[24] Flury MP, Frey P, Goldhahn J, Schwyzer H-K, Simmen BR. Reverse shoulder arthroplasty as a salvage procedure for failed conventional shoulder replacement due to cuff failure--midterm results. Int Orthop. 2011;35:53–60. doi:10.1007/s00264-010-0990-z.
[25] Groh GI, Groh GM. Complications rates, reoperation rates, and the learning curve in reverse shoulder arthroplasty. J Shoulder Elbow Surg. 2014;23:388–394. doi:10.1016/j.jse.2013.06.002.
[26] Jacquot A, Sirveaux F, Roche O, Favard L, Clavert P, Molé D. Surgical management of the infected reversed shoulder arthroplasty: a French multicenter study of reoperation in 32 patients. J Shoulder Elbow Surg. 2015;24:1713–1722. doi:10.1016/j.jse.2015.03.007.
[27] Jo SH, Kim JY, Cho NS, Rhee YG. Reverse total shoulder arthroplasty: salvage procedure for failed prior arthroplasty. Clin Orthop Surg. 2017;9:200–206. doi:10.4055/cios.2017.9.2.200.
[28] Melis B, Bonnevialle N, Neyton L, Lévigne C, Favard L, Walch G, et al. Glenoid loosening and failure in anatomical total shoulder arthroplasty: is revision with a reverse shoulder arthroplasty a reliable option? J Shoulder Elbow Surg. 2012;21:342–349. doi:10.1016/j.jse.2011.05.021.
[29] Stephens BC, Simon P, Clark RE, Christmas KN, Stone GP, Lorenzetti AJ, et al. Revision for a failed reverse: a 12-year review of a lateralized implant. J Shoulder Elbow Surg. 2016;25:e115–e124. doi:10.1016/j.jse.2015.09.027.
[30] Walker M, Willis MP, Brooks JP, Pupello D, Mulieri PJ, Frankle MA. The use of the reverse shoulder arthroplasty for treatment of failed total shoulder arthroplasty. J Shoulder Elbow Surg. 2012;21:514–522. doi:10.1016/j.jse.2011.03.006.
[31] Glanzmann MC, Kolling C, Schwyzer H-K, Audigé L. Conversion to hemiarthroplasty as a salvage procedure for failed reverse shoulder arthroplasty. J Shoulder Elbow Surg. 2016;25:1795–1802. doi:10.1016/j.jse.2016.03.011.
[32] Gamradt SC, Gelber J, Zhang AL. Shoulder function and pain level after revision of failed reverse shoulder replacement to hemiarthroplasty. Int J Shoulder Surg. 2012;6:29–35. doi:10.4103/0973-6042.96991.
[33] Assenmacher AT, Alentorn-Geli E, Dennison T, Baghdadi YMK, Cofield RH, Sánchez-Sotelo J, et al. Two-stage reimplantation for the treatment of deep infection after shoulder arthroplasty. J Shoulder Elbow Surg. 2017;26:1978–1983. doi:10.1016/j.jse.2017.05.005.
[34] Hsu JE, Gorbaty JD, Whitney IJ, Matsen FA. Single-stage revision is effective for failed shoulder arthroplasty with positive cultures for Propionibacterium. J Bone Joint Surg Am. 2016;98:2047–2051. doi:10.2106/JBJS.16.00149.
[35] Farshad M, Gerber C. Reverse total shoulder arthroplasty-from the most to the least common complication. Int Orthop. 2010;34:1075–1082. doi:10.1007/s00264-010-1125-2.
[36] Antuna SA, Sperling JW, Cofield RH, Rowland CM. Glenoid revision surgery after total shoulder arthroplasty. J Shoulder Elbow Surg. 2001;10:217–224. doi:10.1067/mse.2001.113961.
[37] Bonnevialle N, Melis B, Neyton L, Favard L, Molé D, Walch G, et al. Aseptic glenoid loosening or failure in total shoulder arthroplasty: revision with glenoid reimplantation. J Shoulder Elbow Surg. 2013;22:745–751. doi:10.1016/j.jse.2012.08.009.
[38] Muh SJ, Streit JJ, Lenarz CJ, McCrum C, Wanner JP, Shishani Y, et al. Resection arthroplasty for failed shoulder arthroplasty. J Shoulder Elbow Surg. 2013;22:247–252. doi:10.1016/j.jse.2012.05.025.
[39] Rispoli DM, Sperling JW, Athwal GS, Schleck CD, Cofield RH. Pain relief and functional results after resection arthroplasty of the shoulder. J Bone Joint Surg Br. 2007;89:1184–1187. doi:10.1302/0301-620X.89B9.19464.
[40] Stevens NM, Kim HM, Armstrong AD. Functional outcomes after shoulder resection: the patient's perspective. J Shoulder Elbow Surg. 2015;24:e247–e254. doi:10.1016/j.jse.2015.03.027.
[41] Debeer P, Plasschaert H, Stuyck J. Resection arthroplasty of the infected shoulder: a salvage procedure for the elderly patient. Acta Orthop Belg. 2006;72:126–130.
[42] Braman JP, Sprague M, Bishop J, Lo IK, Lee EW, Flatow EL. The outcome of resection shoulder arthroplasty for recalcitrant shoulder infections. J Shoulder Elbow Surg. 2006;15:549–553. doi:10.1016/j.jse.2005.11.001.
[43] Levy JC, Triplet J, Everding N. Use of a functional antibiotic spacer in treating infected shoulder arthroplasty. Orthopedics. 2015;38:e512–e519. doi:10.3928/01477447-20150603-60.
[44] Mahure SA, Mollon B, Yu S, Kwon YW, Zuckerman JD. Definitive treatment of infected shoulder arthroplasty with a cement spacer. Orthopedics. 2016;39:e924–e930. doi:10.3928/01477447-20160623-07.
[45] Pellegrini A, Legnani C, Macchi V, Meani E. Management of periprosthetic shoulder infections with the use of a permanent articulating antibiotic spacer. Arch Orthop Trauma Surg. 2018;138:605–609. doi:10.1007/s00402-018-2870-8.

3.6. TREATMENT: RESECTION

Authors: José M. Mora, Simon Lambert

QUESTION 1: What are the indications for resection shoulder arthroplasty in acute periprosthetic joint infection (PJI)?

RECOMMENDATION: There are no available reports on resection shoulder arthroplasty for acute PJI. At this time there is no evidence to routinely recommend this treatment for this indication.

LEVEL OF EVIDENCE: No Evidence

DELEGATE VOTE: Agree: 88%, Disagree: 8%, Abstain: 4% (Super Majority, Strong Consensus)

RATIONALE

Search Strategy

A request via the Royal Society of Medicine Library utilizing ProQuest Dialog, searching Embase and Medline archives. Search terms: (excision arthroplasty) OR (resection arthroplasty) AND (acute periprosthetic infection) OR (chronic periprosthetic infection) OR (subacute periprosthetic infection). Yielded 1,649 references. After limiting these to shoulder-specific references and eliminating duplicates 100 references were further searched for exact matching to the question of the role of resection arthroplasty in the management of acute PJI (subacute or chronic PJI). All full papers, reviews and abstracts in English between 1990 and 2018 were examined, and those reporting the indications and outcomes of resection (excision) arthroplasty of the shoulder were examined further. Personal searches of PubMed archives were performed by both authors using the same criteria, and their searches were compared. The bibliographies of two recent reviews (one specifically examining the question of resection, the value of spacers and one-and two-stage revision arthroplasty in subacute or chronic PJI [1], the other a more general review [2]) were examined for further references and cross-checked with the first enquiry and the personal searches.

No manuscripts were identified which reported on resection shoulder arthroplasty for acute PJI.

Conclusion

The available literature has no evidence pertaining to resection arthroplasty in acute shoulder PJI to provide guidance on this question.

REFERENCES

[1] George DA, Volpin A, Scarponi S, Haddad FS, Romanò CL. Does exchange arthroplasty of an infected shoulder prosthesis provide better eradication rate and better functional outcome, compared to a permanent spacer or resection arthroplasty? a systematic review. BMC Musculoskelet Disord. 2016;17:52. doi:10.1186/s12891-016-0901-6.

[2] Bonnevialle N, Dauzères F, Toulemonde J, Elia F, Laffosse J-M, Mansat P. Periprosthetic shoulder infection: an overview. EFORT Open Rev. 2017;2:104–109. doi:10.1302/2058-5241.2.160023.

Authors: José M. Mora, Simon Lambert

QUESTION 2: Is there a role for resection shoulder arthroplasty in the management of subacute or chronic periprosthetic joint infection (PJI)?

RECOMMENDATION: The available literature does not support specific indications for resection arthroplasty for subacute or chronic shoulder PJI with sufficient quality information to provide guidance. Resection arthroplasty is an acceptable salvage treatment to eradicate shoulder PJI when revision to a definitive implant is considered too risky due to patient medical co-morbidities or technical complexity.

LEVEL OF EVIDENCE: Limited

DELEGATE VOTE: Agree: 95%, Disagree: 0%, Abstain: 5% (Unanimous, Strongest Consensus)

RATIONALE

There are no prospective studies or randomized trials on this topic, and all published reports are retrospective case series. In addition, many of these case series include no other cohort to directly compare against any other form of treatment strategy for infected shoulder arthroplasty. The available literature is further limited by the fact that all published series examine outcomes using a variety of methods: (a) pain relief, recorded either as a subset of a score, e.g., the Constant-Murley (CMS) or American Shoulder and Elbow Surgeons (ASES) scores, or as a visual analog scale (VAS); (b) function, recorded either as a subset of a score, or by direct description; (c) management of infection, recorded as either "eradicated," "recurrent" or "persistent" (with no clear definition on how these categories was diagnosed/confirmed).

The systematic review of management strategies for shoulder PJI by George et al. [1] found 8 papers (total number of cases, 83) relating to the use of resection arthroplasty. The number of cases reported per series varied between 5 and 21 with a mean duration of follow-up of post-resection 39.8 months (standard deviation 20.8), minimum 19.2 (9.4), maximum 102.6 (41.9). The number of infections considered eradicated was 72/83 (86.7%) with no difference (statistical or clinically meaningful) in infection eradication observed between resection, single-stage, two-stage and permanent spacer arthroplasty. Preoperative and postoperative functional scores were incompletely reported. Single-stage revision cases had better preoperative scores than other groups, and better outcomes. It should be noted that patients reported worse functional scores (CMS) after surgery than before surgery, particularly for resection arthroplasty. There was no consistency in the choice or duration of antibiotic administration after surgery. Importantly, the authors pointed out that the limited quality of the available literature meant that it was not possible to provide a conclusion concerning the indication for one modality over another if the aim of intervention was to eradicate infection while optimizing the functional outcome for patients.

When reviewing the available literature, it should be noted that the majority of PJI for which resection is reported as an outcome are reverse total shoulder arthroplasties [2–4]. It is not clear whether this relates to the more challenging reconstructions often encountered after revision reverse total shoulder arthroplasty (TSA) or perhaps the nature of the reverse TSA patient population who tend to have more medical comorbidities and lower functional demands.

Patient outcomes including eradication of infection, pain relief and function were reported using variable standards. The concept that resection arthroplasty carries the advantage of being "one final surgery" should be tempered by the results showing that, on average, two debridements were required for infection to be clinically eradicated (mean follow-up 20 months) [5]. Braman et al. [5] showed that in their series of seven patients, while the functional scores were generally poor, all patients were able to perform activities between the mouth, opposite axilla and perineum and were satisfied with the outcome. Other authors, however, have shown that patient satisfaction is poor overall. Rispoli et al. reported one-third of cases falling into the lower third of categories for satisfaction, and 16 of 18 cases having an unsatisfactory outcome by Neer criteria [6]. If preoperative impairment was not substantial (defined as a CMS of greater than 30) then there was no significant improvement after surgery [2]. The same authors considered that reimplantation (whether one- or two-stage) delivered better functional outcomes than resection arthroplasty [2]. Zavala et al. (2012) concluded that resection was inferior to a debridement, antibiotics, irrigation and implant retention (DAIR) strategy in providing for function without increasing the risk of persistent or recurrent infection at a minimum of 12 months follow-up, while also commenting that implant retrieval lead to (potentially) revision-limiting bifocal bone loss [7]. DeBeer et al. recommended resection be indicated for the elderly with PJI and with lower functional expectations [8]. A single comparative study comparing resection with staged reimplantaion demonstrated that there was benefit for range of motion if a staged reimplantation could be safely undertaken with no increased risk of persistent or recurrence of infection [9]. This study was presented at the American Academy of Orthopaedic Surgeons (AAOS) and does not appear to have been published elsewhere. Resection arthroplasty for subacute or chronic PJI may some provide pain relief in approximately one-third to one-half of cases [3,6,7,10–12].

There are some technical and prognostic factors which may effect patient functional outcome and satisfaction. Retention of the tuberosities appears useful for function, possibly by reducing the tendency for proximal humeral migration [12]. In addition, there is some debate regarding how an antibiotic spacer may compare with resection alone with respect to eradication of infection and function. Verhelst et al. reported that use of a spacer (permanent