

Evidence Discussion (CMM-318: Shoulder Arthroplasty/ Replacement/ Resurfacing/ Revision/ Arthrodesis)

Risks of shoulder arthroplasty surgery include but are not limited to infection, functional limitations, persistent pain or stiffness, neurovascular injury, fracture, instability, loosening, deep venous thrombosis, pulmonary embolism, anesthesia complications and death. [1-4, 13, 34] Craig et al. noted alarmingly high rates of adverse events in elderly patients. [34] Given the potential possibility for significant complications, proper patient selection is crucial to minimize the risk benefit ratio.

The initial approach for patients with glenohumeral osteoarthritis begins with conservative care. [5] Nonsurgical treatment is also used as the first-line treatment for patients with irreparable rotator cuff tears and rotator cuff arthropathy. [7] Nonsurgical treatment can be successful in many patients and improvements may be seen within a few weeks or months. [6, 7]

Imaging findings supporting anatomic total shoulder replacement should demonstrate marked narrowing of the glenohumeral joint space with additional findings that can include cystic changes in the humeral head, irregular joint surfaces, glenoid sclerosis, glenoid osteophyte changes or glenoid flattening. [8-12] These findings are indicative of end stage joint disease. As studies have shown that radiologic severity of shoulder osteoarthritis does not correlate with pain intensity [8, 11], the presence of function limiting pain should be confirmed for potential candidates for shoulder replacement surgery. [12, 30]

Indications in the literature for reverse total shoulder arthroplasty (RTSA) include patients with rotator cuff tear arthropathy or pseudoparalysis from an unreparable rotator cuff tear. [7, 14-17, 21] Additionally, the literature supports RTSA for patients with osteoarthritis and an intact rotator cuff, in the presence of posterior glenoid wear and/or humeral head subluxation. [17-21] Deltoid muscle function is essential for RTSA function and stability, therefore, patients under consideration for RTSA should be carefully screened for deltoid function and any potential cause of deltoid weakness. [16, 17] The presence of function limiting pain should also be confirmed for potential surgical candidates. [12, 30]

RTSA has also been supported in the literature for reconstruction after tumor resection and for proximal humeral fractures that are not repairable or unable to be reconstructed with other techniques. [17, 21, 22] RTSA is also indicated for failed total shoulder replacement or failed hemiarthroplasty with a dysfunctional rotator cuff that is unreparable. [17, 21]

Shoulder hemiarthroplasty is rarely performed compared to anatomic and reverse total shoulder arthroplasty. The American Academy of Orthopaedic Surgeons (AAOS) Shoulder and Elbow Registry (SER): 2023 Annual Report noted that hemiarthroplasty composed .32% of all shoulder arthroplasty procedures performed between 2015 and 2022. [23] Although not a frequently performed procedure, indications for shoulder hemiarthroplasty include arthritic conditions in which the glenoid bone stock is

inadequate to support a glenoid prosthesis, avascular necrosis without glenoid involvement and proximal humerus fractures not amenable to internal fixation. [24, 27]

Contraindications to shoulder arthroplasty procedures include active infection, Charcot arthropathy, severe neurological pathologies and medical comorbidities which would preclude joint replacement surgery. [25, 26, 30]

Regarding shoulder resurfacing, there is insufficient high level evidence to support this procedure. [28] von Gerhardt et al. reported the high overall revision rate of 27% between short- and long-term follow-up reflects the need to limit the use of uncemented resurfacing shoulder hemiarthroplasty for the treatment of glenohumeral osteoarthritis. [28]

Revision rates after shoulder arthroplasty have been reported as high as one in four [34]. Revision surgery may be performed for recurrent dislocations unresponsive to non-surgical care, instability, aseptic loosening, periprosthetic infection and periprosthetic fracture. [17, 30-34] Revision surgery may also be recommended for persistent unexplained pain that is unresponsive to conservative care. [32, 36] It should be of note that revision surgery is associated with high complication rates. [32]

Shoulder arthrodesis/fusion is a salvage procedure that is rarely considered as a first-line treatment and is rarely performed. Complication rates as high as 43% [40] and revision surgery rates as high as 62% [41] have been associated with shoulder arthrodesis. Common complications include nonunion, malposition of the involved extremity (malunion), fracture, infection, and need for revision surgery. [37-40] General risks of surgery including but not limited to neurovascular injury, deep venous thrombosis, pulmonary embolism, anesthesia complications and death are also present. Given the significant risks, other treatment options, including extensive conservative management, should be highly considered before proceeding with shoulder fusion. [39] Function limiting symptoms should also be present when considering shoulder arthrodesis. Indications for shoulder arthrodesis include brachial plexus injury, prior failed shoulder arthroplasty, reconstruction after tumor resection and chronic infection. [37-39] Additional indications include patients with insufficient function of both the rotator cuff and deltoid musculature, refractory glenohumeral instability and obstetric injury resulting in a flail extremity. [37-39] Contraindications include deficient functional scapulothoracic motion, paralysis of trapezius, levator scapulae and serratus anterior muscles, Charcot arthropathy, ipsilateral elbow arthrodesis and contralateral shoulder arthrodesis. [37-39]

As risk for major complications exists for arthroplasty and arthrodesis procedures, it is critical to optimally ensure that patients receive treatment that is appropriate, safe and effective. Although the use of any coverage criteria includes the possible risk of delayed care, application of evidence based criteria best ensure patient safety and highly outweigh any clinical harms.

2. Amundsen A, Rasmussen JV, Olsen BS, Brorson S. Mortality after shoulder arthroplasty: 30-day, 90-day, and 1-year mortality after shoulder replacement--5853 primary operations reported to the Danish Shoulder Arthroplasty Registry. *J Shoulder Elbow Surg.* 2016 May;25(5):756-62.
3. Westermann RW, Pugely AJ, Martin CT, Gao Y, Wolf BR, Hettrich CM. Reverse Shoulder Arthroplasty in the United States: A Comparison of National Volume, Patient Demographics, Complications, and Surgical Indications. *Iowa Orthop J.* 2015;35:1-7.
4. Wronka KS, Pritchard M, Sinha A. Incidence of symptomatic venous thrombo-embolism following shoulder surgery. *Int Orthop.* 2014 Jul;38(7):1415-8. doi: 10.1007/s00264-014-2329-7.
5. Millett PJ, Gobeze R, Boykin RE. Shoulder osteoarthritis: diagnosis and management. *Am Fam Physician.* 2008 Sep 1;78(5):605-11.
6. Pompan DC. Appropriate use of MRI for evaluating common musculoskeletal conditions. *Am Fam Physician.* 2011 Apr 15;83(8):883-4.
7. Cvetanovich GL, Waterman BR, Verma NN, Romeo AA. Management of the Irreparable Rotator Cuff Tear. *J Am Acad Orthop Surg.* 2019 Dec 15;27(24):909-917.
8. Märtens N, März V, Bertrand J, Lohmann CH, Berth A. Radiological changes in shoulder osteoarthritis and pain sensation correlate with patients' age. *J Orthop Surg Res.* 2022 May 15;17(1):277.
9. Ibounig T, Simons T, Launonen A, Paavola M. Glenohumeral osteoarthritis: an overview of etiology and diagnostics. *Scandinavian Journal of Surgery.* 2021;110(3):441-451.
10. Caniggia M, Fornara P, Franci M, Maniscalco P, Picinotti A. Shoulder arthroplasty. Indications, contraindications and complications. *Panminerva Med.* 1999 Dec;41(4):341-9.
11. Kircher J, Morhard M, Magosch P, Ebinger N, Lichtenberg S, Habermeyer P. How much are radiological parameters related to clinical symptoms and function in osteoarthritis of the shoulder? *Int Orthop.* 2010 Jun;34(5):677-81.
12. Schumaier A, Abboud J, Grawe B, Horneff JG, Getz C, Romeo A, Keener J, Friedman R, Yian E, Muh S, Nicholson G, Delaney R, Otto R, William W, Tokish JT, Williams G, Kazanjian J, Dines J, Ramsey M, Green A, Paxton S, Namdari S, Flanagan B, Hasan S, Kaar S, Miniaci A, Cuomo F. Evaluating Glenohumeral Osteoarthritis: The Relative Impact of Patient Age, Activity Level, Symptoms, and Kellgren-Lawrence Grade on Treatment. *Arch Bone Jt Surg.* 2019 Mar;7(2):151-160.
13. American Academy of Orthopaedic Surgeons. Management of Glenohumeral Joint Osteoarthritis Evidence-Based Clinical Practice Guideline. www.aaos.org/gjocpg. Published March 23, 2020.
14. Burnier M, Elhassan BT, Sanchez-Sotelo J. Surgical Management of Irreparable Rotator Cuff Tears: What Works, What Does Not, and What Is Coming. *J Bone Joint Surg Am.* 2019 Sep 4;101(17):1603-1612.
15. Sellers TR, Abdelfattah A, Frankle MA. Massive Rotator Cuff Tear: When to Consider Reverse Shoulder Arthroplasty. *Curr Rev Musculoskelet Med.* 2018 Mar;11(1):131-140.
16. Hartzler RU, Steen BM, Hussey MM, Cusick MC, Cottrell BJ, Clark RE, Frankle MA. Reverse shoulder arthroplasty for massive rotator cuff tear: risk factors for poor functional improvement. *J Shoulder Elbow Surg.* 2015 Nov;24(11):1698-706.

17. Kozak T, Bauer S, Walch G, Al-Karawi S, Blakeney W. An update on reverse total shoulder arthroplasty: current indications, new designs, same old problems. *EFORT Open Rev.* 2021 Mar 1;6(3):189-201.
18. Virk M, Yip M, Liuzza L, et al.. Clinical and radiographic outcomes with a posteriorly augmented glenoid for Walch B2, B3, and C glenoids in reverse total shoulder arthroplasty. *J Shoulder Elbow Surg* 2020;29:e196–e204.
19. Collin P, Hervé A, Walch G, Boileau P, Muniandy M, Chelli M. Mid-term results of reverse shoulder arthroplasty for glenohumeral osteoarthritis with posterior glenoid deficiency and humeral subluxation. *J Shoulder Elbow Surg* 2019;28:2023–2030.
20. McFarland EG, Huri G, Hyun YS, Petersen SA, Srikumaran U. Reverse total shoulder arthroplasty without bone-grafting for severe glenoid bone loss in patients with osteoarthritis and intact rotator cuff. *J Bone Joint Surg Am* 2016;98:1801–1807.
21. Rugg CM, Coughlan MJ, Lansdown DA. Reverse Total Shoulder Arthroplasty: Biomechanics and Indications. *Curr Rev Musculoskelet Med.* 2019 Dec;12(4):542-553.
22. Martin T, Iannotti J. Reverse total shoulder arthroplasty for acute fractures and failed management after proximal humeral fractures. *Orthop Clin North Am.* 2008;39(4):451-457.
23. Shoulder and Elbow Registry (SER): 2023 Annual Report. Rosemont, IL: American Academy of Orthopaedic Surgeons (AAOS), 2023.
24. Hackett DJ Jr, Hsu JE, Matsen FA 3rd. Primary Shoulder Hemiarthroplasty: What Can Be Learned From 359 Cases That Were Surgically Revised? *Clin Orthop Relat Res.* 2018 May;476(5):1031-1040.
25. Caniggia M, Fornara P, Franci M, Maniscalco P, Picinotti A. Shoulder arthroplasty. Indications, contraindications and complications. *Panminerva Med.* 1999 Dec;41(4):341-9.
26. Kumar S, Kelly CP. Best practice in shoulder arthroplasty-a reflective personal review. *J Orthop.* 2022 Nov 17;35:140-144.
27. Castillo Mercado JS, Rojas Lievano J, Zaldivar B, Barajas C, Fierro G, González JC. Atraumatic osteonecrosis of the humeral head: pathophysiology and current concepts of evaluation and treatment. *JSES Rev Rep Tech.* 2022 Mar 23;2(3):277-284.
28. von Gerhardt AL, Willems JIP, Geervliet PC, Spruyt P, van Noort A, Visser CPJ. Long-term results of the uncemented resurfacing shoulder hemiarthroplasty (Global Conservative Anatomic Prosthesis). *J Shoulder Elbow Surg.* 2022 Apr;31(4):839-846.
29. Miettinen SSA, Liu Y, Kröger H. Long-term survival of resurfacing humeral hemiarthroplasty. *Eur J Orthop Surg Traumatol.* 2024 May 29. doi: 10.1007/s00590-024-04010-9. Epub ahead of print.
30. Eichinger JK, Galvin JW. Management of complications after total shoulder arthroplasty. *Curr Rev Musculoskelet Med.* 2015 Mar;8(1):83-91.
32. Ravi V, Murphy RJ, Moverley R, Derias M, Phadnis J. Outcome and complications following revision shoulder arthroplasty : a systematic review and meta-analysis. *Bone Jt Open.* 2021 Aug;2(8):618-630.

33. Gauci MO, Cavalier M, Gonzalez JF, Holzer N, Baring T, Walch G, Boileau P. Revision of failed shoulder arthroplasty: epidemiology, etiology, and surgical options. *J Shoulder Elbow Surg*. 2020 Mar;29(3):541-549.
34. Craig RS, Lane JCE, Carr AJ, Furniss D, Collins GS, Rees JL. Serious adverse events and lifetime risk of reoperation after elective shoulder replacement: population based cohort study using hospital episode statistics for England. *BMJ*. 2019 Feb 20;364:l298.
36. Ardebol J, Pasqualini I, Hartzler RU, Griffin JW, Lederman E, Denard PJ. Arthroscopic Management of Stiffness and Anterior Shoulder Pain Following Reverse Shoulder Arthroplasty. *Arthrosc Tech*. 2022 Sep 17;11(10):e1763-e1768.
37. Arenas-Miquelez A, Arbeloa-Gutierrez L, Familiari F, de Pablos J. Salvage Procedures of the Shoulder: Glenohumeral Arthrodesis and Resection Arthroplasty. *Indian J Orthop*. 2020 Oct 22;55(Suppl 1):27-37.
38. Del Core MA, Cutler HS, Schacherer T, Khazzam M. Glenohumeral arthrodesis. *JSES Rev Rep Tech*. 2021 Sep 24;1(4):367-372.
39. Abboud JA, Cronin KJ. Shoulder Arthrodesis. *J Am Acad Orthop Surg*. 2022 Aug 15;30(16):e1066-e1075.
40. Fuchs B., O'Connor M.I., Padgett D.J., Kaufman K.R., Sim F.H. Arthrodesis of the shoulder after tumor resection. *Clin Orthop Relat Res*. 2005;436:202–207.
41. Puskas GJ, Läderrmann A, Hirsiger S, Hoffmeyer P, Gerber C: Revision rate after screw or plate arthrodesis of the glenohumeral joint. *Orthop Traumatol Surg Res* 2017;103:875-884.