



KEY JOURNAL ARTICLES AND INSIGHTS

STRENGTH IN NUMBERS

100+ 
PEER-REVIEWED
JOURNAL ARTICLES

10,000 PATIENTS

 **30**


CLINICAL SITES

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EXACTECHGPS®

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Insights by Moby Parsons, MD, and Ari Youderian, MD

Overview

This collection of articles reflects on the stability of the glenoid component in both reverse and total shoulder arthroplasty and how best to achieve accurate positioning. CT-based preoperative planning has become increasingly popular in shoulder arthroplasty - recognizing the importance of anatomic reconstruction, version and inclination correction and implant stability. The ability to precisely execute the surgical plan is equally important to accomplish these goals using either conventional freehand techniques, patient-specific instrumentation (PSI) or computer-assisted surgery (CAS). ExactechGPS was shown to be significantly more accurate in correcting version and inclination according to a preoperative plan compared to standard instrumentation (page 3). These studies additionally demonstrated the value of ExactechGPS replicating the surgical plan, the importance of augmented implants when correcting version and inclination, increased screw length, reduced central peg perforation and short learning curve (pages 3-7).

Key Insights:

- There are multiple ways to execute a surgical plan – freehand/conventional instrumentation, PSI and computer assisted surgery/GPS.
- Regardless of experience and expertise, surgeons are decidedly not as precise as we would like to think when orienting glenoid implants in primary and reverse total shoulder arthroplasty.
- ExactechGPS offers the only surgical navigation system for anatomic and reverse shoulder arthroplasty that allows precise recreation of the preoperative plan along with real-time intra-operative flexibility.
- Regardless of whether your plan is anatomic or reverse, version/inclination correction, implant to bone contact, cage position and screw fixation are paramount to implant longevity (pages 7 and 9).
- ExactechGPS has been shown to be significantly more accurate after preoperative planning in correcting version and inclination compared to conventional instrumentation and PSI (page 3).
 - Recent meta-analyses have shown that PSI is not significantly better than conventional instrumentation with regards to accuracy after preoperative planning (page 6).
- Increased screw length, less central peg perforation, and number of screws have been shown to be critical for reverse baseplate fixation – all of which can be improved with the use of ExactechGPS (pages 5, 7 and 9).
- With no capital purchase required, GPS is a cost-effective way to improve glenoid component accuracy with a short learning curve of eight cases or less in order to be time neutral (page 8).
- With the technology available today, “eyeballing” it in the operating room is not good enough; and to the degree that this technology can greatly improve our ability to reconstruct the glenoid with minimal cost in time, it provides compelling value to the shoulder arthroplasty whether low or high volume.
- Additional studies with clinical outcomes and data driven algorithms using GPS will hopefully prove even more benefit with range of motion, stability, and reduction of complications such as acromial stress fractures, dislocation and component loosening.



1 in 3



Equinoxe shoulders navigated using ExactechGPS®

ExactechGPS
accuracy



surgeons guided within 2mm of implant placement and 2° of version/inclination compared to their plan

Navigated vs. non-navigated results of a CT based computer assisted shoulder arthroplasty system in 30 cadavers*

Alexander T. Greene, Matthew A. Hamilton, PhD, Sandrine V. Polakovic, Nicole J. Mohajer, Ari R. Youderian, MD, Thomas W. Wright, MD, Ira M. Parsons, MD; Paul D. Saadi, MD, Emilie V. Cheung, MD, Richard B. Jones, MD

Presented at ISTA 2018.

INTRODUCTION

Variability in placement of total shoulder arthroplasty (TSA) glenoid implants has led to the increased use of 3D CT preoperative planning software. Computer assisted surgery (CAS) offers the potential of improved accuracy in TSA while following a preoperative plan, as well as the flexibility for intraoperative adjustment during the procedure. This study compares the accuracy of implantation of reverse total shoulder arthroplasty (rTSA) glenoid implants using a CAS TSA system versus traditional non-navigated techniques in 30 cadaveric shoulders relative to a preoperative plan from 3D CT software.

METHODS

High resolution 1mm slice thickness CT scans were obtained on 30 cadaveric shoulders from 15 matched pair specimens. Each scan was segmented and the digital models were incorporated into a preoperative planning software. Five fellowship trained orthopedic shoulder specialists used this software to virtually place a rTSA glenoid implant as they deemed best fit in six cadavers each. The specimens were randomized with respect to side and split into a cohort utilizing the CAS system and a cohort utilizing conventional instrumentation, for a total of three shoulders per cohort per surgeon. A BaSO₄ PEEK surrogate implant identical in geometry to the metal implant used in the preoperative plan was used in every specimen, to maintain high CT resolution while minimizing CT artifact. The surgeons were instructed to implant the rTSA implants as close to their preoperative plans as possible for both cohorts. In the CAS cohort, each surgeon used the system to register the native cadaveric bones to each respective CT, perform the TSA procedure, and implant

the surrogate rTSA implant. The surgeons then performed the TSA procedure on the opposing side of the matched pair using conventional instrumentation. Postoperatively, CT scans were repeated on each specimen and segmented to extract the digital models. The pre- and postoperative scapulae models were aligned using a best fit match algorithm, and variance between the virtual planned position of the implant and the executed surgical position of the implant was calculated.

RESULTS

For version and inclination, implants in the CAS cohort showed significantly less deviation from preoperative plan than those in the non-navigated cohort (Version: $1.9 \pm 1.9^\circ$ vs $5.9 \pm 3.5^\circ$; $p < .001$; Inclination: $2.4 \pm 2.5^\circ$ vs $6.3 \pm 6.2^\circ$; $p = .031$). No significant difference was noted between the two cohorts regarding deviation from the preoperative plan in anterior-posterior and superior-inferior positioning on the glenoid face ($1.5 \pm 1.0\text{mm}$ CAS cohort, $2.4 \pm 1.3\text{mm}$ non-navigated cohort; $p = .055$). No significant difference was found for deviation from preoperative plan for reaming depth ($1.1 \pm 0.7\text{mm}$ CAS cohort, $1.3 \pm 0.9\text{mm}$ non-navigated cohort; $p = .397$).

CONCLUSION

The results of this study demonstrate that this CAS navigation system facilitates a surgeon's ability to more accurately reproduce their intended glenoid implant version and inclination (with respect to their preoperative plan), compared to conventional non-navigated techniques. Future work will determine if more accurate and precise implant placement is associated with improved clinical outcomes.

**In vitro (bench) test results may not necessarily be indicative of clinical performance.*

Computer navigation re-creates planned glenoid placement and reduces correction variability in total shoulder arthroplasty: an *in vivo* case-control study

Piyush S. Nashikkar, MS, DNB, Corey J. Scholes, PhD, Mark D. Haber, FRACS

Article in Press. J Shoulder Elbow Surg (2019) -, 1–12.

BACKGROUND

Accurate glenoid component placement is important to prevent glenoid component failure in total shoulder arthroplasty (TSA). Navigation may reduce the variability of glenoid component version and inclination; therefore, the aims of this study were to determine, in patients undergoing TSA, whether computer navigation improved the ability to achieve neutral postoperative version and inclination, as well as achieve the individualized preoperative plan.

METHODS

Patients undergoing TSA using navigation (computer-assisted surgery [CAS], n=33) or the conventional technique (n=27) from January 2014 to July 2017 were recruited and compared. Preoperative and postoperative version and inclination, as well as postoperative inferior overhang, were measured using computed tomography scans.

RESULTS

The CAS group had more than twice as many augmented glenoid components as the conventional group (45.5% vs. 19.2%). CAS significantly reduced the between-patient variability in postoperative version and led to a greater proportion of components positioned in “neutral” alignment for both inclination and version ($P < .015$). The incidence of neutral inclination or version postoperatively was significantly higher in the CAS group, and the glenoid was implanted within 5° of the surgical plan in more than 70% of cases, with more than 40% displaying no detectable difference.

CONCLUSION

An integrated system of 3-dimensional surgical planning, augmented glenoid components, and intraoperative navigation may reduce the risk of glenoid placement outside of a neutral position in patients undergoing TSA compared with conventional methods. This study demonstrated the capacity for CAS to replicate the surgical plan in a majority of cases.

Role of intraoperative navigation in the fixation of the glenoid component in reverse total shoulder arthroplasty: a clinical case-control study

Piyush S. Nashikkar, MS, DNB, Corey J. Scholes, PhD, Mark D. Haber, FRACS

Article in Press. J Shoulder Elbow Surg (2019) -, 1–7.

BACKGROUND

Fixation of the glenoid baseplate in reverse total shoulder arthroplasty (rTSA) is an important factor in the success of the procedure. There is limited information available regarding the effect of navigation on fixation characteristics. Therefore, the aims of this study were to determine whether computed tomography–based computer navigation improved the glenoid base plate fixation by (1) increasing the length of screw purchase, (2) altering screw angulation, and (3) decreasing central cage perforation in patients undergoing rTSA.

METHODS

Patients undergoing rTSAs using navigation (NAV, N=27) and manual technique (MAN, N=23) from January 2014 to July 2017 were analyzed in a case-control design. Screw purchase length and central cage perforation were assessed using multiplanar computed tomography.

RESULTS

Median screw purchase length was significantly longer in the NAV group for both anterior (20 mm vs. 15 mm, $P < .01$) and posterior screws (20 mm vs. 13 mm, $P < .01$). In addition, the NAV group displayed significantly lower incidences of inadequate screw purchase (< 22 mm) for the anterior (64.7% vs. 95.2%, $P = .03$) and posterior (70.6% vs. 100%, $P = .01$) screws. Significant differences in axial and coronal screw angulation were observed between groups. Similarly, the NAV group displayed significantly reduced incidence of central cage perforation (17.7% vs. 52.4%, $P = .04$).

CONCLUSION

The use of computer-assisted navigated rTSA contributes to significant alterations in screw purchase length, screw angulation, and central cage perforation of the glenoid baseplate compared with non-navigated methods.

Accuracy of patient-specific instrumentation in shoulder arthroplasty: a systematic review and meta-analysis

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JSES Open Access. September 2019;3(3):117-129.

BACKGROUND

There has been significant recent emphasis on the use of patient-specific instrumentation (PSI) in shoulder arthroplasty. However, clinical data are lacking to support the increased time and expense associated with PSI. Our purposes were to determine whether PSI significantly improves implantation accuracy during total shoulder arthroplasty (TSA) and to analyze available techniques and correlation with clinical outcomes. We hypothesized that PSI may improve glenoid component position radiographically but without correlation with clinical outcomes.

METHODS

The MEDLINE, Scopus, Embase, and Cochrane Library databases were queried. Included articles reported use of any preoperative or intraoperative PSI techniques, models, or guides to assist with TSA prosthesis implantation. The primary outcomes were mean deviation from the preoperative plan in version (in degrees), inclination (in degrees), and entry-point offset on the glenoid (in millimeters).

RESULTS

Among the included articles, 518 TSA procedures (352 anatomic and 166 reverse) were performed. The mean postoperative errors in both version and inclination angles were 5° or less in 20 articles (90.9%) using PSI. Meta-analysis revealed no statistically significant differences in version error ($P > .999$, $I^2 = 64.6\%$), inclination error ($P = .702$, $I^2 = 82.2\%$), or positional offset ($P = .777$, $I^2 = 85.7\%$) between PSI and standard instrumentation. No data regarding patient-reported outcome measures, range of motion, strength, or glenoid component loosening, and longevity were reported.

CONCLUSION

Meta-analysis revealed no significant differences in accuracy between PSI and standard instrumentation. Although PSI may possess the potential to improve TSA techniques, further investigations regarding long-term clinical outcomes, impact on operating room time, and cost-effectiveness are warranted before PSI can be routinely recommended over conventional instrumentation.

Factors contributing to glenoid baseplate micromotion in reverse shoulder arthroplasty: a biomechanical study*

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J Shoulder Elbow Surg. 2019 Apr;28(4):648-53.

BACKGROUND

Reverse shoulder arthroplasty (RSA) is typically performed in patients with cuff tear arthropathy. A common type of RSA baseplate has a central peg and 4 peripheral screws inserting into the glenoid surface. Baseplate failure is a significant postoperative complication that reduces prosthetic longevity and usually requires revision surgery. This study evaluated the contribution of mechanical factors on initial baseplate fixation.

METHODS

This study simulated glenoid baseplate loading in a RSA. A half-fractional factorial design was used to test 5 factors: bone density (160 or 400 kg/m³), screw length (18 or 36 mm), number of screws (2 or 4), screw angle (neutral or diverging), and central peg length (13.5 or 23.5 mm). Trials were cyclically loaded at a 60° angle with 500 N for 1000 cycles. Micromotion at 4 peripheral screw positions was analyzed using a multifactorial analysis of variance (P < .05).

RESULTS

We found an increase in micromotion with 3 scenarios: (1) lower bone density at all screw positions; (2) shorter central peg length at the inferior, superior and anterior screws; and (3) shorter screw length at the inferior and anterior screws. There were interactions between bone density and screw length at the inferior and anterior screws and between bone density and central peg length at the inferior, superior, and anterior screws.

CONCLUSION

Greater bone density, a longer central peg, and longer screws provide improved initial glenoid fixation in an RSA, whereas the number of screws, and the angle of screw insertion do not. These findings may help minimize baseplate failure and revision operations.

**In vitro (bench) test results may not necessarily be indicative of clinical performance.*

Computer navigation of the glenoid component in reverse total shoulder arthroplasty: a clinical trial to evaluate the learning curve

Allan W. Wang, PhD, FRACS, Alex Hayes, BE, PhD, Rebekah Gibbons, BSc (Physio)(Hons) and Katherine E. Mackie, BSc, BMedSc(Hons), PhD

Article in Press. J Shoulder Elbow Surg (2019) -, 1-7.

BACKGROUND

Intraoperative computer navigation has been introduced recently to assist with placement of the glenoid component. The aim of this study was to evaluate the learning curve of a single surgeon performing computer navigation of glenoid implant placement in primary reverse total shoulder arthroplasty (RTSA).

METHODS

Following training with the intraoperative computer navigation system, we conducted a prospective case-series study of the first 24 consecutive patients undergoing a primary RTSA with navigation performed by a single surgeon. Surgical times, complications, and accuracy of glenoid positioning compared with the preoperative plan were evaluated. Surgical times were compared with the preceding non-navigated series of 24 consecutive primary RTSA cases. Postoperative 3-dimensional computed tomography scans were performed to evaluate glenoid component version and inclination compared with the preoperative plan.

RESULTS

The total surgical time was 77.3 minutes (standard deviation [SD], 11.8 minutes) in the navigated RTSA cohort and 78.5 minutes (SD, 18.1 minutes) in the non-navigated series. A significant downward trend in the total surgical time was observed in the navigated cohort ($P = .038$), which flattened after 8 cases. No learning curve was observed in deviation of glenoid version or inclination from the preoperative plan. The mean deviation of achieved version from planned version was 3° (SD, 2°), and the mean deviation of achieved inclination from planned inclination was 5° (SD, 3°).

CONCLUSION

Findings from this study suggest that intraoperative computer navigation will not require substantially increased operating times compared with standard surgical techniques. With prior surgeon training, approximately 8 operative cases are required to achieve proficiency in intraoperative computer navigation of the glenoid component.

Impact of screw length and screw quantity on rTSA glenoid fixation for two different sizes of glenoid baseplates*

Roche, C; Digeorgio, C; Yegres, J; VanDeven, J; Stroud, N; Flurin, PH; Wright, T; Cheung, E; Zuckerman, J.

JSES Open Access. December 2019;3(4):296-303.

BACKGROUND

Little guidance exists regarding the minimum screw length and screw quantity necessary to achieve fixation with reverse shoulder arthroplasty (rTSA); to that end, this study quantifies the displacement of two different sizes of glenoid baseplates using multiple different screw lengths and quantity of screws in a low-density polyurethane bone substitute model.

METHODS

This rTSA glenoid loosening test was conducted according to ASTM F 2028-17. To independently evaluate the impact of screw quantity and screw length on rTSA glenoid fixation in two different sizes of glenoid baseplates, baseplates were constructed using 2, 4, and 6 screws (for the larger baseplate only) with 3 different poly-axial locking compression screws lengths. A two-tailed unpaired student's t-test compared the baseplate displacement associated with each construct and between baseplate sizes ($p < 0.05$).

RESULTS

Both sizes of glenoid baseplates remained well-fixed after cyclic loading regardless of screw length or screw quantity. Baseplates with 2 screws had significantly greater displacement than baseplates with 4 and 6 screws. No differences were observed between baseplates of 4 and 6 screws (for the larger baseplate). Both baseplates with 18mm screws had significantly greater displacement than baseplates with 30mm and 46mm screws. For the larger baseplate, 30mm screws had significantly greater displacement than baseplates with 46mm screws in the S/I direction.

CONCLUSION

rTSA glenoid fixation in two different size baseplates is impacted by both screw quantity and screw length for the 2 sizes of baseplates tested in this study. Irrespective of screw quantity, longer screws had significantly better fixation. Irrespective of screw length, the use of more screws had significantly better fixation, up to a point, as the use of >4 screws showed no incremental benefit. Finally, longer screws can be used as a substitute for additional fixation if it is not feasible to use more screws.

*In vitro (bench) test results may not necessarily be indicative of clinical performance.

Insights by Joseph Zuckerman, MD, and Ryan Simovitch, MD

Overview

With unmatched research, including 100+ peer-reviewed articles and 30 clinical sites with 10,000 patients, the Equinox is the most studied shoulder system on the market. These key studies highlight the unique features of the Equinox implants, which were designed specifically to solve unmet clinical needs. The articles range from tuberosity healing rates in 3- and 4-part fractures, acromial stress fractures, instability in rTSA and stem convertibility to subscapularis repair.

Key Insights:

PLATFORM FRACTURE STEM

- Use of the Equinox fracture stem showed that **83%** of the greater tuberosities that were repaired, healed. This resulted in greater active ER for these patients and showed a statistically significant difference in their ability to participate in daily activities that require ER such as reaching their head (page 12).
- These results are much better than previous studies that report GT healing rates as low as 47% and may be attributed to the design of the Equinox fracture stem lending itself to a more anatomic tuberosity reconstruction.

SCAPULAR NOTCHING

- The Equinox reverse achieves a **low rate of scapular notching of 10% (short-term) and 14.5% (mid-term)** in RTSA due to a combination of its lateral humeral offset, 145 degree neck shaft angle and inherent inferior glenoid overhang.
 - Other systems have been shown notching rates between 36-96%. In an effort to reduce the rate of notching in these systems, surgeons have proposed utilizing a bio-rsa to lateralize their baseplate with the addition of bone graft. This introduces another potential mode of failure (graft not healing or resorption) as well as requiring additional time to prepare and insert graft. The Equinox system achieves a much lower notching rate without this sort of “work-around.”
- While other studies have found that scapular notching has no effect on clinical outcomes, these studies have been significantly underpowered. The Equinox database has shown that notching does matter and is associated with poorer outcomes and increased rates of humeral lucency. Patients with notching also had significantly higher rates of revision and complications (page 13). Differences in design can affect notching, and it is important to understand the biomechanics of RTSA that lead to higher or lower rates of notching.

- The best strategy is to use an implant that is biomechanically biased towards avoiding notching and to implant that prosthesis in the best position (inferior) possible, which can predictably be accomplished through the use of 3D preoperative planning and ExactechGPS navigation (page 5).

ACROMIAL AND SCAPULAR FRACTURES AFTER RTSA

- The reported rate of combined fractures after RTSA across the literature is 2.8%, with higher rates reported in patients who received with RTSA for massive cuff tears, inflammatory arthritis and in patients with lateralized glenosphere designs.
- The reported rate for the **Equinox shoulder is 1.5%**, nearly 50% less than the average of our competitors. Acromial and scapular fractures are a devastating complication of RTSA and can potentially be significantly reduced through RTSA implant design and biomechanics.

INSTABILITY AFTER RTSA

- Subscapularis repair has previously been emphasized after RTSA out of concern for instability, with reported rates of instability after RTSA being shown between 4-5%. However, the higher rates of instability without repair were in medialized humeral RTSA designs.
- The Equinox RTSA system is a lateralized humeral design which has shown a **low rate of instability at 0.5%**. These rates show that not all RTSA designs are created equal. The low rate of instability with the Equinox prosthesis is with or without subscapularis repair, showing that subscap repair is not necessary for stability in this prosthesis. The biomechanics of the Equinox RTSA with its lateralized humeral design may contribute to the inherent stability of this prosthesis.



PLATFORM STEM

- The Equinoxe platform shoulder system has a **proven convertibility rate of 78%** when converting from anatomic to reverse shoulder. This is the highest reported rate of convertibility in the industry.
- Patients who were able to be converted had significantly shorter operative time, lower estimated blood loss, and lower complication rates (page 17).

IMPROVEMENT IN EXTERNAL ROTATION

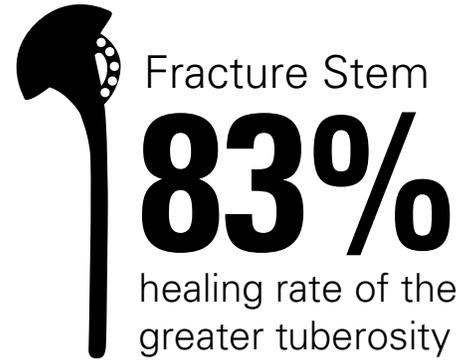
- Subscapularis repair has been studied to see whether repair improves or impairs external rotation after RTSA. In the Equinoxe system, passive external rotation, active flexion and active abduction was not negatively impacted by subscapularis repair preop to post op. External rotation was actually improved in subscap repair patients. While subscap repair is not necessary for stability in the Equinoxe system, it has been shown to improve other measures of ROM, especially external rotation (page 16).

GLENOID BONE PRESERVATION

- Conserving glenoid bone is critical in general and even more so in retroverted glenoids (B2/B3). Computer modeling studies have shown that a full wedge augment such as the Equinoxe preserves **89% more bone** than a standard glenoid component and **51% more glenoid bone** than a stepped design.
- Studies have also shown that medializing a glenoid by eccentric reaming medialized the humerus, which can affect joint stability and tension/function of the rotator cuff (page 19).
- Wedge augments preserve joint lateralization as well as cancellous and subchondral bone more than other implant designs or techniques (page 18).

PATIENT REPORTED OUTCOMES

- The Equinoxe database has shown that more than **90% of patients report high satisfaction** after aTSA and rTSA, and more than 80% reached the minimal clinically important difference. No other implant system has similarly established MCID values to date.
- At a time when “value based” medicine is becoming more emphasized, understanding and reporting on patient outcomes will become more important.



Effect of tuberosity healing on clinical outcomes in elderly patients treated with a reverse shoulder arthroplasty for 3- and 4-part proximal humerus fractures

Ryan W. Simovitch, MD, Chris P. Roche, MSE, MBA, Richard B. Jones, MD, Howard D. Routman, DO, Yann Marczuk, MD, Thomas W. Wright, MD, and Joseph D. Zuckerman, MD

J Orthop Trauma 33(2), e39-e45. 2019.

OBJECTIVES

To evaluate tuberosity union rate and clinical outcome after 3- and 4-part proximal humerus fractures in the elderly.

DESIGN

Retrospective, multicenter database cohort study.

SETTING

Level I and Level II trauma centers.

PATIENTS

Fifty-five patients older than 65 years had insertion of reverse shoulder arthroplasty (RTSA) for OTA/AO 11-B and 11-C proximal humerus fractures.

INTERVENTION

Treatment with RTSA using a dedicated low profile onlay fracture stem using variable tuberosity fixation.

MAIN OUTCOME MEASURES

Constant score, the American Shoulder and Elbow Surgeons score, Shoulder Pain and Disability Index score, University of California at Los Angeles score, Simple Shoulder Test score,

visual analog pain score, shoulder function score, active range of motion, external rotation (ER)-specific tasks and position, rate of greater tuberosity healing, effect of tuberosity healing on overall clinical metrics, incidence of humeral lucency, and scapular notching.

RESULTS

Eighty-three percent of the greater tuberosities that were repaired united. Greater tuberosity union resulted in greater active ER ($P = 0.0415$). There was a statistically significant difference in the ability to do ER-type activities between the 2 cohorts reflected in the ability to position one's hand behind their head with the elbow forward ($P = 0.002$) and comb their hair ($P < 0.001$).

CONCLUSION

The use of a low profile onlay fracture stem in RTSA for acute 3- and 4-part proximal humerus fractures in the elderly can result in a high tuberosity union rate. Greater tuberosity healing significantly influences ER and ER-type activities that are not apparent by analysis of the overall metrics studied.



Short-term follow-up:

Impact of scapular notching on clinical outcomes after reverse total shoulder arthroplasty: an analysis of 476 shoulders

Brent Mollon, MD, FRCSC, Siddharth A. Mahure, MD, MBA, Christopher P. Roche, MSE, Joseph D. Zuckerman, MD

J Shoulder Elbow Surg. 2017 July;26(7):1253-61.

BACKGROUND

Scapular notching is a complication unique to reverse total shoulder arthroplasty (rTSA), although its clinical implications are unclear and remains controversial.

METHODS

We retrospectively reviewed rTSA patients of a single implant design in 476 shoulders with a minimum 2-year clinical and radiographic follow-up. Clinical measures included active range of motion and American Shoulder and Elbow Surgeons scores, in addition to one or more of the Constant score, Shoulder Pain and Disability Index, Simple Shoulder Test (SST), and University of California, Los Angeles Shoulder Rating Scale. Complications and rates of humeral radiolucencies were also recorded.

RESULTS

Scapular notching was observed in 10.1% (48 of 476) of rTSAs and was associated with a longer clinical follow-up, lower body weight, lower body mass index, and when the operative side was the nondominant extremity. Patients with scapular

notching had significantly lower postoperative scores on the Shoulder Pain and Disability Index, Constant, Simple Shoulder Test, and University of California, Los Angeles, Shoulder Rating Scale compared with patients without scapular notching. Patients with scapular notching also had significantly lower active abduction, significantly less strength, and trended toward significantly less active forward flexion ($P = .0527$). Finally, patients with scapular notching had a significantly higher complication rate and trended toward a significantly higher rate of humeral radiolucent lines ($P = .0896$) than patients without scapular notching.

CONCLUSION

This large-scale outcome study demonstrates that patients with scapular notching have significantly poorer clinical outcomes, significantly less strength and active range of motion, and a significantly higher complication rate than patients without scapular notching. Longer-term follow-up is necessary to confirm that these statistical observations in the short-term will result in greater clinically meaningful differences over time.

Mid-term follow-up:

Impact of scapular notching on reverse total shoulder arthroplasty midterm outcomes: 5-year minimum follow-up

Ryan Simovitch, MD, Pierre-Henri Flurin, MD, Thomas W. Wright, MD, Joseph D. Zuckerman, MD, Christopher Roche, MSE, MBA

J. Shoulder Elbow Surg. 2019 Dec;28(12):2301-07.

BACKGROUND

The impact of scapula notching on reverse total shoulder arthroplasty (rTSA) clinical outcomes is controversial. The purpose of this study was to conduct a sufficiently statistically powered analysis to quantify the impact of scapular notching on midterm rTSA outcomes.

METHODS

There were 324 rTSA patients with 5 years of minimum follow-up evaluated. Patients were stratified according to the presence of a scapular notch at latest follow-up; radiographs were also assessed at each time point for patients with notching to determine the time for notch grade development. A 2-tailed, unpaired t-test compared preoperative, postoperative, and preoperative to postoperative outcomes between cohorts.

RESULTS

There were 324 patients having an average follow-up of 75.1 months assessed; 47 (14.5%) patients had scapular notching. For scapular notching patients, the average notching grade was 1.7 ± 0.8 (24 grade 1, 15 grade 2, and 8 grade 3). The average time to notch development was 51.4 ± 24.1 months; grade 1, grade 2, and grade 3 notches developed at 49.0 ± 22.1 months, 57.5 ± 22.6 months, and 71.6 ± 15.8 months, respectively. No preoperative differences were observed between cohorts. At latest follow-up, scapular notching patients had significantly worse outcome scores and significantly less active abduction, forward flexion, and strength. Finally, scapular notching patients had significantly more complications, revisions, and humeral radiolucent lines.

CONCLUSIONS

Scapular notching patients had significantly worse clinical outcomes and less range of motion than patients without scapular notching; these differences exceeded the minimal clinically important difference threshold for several outcome metrics. Based on these results, we recommend minimizing scapular notching through patient and implant selection and technique modification.

1.5%

combined scapular
and acromial
fractures

How common are acromial and scapular spine fractures after reverse shoulder arthroplasty?

J. J. King, S. S. Dalton, L. V. Gulotta, T. W. Wright, B. S. Schoch

Bone Joint J 2019;101-B:627–634.

BACKGROUND

Acromial fractures following reverse shoulder arthroplasty (RSA) have a wide range of incidences in reported case series. This study evaluates their incidence following RSA by systematically reviewing the current literature.

METHODS

A systematic review using the search terms “reverse shoulder,” “reverse total shoulder,” or “inverted shoulder” was performed using PubMed, Web of Science, and Cochrane databases between 1 January 2010 and 31 March 2018. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were used. Studies were included if they reported on RSA outcomes and the incidence rate of acromial and/ or scapular spine fractures. The rate of these fractures was evaluated for primary RSA, revision RSA, RSA indications, and RSA implant design.

RESULTS

The review included 90 articles out of 686 identified after exclusions. The incidence rate of acromial and/or scapular spine fractures was 2.8% (253/9048 RSAs). The fracture rate was similar for primary and revision RSA (2.8% vs 2.1%; $p = 0.4$). Acromial fractures were most common after RSA for inflammatory arthritis (10.9%) and massive rotator cuff tears (3.8%). The incidence was lowest in RSA for post-traumatic arthritis (2.1%) and acute proximal humerus fractures (0%). Lateralized Glenosphere design had a significantly higher rate of acromial fractures compared with medial Glenosphere designs.

CONCLUSION

Based on current English literature, acromial and/or scapular spine fractures occur at a rate of 2.8% after RSA. The incidence is slightly more common after primary compared with revision arthroplasty. Also, higher rates of acromial fractures are reported in RSA performed for inflammatory arthritis and in the lateralized glenoid design.

Reverse
0.5%
 instability

3X
IMPROVEMENT
 in external rotation post-op

Comparison of reverse total shoulder arthroplasty outcomes with and without subscapularis repair

Richard J. Friedman, MD, FRCSC, Pierre-Henri Flurin, MD, Thomas W. Wright, MD, Joseph D. Zuckerman, MD, Christopher P. Roche, MSE, MBA

J Shoulder Elbow Surg. 2017 Apr;26(4):662-668.

BACKGROUND

Repair of the subscapularis with reverse total shoulder arthroplasty (rTSA) is controversial. The purpose of this study is to quantify rTSA outcomes in patients with and without subscapularis repair to determine if there is any impact on clinical outcomes.

METHODS

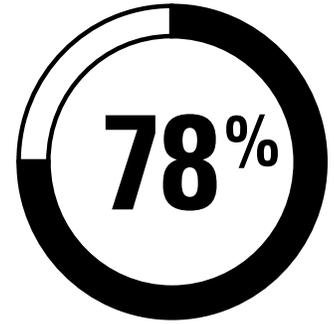
Three hundred forty patients received rTSA and had the subscapularis repaired, whereas 251 patients received rTSA and did not have the subscapularis repaired. The patients were scored preoperatively and at latest follow-up using the Simple Shoulder Test; University of California, Los Angeles; American Shoulder and Elbow Surgeons; Constant; and Shoulder Pain and Disability Index metrics. Motion was also measured. Mean follow-up was 37 months.

RESULTS

All patients showed significant improvements in pain and function after treatment with rTSA. For both cohorts, American Shoulder and Elbow Surgeons and Constant scores significantly improved, as did range of motion. The repaired cohort had significantly higher postoperative scores as measured by 4 of the 5 metrics and significantly more internal rotation, whereas the non-repaired cohort had significantly more active abduction and passive external rotation. The complication rate was 7.4% (0% dislocations) for the subscapularis-repaired cohort and 6.8% (1.2% dislocations) for the non-subscapularis-repaired cohort.

CONCLUSION

Significant clinical improvements were observed for both the subscapularis-repaired and non-repaired cohorts, with some statistical differences observed using a variety of outcome measures. Repair of the subscapularis did not lead to inferior clinical outcomes as predicted by biomechanical models. No difference was noted in the complication or scapular notching rates between cohorts. These clinical results show that rTSA using a lateralized humeral prosthesis delivers reliable clinical improvements with a low risk of instability, regardless of subscapularis repair.



convertibility Platform Stem

Conversion to reverse total shoulder arthroplasty with and without humeral stem retention: the role of a convertible-platform stem

Lynn A. Crosby, MD, Thomas W. Wright, MD, Stephen Yu, MD, and Joseph D. Zuckerman, MD

J Bone Joint Surg Am. 2017 May 3;99(9):736-742.

BACKGROUND

Revision shoulder arthroplasty is a technically challenging procedure. It is associated with increased blood loss and operative time, and it frequently necessitates revision implants, augments, and bone-grafting. Shoulder arthroplasty systems with a convertible-platform humeral stem have been developed to reduce the complexity of revision procedures by eliminating the need for humeral component explantation when converting from anatomic shoulder arthroplasty (hemiarthroplasty or total shoulder arthroplasty) to reverse total shoulder arthroplasty (rTSA).

METHODS

A multicenter, retrospective analysis involving 102 consecutive shoulders (102 patients) that underwent revision of an anatomic shoulder arthroplasty to an rTSA was conducted. During the revision, 73 of the shoulders needed exchange of the humeral stem (the exchange group) and 29 had retention of a convertible-platform humeral component (the retention group). Patient demographics, operative time, blood management, range of motion, complications, and patient-reported outcomes were compared between the 2 groups.

RESULTS

Patients with retention had significantly shorter operative time (mean and standard deviation, 130 ± 48 versus 195 ± 58 minutes; $p < 0.001$) and lower estimated blood loss (292 ± 118 versus 492 ± 334 mL; $p = 0.034$). The rate of intraoperative complications was lower in the retention group (0% versus 15%; $p = 0.027$). Patients with retention had slightly better postoperative range of motion (active external rotation, $26^\circ \pm 23^\circ$ versus $11^\circ \pm 23^\circ$ [$p = 0.006$]; active forward elevation, $112^\circ \pm 37^\circ$ versus $96^\circ \pm 33^\circ$ [$p = 0.055$]).

CONCLUSION

Shoulder arthroplasty systems that utilize a convertible-platform humeral stem offer an advantage for rTSA conversion in that a well-fixed, well-positioned humeral stem can be retained. There were significantly fewer complications as well as significantly decreased blood loss and operative time when a convertible-platform stem was utilized ($p < 0.050$).

Posterior augmented glenoid designs preserve more bone in biconcave glenoids

Andrew D. Kersten, MD, Cesar Flores-Hernandez, BS, Heinz R. Hoenecke, MD, Darryl D. D'Lima, MD, PhD

J Shoulder Elbow Surg. 2015 Jul;24(7):1135-41.

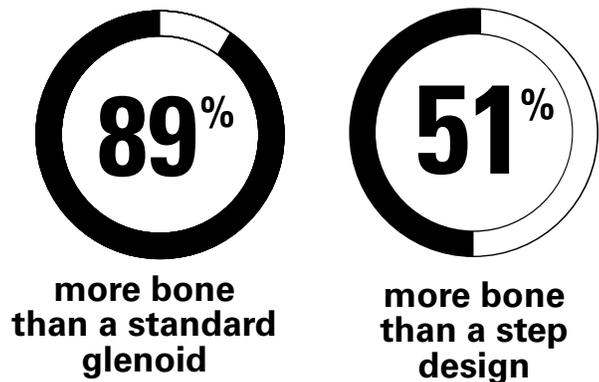
BACKGROUND

Total shoulder arthroplasty is recommended treatment for severe osteoarthritis of the glenohumeral joint, which often results in excessive posterior wear. Two recent glenoid components with posterior augments have been designed to correct excessive posterior wear and retroversion. Our primary hypothesis was that posterior augmented glenoid designs require less bone removal than a standard glenoid design.

METHODS

Ten arthritic scapulae classified as Walch B2 glenoids were virtually implanted with standard, stepped, and wedged components. The volume of surgical bone removal, the maximum reaming depth, and the portion of the implant surface in contact with cancellous vs. cortical bone were calculated for each implant.

aTSA wedge augment preserves



RESULTS

The neoglenoid made up an average of $65\% \pm 12\%$ of the glenoid width. Mean surgical bone volume removed was least for the wedged ($2857 \pm 1618 \text{ mm}^3$) compared with the stepped ($4307 \pm 1485 \text{ mm}^3$; $P < .001$) and standard ($5385 \pm 2348 \text{ mm}^3$; $P < .001$) designs. Maximum bone depth removed for the wedged ($4.2 \pm 2.0 \text{ mm}$) was less than for the stepped ($7.6 \pm 1.2 \text{ mm}$; $P < .001$) and standard ($9.9 \pm 3.2 \text{ mm}$; $P < .001$). The mean percentage of the implant's back surface supported by cancellous bone was 18.2% for the standard, 8.8% for the stepped ($P = .02$), and 4.3% for the wedged ($P = .01$).

CONCLUSION

Both augmented components corrected glenoid version to neutral and required less bone removal, required less reaming depth, and were supported by more cortical bone than in the standard implant. The least amount of bone removed was with the wedged design.

Biomechanical impact of posterior glenoid wear on anatomic total shoulder arthroplasty

Christopher P. Roche, M.S., M.B.A., Phong Diep, B.S., Sean G. Grey, M.D., and Pierre-Henri Flurin, M.D

Bulletin of the Hospital for Joint Diseases 2013;71(Suppl 2):S5-11.

INTRODUCTION

This study quantified bone removed to correct three different sizes of posterior glenoid defects and also quantified the change in rotator cuff muscle length resulting from correction of each defect using three different glenoid designs.

METHODS

A 3-D computer model quantified the cortical and cancellous bone removed when correcting three sizes of posterior glenoid defects and simulated internal/external rotation to quantify changes in rotator cuff muscle length when correcting glenoid retroversion in three sizes of posterior glenoid defects using three different glenoid prostheses: 1. eccentric reaming using a non-augmented glenoid (Equinox standard pegged), 2. 8°, 12°, and 16° Equinox posterior augment glenoid (wedge), and 3. 3 mm, 5 mm, and 7 mm Global Step-Tech posterior augment glenoid (step).

RESULTS

For small defects, the 8° wedge and 3 mm step posterior augment glenoids conserves 50% (1.295 cm³) and 23% (1.704 cm³) more bone than eccentric reaming (2.147 cm³),

respectively. For medium defects, the 12° wedge and 5 mm step glenoids conserves 69% more (1.295 cm³) and 2% less (2.720 cm³) bone than eccentric reaming (2.655 cm³), respectively. For large defects, the 16° wedge and 7 mm step glenoids conserve 48% more (1.852 cm³) and 36% less (4.343 cm³) bone than eccentric reaming (3.736 cm³), respectively. For each size defect, muscle shortening was observed for both eccentric reaming and each augmented glenoid design. Eccentric reaming medialized the humerus and resulted in additional muscle shortening (wedge: 2.0%, 2.9%, and 3.6%; step: 1.2%, 1.7%, and 1.7%) in each size defect, respectively.

CONCLUSION

Both step and wedge augmented glenoid designs conserved more anterior glenoid bone and were associated with less muscle shortening than correction with eccentric reaming. However, wedge posterior augment glenoids medialized the humerus less and were observed to be more bone conserving than step posterior augment glenoids, particular in large glenoid defects.



90%

patients report doing “better” or “much better” after TSA

Quantifying success after total shoulder arthroplasty: the minimal clinically important difference

Ryan Simovitch, MD, Pierre-Henri Flurin, MD, Thomas Wright, MD, Joseph D. Zuckerman, MD, Christopher P. Roche, MSE, MBA

J Shoulder Elbow Surg. 2018 Feb;27(2):298-305.

BACKGROUND

Knowledge of the minimal clinically important difference (MCID) for different shoulder outcome metrics and range of motion after total shoulder arthroplasty (TSA) can be useful to establish a minimum threshold of improvement that defines successful treatment. This study quantifies how MCID varies with different prosthesis types, patient age, gender, and length of follow-up after TSA.

METHODS

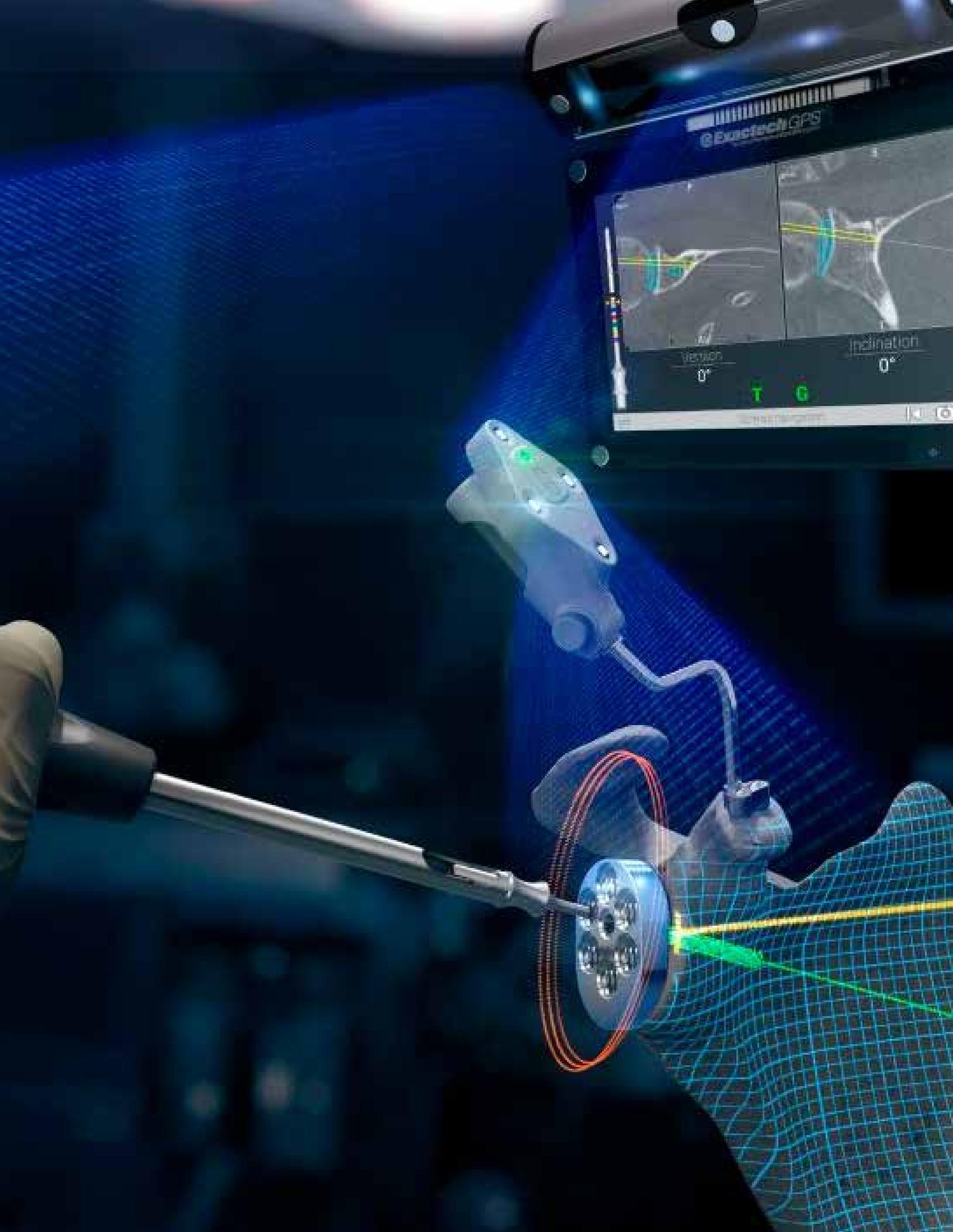
A total of 466 anatomic TSA (aTSA) and reverse TSA (rTSA) with 2-year minimum follow-up were performed by 13 shoulder surgeons. The MCID for the American Shoulder and Elbow Surgeons, Constant, University of California Los Angeles Shoulder Rating Scale, Simple Shoulder Test, Shoulder Pain and Disability Index, global shoulder function, and visual analog scale for pain scores, as well as active abduction, forward flexion, and external rotation, were calculated for different prosthesis types and patient cohorts using an anchor-based method.

RESULTS

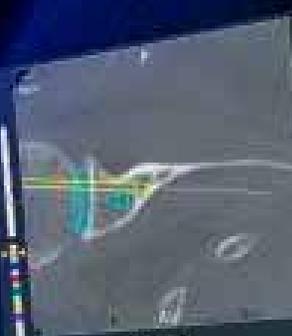
The anchor-based MCID results were American Shoulder and Elbow Surgeons = 13.6 ± 2.3 , Constant score = 5.7 ± 1.9 , University of California Los Angeles Shoulder Rating Scale = 8.7 ± 0.6 , Simple Shoulder Test score = 1.5 ± 0.3 , Shoulder Pain and Disability Index score = 20.6 ± 2.6 , global shoulder function = 1.4 ± 0.3 , pain visual analog scale = 1.6 ± 0.3 , active abduction = $7^\circ \pm 4^\circ$, active forward flexion = $12^\circ \pm 4^\circ$, and active external rotation = $3^\circ \pm 2^\circ$. Female gender and rTSA were associated with lower MCID values compared with male gender and aTSA patients.

CONCLUSION

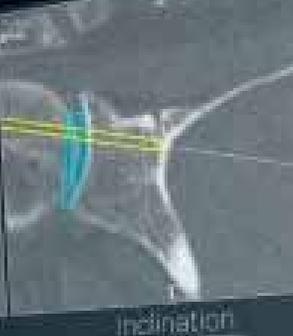
The minimum improvement necessary for patients to achieve a result they believe is clinically meaningful after aTSA and rTSA is nominal and was achieved by at least 80% of the patients. Future endeavors should investigate the influence of different anchor questions on the MCID calculation.



Exactech GPS



Tilt
0°



Inclination
0°

T G

Navigation System





Key insights from Thomas Wright, MD, and Larry Gulotta, MD

Overview

The first three papers evaluated fixation of an anatomic glenoid or reverse baseplate. The cage glenoid for anatomic shoulder replacements had a lower revision rate compared to the traditional cemented pegged implants. The cage technology is also useful for the reverse shoulder baseplate, as the two biomechanical papers demonstrated better initial fixation and durability during cyclic testing, even in poor bone models.

The next four articles evaluated augments and bone grafting in the treatment of severely worn glenoids with either an RTSA or TSA. One interesting finding was that massive structural grafts have a 25% failure rate whereas all metal augments worked as well as glenoids that received no augments.

The final paper evaluated the use of Interspace for treating infections and showed that it worked well but from a functional standpoint a second stage conversion to a RTSA gives better results.

Key Insights:

4X REDUCTION IN RADIOLUCENT LINES compared to all polyethylene pegged glenoids at mid-term follow-up

- With the addition of ExactechGPS, the fixation of both the anatomic cage glenoid and reverse baseplate may help improve on an already industry leading low failure rate (page 23).

EXCELLENT INITIAL BASEPLATE FIXATION

- Oval curved back baseplates (Equinox) showed much higher load to failure than the circular flat back baseplates (pages 24 and 25).
 - No oval baseplates failed at any point in 10,000 cycles compared to six out of seven circular flat back baseplates failing at an average of 2,600 cycles.
- Number of screws significantly impacts fixation, with no more than four making a significant difference, but less than four showing earlier load to failure (page 9).
- Exactech has been a champion of bone ingrowth technology with the use of the cage both on the anatomic glenoid and RTSA.

EXACTECH FIRST TO MARKET WITH REVERSE GLENOID AUGMENTS

- Multiple studies now show that patients who received an augment experienced excellent clinical radiographic outcomes, with low complication rates and no reports of aseptic loosening (pages 27-29).
- With advent of preoperative planning and ExactechGPS, glenoid augment usage is expected to continue to increase.
- Due to high graft failure rates (~25%), structural grafts will likely be reserved for the most severe glenoid defects. Using ExactechGPS in this operation will improve visibility compared to grafting blindly.
- Exactech has been the pioneer in using augments both on the RTSA and anatomic prosthesis. This technology has caught on as nearly every company now has augments. It appears based on the paper by Ho et al. that massive structural bone grafts are not a panacea, and augments may represent a simpler and more predictable solution (page 26).

ANTIBIOTIC SPACERS

- This study shows that the Interspace functions well in clearing infection, but it also can be left in permanently with reasonable expectation for pain relief but inferior function compared to revising it to an RTSA (page 30).

@4Y
4X

**reduction in aTSA
glenoid radiolucent lines
(cage vs all-poly)**

Clinical and radiographic comparison of a hybrid cage glenoid to a cemented polyethylene glenoid in anatomic total shoulder arthroplasty

Richard J. Friedman, MD, FRCSC, Emilie Cheung, MD, Sean G. Grey, MD, Pierre-Henri Flurin, MD, Thomas W. Wright, MD, Joseph D. Zuckerman, MD, Christopher P. Roche, MSE, MBA

J Shoulder Elbow Surg. 2019 Dec;28(12):2308-16.

BACKGROUND

This study reports the clinical and radiographic outcomes of a hybrid cage glenoid compared with an age-matched, sex-matched, and follow-up-matched cohort of cemented all polyethylene peg glenoids in patients undergoing anatomic total shoulder arthroplasty with 2 years' minimum follow-up.

METHODS

We reviewed 632 primary anatomic total shoulder arthroplasty patients from an international multi-institutional database; 316 patients received hybrid cage glenoids and were matched for age, sex, and follow-up with 316 patients with cemented all-polyethylene peg glenoids. Each cohort received the same humeral component. Scoring was performed in all patients preoperatively and at latest follow-up using 5 outcome scoring metrics and 4 active range-of-motion measurements. A student 2-tailed unpaired t test identified differences in outcomes; $P < .05$ denoted a significant difference.

RESULTS

Cage glenoid patients had significantly lower rates of radiolucent glenoid lines (9.0% vs. 37.6%, $P < .0001$) and radiolucent humeral lines (3.0% vs. 9.1%, $P = .0088$) than all-polyethylene peg glenoid patients. In the cage glenoid cohort, 4 cases of aseptic glenoid loosening (1.3%) and 4 cases of articular surface dissociation (1.3%) occurred. In the all-polyethylene peg cohort, 12 cases of aseptic loosening (3.8%) occurred. Cage glenoid patients had a significantly lower revision rate than all-polyethylene peg glenoid patients (2.5% vs. 6.9%, $P = .0088$).

CONCLUSION

At 50 months' mean follow-up, cage glenoids demonstrated equally good clinical outcomes to all-polyethylene peg glenoids. Cage glenoids had significantly fewer radiolucent lines around both the glenoid and humeral components and a lower revision rate. Longer-term follow-up is required to confirm these promising short-term results.

**98%
& 85%**
improvement in
initial fixation

Initial glenoid fixation using two different reverse shoulder designs with an equivalent center of rotation in a low-density and high-density bone substitute*

Nicholas J. Stroud, MS, Matthew J. DiPaola, MD, Brian L. Martin, BS, Cindy A. Steiler, AA, Pierre-Henri Flurin, MD, Thomas W. Wright, MD, Joseph D. Zuckerman, MD, Christopher P. Roche, MS

J Shoulder Elbow Surg. 2013 Nov;22(11):1573-79.

BACKGROUND

Numerous glenoid implant designs have been introduced into the global marketplace in recent years; however, little comparative biomechanical data exist to substantiate one design consideration over another.

METHODS

This study dynamically evaluated reverse shoulder glenoid baseplate fixation and compared the initial fixation associated with 2 reverse shoulder designs having an equivalent center of rotation in low-density and high-density bone substitute substrates.

RESULTS

Significant differences in fixation were observed between implant designs, where the circular-porous reverse shoulder was associated with approximately twice the micromotion per equivalent test than the oblong-grit-blasted design.

Additionally, 6 of the 7 circular-porous reverse shoulders failed catastrophically in the low-density bone model at an average of 2603 ± 981 cycles. None of the oblong-grit-blasted designs failed in the low-or high-density bone models and none of the circular-porous designs failed in the high-density bone models after 10,000 cycles of loading.

CONCLUSION

These results demonstrate that significant differences in initial fixation exist between reverse shoulder implants having an equivalent center of rotation and suggest that design parameters, other than the position of the center of rotation, significantly affect fixation in low-density and high-density polyurethane bone substitutes. Subtle changes in glenoid baseplate design can dramatically affect fixation, particularly in low-density bone substitutes that are intended to simulate the bone quality of the recipient population for reverse shoulders.

*In vitro (bench) test results may not necessarily be indicative of clinical performance.

Reverse shoulder glenoid loosening: An evaluation of the initial fixation associated with six different reverse shoulder designs*

Nick Stroud, MS, Matthew J. DiPaola, MD, Pierre-Henri Flurin, MD, and Christopher P. Roche, MS, MBA

Bulletin of the Hospital for Joint Diseases 2013;71(Suppl 2): S12-7.

BACKGROUND

This study quantified glenoid fixation before and after cyclic loading of six reverse shoulder prosthesis designs when secured to low- and high-density bone substitute blocks.

METHODS

A displacement test quantified fixation of six reverse shoulder designs: 38 mm Equinoxe standard offset (EQ), 38 mm Equinoxe lateral offset (EQL), 36 mm Depuy Delta III (DRS), 36 mm Zimmer (ZRS), 32 mm DJO RSP (DJO), and a 36 mm Tornier BIO-RSA (BIO), secured to 0.24 and 0.48 g/cm³ polyurethane blocks as a shear (357 N) and compressive (50 N) load were applied before and after cyclic loading. Displacement was measured with a dial indicator in the directions of the applied loads along the superior/inferior axis. A cyclic test rotated each glenosphere (N = 7) at 0.5 Hz for 10 k cycles as 750 N was constantly applied. A two-tailed Student's unpaired t-test compared mean displacements.

RESULTS

The average displacement of the EQ, EQL, ZRS, DJO, DRS, and BIO-RSA devices in the low-density substrate was 182, 137, 431, 321, 190, and 256 microns, respectively.

The average displacement of the EQ, EQL, ZRS, DRS, and BIO-RSA devices in the high-density substrate was 102, 95, 244, 138, and 173 microns, respectively. Pre- and post-cyclic displacement was significantly less in the high-density bone substitutes than in the low-density bone substitutes for the majority of implant comparisons. During the cyclic test, six of seven ZRS devices failed at an average of 2,603 cycles, one of seven 32 mm DJO failed at 7,342 cycles, and four of seven BIO devices failed at an average of 2,926 cycles. All seven of the EQ, EQL, and DRS devices remained well fixed throughout cyclic loading.

CONCLUSION

This study quantified glenoid fixation of six reverse shoulder designs; significant differences in fixation were observed between nearly every implant design tested.

**In vitro (bench) test results may not necessarily be indicative of clinical performance.*

Early radiographic failure of reverse total shoulder arthroplasty with structural bone graft for glenoid bone loss

Jason C. Ho, MD, Ocean Thakar, BS, Wayne W. Chan, MD, PhD, Thema Nicholson, MS, Gerald R. Williams, MD and Surena Namdari, MD, MS

Article in press. J Shoulder Elbow Surg (2019) -, 1-11.

BACKGROUND

Structural glenoid bone grafting in reverse total shoulder arthroplasty (RSA) has previously been reported to have good functional outcomes and low complication rates. We have observed different complication rates and hypothesized that baseplate fixation and severity of deformity may be predictors of early failure.

METHODS

We retrospectively identified 44 patients who underwent RSA with structural bone grafting for glenoid bone defects. All patients had preoperative and postoperative (Grashey and axillary) radiographs at a minimum of 1 year after surgery and within 3 months of surgery for evaluation of implant and graft positioning. Clinical data and outcome scores were collected at the same intervals.

RESULTS

There were 61% females and 39% males, with an average age of 74 ± 8 years at the time of surgery. The median final radiographic follow-up was 20 months, with 37 primary RSA and 7 revision RSA. Graft resorption was found in 11 of 44 patients (25%), and radiographic failure was found in 11 of 44 patients (25%) at a median of 8 months (range 3-51 months). Forward elevation, American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form, Single Assessment Numeric Evaluation (SANE), and Simple Shoulder Test (SST) scores all significantly improved postoperatively ($P < .0001$). Radiographic baseplate failure was associated with graft resorption ($P = .002$), more retroversion correction ($P = .02$), and worse SANE scores at final follow-up ($P = .01$).

CONCLUSION

RSA with structural bone graft improved range of motion and function, but there was a larger than previously reported baseplate loosening rate. This early radiographic loosening appeared to be associated with graft resorption, retroversion correction, and worse outcome scores.



Clinical outcomes of augmented rTSA glenoid baseplates

Lawrence V. Gulotta, MD, Sean G. Grey, MD, Pierre-Henri Flurin, MD, Thomas W. Wright, MD, Joseph D. Zuckerman, MD, Christopher P. Roche, MSE, MBA

Presented at ASES 2019 (Nominated for Neer Award).

BACKGROUND

Glenoid wear is a common challenge in patients undergoing reverse total shoulder arthroplasty (rTSA). Augmented baseplates have recently been designed to address this. The purpose of this study is to determine the clinical outcomes, complications, and revision rates of patients undergoing rTSA with an augmented baseplate compared to those that received a standard, non-augmented baseplate.

METHODS

Preoperative and postoperative data were analyzed for 341 patients with glenoid bone loss who underwent primary rTSA with either an 8° posterior augmented glenoid baseplate (PAB), a 10° superior augmented baseplate (SAB), or an 8° posterior/10° superior augmented baseplate (P/SAB). These patients were compared to 1491 primary rTSA patients who received a standard baseplate. Clinical outcomes were scored using the Simple Shoulder Test (SST), UCLA, ASES, Constant and SPADI clinical outcome scoring metrics. Range of motion for active abduction, forward flexion, internal rotation and external rotation were used to quantify function. Complication

and revision rates were also documented, and post-operative radiographs were analyzed for scapular notching. A two-tailed, unpaired t-test was used to identify differences between continuous parameters and a Chi Sq test was used for categorical parameters, with $p < 0.05$ denoting a significant difference.

RESULTS

At an average follow-up of 45.7 ± 22.5 months, the augmented baseplates performed as well, or better, than standard baseplates, with a similar complication rate and scapular notching rate.

CONCLUSION

Augmented baseplates are a safe and effective option for patients with glenoid bone loss in the setting of rTSA at mid-term follow-up. For each baseplate type, the outcomes were similar, and the complication/revision and scapular notching rates were low and comparable to that of the standard baseplate cohort.

Clinical and radiographic outcomes with a posteriorly augmented glenoid for Walch B glenoids in anatomic total shoulder arthroplasty



Grey, S; Wright, T; Flurin, PH; Zuckerman, J; Roche, C; Friedman, R

Article in press. J Shoulder Elbow Surg (2019).

INTRODUCTION

Osteoarthritis of the glenohumeral joint is often associated with posterior glenoid wear. Options for treating posterior glenoid wear include eccentric glenoid reaming and bone grafting. More recently, posterior augmented glenoids have been introduced, which can restore the native joint line while reaming a minimal amount of glenoid bone, and better tension the soft tissues. The purpose of this study is to quantify the clinical and radiographic outcomes of posterior augmented glenoid patients who have a Walch B glenoid deformity and were treated with anatomic total shoulder arthroplasty (aTSA).

METHOD

Clinical outcomes data utilized in this study was retrospectively queried from a multi-institutional WIRB approved database. 84 primary aTSA patients with osteoarthritis and posterior glenoid wear were treated with an 8° posterior augmented glenoid and had 2yr minimum follow-up. Patients without pre-operative assessment of glenoid version and Walch glenoid classification were excluded. These criteria yielded a study cohort consisted of 68 primary posterior augment glenoid aTSA patients with a Walch B glenoid and had a mean follow-up of 50 months. All patients were evaluated and scored pre-operatively and at latest follow-up using 5 clinical outcome scoring metrics; active range of motion was also measured. Grashey and axillary lateral radiographs were evaluated at latest follow-up. A Student's two-tailed, unpaired t-test quantified differences in pre-operative, post-operative, and pre-to-post-operative improvement, where $p < 0.05$ denoted a significant difference.

RESULTS

All Walch B glenoid patients experienced significant improvements in pain and function following aTSA with a posterior augment glenoid, where 90% of patients exceeded the minimal clinically important difference (MCID) threshold for the clinical outcome metric scores and ROM measures. Additionally, 2/3 of patients exceeded the substantial clinical benefit (SCB) threshold for the clinical outcome metrics and ROM measures. Prior to surgery, the humeral head was posteriorly subluxed at an average of 72.7% for each Walch B glenoid type and at latest follow-up the humeral head was observed to be re-centered on the posterior augment glenoid. Additionally, no differences in clinical outcomes, range of motion measures, radiolucent glenoid line rates or grades, radiolucent humeral line rates, or humeral head subluxation were observed between patients of different Walch B glenoid types. Two patients with augmented glenoids in Walch B2 glenoids were revised for aseptic glenoid loosening.

DISCUSSION

aTSA patients with Walch B glenoids receiving an 8° posterior augment wedge glenoid experienced excellent clinical and radiographic outcomes with >97% patient satisfaction and a low complication rate at a mean follow-up of 50 months. Additionally, humeral head centering was restored for each type of Walch B glenoid. Based on these results, we conclude that an 8° posterior augmented glenoid with aTSA is a viable treatment option for the Walch B posteriorly worn osteoarthritic glenoid.

Clinical and radiographic outcomes with a posteriorly augmented glenoid for Walch B2, B3, and C glenoids in reverse total shoulder arthroplasty

Virk, M. et al.

Article in press. J Shoulder Elbow Surg (December 2019). ePub S1058-2746(19) 30658-5.

INTRODUCTION

The purpose of this study is to quantify the clinical and radiographic outcomes of patients with severe posterior glenoid wear who were treated with reverse total shoulder arthroplasty (rTSA) and a posterior augment baseplate.

METHODS

67 primary rTSA patients with osteoarthritis and posterior glenoid wear were treated with an 8° posterior augmented glenoid baseplate. All patients had a Walch B2, B3, or C glenoid, 2-year minimum follow-up, and had a mean follow-up of 40 months. All patients were scored preoperatively and at latest follow-up using 5 clinical outcome metrics; active range of motion was also measured. A Student's two-tailed, unpaired t-test quantified differences in outcomes, where $p < 0.05$ denoted significance.

RESULTS

All patients experienced significant improvements in pain and function following primary rTSA with a posterior augment glenoid baseplate. Three complications were reported for a rate of 4.5%; no cases of aseptic glenoid loosening occurred. 90% of patients exceeded the minimal clinically important difference threshold and 80% of patients exceeded the substantial clinical benefit threshold for each clinical outcome metric and range of motion measure. No differences in outcomes or complications were observed between Walch B2 and B3 patients, demonstrating this full-wedge posterior augment baseplate was equally good in each type of glenoid deformity.

DISCUSSION

Primary rTSA patients with Walch B2, B3, and C glenoids who received an 8° posterior augment glenoid baseplate experienced excellent clinical and radiographic outcomes with a low complication rate and no reports of aseptic glenoid loosening at a mean follow-up of 40 months.

Management of infected shoulder arthroplasty: a comparison of treatment strategies

Matthew Patrick, MD, Heather K. Vincent, PhD, Kevin W. Farmer, MD, Joseph J. King, MD, Aimee M. Struk, MEd, ATC and Thomas W. Wright, MD

J Shoulder Elbow Surg. 2019 Sept;28(9):1658-65.

BACKGROUND

The study purpose was to determine whether 2-stage revision procedures result in superior outcomes and whether reverse shoulder arthroplasty produced superior outcomes to hemiarthroplasty or anatomic total shoulder arthroplasty at the time of reimplantation.

METHODS

Our prospectively collected database was retrospectively reviewed for all surgically treated infected shoulder arthroplasties between 2006 and 2014. We included 47 patients in this study: 27 underwent a 2-stage revision, and 20 were treated with an antibiotic spacer as definitive treatment. Preoperative laboratory results, intraoperative cultures and pathology findings, recurrence of infection, complications, and outcome measures were compared between treatment groups.

RESULTS

A recurrent infection developed in 3 patients in the antibiotic spacer group and 2 patients in the 2-stage revision group ($P = .25$). A total of 20 procedure-related complications and 11 medical complications occurred between the 2 groups; however, there was no statistically significant difference between groups. The 2-stage group had statistically significantly better Constant scores (58.1 vs. 33.3, $P = .04$) and elevation (94.4° vs. 48.6° , $P = .02$) than the antibiotic spacer group. Subanalysis of the 2-stage revision group showed that reverse total shoulder arthroplasties had statistically superior Shoulder Pain and Disability Index, Simple Shoulder Test, American Shoulder and Elbow Surgeons, University of California at Los Angeles, and Constant scores; elevation; and abduction compared with hemiarthroplasties or anatomic total shoulder arthroplasties.

CONCLUSION

Two-stage revision procedures and use of an antibiotic spacer for definitive management of periprosthetic shoulder infections appear to be similar and effective in eradicating infections. Two-stage revisions using a reverse total shoulder arthroplasty at the time of reimplantation generate superior range of motion and functional outcome scores.



