Sex differences in complications and readmission rates following shoulder arthroplasty in the United States

Brock M. Knapp, BS a, Mina Botros, MSc b, David C. Sing, MD a,c, Emily J. Curry, BA c,d, Josef K. Eichinger, MD e, Xinning Li, MD a,c,*

a Boston University School of Medicine, Boston, MA, USA
b Meharry Medical College, Nashville, TN, USA
c Boston Medical Center, Boston, MA, USA
d Boston University School of Public Health, Boston, MA, USA
e Medical University of South Carolina, Charleston, SC, USA

Introduction: Shoulder arthroplasty (SA) procedures are increasingly performed in the United States. However, there is a lack of data evaluating how patient sex may affect perioperative complications. The purpose of this study was to evaluate sex-based differences in 30-day postoperative complication and readmission rates after SA.

Methods: Total SA and reverse SA cases between 2012-2016 were identified from the American College of Surgeons National Surgical Quality Improvement Program database. The 30-day complication rate, readmission rate, operation time, length of stay, and mortality were compared between women and men. Multivariable logistic regression analysis was performed to identify independent perioperative complications associated with patient sex.

Results: Of 12,530 SA cases, 6949 (55.4%) were female and 5499 (44.5%) were male. Compared with women, on average men were significantly younger, had lower body mass index, and were less likely to be functionally dependent, and less likely to have an American Society of Anesthesiologists score of 3+ (P < .001). Although overall complications and readmission rates between women and men were similar (3.4% vs. 3.7%, P = .489; 3.0% vs. 2.8%, P = .497), men were significantly less likely to develop urinary tract infections (UTIs; odds ratio [OR] 0.58, P = .032) and require transfusions (OR 0.49, P < .001) and had shorter lengths of stay (P < .001). However, men were significantly more likely to have a superficial surgical site infection (OR 2.63, P = .035) and 6.8 minute longer operating time (P < .001) compared with women.

Conclusion: Though the overall complication risk is similar between the sexes, their risk profiles are distinct. Men had decreased risk of UTI, blood transfusions, and shorter length of stay but increased risk of surgical site and longer operating time compared with women. This disparity should be discussed when counseling and risk-stratifying patients for SA.

© 2019 The Author(s). Published by Elsevier Inc. on behalf of American Shoulder and Elbow Surgeons. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).
Methods and materials

This is a retrospective cohort study using the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) information for 2012-2016. The ACS-NSQIP is a centralized database that contains a collection of patient-based variables and surgical outcomes over a 30-day postoperative period. Past studies have validated NSQIP as a reliable source for surgical outcomes.

The NSQIP database was queried for patients who underwent total shoulder arthroplasty (TSA) or reverse total shoulder arthroplasty (rTSA) using the Current Procedural Terminology code 23472. Patient demographics and medical information were collected, including patient sex, age, medical comorbidities (using the Elixhauser comorbidity index), medical history, body mass index, and insurance status. Primary outcome measures were any perioperative complication within 30 days of the index surgery. Secondary outcome measures included operation time, length of stay, and mortality.

Perioperative complications within the 30-day period were divided into major complications (deep infection, sepsis, septic shock, wound infection, etc.), minor complications (UTIs, superficial surgical site infection, renal insufficiency, etc.), need for transfusion, unplanned readmissions, and unplanned reoperations. Operating time and lengths of stay (LOSs) were also included. Patient characteristics were stratified on the basis of sex (men vs. women), and within-group differences were compared using Pearson χ² test. Multivariable logistic regression analysis was used to compare perioperative complications between men and women.

Results

We identified 12,530 patients who underwent TSA and rTSA during the period of interest with an overall mean age of 69.1 years and a body mass index of 31.2. There were 6949 women (55.4%) and 5499 men (44.5%) (Table I). Men were found to be significantly younger (67.4 vs. 70.4 years, P < .001, respectively) and have a lower body mass index than women (30.9 vs. 31.4, P < .001, respectively). Men were also less likely to have a dependent functional status (51.9% vs. 55.9%, P < .001) but a 6.75% shorter length of stay (P < .001) but a 6.75% shorter length of stay (P < .001) but a 6.75% shorter length of stay (P < .001) but a 6.75% shorter length of stay (P < .001).

The overall complication rate for all patients was low (440, 3.5%). There was no significant difference in the overall complication rate between men and women (3.7% vs. 3.4%; P = .489; Table II). Similarly, there were no significant differences between men and women when these complications were categorized as major complications (2.5% vs. 2.2%, P = .195) and minor complications (1.5% vs. 1.7%, P = .366).

Multivariable logistic regression revealed complications that were independently associated with patient sex (Table II). Compared with women, men were less likely to develop UTIs (odds ratio [OR] 0.58, 95% confidence interval 0.35-0.95; P = .032) but were more prone to develop superficial surgical site infection (OR 2.63, P = .035). Postoperatively, compared with women, men were significantly less likely to require transfusions (OR 0.49, P < .001) and had a third of a day shorter length of stay (P < .001) but a 6.75 minutes longer operating time (OT; P < .001).

Discussion

Summary of findings

In this large nationwide database study evaluating 30-day perioperative complications after shoulder arthroplasty, we found that distinct risk profiles exist between male and female patients after controlling for demographic and comorbidity differences. Although the overall complication rate was similar, men were less likely to develop UTI and require postoperative transfusion than women but were more likely to develop superficial surgical site infection. Additionally, men had on average a significantly longer OT compared with women.

Transfusion risk

Previous studies have reported mixed findings of women undergoing SA having a higher risk of transfusion.1,2,7,26 Gruson et al1 identified that transfusion risk increased by 32%, for every 5-year increase in age; they also discovered that patients aged ≥65 years are 3-fold more likely to receive a transfusion. Additionally, Gruson et al1 reported that lower preoperative hemoglobin levels (men <13 g/dL and women <12 g/dL) were a risk factor for blood transfusion along with implanting reverse arthroplasty compared with a total or hemiarthroplasty. It is also known that women undergoing SA tend to be...
older and more likely to be on Medicare insurance.31 Hence, it is appropriate to question whether it is the age or medical complexity differences that account for the elevated transfusion rate in women; however, the transfusion rate discrepancy remained significant in our study when accounting for these differences with a multivariable logistic regression. Thus, it is important to counsel older female patients undergoing reverse shoulder arthroplasty of the potential need for blood transfusion during the perioperative time period.

**Comparison of complications**

Overall, 30-day complication rates following SA were found to be similar in both male and female patients. Additionally, patient sex did not have a significant association when these complications were stratified into major and minor complications. This contradicts the finding by Saltzman et al,31 which reported that men are at a significantly higher odds to develop myocardial infarction, sepsis, or even death; the variation of results could be attributed to the anatomic findings by Saltzman et al,21 which reported that men are at a significantly higher odds to develop myocardial infarction, sepsis, or even death; the variation of results could be attributed to the anatomic

| Complication | Female (n = 6946)* | Male (n = 5499)* | P value | Adjusted OR (95% CI) | P value |
|--------------|--------------------|-----------------|---------|----------------------|---------|
| Any complication | 238 (3.4) | 202 (3.7) | .489 | 1.14 (0.93, 1.38) | .201 |
| Major complications | 150 (2.2) | 139 (2.5) | .195 | 1.25 (0.98, 1.58) | .068 |
| Deep infection | 13 (0.2) | 20 (0.4) | .084 | 1.68 (0.83, 3.43) | .152 |
| Sepsis | 11 (0.2) | 11 (0.2) | .738 | 1.27 (0.54, 2.98) | .585 |
| Septic shock | 7 (0.1) | 1 (0) | .147 | 0.26 (0.03, 2.19) | .217 |
| Wound dehiscence | 2 (0) | 5 (0.1) | .284 | 2.84 (0.53, 15.16) | .222 |
| Pulmonary embolism | 29 (0.4) | 15 (0.3) | .231 | 0.78 (0.41, 1.48) | .447 |
| Ventilator >48 h | 10 (0.1) | 3 (0.1) | .21 | 0.59 (0.16, 2.23) | .44 |
| Unplanned intubation | 14 (0.2) | 8 (0.1) | .6 | 0.91 (0.37, 2.21) | .835 |
| Acute renal failure | 2 (0) | 4 (0.1) | .485 | 5.14 (0.81, 32.58) | .083 |
| Cardiac arrest requiring CPR | 5 (0.1) | 3 (0.1) | .98 | 1.12 (0.26, 4.88) | .876 |
| Myocardial infarction | 14 (0.2) | 13 (0.2) | .825 | 1.36 (0.63, 2.94) | .432 |
| Cerebrovascular accident | 5 (0.1) | 6 (0.1) | .698 | 1.76 (0.53, 5.84) | .353 |
| Return to operating room | 77 (1.1) | 80 (1.5) | .101 | 1.27 (0.92, 1.75) | .143 |
| Mortality | 12 (0.2) | 9 (0.2) | 1.13 (0.47, 2.72) | .79 |
| Minor complications | 119 (1.7) | 82 (1.5) | .366 | 0.93 (0.71, 1.24) | .62 |
| Superficial SSI | 7 (0.1) | 17 (0.3) | .015 | 2.63 (1.07, 6.43) | .035 |
| Pneumonia | 34 (0.5) | 23 (0.4) | .652 | 0.968 (0.576, 1.7246) | .991 |
| Urinary tract infection | 56 (0.8) | 23 (0.4) | .01 | 0.58 (0.35, 0.95) | .032 |
| DVT or thrombophlebitis | 24 (0.3) | 18 (0.3) | .986 | 0.95 (0.52, 1.81) | .937 |
| Renal insufficiency | 8 (0.1) | 5 (0.1) | .891 | 0.91 (0.29, 2.88) | .876 |
| Transfusion | 297 (4.3) | 111 (2) | <.001 | 0.49 (0.39, 0.61) | <.001 |
| Unplanned readmission | 208 (3) | 153 (2.8) | .003 | 1.07 (0.88, 1.32) | .497 |

**Table II**

Association of sex with 30-day adverse events and readmission after TSA

| Complication | Multivariable logistic regression: female vs. male |
|--------------|--------------------------------------------------|
| Any complication | 1.14 (0.93, 1.38) | .201 |
| Major complications | 1.25 (0.98, 1.58) | .068 |
| Deep infection | 1.68 (0.83, 3.43) | .152 |
| Sepsis | 1.27 (0.54, 2.98) | .585 |
| Septic shock | 0.26 (0.03, 2.19) | .217 |
| Wound dehiscence | 2.84 (0.53, 15.16) | .222 |
| Pulmonary embolism | 0.78 (0.41, 1.48) | .447 |
| Ventilator >48 h | 0.59 (0.16, 2.23) | .44 |
| Unplanned intubation | 0.91 (0.37, 2.21) | .835 |
| Acute renal failure | 5.14 (0.81, 32.58) | .083 |
| Cardiac arrest requiring CPR | 1.12 (0.26, 4.88) | .876 |
| Myocardial infarction | 1.36 (0.63, 2.94) | .432 |
| Cerebrovascular accident | 1.76 (0.53, 5.84) | .353 |
| Return to operating room | 1.27 (0.92, 1.75) | .143 |
| Mortality | 1.13 (0.47, 2.72) | .79 |
| Minor complications | 0.93 (0.71, 1.24) | .62 |
| Superficial SSI | 2.63 (1.07, 6.43) | .035 |
| Pneumonia | 0.968 (0.576, 1.7246) | .991 |
| Urinary tract infection | 0.58 (0.35, 0.95) | .032 |
| DVT or thrombophlebitis | 0.95 (0.52, 1.81) | .937 |
| Renal insufficiency | 0.91 (0.29, 2.88) | .876 |
| Transfusion | 0.49 (0.39, 0.61) | <.001 |
| Unplanned readmission | 1.07 (0.88, 1.32) | .497 |

| Complication | Multivariable linear regression |
|--------------|---------------------------------|
| Any complication | 6.75 (5.08, 8.41) | <.001 |
| Major complications | 0.31 (0.06, 1.87) | <.001 |
| Deep infection | 0.38 (0.02, 6.27) | <.001 |
| Sepsis | 0.58 (0.36, 0.95) | .035 |
| Septic shock | 0.95 (0.52, 1.81) | .937 |
| Wound dehiscence | 0.91 (0.29, 2.88) | .876 |
| Pulmonary embolism | 0.58 (0.35, 0.95) | .032 |
| Ventilator >48 h | 0.58 (0.35, 0.95) | .032 |
| Unplanned intubation | 0.49 (0.39, 0.61) | <.001 |
| Acute renal failure | 1.07 (0.88, 1.32) | .497 |

**Table II**

Association of sex with 30-day adverse events and readmission after TSA

* Percentage of patients with presence of complication shown in parentheses.

- TSA, total shoulder arthroplasty; CPR, cardiopulmonary resuscitation; SSI, surgical site infection; DVT, deep vein thrombosis; SD, standard deviation; OR, odds ratio; CI, confidence interval.
variation that exists between both sexes—where men have a greater amount of soft tissue and muscle mass, which requires a longer OT to expose the glenohumeral joint to implant the components. Perioperative complications associated with OT has been reported in total hip arthroplasty, where patients with a prolonged OT are more likely to develop infections. This may be explained by the correlation between OT and surgical tray contamination as well as increased surgical site infection in men compared with women. Dalstrom et al reported that in the first hour they identified 15% contamination, by the 2 hours 22%, and by 3 hours 26%. In addition to infection, increased OT may lead to other surgical complications. During SA, the surgeon must position the arm in an external rotation to expose the glenoid, thus increasing the risk of nerve damage with prolonged OT, especially in larger and muscular male patients.

It is also important to consider the costs associated with OT. Singh et al observed that the OT difference between high- and low-volume surgeons is 50 minutes for TSA and 30 minutes for rTSA and HA, respectively. Consequently, Hammond et al found that the cost of SA (TSA or HA) is $1000 less when performed by high-volume surgeons. It is reported that the average OT ranges from $15 to $20, per minute, for basic surgical procedures. It is also important to consider the costs associated with OT. Singh et al observed that the OT difference between high- and low-volume surgeons is 50 minutes for TSA and 30 minutes for rTSA and HA, respectively. Consequently, Hammond et al found that the cost of SA (TSA or HA) is $1000 less when performed by high-volume surgeons. It is reported that the average OT ranges from $15 to $20, per minute, for basic surgical procedures.

Strength and limitations

The strengths of this study include the large sample size provided by the ACS-NSQIP database. This database encompasses a multicenter data sample, including 462 hospitals in the United States and 34 hospitals in foreign nations, as reported in 2015. This affords a diverse patient population from which detailed perioperative complications and patient demographics can be evaluated.

Limitations of this study include those inherent to a retrospective cohort study including the reliance on proper data collection and documentation in the NSQIP database. However, previous studies have confirmed the reliability of NSQIP for evaluating complications and readmissions in multiple surgical subspecialties. Because NSQIP collects data from a variety of surgical procedures in several institutions, the variables collected are broad in nature and do not contain all data pertaining to surgical outcomes, such as amount of blood loss, hematoglobin levels, specific time from the moment of skin incision to closure, and preoperative complications. Because NSQIP data are gathered from hospital-based systems, there may be underreporting of complications that are documented at outpatient clinic charts. This may explain why the complication rate in our study was lower compared with other studies. Further, this database does not delineate the surgical sites from which the data are collected, nor does it include the surgeon’s surgical experience, technique, prosthetic design, hospital case-volume, and perioperative protocols. No preoperative imaging is available to determine the severity of preoperative pathology that may certainly also influence outcomes.

Another important limitation inherent to the NSQIP database is the complication surveillance period of 30 days postsurgery, which excludes mid- to late-term complications that occur after this time frame. Although the inclusion of all complications would broaden the scope of our findings, an understanding of short-term complication differences with regard to patient sex provides important insight to appropriately optimize surgical outcomes.

Another shortcoming is that Current Procedural Terminology codes lack specificity in differentiating between TSA and rTSA along with the indications for surgery. Although these codes will likely be updated soon, for the purposes of this study the authors could not stratify by procedure to evaluate complications specific to each surgical procedure.

Conclusion

In this analysis of 12,530 shoulder arthroplasty cases, we found that women have a greater 30-day perioperative risk of developing UTI, increased risk of blood transfusions, and have a greater LOS compared with men who have a greater risk of superficial surgical site infection and have a longer OT. It is important to consider these risk factors for perioperative complications to appropriately counsel and optimize patients for shoulder arthroplasty surgery.

Disclaimer

Josef Eichinger reports that he receives industry support from Arthrex Inc, Johnson & Johnson, and Smith & Nephew. He also is a consultant for Exactech. Xinning Li reports that he holds equity in the Journal of Medical Insight and is on the editorial board.

The other authors, their immediate families, and any research foundations with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

References

1. Anthony CA, Westermann RW, Gao Y, Pugely AJ, Wolf BR, Hettrich CM. What are risk factors for 30-day morbidity and transfusion in total shoulder arthroplasty? A review of 1922 cases. Clin Orthop Relat Res 2015;473:2099–105. https://doi.org/10.1007/s11999-014-4107-7.
2. Rohbali K, Wirth MA, Rockwood CA Jr. Complications of total shoulder arthroplasty. J Bone Joint Surg Am 2006;88:2279–92. https://doi.org/10.12967/JBJSF.00125.
3. Dalstrom DJ, Venkataryayappa I, Manternach AL, Palcic MS, Heyse BA, Prayson MJ. Time-dependent contamination of opened sterile operating-room trays. J Bone Joint Surg Am 2008;90:1022–5. https://doi.org/10.12967/JBJS.C.00689.
4. Dunn JC, Lanza J, Kusnezov N, Bader J, Waterman BR, Belmont PJ Jr. Predictors of length of stay after elective total shoulder arthroplasty in the United States. J Shoulder Elbow Surg 2015;24:754–9. https://doi.org/10.1016/j.jse.2014.11.042.
5. Epelboym I, Gawlas I, Lee JA, Schrobe B, Chabot JA, Allendorf JD. Limitations of ACS-NSQIP in reporting complications for patients undergoing pancreatotectomy: underscoring the need for a pancreas-specific module. World J Surg 2014;38:1461–7. https://doi.org/10.1007/s00268-013-2439-1.
6. Gross ER, Christensen M, Schultz JF, Cassidy LD, Anderson Y, Arca MJ. Does the American College of Surgeons NSQIP-Pediatric accurately represent overall patient outcomes? J Am Coll Surg 2015;221:828–36. https://doi.org/10.1016/j.jamcollsurg.2015.07.014.
7. Gruson KI, Accouti KJ, Parsons BO, Pillai G, Flatow EL. Transfusion after shoulder arthroplasty: an analysis of rates and risk factors. J Shoulder Elbow Surg 2009;18:225–30. https://doi.org/10.1016/j.jse.2008.08.005.
8. Hammond JW, Queale WS, Kim TK, McFarland EG. Surgeon experience and clinical and economic outcomes for shoulder arthroplasty. J Bone Joint Surg Am 2003;85:2318–24. https://doi.org/10.1302/0301-620X.85A11.ADJ12133.
9. Khuri SF, Daley J, Henderson W, Hur K, Demakis J, Aust JB, et al. The Department of Veterans Affairs’ NSQIP: the first national, validated, outcome-based, risk-adjusted, and peer-controlled program for the measurement and enhancement of the quality of surgical care. National VA Surgical Quality Improvement Program. Ann Surg 1998;228:491–507.
10. Kim SH, Wise BL, Zhang Y, Szabo RM. Increasing incidence of shoulder arthroplasty in the United States. J Bone Joint Surg Am 2011;93:2249–54. https://doi.org/10.1302/0301-620X.85A11.ADJ12133.
11. Li X, Veltre DR, Cusano A, Yi P, Sing D, Gagnier JJ, et al. Insurance status affects related to the subject of this article.
12. Lynch NM, Cofield RH, Silbert PL, Hermann RC. Neurologic complications after total shoulder arthroplasty. J Shoulder Elbow Surg 1996;5:53–61.
13. Macario A. What does one minute of operating room time cost? J Clin Anesth 2010;22:233–6. https://doi.org/10.1016/j.claneur.2010.02.003.
14. Macedo FJ, Carvalho EM, Hassan M, Ricci M, Gologorsky E, Salerno TA. Beating heart valve surgery in patients with low left ventricular ejection fraction. J Card Surg 2010;25:267–71. https://doi.org/10.1111/j.1540-8191.2010.01000.x.
15. Malcherczyk D, Hack J, Klasan A, Abdelmoula A, Heyse TJ, Greene B, et al. Differences in total blood loss and transfusion rate between different indications for shoulder arthroplasty. Int Orthop 2019;43:653–8. https://doi.org/10.1007/s00264-018-4047-z.

16. Molina CS, Thakore RV, Blumer A, Obremskey WT, Sethi MK. Use of the National Surgical Quality Improvement Program in orthopaedic surgery. Clin Orthop Relat Res 2015;473:1574–81. https://doi.org/10.1007/s11999-014-3597-7.

17. Padegimas EM, Hendy BA, Lawrence C, Devasagarayaraj R, Zmistowski BM, Abboud JA, et al. An analysis of surgical and nonsurgical operating room times in high-volume shoulder arthroplasty. J Shoulder Elbow Surg 2017;26:1058–63. https://doi.org/10.1016/j.jse.2016.11.040.

18. Padegimas EM, Zmistowski BM, Clyde CT, Restrepo C, Abboud JA, Lazarus MD, et al. Length of stay after shoulder arthroplasty—the effect of an orthopedic specialty hospital. J Shoulder Elbow Surg 2016;25:1404–11. https://doi.org/10.1016/j.jse.2016.01.010.

19. Ponce BA, Oladeji LO, Rogers ME, Menendez ME. Comparative analysis of anatomic and reverse total shoulder arthroplasty: in-hospital outcomes and costs. J Shoulder Elbow Surg 2015;24:460–7. https://doi.org/10.1016/j.jse.2014.08.016.

20. Robinson J, Shin JI, Dowdell JE, Moucha CS, Chen DD. Impact of gender on 30-day complications after primary total joint arthroplasty. J Arthroplasty 2017;32:2370–4. https://doi.org/10.1016/j.arth.2017.03.001.

21. Saltzman BM, Basques B, Leroux T, Frank RM, Nicholson GP, Verma NN, et al. The influence of gender on early adverse events, hospital charges and length of stay after shoulder arthroplasty. Int Orthop 2018;42:149–53. https://doi.org/10.1007/s00264-017-3547-6.

22. Sanford DE, Woolsey CA, Hall BL, Linehan DC, Hawkins WG, Fields RC, et al. Variations in definition and method of retrieval of complications influence outcomes statistics after pancreatectoduodenectomy: comparison of NSQUIP with non-NSQUIP methods. J Am Coll Surg 2014;219:407–15. https://doi.org/10.1016/j.jamcollsurg.2014.01.064.

23. Schairer WW, Nwachukwu BU, Lyman S, Craig EV, Gulotta LV. National utilization of reverse total shoulder arthroplasty in the United States. J Shoulder Elbow Surg 2015;24:91–7. https://doi.org/10.1016/j.jse.2014.08.026.

24. Sellers MM, Merkow RP, Halverson A, Hinami K, Kelz RR, Bentrem DJ, et al. Validation of new readmission data in the American College of Surgeons National Surgical Quality Improvement Program. J Am Coll Surg 2013;216:420–7. https://doi.org/10.1016/j.jamcollsurg.2012.11.013.

25. Singh A, Yuan EH, Dillon MT, Takayanagi M, Burke MF, Navarro RA. The effect of surgeon and hospital volume on shoulder arthroplasty perioperative quality metrics. J Shoulder Elbow Surg 2014;23:1187–94. https://doi.org/10.1016/j.jse.2013.11.017.

26. Smabrekke A, Espehaug B, Havelin L, Furnes O. Operating time and survival of primary total hip replacements: an analysis of 31,745 primary cemented and uncemented total hip replacements from local hospitals reported to the Norwegian Arthroplasty Register 1987–2001. Acta Orthop Scand 2004;75:524–32. https://doi.org/10.1080/00016470410001376.

27. Sperling JW, Duncan SF, Cofield RH, Schleck CD, Harmsen WS. Incidence and risk factors for blood transfusion in shoulder arthroplasty. J Shoulder Elbow Surg 2005;14:599–601. https://doi.org/10.1016/j.jse.2005.03.006.

28. Tang JH, Lyu Y, Cheng LM, Li YC, Gou DM. Risk factors for the postoperative transfusion of allogeneic blood in orthopedics patients with intraoperative blood salvage: a retrospective cohort study. Medicine (Baltimore) 2016;95:e2866. https://doi.org/10.1097/MD.0000000000002866.

29. Werner BC, Dines JS, Dines DM. Platform systems in shoulder arthroplasty. Curr Rev Musculoskelet Med 2016;9:49–53. https://doi.org/10.1007/s12178-016-9317-z.

30. Wirth MA, Rockwood CA Jr. Complications of total shoulder-replacement arthroplasty. J Bone Joint Surg Am 1996;78:903–16.

31. Xu S, Baker DK, Woods JC, Brabston EW 3rd, Ponce BA. Risk factors for early readmission after anatomic or reverse total shoulder arthroplasty. Am J Orthop (Belle Mead NJ) 2016;45:E386–92.