Reverse total shoulder arthroplasty for the
treatment of proximal humeral fractures: patterns
of use among newly trained orthopedic surgeons

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Background: This study compared the use of reverse and hemishoulder arthroplasty for the treatment of proximal humeral fractures among orthopedic surgeons taking part II of the American Board of Orthopaedic Surgery board examination. We hypothesized that the use of reverse shoulder arthroplasty for fractures in the elderly is increasing amongst newly trained orthopedic surgeons.

Materials and methods: We queried the American Board of Orthopaedic Surgery database for the cases of proximal humeral fractures treated with arthroplasty submitted between 2005 and 2012. We evaluated the prosthesis used, patient-specific factors, complications, and the difference in use by shoulder fellowship-trained surgeons.

Results: From 2005 to 2012, 5395 board-eligible orthopedic surgeons submitted cases to the database. Of these, 435 (mean, 54 per year) were proximal humeral fractures treated with arthroplasty. The overall incidence of reverse shoulder arthroplasty for fracture increased from 2% to 4% during 2005 to 2007 to 38% in 2012. Shoulder surgeons treated 5 times more proximal humeral fractures with shoulder arthroplasty and were also more than 20 times more likely to use a reverse implant (P < .0001). The difference in complication rates between reverse and hemishoulder arthroplasty was not significant (P = .49). Patients who received a hemiarthroplasty tended to be younger (mean age, 70.8 vs 75.7 years; P = .0015).

Conclusions: Overall, the use of a hemiarthroplasty for fracture is still more common (62% in 2012), although the relative proportion of reverse implants is rising. Among shoulder surgeons, more than 50% of the arthroplasties performed for fractures during the past 3 years (2010-2012) have been reverse arthroplasties.

Level of evidence: Epidemiology Study, Database Analysis.
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Proximal humeral fractures (PHFx) are the third most common fracture in patients aged older than 65 years. Although most PHFx in this population can be treated nonoperatively, there is a role for surgical intervention. Treating PHFx in the elderly with open reduction and
internal fixation or hemishoulder arthroplasty (HSA) is fraught with complications, including hardware impingement, tuberosity nonunion, malunion, and varying functional results. Since the 2004 introduction of the reverse shoulder arthroplasty (RSA) to the USA, the indications for this technique have expanded from cuff tear arthropathy to revisions for failed HSA, proximal humeral malunions, and acute PHFxs in the elderly.19

RSA is an attractive possible option for complex 3- and 4-part PHFx in the elderly. Traditionally, HSA has been used in this patient population but has achieved varying functional results. HSA success depends on proper height, retroversion, and tuberosity healing, making this operation technically demanding even for the most experienced shoulder surgeons. The potential for poor outcomes when treating PHFxs with HSA has prompted interest in RSA as a means to gain pain relief and improved functional outcomes. RSA affords the deltoid a better mechanical advantage for elevating the arm by moving the center of rotation of the shoulder more medial and inferior. This implant can achieve adequate function in the absence of a competent rotator cuff and may offer more reliable results in the absence of tuberosity healing.

A recent study that examined a nationwide database showed that there was a 2.5-fold increase in the use of shoulder arthroplasty in the USA from 1993 to 2008. The increase in shoulder arthroplasty in this study was speculated to be due to the rising use of RSA to serve a population of patients that was unmet before the release of this implant. One reason for this may be the use of RSA for PHFxs in the elderly. Arthroplasty for fracture is a complex procedure, and subspecialty training of the treating surgeon may have an effect on the type of procedure performed and on the rates of complications. It may be that newly trained surgeons are performing more RSAs for this indication.

This study examined the prevalence of RSA as treatment for PHFx amongst orthopedic surgeons early on in their careers. Our hypothesis were that:

1. the use of RSA for PHFx significantly increased after it was approved by the Food and Drug Administration in November 2004;
2. newly trained orthopedic surgeons would be more likely to use RSA than HSA when treating a PHFx;
3. the early complication rates for RSA and HSA reported by these surgeons would be higher than those reported in the literature;
4. surgeons with shoulder and elbow fellowship training would be more likely than their colleagues to perform RSA for a PHFx;
5. geographic region would have an effect on practice patterns;
6. patient gender would not appreciably affect choice of treatment; and
7. younger patients would be more likely than older patients to receive an HSA for a PHFx.

Materials and methods

A research proposal was sent to the American Board of Orthopaedic Surgery (ABOS) to query the ABOS database for patients with PHFxs treated with RSA or HSA submitted by surgeons taking part II of the ABOS board examination between 2005 and 2012. The RSA was made available in the USA in November 2004, and thus, 2005 was chosen as the initial year for data collection.

We requested information for all cases reported under the Current Procedural Terminology (CPT; American Medical Association, Chicago, IL USA) codes 23616 (shoulder arthroplasty for fracture), 23472 (total shoulder arthroplasty), and 23470 (hemiarthroplasty of the shoulder) performed for International Classification of Diseases Ninth Edition (ICD 9) codes 812.00 (closed proximal humeral fracture), 812.01 (surgical neck fracture), or 812.03 (anatomic neck fracture).

The CPT does not have a specific code for RSA; consequently, these cases are submitted under the CPT code for total shoulder arthroplasty. A member at the ABOS also used the narrative description of cases to ensure that RSA was used. In addition, our assumption was that code 23472 in conjunction with fracture codes was an RSA because a conventional total shoulder arthroplasty in the setting of a fracture would be very rare.

Data obtained from the ABOS database during the 8-year period, which were devoid of any patient- or surgeon-identifying data, included the fellowship training of the surgeon, procedure performed, diagnosis, patient age, sex, and reported complications. The resulting data set was divided into 2 groups according to whether or not the surgeon had completed fellowship training in shoulder surgery. These 2 groups—shoulder and nonshoulder surgeons—were compared for type of prosthesis used (RSA vs HSA), complications, and trends of use over time.

The Fisher exact test was used to compare the use of RSA for PHFx between surgeons who were and were not shoulder trained and to evaluate a possible relationship between the types of arthroplasty used and patient gender. The Student t test was used to determine if age influenced the type of arthroplasty implanted. A χ² test was performed to compare the rates of complications between surgeons by fellowship training.

Results

From 2005 to 2012, 5395 board-eligible orthopedic surgeons submitted cases for the ABOS part II board examination. During this 8-year period, 173 fellowship-trained shoulder surgeons took the examination. There were 435 cases involving the treatment of a PHFx with HSA or RSA (mean, 54 cases per year), of which 69 were RSA and 366 were HSA. Shoulder-trained surgeons performed 28 RSAs and 35 HSAs, and nonshoulder-trained surgeons performed 41 RSAs and 331 HSAs. Of the 69 patients who received RSA, 11 were male and 58 were female. In the HSA group, 76 were male and 290 were female. The mean age was 75.7 ± 8 years for those who received RSA and 70.8 ± 12 years for those who received HSA. No gender difference between patients treated with HSA vs RSA was
found; however, patients who received HSA tended to be younger (mean age, 70.8 vs 75.7 years; $P = .0015$).

The overall incidence of RSA for PHFx increased from 1 to 2 per year (2%-4%) during 2005 to 2007 to 34 (38%) in 2012. Shoulder surgeons treated 63 of the 435 PHFxs (28 RSAs and 35 HSAs). Amongst shoulder surgeons, the use of RSA for PHFx increased from 0 (0%) in 2005 to 9 (75%) in 2011 and to 13 (65%) in 2012. During the entire study period, each shoulder surgeon treated 5 times more PHFxs with shoulder arthroplasty than did nonshoulder surgeons and were also more than 20 times more likely to use RSA ($P < .0001$; Fig. 1 and Fig. 2).

A total of 17 complications were documented in the RSA group and 70 complications in the HSA group (Table I). The difference in complication rates between HSA (19.1%) and RSA (24.6%) was not statistically significant ($P = .49$). The complication rates for shoulder-trained surgeons were 11.4% for the HSA group and 17.9% for the RSA group and for the other surgeons were 20% for the HSA and 29.3% for the RSA groups. The complication rates differed between the 2 groups, but our sample size was not large enough to confirm that these differences were significant. Nerve injuries, nonunion, and delayed union tended to be more common in the HSA group, whereas dislocations, hemorrhage, pulmonary embolism, and renal failure tended to occur more frequently in the RSA group. The number of patients in this study was insufficient to determine if the geographic region of the surgeons’ practices affected the type of arthroplasty used.

**Discussion**

The use of shoulder arthroplasty in the USA has been on the rise, particularly from 1993 to 2008. The increase in use has been postulated to be due to the ability of RSA to treat shoulder problems that previously had poor or no solutions. Surgically indicated PHFx in the elderly continue to be a difficult problem to treat. For those patients in whom an arthroplasty is indicated, HSA may have a variable result, and there may be a growing trend to use RSA to treat elderly patients with complex 3-part and 4-part PHFx.4,5,8,13,16,18,20

This study confirmed our hypothesis that the use of RSA has risen amongst newly trained surgeons, from 2% to 38% during the previous 8 years. Although more RSAs are being performed for PHFx, most of these fractures in our study population were still being treated with HSA. The use of RSA in 2005 was substantially lower than in later years, which could have been partly due to availability and familiarity with the prosthesis. The increase that we see in our study may not reflect the current trends on a national level, and that there is an even larger rise amongst surgeons in practice is possible.

The proportion of fellowship trained shoulder surgeons in our study was relatively small (173 of 5395). However, they performed 28 of the 69 RSA cases, making shoulder surgeons 20 times more likely to use RSA for a PHFx than nonshoulder surgeons ($P < .0001$). This may be due to experience gained in a shoulder fellowship that uses this particular implant. We had no information on the type of practice of the surgeons in this study, and it is possible that shoulder specialists were referred more complex fractures, which may have mandated RSA over HSA. Our hypothesis that newly trained orthopedic surgeons would be more likely to use RSA than HSA when treating a PHFx was incorrect, and the use of the gold standard HSA is still a more common treatment for complex PHFx.

RSA is a technically demanding procedure that offers its own unique set of complications.22 Our study was unable to show a difference in the complication rates between HSA and RSA when used for PHFx (19.1% vs 24.6; $P = .46$). The low rate of complications seen with RSA was surprising. A recent systematic review showed that the average complication rate was 44% across all indications, with a
There is no evidence in the literature comparing the rate of complications for RSA based on fellowship training of the surgeons.

Long-term survivorship for this relatively new implant has been approximately 91% at 10 years and was previously recommended for patients aged older than 70 years. Our study was unable to show a significant association between age and the type of prosthesis used; however, patients who received RSA were older (mean age, 75.7 years). The current literature examining patients who have an RSA reports a patient population with a similar average age. The surgeons in this group likely had stringent indications for RSA during their ABOS collection period and attempted to reserve RSA for a more elderly patient.

Our study had some limitations. This was a retrospective study during a defined period of time in a surgeon’s career. The data obtained only show us the reported rates of RSA and HSA for this particular population of surgeons and not the trend across the nation. The low complication rate reported for this study was very short-term, and the patients in this study may have more complications arising with longer follow-up. We had no access to the radiographs of these cases, and there are also radiographic complications specific to an RSA, such as scapular notching, that may have been overlooked by surgeons early on in their career, thus artificially lowering the reported complication rate.

Another limitation that bears mention is that because we did not have access to radiographs in this study, we were unable to evaluate the characteristics of the fractures. This is important, because more complex PHFxs that are not amenable to fixation are often referred to surgeons with fellowship training in shoulder surgery. In addition, more complex fractures may have been thought to be more suitable for RSA than for HSA and, therefore, were sent to fellowship-trained surgeons as well. These factors may have inflated the proportion of RSAs for PHFxs performed by shoulder fellowship-trained surgeons. Lastly, surgeons tend to be more conservative in their treatments during their board collection period, and this study may not reflect the use of RSA for PHFxs in their general practice.

Conclusions

Our data show that it is becoming increasingly common for board-eligible orthopedic surgeons to use RSA in the treatment of PHFxs. Although the use of HSA for PHFxs is still more common (62% in 2012), the use of RSA for PHFxs is rising. Among shoulder surgeons, more than half of the arthroplasties performed for PHFxs during the past 3 years have been RSA. The difference in complication rates between the HSA and RSA groups was not statistically significant. However, more complications in the RSA group, such as renal failure and
pulmonary embolism, seem unrelated to the implant and could potentially be explained by the fact that the patients in the RSA group were on average older.

References


