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Metallic Lateralized-Offset Glenoid Reverse Shoulder Arthroplasty

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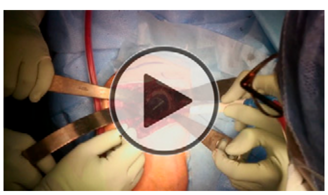
Investigation performed at the Schulthess Clinic, Zurich, Switzerland



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Abstract

Background: Metallic lateralized-offset glenoid reverse shoulder arthroplasty (RSA) for cuff tear arthropathy combines the use of a metallic augmented baseplate with a metaphyseally oriented short stem design that can be applied at a 135° or 145° neck-shaft angle, leading to additional lateralization on the humeral side. Lateralization of the center of rotation decreases the risk of inferior scapular notching and improves external rotation, deltoid wrapping, residual rotator cuff tensioning, and prosthetic stability[1-4]. Metallic increased-offset RSA (MIO-RSA) achieves lateralization and corrects inclination and retroversion while avoiding graft resorption and other complications of bony increased-offset RSA (BIO-RSA)[5-8]. Reducing the neck-shaft angle from the classical Grammont design, in combination with glenoid lateralization, improves range of motion[9,10] by reducing inferior impingement during adduction at the expense of earlier superior impingement during abduction[2,11]. Lädermann et al.[12] investigated how different combinations of humeral stem and glenosphere designs influence range of motion and muscle elongation. They assessed 30 combinations of humeral components, as compared with the native shoulder, and found that the combination that allows for restoration of >50% of the native range of motion in all directions was a 145° onlay stem with a concentric or lateralized tray in conjunction with a lateralized or inferior eccentric glenosphere. In addition, the use of a flush-lay or a slight-onlay stem design (like the one utilized in the presently described technique) may decrease the risk of secondary scapular spine fracture[13,14]. The goal of this prosthetic design is to achieve an excellent combination of motion and stability while reducing complications.

Description: This procedure is performed via a deltopectoral approach with the patient in the beach-chair position under general anesthesia combined with a regional interscalene nerve block. Subscapularis tenotomy and capsular release are performed, the humeral head is dislocated, and any osteophytes are removed. An intramedullary cutting guide is placed for correct humeral resection. The osteotomy of the humeral head is performed in the anatomical

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neck with an inclination of 135° and a retroversion of 20° to 40°, depending on the anatomical retroversion. The glenoid is prepared as usual. The lateralized, augmented baseplate is assembled with the central screw and the baseplate-wedge-screw complex is placed by inserting the screw into the central screw hole. Four peripheral screws are utilized for definitive fixation. An eccentric glenosphere with inferior overhang is implanted. The humerus is dislocated, and the metaphysis is prepared. Long compactors are utilized for proper stem alignment, and an asymmetric trial insert is positioned before the humerus is reduced. Stability and range of motion are assessed. The definitive short stem is inserted and the asymmetric polyethylene is impacted, resulting in a neck-shaft angle of 145°. Following reduction, subscapularis repair and wound closure are performed.

Alternatives: BIO-RSA is the main alternative to MIO-RSA. Boileau et al.[15] demonstrated satisfactory early and long-term outcomes of BIO-RSA for shoulder osteoarthritis. A larger lateral offset may also be achieved with a thicker glenosphere[2,16]. Mark A. Frankle developed an implant that addressed the drawbacks of the Grammont design: a lateralized glenosphere combined with a 135° humeral neck-shaft angle. The 135° neck-shaft angle provides lateral humeral offset, preserving the normal length-tension relationship of the residual rotator cuff musculature, which optimizes its strength and function. The lateralized glenosphere displaces the humeral shaft laterally, minimizing the potential for impingement during adduction[2,9,17,18]. The advantage of BIO-RSA and MIO-RSA over lateralized glenospheres is that the former options provide correction of angular deformities without excessive reaming, which can lead to impingement[19].

Rationale: BIO-RSA has been proven to achieve excellent functional outcomes[15,20,21]; however, the bone graft can undergo resorption, which may result in early baseplate loosening. Bipolar metallic lateralized RSA is an effective strategy for achieving lateralization and correction of multiplanar defects while avoiding the potential complications of BIO-RSA[6,7,22-24]. MIO-RSA also overcomes another limitation of BIO-RSA, namely that BIO-RSA is not applicable when the humeral head is not available for use (e.g., humeral head osteonecrosis, revision surgery, fracture sequelae).

Expected Outcomes: A recent study evaluated the clinical and radiographic outcomes of metallic humeral and glenoid lateralized implants. A total of 42 patients underwent primary RSA. Patients were documented prospectively and underwent follow-up visits at 1 and 2 years postoperatively. That study demonstrated that bipolar metallic lateralized RSA achieves excellent clinical results in terms of shoulder function, pain relief, muscle strength, and patient-reported subjective assessment, without instability or radiographic signs of scapular notching[23]. Kirsch et al.[25] reported the results of primary RSA with an augmented baseplate in 44 patients with a minimum of 1 year of clinical and radiographic follow-up. The use of an augmented baseplate resulted in excellent short-term clinical outcomes and substantial deformity correction in patients with advanced glenoid deformity. No short-term complications and no failure or loosening of the augmented baseplate were observed. Merolla et al.[7] compared the results of 44 patients who underwent BIO-RSA and 39 patients who underwent MIO-RSA, with a minimum follow-up of 2 years. Both techniques provided good clinical outcomes; however, BIO-RSA yielded union between the cancellous bone graft and the surface of the native glenoid in <70% of patients. On the other hand, complete baseplate seating was observed in 90% of MIO-RSA patients.

Important Tips:

- When performing subscapularis tenotomy, leave an adequate stump to allow end-to-end repair.
- Tenotomize the superior part of the subscapularis tendon in an L-shape, sparing the portion below the circumflex vessels.
- As glenoid exposure is critical, perform a 270° capsulotomy.
- Continuously check the orientation of the baseplate relative to the prepared hole and reamed surface to ensure accurate implantation of the full wedge baseplate to achieve a proper fit.
- Aim for 70% to 80% seating of the baseplate onto the prepared glenoid surface. Avoid overtightening or excessive advancement of the baseplate into the subchondral bone. Gaps between the baseplate and glenoid surface should also be avoided.

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- In order to avoid varus or valgus malpositioning of the final implant, obtain proper diaphyseal alignment by following "the three big Ls": large, lateral, and long. Use a large metaphyseal component to fill the metaphysis. Place the guide pin for the reaming of the metaphysis slightly laterally into the resected surface of the humerus. Use long compactors for diaphyseal alignment to avoid varus or valgus malpositioning of the final implant.
- Use an intramedullary cutting guide for correct humeral resection.
- Utilize the correct liner in order to obtain proper tensioning and avoid instability.

Acronyms and Abbreviations:

K wire = Kirschner wire
ROM = range of motion

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References

1. Bauer S, Corbaz J, Athwal GS, Walch G, Blakeney WG. Lateralization in reverse shoulder arthroplasty. J Clin Med. 2021 Nov 18;10(22):1-14.

2. Frankle MA, Marberry S, Pupello D, editors. Reverse Shoulder Arthroplasty: Biomechanics, Clinical Techniques, and Current Technologies. Switzerland: Springer International Publishing; 2015.

3. Freislederer F, Toft F, Audigé L, Marzel A, Endell D, Scheibel M. Lateralized vs. classic Grammont-style reverse shoulder arthroplasty for cuff deficiency Hamada stage 1-3: does the design make a difference? J Shoulder Elbow Surg. 2022 Feb;31(2):341-51.

4. Werner BC, Lederman E, Gobezie R, Denard PJ. Glenoid lateralization influences active internal rotation after reverse shoulder arthroplasty. J Shoulder Elbow Surg. 2021 Nov;30(11):2498-505.

5. Ho JC, Thakar O, Chan WW, Nicholson T, Williams GR, Namdari S. Early radiographic failure of reverse total shoulder arthroplasty with structural bone graft for glenoid bone loss. J Shoulder Elbow Surg. 2020 Mar;29(3):550-60.

6. Jones RB, Wright TW, Roche CP. Bone Grafting the Glenoid Versus Use of Augmented Glenoid Baseplates with Reverse Shoulder Arthroplasty. Bull Hosp Jt Dis((2013). 2015 Dec;73(Suppl 1):S129-35.

7. Merolla G, Giorgini A, Bonfatti R, Micheloni GM, Negri A, Catani F, Tarallo L, Paladini P, Porcellini G. BIO-RSA vs. metal-augmented baseplate in shoulder osteoarthritis with multiplanar glenoid deformity: a comparative study of radiographic findings and patient outcomes. J Shoulder Elbow Surg. 2023 Nov; 32(11):2264-75.

8. Ernstbrunner L, Werthel JD, Wagner E, Hatta T, Sperling JW, Cofield RH. Glenoid bone grafting in primary reverse total shoulder arthroplasty. J Shoulder Elbow Surg. 2017 Aug;26(8):1441-7.

9. Keener JD, Patterson BM, Orvets N, Aleem AW, Chamberlain AM. Optimizing reverse shoulder arthroplasty component position in the setting of advanced arthritis with posterior glenoid erosion: a computer-enhanced range of motion analysis. J Shoulder Elbow Surg. 2018 Feb;27(2):339-49.

10. Werner BS, Chaoui J, Walch G. The influence of humeral neck shaft angle and glenoid lateralization on range of motion in reverse shoulder arthroplasty. J Shoulder Elbow Surg. 2017 Oct;26(10):1726-31.

11. Roche CP. Reverse Shoulder Arthroplasty Biomechanics. J Funct Morphol Kinesiol. 2022 Jan 19;7(1):13.

12. Lädermann A, Denard PJ, Collin P, Zbinden O, Chiu JC, Boileau P, Olivier F, Walch G. Effect of humeral stem and glenosphere designs on range of motion and muscle length in reverse shoulder arthroplasty. Int Orthop. 2020 Mar;44(3):519-30.

13. Ascione F, Kilian CM, Laughlin MS, Bugelli G, Domos P, Neyton L, Godeneche A, Edwards TB, Walch G. Increased scapular spine fractures after reverse shoulder arthroplasty with a humeral onlay short stem: an analysis of 485 consecutive cases. J Shoulder Elbow Surg. 2018 Dec;27(12):2183-90.

14. Haidamous G, Lädermann A, Frankle MA, Gorman RA 2nd, Denard PJ. The risk of postoperative scapular spine fracture following reverse shoulder arthroplasty is increased with an onlay humeral stem. J Shoulder Elbow Surg. 2020 Dec;29(12):2556-63.

15. Boileau P, Morin-Salvo N, Bessière C, Chelli M, Gauci MO, Lemmex DB. Bony increased-offset-reverse shoulder arthroplasty: 5 to 10 years' follow-up. J Shoulder Elbow Surg. 2020 Oct;29(10):2111-22.

16. Liu B, Kim YK, Nakla A, Chung MS, Kwak D, McGarry MH, Lee TQ, Oh JH. Biomechanical consequences of glenoid and humeral lateralization in reverse total shoulder arthroplasty. J Shoulder Elbow Surg. 2023 Aug;32(8):1662-72.

17. Boutsiadis A, Lenoir H, Denard PJ, Panisset JC, Brossard P, Delsol P, Guichard F, Barth J. The lateralization and distalization shoulder angles are important determinants of clinical outcomes in reverse shoulder arthroplasty. J Shoulder Elbow Surg. 2018 Jul;27(7):1226-34.

18. Cuff DJ, Pupello DR, Santoni BG, Clark RE, Frankle MA. Reverse Shoulder Arthroplasty for the Treatment of Rotator Cuff Deficiency: A Concise Follow-up, at a Minimum of 10 Years, of Previous Reports. J Bone Joint Surg Am. 2017 Nov 15;99(22):1895-9.

19. Sanchez-Sotelo J. Current concepts in humeral component design for anatomic and reverse shoulder arthroplasty. J Clin Med. 2021 Nov 2;10(21):5151.

20. Boileau P, Morin-Salvo N, Gauci MO, Seeto BL, Chalmers PN, Holzer N, Walch G. Angled BIO-RSA (bony-increased offset-reverse shoulder arthroplasty): a solution for the management of glenoid bone loss and erosion. J Shoulder Elbow Surg. 2017 Dec;26(12):2133-42.

21. Dimock R, Fathi Elabd M, Imam M, Middleton M, Godenèche A, Narvani AA. Bony increased-offset reverse shoulder arthroplasty: A meta-analysis of the available evidence. Shoulder Elbow. 2021 Feb;13(1):18-27.

22. Colasanti CA, Lin CC, Ross KA, Luthringer T, Elwell JA, Roche CP, Virk MS, Simovitch RW, Routman HD, Zuckerman JD. Augmented baseplates yield optimum outcomes when compared with bone graft augmentation for managing glenoid deformity during reverse total shoulder arthroplasty: a retrospective comparative study. J Shoulder Elbow Surg. 2023 May;32(5):958-71.

23. Imiolczyk JP, Audigé L, Harzbecker V, Moroder P, Scheibel M. Metallic humeral and glenoid lateralized implants in reverse shoulder arthroplasty for cuff tear arthropathy and primary osteoarthritis. JSES Int. 2021 Dec 14;6(2):221-8.

24. Levin JM, Bokshan S, Roche CP, Zuckerman JD, Wright T, Flurin PH, Klifto CS, Anakwenze O. Reverse shoulder arthroplasty with and without baseplate wedge augmentation in the setting of glenoid deformity and rotator cuff deficiency-a multicenter investigation. J Shoulder Elbow Surg. 2022 Dec; 31(12):2488-96.

25. Kirsch JM, Patel M, Singh A, Lazarus MD, Williams GR, Namdari S. Early clinical and radiographic outcomes of an augmented baseplate in reverse shoulder arthroplasty for glenohumeral arthritis with glenoid deformity. J Shoulder Elbow Surg. 2021 Jul;30(7S):S123-30.