the potential to reduce morbidity and improve the results.

### METHOD


In a retrospective study of 14 patients (15 shoulders) with a mean age of 70 years (47 to 83) we reviewed the clinical and radiological outcome of converting an anatomical shoulder arthroplasty (ASA) to a RSA using a convertible prosthetic system (SMR system, Lima, San Daniele, Italy).

### RESULTS

The mean operating time was 64 minutes (45 to 75). All humeral stems and glenoid baseplates were found to be well-fixed and could be retained. There were no intra-operative or early post-operative complications and no post-operative infection. The mean follow-up was 43 months (21 to 83), by which time the mean visual analogue scale for pain had decreased from 8 pre-operatively to 1, the mean American Shoulder and Elbow Surgeons Score from 12 to 76, the mean Oxford shoulder score from 3 to 39, the mean Western Ontario Osteoarthritis of the Shoulder Score from 1618 to 418 and the mean Subjective shoulder value from 15 to 61. On radiological review, one patient had a lucency around the humeral stem, two had stress shielding. There were no fatigue fractures of the acromion but four cases of grade 1 scapular notching.

### CONCLUSION

The use of a convertible prosthetic system to revise a failed ASA reduces morbidity and minimises the rate of complications. The mid-term clinical and radiological results of this technique are promising.



The study highlights the effectiveness of a reverse shoulder arthroplasty performed through a modular convertible system. This technique allows for improved recovery, decrease of post-operative pain and morbidity. **Medacta Shoulder System** is characterized by unparalleled modularity providing solutions for problems such as those described in this article. The +20° left/-20° right e +20° right/-20° left reverse humeral metaphyses are designed to address positioning concerns during conversion.

## Conversion of stemmed hemi-or total to reverse total shoulder arthroplasty: advantages of a modular stem design

WIESER, K., BORBAS, P., EK, E. T., MEYER, D. C., & GERBER, C. (2015). *CLINICAL ORTHOPAEDICS AND RELATED RESEARCH®*, 473(2), 651-660. DOI : 10.1007/S11999-014-3985-Z

### BACKGROUND

If revision of a failed anatomic hemiarthroplasty or total shoulder arthroplasty is uncertain to preserve or restore satisfactory rotator cuff function, conversion to a reverse total shoulder arthroplasty has become the preferred treatment, at least for elderly patients. However, revision of a well-fixed humeral stem has the potential risk of loss of humeral bone stock, nerve injury, periprosthetic fracture, and malunion or nonunion of a humeral osteotomy with later humeral component loosening. The purposes of this study were to determine whether preservation of a modular stem is associated with (1) less blood loss and operative time; (2) fewer perioperative and postoperative complications, including reoperations and revisions; and/or (3) improved Constant and Murley scores and subjective shoulder values for conversion to a reverse total shoulder arthroplasty compared with stem revision.

### METHODS

Between 2005 and 2011, 48 hemiarthroplasties and eight total shoulder arthroplasties (total = 56 shoulders; 54 patients) were converted to an Anatomical™ reverse total shoulder arthroplasty system without (n = 13) or with (n = 43) stem exchange. Complications and revisions for all patients were tallied through review of medical and surgical records. The outcomes scores included the Constant and Murley score and the subjective shoulder value. Complete clinical followup was available on 80% of shoulders (43 patients; 45 of 56 procedures, 32 with and 13 without stem exchange) at a minimum of 12 months (mean, 37 months; range, 12–83 months).

### RESULTS

Blood loss averaged 485 mL (range, 300–700 mL; SD, 151 mL) and surgical time averaged 118 minutes (range, 90–160 minutes; SD, 21 minutes) without stem exchange and 831 mL (range, 350–2000 mL; SD, 400 mL) and 176 minutes (range, 120–300 minutes; SD, 42 minutes) with stem exchange (p = 0.001). Intraoperative

complications (8% versus 30%; odds ratio [OR], 5.2) and reinterventions (8% versus 14%; OR, 1.9) were substantially fewer in patients without stem exchange. The complication rate leading to dropout from the study was substantial in the stem revision group (six patients; 43 shoulders [14%]), but there were no complication-related dropouts in the stem retaining group. If, however, such complications could be avoided, with the numbers available we detected no difference in the functional outcome between the two groups.

### CONCLUSION

Patients undergoing revision of stemmed hemiarthroplasty or total to reverse total shoulder arthroplasty without stem exchange had less intraoperative blood loss and operative time, fewer intraoperative complications, and fewer revisions than did patients whose index revision procedures included a full stem exchange.



Revision of failed shoulder arthroplasty represents a technically demanding procedure with improved but limited functional results. Modular designs used for shoulder arthroplasty allow for conversion from anatomic to reverse shoulder arthroplasty without removal of a well-fixed humeral component. As a consequence, the risk of humeral shaft fracture is reduced. **Medacta Shoulder System** is characterized by unparalleled modularity providing solutions for problems such as those described in this article. The +20° left/-20° right e +20° right/-20° left reverse humeral metaphyses were designed to address positioning concerns during conversion.



## Conversion to Reverse Total Shoulder Arthroplasty with and without Humeral Stem Retention: The Role of a Convertible-Platform Stem.

CROSBY, L. A., WRIGHT, T. W., YU, S., & ZUCKERMAN, J. D. - JBJS 2017. 99(9), 736-742. DOI:10.2106/JBJS.16.00683

### BACKGROUND

Revision shoulder arthroplasty is a technically challenging procedure. It is associated with increased blood loss and operative time, and it frequently necessitates revision implants, augments, and bone-grafting. Shoulder arthroplasty systems with a convertible-platform humeral stem have been developed to reduce the complexity of revision procedures by eliminating the need for humeral component explantation when converting from anatomic shoulder arthroplasty (hemiarthroplasty or total shoulder arthroplasty) to reverse total shoulder arthroplasty (rTSA).

### METHOD

A multicenter, retrospective analysis involving 102 consecutive shoulders (102 patients) that underwent revision of an anatomic shoulder arthroplasty to an rTSA was conducted. During the revision, 73 of the shoulders needed exchange of the humeral stem (the exchange group) and 29 had retention of a convertible-platform humeral component (the retention group). Patient demographics, operative time, blood management, range of motion, complications, and patient-reported outcomes were compared between the 2 groups.

### RESULTS

Patients with retention had significantly shorter operative time (mean and standard deviation,  $130 \pm 48$  versus  $195 \pm 58$  minutes;  $p < 0.001$ ) and lower estimated blood loss ( $292 \pm 118$  versus  $492 \pm 334$  mL;  $p = 0.034$ ). The rate of intraoperative complications was lower in the retention group (0% versus 15%;  $p = 0.027$ ). Patients with retention had slightly better postoperative range of motion (active external rotation,  $26^\circ \pm 23^\circ$  versus  $11^\circ \pm 23^\circ$  [ $p = 0.006$ ]; active forward elevation,  $112^\circ \pm 37^\circ$  versus  $96^\circ \pm 33^\circ$  [ $p = 0.055$ ]).

### CONCLUSION

Shoulder arthroplasty systems that utilize a convertible-platform humeral stem offer an advantage for rTSA conversion in that a well-fixed, well-positioned humeral stem can be retained. There were significantly fewer complications as well as significantly decreased blood loss and operative time when a convertible-platform stem was utilized ( $p < 0.050$ ).



This study highlights the advantages of shoulder arthroplasty systems with a convertible platform by comparing two groups of patients who underwent exchange and retention surgeries. The retention group benefitted from shorter operative times, lower estimated blood loss and better postoperative range of motion compared to the exchange group. **Medacta Shoulder System** is characterized by unparalleled modularity providing solutions for problems such as those described in this article. The  $+20^\circ$  left/ $-20^\circ$  right e  $+20^\circ$  right/ $-20^\circ$  left reverse humeral metaphyses were designed to address positioning concerns during conversion.

## 2. Total Anatomic Shoulder Arthroplasty

# Anatomic Humeral Metaphysis

## Geometry of the Proximal Humerus and Implications for Prosthetic Design.

HERTEL, R., KNOTHE, U., & BALLMER, F. T. - JSES 2002. 11(4), 33 -338. DOI: 10.1067/MSE.2002.124429

### BACKGROUND

The purpose of this study was to add critical information to the data already available on anthropometry of the proximal humerus.

### METHOD

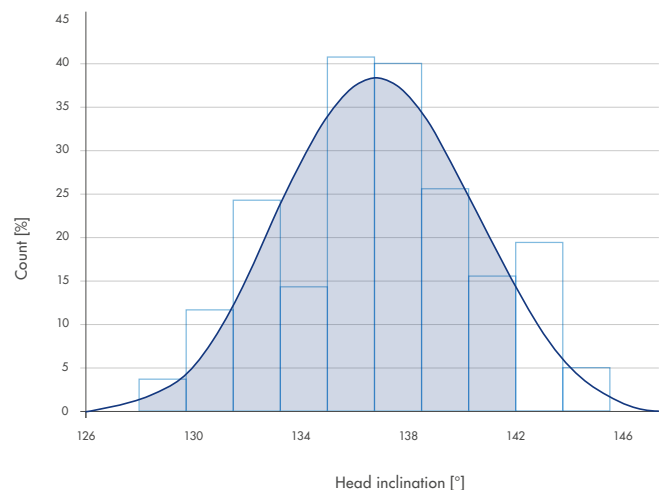
Two hundred macerated humeri were examined. Measurements were taken either directly on the bones or on standardized radiographic projections. The methodology was validated and showed a mean interobserver correlation of  $0.94 \pm 0.067$ .

### RESULTS

Results were expressed in mean values, first SD, and minimum and maximum values, as well as the 10th and 90th percentiles. The frontal radius of the head ranged between 21 and 26.5 mm (10th respectively 90th percentile). The frontal diameter of the base of the head ranged between 39.4 and 50 mm. The head height ranged between 14.4 and 18.8 mm. The frontal radius-head height ratio ranged between 0.64 and 0.77. The inclination of the head ranged between  $132^\circ$  and  $142^\circ$ . The medial offset ranged between 3.9 and 8.6 mm. The posterior offset ranged between  $-0.4$  and 3.2 mm. The greater tuberosity offset (distance between the axis of the proximal humerus and the most medial insertion point of the supraspinatus tendon) ranged between 2.5 and 9.2 mm. Retrotorsion ranged between  $7^\circ$  and  $38.5^\circ$ . The distance from the bicipital groove to the head equator ranged between 6 and 10.5 mm. The anatomy of the proximal humerus showed a wide range for variables such as the medial offset and the greater tuberosity offset but was surprisingly constant for the inclination and relative dimensions of the head.

### CONCLUSION

The implications for prosthetic design are as follows: stem design and insertion should respect the insertion facet of the supraspinatus, a constant head inclination is an adequate approximation, only one head height per radius is required, and the capability for adjustment of medial offset is mandatory.



The **Medacta Anatomic Metaphysis**  $128^\circ$ ,  $135^\circ$ , and  $142^\circ$  options accommodate the majority of humeral inclinations, providing surgeons with an implant system which delivers concrete anatomic restoration.



## Eccentricity

### The Effect of Articular Malposition after Total Shoulder Arthroplasty on Glenohumeral Translations, Range of Motion, and Subacromial Impingement.

WILLIAMS JR, G. R., WONG, K. L., PEPE, M. D., TAN, V., SILVERBERG, D., RAMSEY, M. L., KARDUNA, A., & IANNOTTI, J. P. - JSES 2001. 10(5), 399-409. DOI: 10.1067/MSE.2001.116871

#### BACKGROUND

The articular surface of the normal humeral head has a variable posterior and medial offset with respect to the central axis of the humeral shaft. Recreation of the normal humeral head shaft offset is postulated to be an important consideration in shoulder arthroplasty. However, the effect of humeral head malposition is unknown. The purpose of this study was to determine the effect of articular malposition after total shoulder arthroplasty on glenohumeral translation, range of motion, and subacromial impingement.

#### METHODS

Twenty-one human cadavers were dissected and tested with the use of an active or passive shoulder model. ROM and translation were recorded by means of an electronic tracking device. The experiment was performed in 2 phases. For kinematics study, 11 cadaver shoulders were positioned both passively and actively from maximum internal rotation to maximum external rotation at 90° of total elevation in the scapular plane. Three rotator cuff and 3 deltoid muscle lines of action were simulated for active joint positioning. Passive joint positioning was accomplished with the use of a torque wrench and a nominal centering force. The testing protocol was used for the natural joint as well as for 9 prosthetic head locations: centered and 2- and 4-mm offsets in the anterior, posterior, inferior, and superior directions. Repeated-measures analysis of variance was used to test for significant differences in the range of motion and translation between active and passive positioning of the natural joint as well as all prosthetic head positions. (2) For impingement study, 10 cadaver shoulders were used in a passive model, loading the tendons of the rotator cuff with a 30-N centering force. The humerus was passively rotated from maximum internal rotation (1500 Nmm) to maximum external rotation (1500 Nmm) by means of a continuous-recording digital torque wrench. Trials were performed with the use of centered, 4-, 6-, and 8-mm offset heads in the anterior, posterior, superior, and inferior positions before and after removal of the acromion and coracoacromial ligament.

#### RESULTS

The relation between change in mean peak torque (with and without acromion), passive range of motion, and humeral head offset was analyzed by means of repeated measures analysis of variance. In the kinematics study, total range of motion and all humeral translations were greater with passive joint positioning than with active positioning ( $P = .01$ ) except for total superior-inferior translation and superior-inferior translation in external rotation. Anterior to posterior humeral head offset was associated with statistically significant changes in total range of motion ( $P = .02$ ), range of internal rotation ( $P = .02$ ), range of external rotation ( $P = .0001$ ), and total anterior-posterior translation ( $P = .01$ ). Superior to inferior humeral head offset resulted in statistically significant changes in total range of motion ( $P = .02$ ), range of internal rotation ( $P = .0001$ ), anterior-posterior translation during external rotation ( $P = .01$ ), and total superior-inferior translation ( $P = .03$ ). In the impingement study, there was a significant increase in torque from centered to 4-mm inferior offset ( $P = .006$ ), 6-mm inferior offset ( $P < .001$ ), and 8-mm inferior offset ( $P < .001$ ). There was no significant increase in torque with superior, anterior, and posterior offsets. Glenohumeral motion significantly decreased from 129° for centered head to 119° for 8-mm superior ( $P = .002$ ), 119° for 8-mm anterior ( $P = .014$ ), 118° for 8-mm inferior ( $P < .001$ ), and 114° for 8-mm posterior ( $P = .001$ ).

#### CONCLUSION

Humeral articular malposition of 4 mm or less during prosthetic arthroplasty of the glenohumeral joint may lead to small alterations in humeral translations and range of motion. Inferior malposition greater than 4 mm can lead to increased subacromial contact; offset of 8 mm in any direction results in significant decreases in passive range of motion. Therefore if subacromial contact is to be minimized and glenohumeral motion maximized after shoulder replacement, anatomic reconstruction of the humeral head-humeral shaft offset within 4 mm is desirable.



Each **Medacta Anatomic Humeral head** utilizes double eccentric technology. This provides up to 5 mm of eccentricity that may be dialed in any direction in order to match the patients anatomy.

# Highly Cross - Linked Polyethylene

## Cross-linked Glenoid Prosthesis: A Wear Comparison to Conventional Glenoid Prosthesis with Wear Particulate Analysis

WIRTH, M. A., KLOTZ, C., DEFFENBAUGH, D. L., MCNULTY, D., RICHARDS, L., & TIPPER, J. L. - JSES 2009. 18(1), 130-137. DOI: 10.1016/J.JSE.2008.06.015

### BACKGROUND

Wear debris has been observed in shoulder arthroplasties that use an ultrahigh-molecular weight polyethylene (UHMWPE) glenoid component, and the biologic response to this debris contributes to aseptic loosening of the implant. The objective of this study was to assess the wear and particle morphology of a cross-linked UHMWPE prosthetic glenoid. To our knowledge, this is the first time a simulator with kinematic considerations for assessing wear has been used in a shoulder model.

### METHODS

Shoulder wear testing was conducted on 2 groups of glenoids (n = 3 in each group) by use of an orthopaedic joint simulator to create worst-case scenario motions. One group was manufactured from conventional UHMWPE. The second was manufactured from 50-kGy cross-linked UHMWPE.

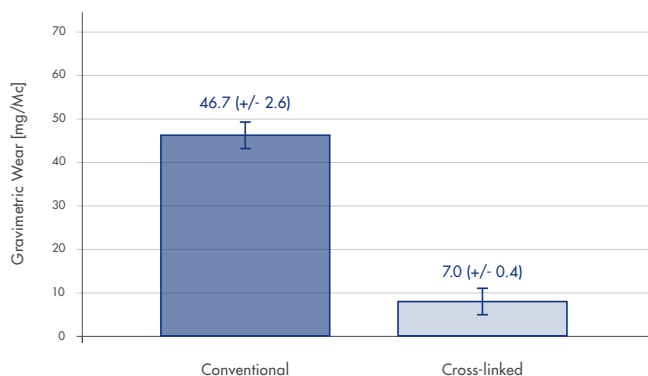
### RESULTS

The resulting wear rates (1 SD) for the conventional and cross-linked glenoid components were 46.7 2.6 mg/million cycles and 7.0 0.4 mg/million cycles, respectively.

### CONCLUSION

Particles isolated from the 2 groups showed similar morphologies; however, the calculated osteolytic potential of the cross-linked glenoid was significantly lower. The results of this study support the use of cross-linked UHMWPE glenoids in clinical applications.

Highly cross-linked polyethylene is one of the most studied materials in orthopedic literature and represents a vastly superior material for the construction of glenoid implants. Medacta Anatomic cemented glenoids are made of highly cross-linked polyethylene and designed for 6 mm diametrical mismatch (cleared 2 to 10 mm).



# Glenoid Humeral Mismatch

## The Influence of Glenohumeral Prosthetic Mismatch on Glenoid Radiolucent Lines: Results of a Multicenter Study

WALCH, G., EDWARDS, T. B., BOULAHIA, A., BOILEAU, P., MOLÈ, D., & ADELEINE, P. - JBJS 2002. 84(12), 2186-2191. DOI: 10.2106/00004623-200212000-00010

### BACKGROUND

In shoulder arthroplasty, mismatch is defined as the difference in the radius or diameter of curvature between the humeral head and glenoid components. Recommendations for mismatch have not been substantiated scientifically. The purpose of this study was to evaluate the effect of mismatch on glenoid radiolucent lines.

### METHODS

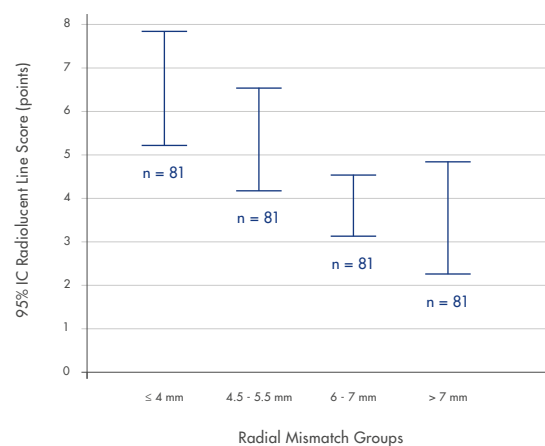
The results of 319 total shoulder arthroplasties performed for the treatment of primary osteoarthritis were evaluated. All of the arthroplasties were performed with a single type of prosthesis (Aequalis; Tornier, Montbonnot, France) that included a cemented, all-polyethylene glenoid component. Three sizes of glenoid components and seven humeral head diameters were utilized. Radial mismatch was categorized as  $\leq 4$  mm, 4.5 to 5.5 mm, 6 to 7 mm, or  $> 7$  to 10 mm. Radio-graphs were evaluated at a mean of 53.5 months (range, twenty-four to 110 months) postoperatively. Glenoid radiolucent lines were scored with a scale ranging from 0 points for no radiolucency to 18 points for radiolucent lines exceeding 2 mm in six zones. Variance, linear contrasts polynomial, quadratic polynomial contrast statistical, and linear regression analyses were performed to evaluate the relationship between radial mismatch and glenoid radiolucent lines.

### RESULTS

A significant linear relationship was found between mismatch and the glenoid radiolucency score ( $p < 0.0001$ ), with significantly lower (better) radiolucency scores associated with radial mismatches of  $> 5.5$  mm.

### CONCLUSION

In this study of glenohumeral prosthetic mismatch ranging from 0 to 10 mm, the mismatch had a significant influence on the scores for the glenoid radiolucent lines, which were best when the radial mismatch was between 6 and 10 mm. The theoretical risk of prosthetic instability with larger mismatch values was not demonstrated within the range of mismatch values evaluated in this series.



The relevance of this study is represented by its sampling size and scope: isolating mismatch as the differentiating factor for radiolucent lines which lead to component loosening. **The 10 glenoid sizes provided by the Medacta Shoulder System** do not lead to compromises when matching sizes and allow surgeons to restore native anatomy.

		Cemented glenoid										
Size		40	42	44	46	48	50	52	54	56	58	
	A.D.	46	48	50	52	54	56	58	60	62	64	
Humeral head	40	40	6	8	10							
	42	42	4	6	8	10						
	44	44	2	4	6	8	10					
	46	46		2	4	6	8	10				
	48	48			2	4	6	8	10			
	50	50				2	4	6	8	10		
	52	52					2	4	6	8	10	
	54	54						2	4	6	8	10
	56	56							2	4	6	8
58	58								2	4	6	

A.D. = Articular Diameter

# Cemented and Cementless Glenoid

## Cementless versus Cemented Glenoid Components in Conventional Total Shoulder Joint Arthroplasty: Analysis from the Australian Orthopaedic Association National Joint Replacement Registry

PAGE, R. S., PAI, V., ENG, K., BAIN, G., GRAVES, S., & LORIMER, M. - JSES 2018. 27(10), 1859-1865. DOI: 10.1016/J.JSE.2018.03.017

### BACKGROUND

Glenoid loosening is a common mode of failure after total shoulder arthroplasty (TSA). Newer cementless glenoid components have been introduced to promote biological fixation with the aim to decrease glenoid loosening. Limited data are available comparing revision rates between cemented and cementless glenoid fixation in TSA. The study aim was to compare the revision rates of cemented and cementless design glenoid components used in conventional TSA performed for the diagnosis of osteoarthritis. The secondary aim was to compare various subclasses of glenoid components.

### METHODS

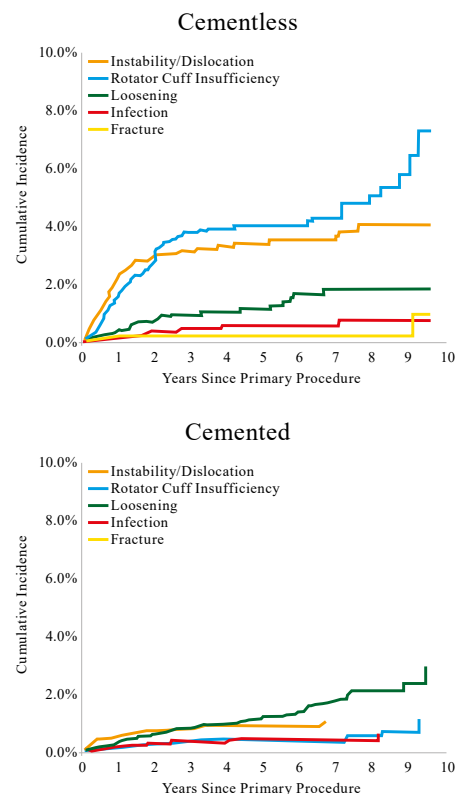
Data were obtained between April 16, 2004, and December 31, 2016, from the Australian Orthopaedic Association National Joint Replacement Registry. Within the study period, 10,805 primary conventional TSAs were identified. The analysis was undertaken for the diagnosis of osteoarthritis, which represented 95.8% of all conventional TSA procedures.

### RESULTS

At 5 years, in patients with primary TSA procedures, those with cemented glenoids had a lower revision rate than those with cementless glenoids: 3.7% versus 17.9% (hazard ratio for entire period, 4.77). The most common revision diagnosis for primary conventional TSA with cementless glenoid fixation was rotator cuff insufficiency (4.4% for cementless vs 0.4% for cemented), instability and/or dislocation (3.8% for cementless vs 0.8% for cemented), and loosening and/or lysis (1.1% for cementless vs 1.1% for cemented).

### CONCLUSION

Cementless glenoid components in conventional TSA had a significantly higher revision.



This study utilized unbiased registry data and is substantial in its sample size. The highly cross-linked cemented glenoid has proven to be the most successful solution available, with lower rates of revisions compared to the cementless options currently available on the market. **Medacta Shoulder System** provides the most robust anatomic glenoid portfolio currently available on the market.



## Metal Back and Cemented Glenoid

### Metal-Backed Glenoid Components Have a Higher Rate of Failure and Fail by Different Modes in Comparison with All-Polyethylene Components

PAPADONIKOLAKIS, A., & MATSEN III, F. A. - JBJS 2014. 96(12), 1041-1047. DOI: 10.2106/JBJS.M.00674

#### BACKGROUND

Glenoid component failure is a common and serious complication of total shoulder arthroplasty. The purpose of this study was to evaluate published evidence on whether metal backing lessens the rate of glenoid component failure.

#### METHODS

A comprehensive systematic review yielded twenty-one studies on radiolucency, radiographic failure, and revision after arthroplasty with metal-backed glenoid components and twenty-three studies with all-polyethylene components. Our analysis included data on 1571 metal-backed and 3035 all-polyethylene components. The mean duration of follow-up was 5.8 years in the studies with metal-backed components and 7.3 years with all-polyethylene components.

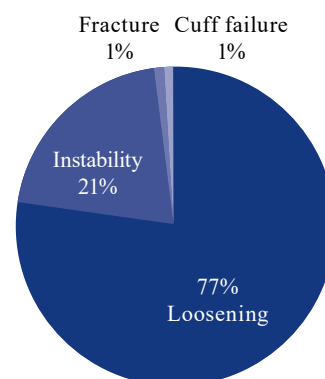
#### RESULTS

All-polyethylene components had a 42.5% rate of radiolucency compared with 34.9% for metal-backed components ( $p = 0.0026$ ) and a 21.1% rate of radiographic loosening or failure compared with 16.8% for metal-backed components ( $p = 0.0005$ ). However, the rate of revision was more than three times higher with metal-backed components (14.0%) than with all-polyethylene components (3.8%,  $p < 0.0001$ ). Although 77% of the revisions of all-polyethylene components were for loosening, 62% of the revisions of metal-backed components were for other reasons, such as component fracture, screw breakage, component dissociation, polyethylene wear, metal wear, and rotator cuff tear ( $p < 0.0001$ ).

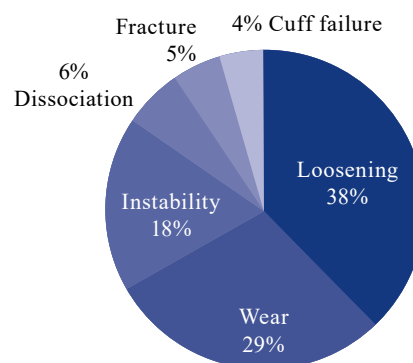
#### CONCLUSION

The published evidence indicates that metal-backed glenoid components require revision at a significantly higher rate and for different reasons in comparison with all-polyethylene components.

This systematic review of the literature provides an extensive analysis of failure rates and modes of metal-backed and all-polyethylene glenoid components. An all polyethylene component tends to fail by loosening, which represents a much more manageable revision compared to metal back failures. A metal back failure tends to result in a cobalt chrome head articulating with a titanium baseplate, causing disastrous revisions. **Medacta Shoulder System** offers for total shoulder arthroplasty glenoid components including a wide portfolio of cemented high crosslink PE implants.



All Polyethylene (97 revisions)  
Reported reasons for the ninety-seven revisions of all-polyethylene glenoid components



Metal Backed (220 revisions)  
Reported reasons for the 220 revisions of metal-backed glenoid components

### 3. Reverse Shoulder Arthroplasty

## Reverse Neck Angle

### Can A Functional Difference Be Detected In Reverse Arthroplasty with 135° vs. 155° Prosthesis for the Treatment Of Rotator Cuff Arthropathy: A Prospective Randomized Study

SHISHANI, Y., LEDERMAN, E. S., DENARD, P. J., & GOBEZIE, R. - JSES 2018. 27(4), E12. DOI: 10.1016/J.JSE.2018.02.007

#### BACKGROUND

Reverse shoulder arthroplasty (RSA) has been an effective treatment for patients with rotator cuff arthropathy (RCA). The original Grammont design had a 155° neck-shaft angle. Recently, other designs with less valgus have become prevalent. However, there are few studies that compare the outcomes and complications of 155° to 135° RSA.

#### METHODS

100 RSAs performed by a single surgeon for RCA were prospectively randomized to receive either a 135° or 155° humeral implant. Range of motion and functional outcome were compared at two years postoperative. In addition, scapular notching and complications were noted.

#### RESULTS

Patients with 135° implants achieved active forward flexion improvement from 78° to 131° ( $P < .005$ ), ASES score improvement from 37 to 74 ( $P < .005$ ), VAS pain score improvement from 6.3 to 1.9 ( $P < .005$ ), and SANE score improvement from 31.5% to 73.7% ( $P < .005$ ). Patients with 155° implants achieved active forward flexion improvement from 76° to 135° ( $P < .005$ ), ASES score improvement from 37 to 78 ( $P < .005$ ), VAS pain score improvement from 6.6 to 1.2 ( $P < .005$ ), and SANE score improvement from 35.9% to 75.6% ( $P < .005$ ). Improvements did not significantly differ between varying neck shaft implant angles for any outcome measure evaluated. Scapular notching was observed in 16% of the 135° group compared to 36% of the 155° group.

#### CONCLUSION

This study did not demonstrate any significant difference in functional outcome between patients with a 155° or 135° RSA. Scapular notching is more common with a 155° implant. Further follow-up is required to determine if these results are maintained in the long-term.



Prospective randomized studies methodology represents an excellent way to isolate independent variables which may affect a given procedure. This study considers the importance of neck angle in reverse shoulder arthroplasty. There are benefits and detriments to 135°, 145°, and 155° that need to be studied further to fully understand differences in outcome. **Medacta Shoulder System** provides both 145° and 155°, allowing the surgeon to choose intraoperatively between enhanced ROM and increased stability.





## The influence of humeral neck shaft angle and glenoid lateralization on range of motion in reverse shoulder arthroplasty

WERNER, B. S., CHAOUI, J., & WALCH, G. - JSES 2017. 26(10), 1726-173. DOI: 10.1016/J.JSE.2017.03.032

### BACKGROUND

Recent developments in reverse shoulder arthroplasty (RSA) have focused on changes in several design-related parameters, including humeral component design, to allow for easier convertibility. Alterations in humeral inclination and offset on shoulder kinematics may have a relevant influence on postoperative outcome. This study used a virtual computer simulation to evaluate the influence of humeral neck shaft angle and glenoid lateralization on range of motion in onlay design RSA.

### METHODS

Three-dimensional RSA computer templating was created from computed tomography (CT) scans in 20 patients undergoing primary total shoulder arthroplasty for concentric osteoarthritis (Walch A1). Two concurrent factors were tested for impingement-free range of motion: humeral inclination (135° vs. 145°) and glenoid lateralization (0 mm vs. 5 mm).

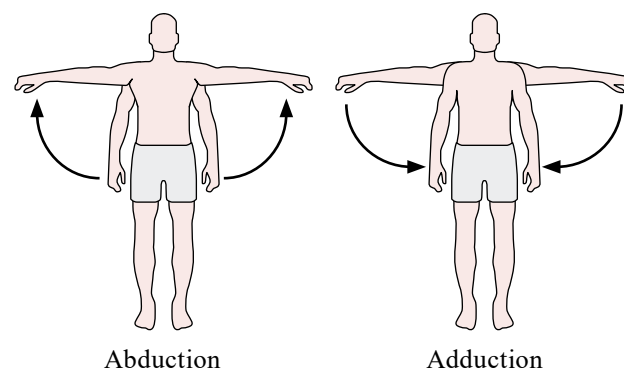
### RESULTS

Decreasing the humeral neck shaft angle demonstrated a significant increase in impingement free range of motion. Compared to the 145° configuration, extension was increased by 42.3° (−8.5° to 73.5°), adduction by 15° (10° to 23°), and external rotation with the arm at side by 15.1° (8.5° to 26.5°); however, abduction was decreased by 6.5° (−1° to 12.5°). Glenoid lateralization led to comparable results, but an additional increase in abduction of 7.6° (−1° to 16.5°) and forward flexion of 26.6° (6.5° to 62°) was observed.

### CONCLUSION

Lower humeral neck shaft angle and glenoid lateralization are effective for improvement in range of motion after RSA. The use of the 135° model with 5 mm of glenoid lateralization provided the best results in impingement-free range of motion, except for abduction.

This study is characterized by several limitations, primarily related to the system studied which is an onlay design. Also, computer simulations result ineffective in evaluating soft tissues or in taking into account ideal tensioning. Instability represents one of the most common complications in shoulder arthroplasty while surgeons are constantly trying to balance potential ROM with dislocation. To focus an analysis solely on ROM might result misleading; it is necessary to consider the maximum level of ROM which provides stability.



## Biomechanical effects of humeral neck shaft angle and subscapularis integrity in reverse total shoulder arthroplasty

OH, J. H., SHIN, S. J., MCGARRY, M. H., SCOTT, J. H., HECKMANN, N., & LEE, T. Q. - JSES 2014. 23(8), 1091-1098. DOI: 10.1016/J.JSE.2013.11.003

### BACKGROUND

The variability in functional outcomes and the occurrence of scapular notching and instability after reverse total shoulder arthroplasty remain problems. The objectives of this study were to measure the effect of reverse humeral component neck-shaft angle on impingement-free range of motion, abduction moment, and anterior dislocation force and to evaluate the effect of subscapularis loading on dislocation force.

### METHODS

Six cadaveric shoulders were tested with 155°, 145°, and 135° reverse shoulder humeral neck-shaft angles. The adduction angle at which bone contact occurred and the internal and external rotational impingement-free range of motion angles were measured. Glenohumeral abduction moment was measured at 0° and 30° of abduction, and anterior dislocation forces were measured at 30° of internal rotation, 0°, and 30° of external rotation with and without subscapularis loading.

### RESULTS

Adduction deficit angles for 155°, 145°, and 135° neck-shaft angle were  $2^\circ \pm 5^\circ$  of abduction,  $7^\circ \pm 4^\circ$  of adduction, and  $12 \pm 2^\circ$  of adduction ( $P < .05$ ). Impingement-free angles of humeral rotation and abduction moments were not statistically different between the neck-shaft angles. The anterior dislocation force was significantly higher for the 135° neck-shaft angle at 30° of external rotation and significantly higher for the 155° neck-shaft angle at 30° of internal rotation ( $P < .01$ ).

### CONCLUSION

The 155° neck-shaft angle was more prone to scapular bone contact during adduction but was more stable at the internally rotated position, which was the least stable humeral rotation position. Subscapularis loading gave further anterior stability with all neck-shaft angles at all positions.



Despite this study was conducted on a cadaveric simulation, the obtained results support the assumption that one neck angle may not fit every patient. Since each neck angle brings both benefits and disadvantages, to dispose of multiple options makes surgeons able to better match the patient anatomy.

The Medacta Shoulder System, thanks to the innovative design of its components, allows the surgeon to choose between two different neck angle options: 145° and 155°.



145°

155°

## Onlay versus Inlay

### Increased Scapular Spine Fractures After Reverse Shoulder Arthroplasty with a Humeral Onlay Short Stem: An Analysis of 485 Consecutive Cases

ASCIONE, F., KILIAN, C. M., LAUGHLIN, M. S., BUGELLI, G., DOMOS, P., NEYTON, L., GODENECHÉ, A., EDWARDS, T. B., WALCH, G. - JSES 2018. IN PRESS. DOI: 10.1016/J.JSE.2018.06.007

#### BACKGROUND

Scapular stress fractures after reverse shoulder arthroplasty (RSA) are a potentially serious complication with modern lateralized and onlay implants. The aim of this study was to report the scapular spine stress fracture rate after RSA with an onlay, 145° humeral stem, analyzing potential fracture risk factors and clinical outcomes in a large cohort of patients.

#### METHODS

A consecutive series of 485 RSAs were implanted with the Aequalis Ascend Flex stem. Data collection included preoperative and postoperative clinical and radiographic assessment findings (rotator cuff Goutallier grade; Hamada, Walch, and Favard classifications; range of motion; Constant score) and perioperative data. Patients with a scapular spine fracture following RSA were matched with nonfracture control patients, and preoperative variables were tested to determine whether they were predictive of a scapular spine fracture.

#### RESULTS

A scapular spine fracture following RSA occurred in 21 patients (4.3%), with a mean time to diagnosis of 8.6 months (range, 1-34 months). No preoperative factor was found to be a significant predictor of scapular spine fracture. Both groups showed significant improvements in active mobility measurements and Constant scores from preoperatively to final follow-up ( $P < .001$ ). The control group scored significantly better than the scapular spine fracture group regarding the Constant score and forward flexion.

#### CONCLUSION

Scapular spine fractures have shown an increased prevalence after onlay-design RSA. This series was not able to link any clear risk factors. Functional results are limited, regardless of the fracture management.

Scapular spine fractures are one of the most difficult complications to deal with in reverse shoulder arthroplasty. This study illustrates that an onlay prosthesis holds a spine fracture complication rate at 4.3% compared to the inlay design at 1.3%. **Medacta Shoulder System** is characterized by a semi-inlay design that reduces the risks related to an onlay design and overcomes the limitation of inlay designs.



## Scapular Fractures in Reverse Shoulder Arthroplasty (Grammont style): Prevalence, Functional, and Radiographic Results with Minimum 5-Year Follow-Up

NEYTON, L., ERICKSON, J., ASCIONE, F., BUGELLI, G., LUNINI, E., & WALCH, G. - JSES 2018. IN PRESS.  
DOI: 10.1016/J.JSE.2018.07.004

### BACKGROUND

Scapular fractures after reverse shoulder arthroplasty (RSA) are an increasingly reported complication. Information is missing regarding midterm to long-term follow-up consequences. The aim of this study was to determine the rate of scapular fracture (acromial base and spine) after Grammont style RSA and to report functional and radiographic results of patients with a minimum 5-year follow-up.

### METHODS

We retrospectively reviewed 1953 Grammont style RSAs in 1745 patients in a multicenter study. Of these, 953 patients (1035 RSAs) had minimum 5-year follow-up for functional and radiographic assessment (anteroposterior and scapular Y views).

### RESULTS

Twenty-six patients (1.3%) had sustained a scapular fracture; of these, 19 (10 acromial base and 9 spine fractures) had minimum 5-year follow-up and were reviewed at a mean follow-up of 97 months. Three patients (15.8%) were diagnosed at the last follow-up after an undiagnosed fracture. There were 3 traumatic cases (15.8%) and 13 (68.4%) without antecedent trauma. These 16 patients underwent non operative treatment. The fracture was healed in 8 (4 acromion and 4 spine). The average active forward elevation was 109° (range, 50°-170°), and the Constant score was 47.0 points (range, 8-81 points).

### CONCLUSION

Scapular fractures after Grammont style RSAs are rare (1.3%) but remain a concern. These fractures occur mainly in the early postoperative 6 months. Immobilization with an abduction splint frequently resulted in nonunion or malunion. Final functional outcomes are poor regardless of acromial or spine fracture compared with primary RSA without fracture.



Scapular fractures are one of the most difficult complication to deal with in reverse shoulder arthroplasty. This study illustrates that a Grammont style prosthesis holds a scapular fracture complication rate at 1.3% compared to the onlay design at 4.3%. **Medacta Shoulder System** is characterized by a semi-inlay design that reduces the risks related to an onlay design and overcomes the limitation of inlay designs.

# Scapular Notching

## Predictors of Scapular Notching in Patients Managed with the Delta III Reverse Total Shoulder Replacement

RYAN W. SIMOVITCH, MATTHIAS A. ZUMSTEIN, EVELINE LOHRI, NAEDER HELMY AND CHRISTIAN GERBER J. BONE JOINT SURG. AM. 89:588-600, 2007. DOI:10.2106/JBJS.F.00226

### BACKGROUND

The reverse Delta III shoulder prosthesis can relieve pain and restore function in patients with cuff tear arthropathy. The most frequently reported radiographic complication is inferior scapular notching. The purpose of the present study was to evaluate the clinical relevance of notching and to determine the anatomic and radiographic parameters that predispose to its occurrence.

### METHODS

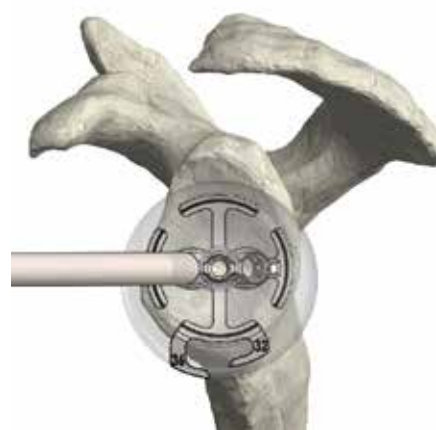
Seventy-seven consecutive shoulders in seventy-six patients with an irreparable rotator cuff deficiency were managed with a reverse Delta III shoulder arthroplasty and were followed clinically and radiographically for a minimum of twenty-four months. The effects of cranial-caudal glenoid component positioning and the prosthesis-scapular neck angle on the development of inferior scapular notching and clinical outcome were assessed.

### RESULTS

All shoulders that had development of notching did so in the first fourteen months. Of the seventy-seven shoulders that were studied, thirty-four (44%) had inferior scapular notching, twenty-three (30%) had posterior notching, and six (8%) had anterior notching. Osteophytes along the inferior part of the scapula occurred in twenty-one (27%) of the seventy-seven shoulders. The angle between the glenosphere and the scapular neck ( $r = 0.667$ ) as well as the craniocaudal position of the glenosphere ( $r = 0.654$ ) were highly correlated with inferior notching ( $p < 0.001$ ). A notching index was calculated with use of the height of implantation of the glenosphere and the postoperative prosthesis-scapular neck angle. This allowed prediction of the occurrence of notching with a sensitivity of 91% and specificity of 88%. The height of implantation of the glenosphere had approximately an eight times greater influence on inferior notching than the prosthesis-scapular neck angle did. Inferior scapular notching was associated with a significantly poorer clinical outcome.

### CONCLUSION

Inferior scapular notching after reverse total shoulder arthroplasty adversely affects the intermediate-term clinical outcome. It can be prevented by optimal positioning of the glenoid component. Level of Evidence: Prognostic Level II. See Instructions to Authors for a complete description of levels of evidence.



# Subscapularis Repair in Reverse Arthroplasty

## Sonographic Assessment of the Subscapularis After Reverse Shoulder Arthroplasty: Impact of Tendon Integrity on Shoulder Function

DEDY, N. J., GOUK, C. J., TAYLOR, F. J., THOMAS, M., & TAN, S. E. - *JSES* 2018. 27(6), 1051-1056.  
DOI:10.1016/J.JSE.2017.12.008

### BACKGROUND

The deltopectoral approach for reverse shoulder arthroplasty (RSA) requires subscapularis tenotomy or lesser tuberosity osteotomy. Whether the subscapularis should be repaired at the conclusion of the procedure remains controversial. The present study sonographically assessed the subscapularis after RSA and evaluated the effect of tendon integrity on functional outcome.

### METHODS

All patients who had undergone RSA in the Gold Coast University Hospital between 2005 and 2016 were included. Sonography was performed by a blinded examiner. Function was assessed using the Disabilities of the Arm, Shoulder and Hand, the Constant Murley, and Oxford Shoulder scores. Internal rotation ability was recorded on a 6-point scale.

### RESULTS

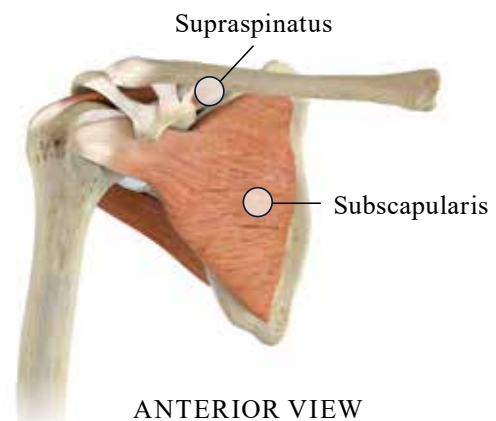
The study included 43 patients (48 shoulders). Median length of follow-up was 19 months (range, 4-132 months). On sonography, the subscapularis was graded intact in 6 shoulders (13%), intact with mild attenuation in 16 (33%), severely attenuated in 15 (31%), and not intact or absent in 11 (23%). Differences in Disabilities of the Arm, Shoulder and Hand, Constant Murley, or Oxford Shoulder scores between intact and attenuated or absent subscapularis shoulders were not significant. Internal rotation scores were significantly higher in the intact and mildly attenuated tendon group than in the absent tendon group ( $U = 1.0$ ,  $P = .001$  and  $U = 28.5$ ,  $P = .007$ , respectively).

### CONCLUSION

The present work is the first long-term outcome study of RSA using sonography to assess the subscapularis. Subscapularis integrity did not appear to have a measurable effect on patient outcome as measured by standard scores but was important for internal rotation ability after RSA.



Due to spacing limitations, subscapularis repair results more difficult with onlay designs. Despite this study does not illustrate a measurable effect on other outcomes, it does illustrate an improvement for internal rotation when the subscapularis is repaired. With its semi-inlay design the **Medacta Shoulder System** eases the subscapular repair compared to onlay design.





## Subscapularis Insufficiency and the Risk of Shoulder Dislocation After Reverse Shoulder Arthroplasty

EDWARDS, T. B., WILLIAMS, M. D., LABRIOLA, J. E., ELKOUSY, H. A., GARTSMAN, G. M., & O'CONNOR, D. P. - *JSES* 2009. 18(6), 892-896. DOI: 10.1016/J.JSE.2008.12.013

### BACKGROUND

Dislocation is the most common serious complication after reverse shoulder arthroplasty. One theorized cause is subscapularis insufficiency because the tendon cannot be repaired at the time of surgery. There are no documented risk assessments of reverse total shoulder arthroplasty dislocation related to this cause. The study objective was to quantify the risk of postoperative dislocation after reverse total shoulder arthroplasty in patients with a subscapularis tendon that was irreparable at the time of surgery.

### METHODS


A prospective evaluation was done of 138 consecutive reverse arthroplasties performed through a deltopectoral approach by a single surgeon (average follow-up, 36 months).

### RESULTS

The subscapularis was reparable in 62 patients and irreparable in 76 at the conclusion of the procedure. Seven postoperative dislocations occurred; all dislocations were in patients whose subscapularis was irreparable ( $P = .012$ ). Dislocations were more likely in patients with complex diagnoses, including proximal humeral nonunion, fixed glenohumeral dislocation, and failed prior arthroplasty.

### CONCLUSION

This report documents that an irreparable subscapularis tendon at the time of re-verse total shoulder arthroplasty using a deltopectoral approach results in a statistically significant risk for postoperative dislocation.



Subscapularis repair with reverse shoulder arthroplasty is often debated. This study features an inlay design highlighting that subscapularis repair has a statistically significant effect on instability. **Medacta Shoulder System's** semi-inlay design provides higher chances for subscapularis repair compared to onlay designs.

# Glenosphere Sizing

Impact of glenosphere size on clinical outcomes after reverse total shoulder arthroplasty: an analysis of 297 shoulders

MOLLON, B., MAHURE, S. A., ROCHE, C. P., & ZUCKERMAN, J. D. - JSES 2016. 25(5), 763-771. DOI: 10.1016/J.JSE.2015.10.027

## BACKGROUND

Although increasing glenosphere diameter has been found to increase passive range of motion (ROM) in simulated models of reverse total shoulder arthroplasty (rTSA), the clinical implications of glenosphere size are unclear. The purpose of our study was to determine the impact that glenosphere size had on short-term and midterm clinical outcomes, specifically American Shoulder and Elbow Surgeons (ASES) scores and ROM.

## METHODS

Prospectively collected data comparing patients receiving an rTSA with either a 38 or 42mm glenosphere after a minimum 2 year follow-up were obtained. Clinical outcome measures included active ROM and ASES scores.

## RESULTS

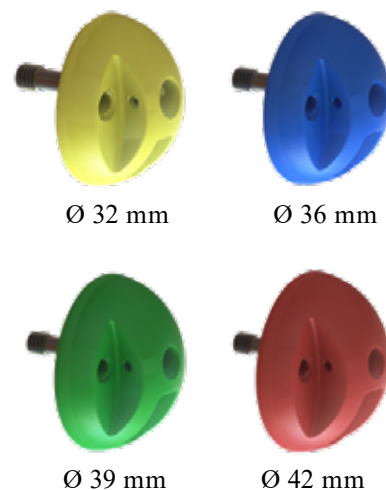
We included 297 primary rTSAs in 290 patients: a 38mm diameter glenosphere was used in 160 shoulders and a 42mm diameter glenosphere in 137 shoulders. Of the patients, 191 were women and 99 were men. The mean age at the time of surgery was 72 years (range, 50-88 years). At last follow-up, improvements in active forward elevation (aFE) and active external rotation (aER) were significantly greater in shoulders with a 42mm glenosphere (+59° vs +44° for aFE and +24° vs +18° for aER). Female shoulders treated with a 4mm glenosphere had significantly greater improvements in aFE, aER, and functional scores. Male shoulders treated with a 38mm glenosphere had significantly greater improvements in pain levels and ASES scores but less improvement in aFE. Complications and rates of scapular notching were similar between glenosphere sizes.

## CONCLUSION

Patients treated with 42mm glenospheres had greater improvements in aFE and aER when compared with 38-mm glenospheres. Our results suggest a potential association among gender, glenosphere size, and improvement in clinical outcome scores.



This study demonstrates that patients tend to reach improvements in post-operative scores when larger glenospheres are utilized. The primary drawback is represented by the fact that larger glenospheres are more difficult to implant. Surgeons tend to generalize glenosphere size due to previous systems' lack of options. **Medacta Shoulder System** offers 32, 36, 39, and 42 sizes, providing surgeons with several options to implant a glenosphere correctly sized for the patient.





## Ancillary Glenosphere Fixation

### Wear Simulation of Reverse Total Shoulder Arthroplasty Systems: Effect of Glenosphere Design

VAUPEL, Z. M., BAKER, K. C., KURDZIEL, M. D., & WIATER, J. M. - JSES 2012. 21(10), 1422-1429. DOI: 10.1016/J.JSE.2011.10.024.

#### BACKGROUND

Although early results with reverse total shoulder arthroplasty (rTSA) have been promising, concern exists about the high reported rates of scapular notching and the potential for catastrophic failure of glenoid component fixation. Generation of polyethylene wear debris may also contribute to notching and osteolysis of the scapula. A testing model for polyethylene wear is currently unavailable for reverse shoulder prostheses. The goal of this study was to develop a testing protocol using a commercially available hip simulator. Component design may also influence the generation of polyethylene debris. It is hypothesized that increased polyethylene wear occurs in glenospheres with holes in the articulating surface.

#### METHODS

Custom fixtures were fabricated to simulate both glenohumeral abduction and flexion on a 12-station hip wear simulator. Loading profiles for both abduction and flexion were alternated every 250,000 cycles for a total of 5 million cycles. Gravimetric analysis of humeral cups throughout the test was used to characterize wear. Lubricant fluid was collected throughout the test and digested for polyethylene particle analysis.

#### RESULTS

Comparisons of volumetric wear rates and total volume loss between glenospheres with and without holes and between flexion and abduction loading profiles showed similar results. Particle analysis displayed fibrillar particles with an equivalent circle diameter of  $0.3 \pm .1$  mm and an aspect ratio of  $2.5 \pm 1.4$ .

#### CONCLUSION

This study represents the first wear simulation and particle characterization of reverse shoulder systems. No significant difference in wear was reported between glenospheres with and without holes.

No correlation was found between wear quality and presence of glenosphere holes in reverse shoulder systems. The articular surface of the **Medacta Shoulder System Glenosphere** does not affect the amount of generated wear debris.



# Glenosphere Lateralization

## Mechanical Tradeoffs Associated with Glenosphere Lateralization in Reverse Shoulder Arthroplasty

HETTRICH, C. M., PERMESWARAN, V. N., GOETZ, J. E., & ANDERSON, D. D. - JSES 2015. 24(11), 1774—1781.  
DOI: 10.1016/J.JSE.2015.06.011.

### BACKGROUND

Scapular notching in reverse shoulder arthroplasty occurs in up to 97% of patients. Notching is associated with decreased strength and reduced motion and may lead to long-term failure due to polyethylene wear. Many implant systems lateralize the glenosphere to address scapular notching, but the mechanical tradeoffs of lateralization have not been rigorously evaluated. We hypothesized that lateralization would decrease bony impingement but also decrease the mechanical advantage of the deltoid.

### METHODS

Finite element models were created using the same implants with different amounts of glenoid lateralization: 5 mm of medialization to replicate glenoid erosion, as well as 2.5, 5, 7.5, and 10 mm of lateralization. Tests were performed with static and dynamic scapulae for motion in either the coronal or scapular plane. The angle of impingement between the scapula and the humeral polyethylene was recorded, as was the deltoid force required to elevate the arm.

### RESULTS

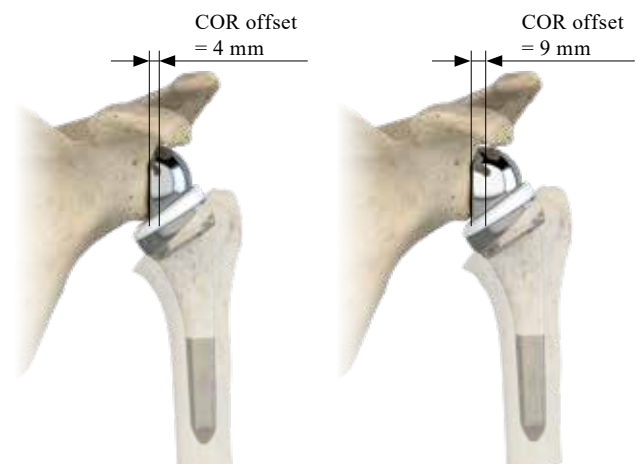
Increasing lateralization decreased impingement while increasing the deltoid force required to elevate the arm. Differences were found between the static and dynamic scapulae, with the dynamic scapula model having increased humeral adduction before impinging. The impingement angle was also substantially affected by the bony prominences on the inferior scapula, showing how individual bony anatomy can affect impingement.

### CONCLUSION

Lateralization is effective in increasing impingement-free range of motion but also increases the deltoid force required to perform identical tasks. In addition, impingement is determined by scapular motion, which should be included in all shoulder models.



Glenosphere lateralization is one of the most debated topics in reverse shoulder arthroplasty. Some degree of lateralization seems to be beneficial for patients however, the ideal degree has not yet been determined. **The Medacta Shoulder System** currently seeks a compromise between the traditional Grammont style and more lateralized options at +4 mm and at +9 mm from the center of rotation.



# Glenosphere Dissociation

## Glenosphere Dissociation After Reverse Shoulder Arthroplasty

CUSICK, M. C., HUSSEY, M. M., STEEN, B. M., HARTZLER, R. U., CLARK, R. E., CUFF, D. J., ANDREAS, F. C., SANTONI, B. G., & FRANKLE, M. A. - JSES 2015. 24(7), 1061-1068. DOI: 10.1016/J.JSE.2014.12.019

### BACKGROUND

Reverse shoulder arthroplasty (RSA) is gaining popularity for the treatment of debilitating shoulder disorders. Despite marked improvements in patient satisfaction and function, the RSA complication rate is high. Glenosphere dissociation has been reported and may result from multiple mechanisms. However, few RSA retrieval studies exist.

### METHODS

We reviewed our RSA database and identified patients with glenosphere dissociation between 1999 and 2013. Prosthesis type, glenosphere size, and contributing factors to dissociation were noted. Five retrieved implants were available for analysis, and evidence of wear or corrosion on the Morse taper was documented. Further, we biomechanically investigated improper Morse taper engagement that may occur intraoperatively as a potential cause of acute dissociation.

### RESULTS

Thirteen patients with glenosphere dissociation were identified (0.5 months to 7 years postoperatively). Glenosphere size distribution was as follows: 32 mm (n = 1), 36 mm (n = 4), 40 mm (n = 6), and 44 mm (n = 2). Incidence of dissociation was correlated to glenosphere size ( $P < .001$ ). Taper damage was limited to fretting wear, and there was minimal evidence of taper corrosion. Biomechanically, improper taper engagement reduced the torsional capacity of the glenosphere baseplate interface by 60% from 19.2  $\pm$  1.0 N-m to 7.5  $\pm$  1.5 N-m.

### CONCLUSION

We identified several mechanisms contributing to glenosphere dissociation after RSA, including trauma and improper taper engagement. Limited evidence of corrosive wear on the taper interface was identified. Although it is rare, the incidence of glenosphere dissociation was higher when 40- and 44-mm glenospheres were implanted compared with smaller glenospheres (32 and 36 mm), probably because of the larger exposed surface area for potential impingement.

Being glenosphere insertion already the most difficult part of the reverse shoulder procedure, to rely upon one mean of fixation between the baseplate and glenosphere represents an unnecessary risk. **Medacta's Ancillary Screw, Torque Driver, and Morse Taper** provide a belt and suspenders approach to fixation between the glenosphere and the baseplate.

# Humeral Lateralization

## Humeral Lateralization: What is it? Is it really useful?

J.D. WERTHEL - ABSTRACT BOOK NICE SHOULDER COURSE 2018. 251-261

### BACKGROUND

Recently developed RSA designs tried to meet Grammont's reverse shoulder arthroplasty drawbacks. This study intended to provide a definition of lateralization as well as to compare and measure the humeral lateralization values collected through the analysis of the most commonly used RSA implants currently available.

### METHOD

The templates of 22 different implants were obtained from manufacturers and analyzed using SolidWorks 2017 SPO. A total of 28 different configurations were included. Vertical lines were traced and used as a reference to measure lateral offset (LO); the horizontal distance between each of these lines was measured. The design of the original Grammont design (Delta III) was used to normalize all measurements. Eventually, humeral implants were separated into four groups: (1) medialized humerus, (2) minimally lateralized humerus, (3) lateralized humerus and (4) highly lateralized humerus. For each implant, LOs were measured using the smallest available baseplate and the thinnest polyethylene humeral insert. Moreover, the maximal possible LO was also measured for each implant.

### RESULTS

The range of humeral LO that is possible to obtain with one given implant varies from 3.3mm to 20.9mm. Seven implants were MH (humeral LO < 8.5mm), six were LH (humeral LO 8.5-13.5mm), five were LH+ (humeral LO 13.5-18.5mm), and only one was LH++ (humeral LO 18.5-23.5). The humeral LO of the Delta III is 3.5mm. All the LH+ and LH++ implants have an onlay design, versus only 13% of the MH and LH implants.

### CONCLUSION

Despite medialized designs provide reliable pain and restore motion, are associated with several drawbacks. Modifications have been proposed by increasing the lateral offset on the humeral side, on the glenoid side, or on both. Although it seems that some degree of glenoid and humeral lateralization is beneficial, the ideal amount of global lateralization and the ideal contribution from the glenoid or from the humerus remain unknown; it probably depends on the patient anatomy.



The descriptive analysis proposed here could help surgeons to understand the features of the implants currently available on the market, specifically in terms of lateralization. It could be useful also for implant selection and surgical technique adaptability depending on the expected lateral offset of the design being implanted. **Medacta Shoulder System** with its semi-inlay design combined with 145° plus 155° NSA options, falls into the LH (Minimally Lateralized Humerus) group that seems to provide the best balance between the original Grammont design (Medialized Humerus) and the LH+ (Lateralized Humerus) group.

# Numbers of Screws and Baseplate Fixation

Reverse shoulder arthroplasty glenoid fixation: is there a benefit in using four instead of two screws?

JAMES, J., ALLISON, M. A., WERNER, F. W., MCBRIDE, D. E., BASU, N. N., SUTTON, L. G., & NANAVATI, V. N. - JSES 2013 22(8), 1030-1036. DOI: 10.1016/J.JSE.2012.11.006

## BACKGROUND

To allow osseous integration to occur and thus provide long-term stability, initial glenoid baseplate fixation must be sufficiently rigid. A major contributing factor to initial rigid fixation is baseplate screw fixation. Current baseplate de-signs use a 4-screw fixation construct. However, recent literature suggests adequate fixation can be achieved with fewer than 4 screws. The purpose of the present study was to determine whether a 4-screw construct provides more baseplate stability than a 2-screw construct.

## METHODS

A flat-backed glenoid baseplate with 4 screw hole options was implanted into 6 matched pairs of cadaver scapulas using standard surgical technique. Within each pair, 2 screws or 4 screws were implanted in a randomized fashion. A glenosphere was attached allowing cyclic loading in an inferior to superior direction and in an anterior-to-posterior direction. Baseplate motion was measured using 4 linear voltage displacement transducers evenly spaced around the glenosphere.

## RESULTS

There was no statistical difference in the average peak central displacements between fixation with 2 or 4 screws ( $P = .338$ ). Statistical increases in average peak central displacement with increasing load ( $P < .001$ ) and with repetitive loading ( $P < .002$ ) were found.

## CONCLUSION

This study demonstrates no statistical difference in baseplate motion between 2-screw and 4-screw constructs. Therefore, using fewer screws could potentially lead to a reduction in operative time, cost, and risk, with no significant negative effect on overall implant baseplate motion.

No statistical difference has been identified in the use of 2 or 4 glenoid screws in terms of primary stability. The pegged baseplate of the **Medacta Shoulder System** is secured with at least 2 screws, and provides the possibility to increase the fixation with the use of 2 additional screws in case of a Ø 27 baseplate. The threaded baseplate is equipped with 4 holes in order to minimize the discrepancy between the desired and the final positioning of the glenoid screws.





# Redefining Better in Orthopaedics and Neurosurgery



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