JSES International 6 (2022) 21–25

Contents lists available at ScienceDirect

JSES International

journal homepage: www.jsesinternational.org

Comparison of press-fit versus peripherally cemented hybrid glenoid components in anatomic total shoulder arthroplasty: minimum 5-year follow-up

J. Brett Goodloe, MD, Kirsi S. Oldenburg, BSPH, Sarah Toner, MD, Justin M. Rabinowitz, MD, William R. Barfield, PhD, Josef K. Eichinger, MD, Richard J. Friedman, MD, FRCSC*

Department of Orthopaedics, Medical University of South Carolina, Charleston, SC, USA

ARTICLE INFO

Keywords:
Anatomic
Shoulder
Arthroplasty
Press fit
Glenoid
Prosthesis
Outcomes

Level of evidence: Level III; Retrospective Cohort Comparison; Treatment Study

Background: A common complication of anatomic total shoulder arthroplasty (aTSA) is aseptic glenoid loosening. Monoblock polyethylene glenoid components with backside ingrowth or on-growth utilize hybrid fixation, with cementation of the peripheral pegs and central ingrowth or on-growth of bone have been designed to decrease glenoid loosening. However, there is a paucity of midterm data comparing cementation of the peripheral peg holes versus all press-fit implantation for hybrid glenoid constructs. The purpose of this study is to compare the minimum five-year clinical and radiographic outcomes of a press-fit hybrid glenoid component with a peripherally cemented hybrid glenoid component in aTSA.

Methods: Between years 2013-2015, we reviewed a total of 169 patients who underwent primary aTSA, with follow-up data spanning a minimum of five years, from an international multi-institutional database. There were 61 press-fit and 108 peripherally cemented glenoids. Shoulders were evaluated for outcome measures, which included clinical outcome scores, radiographic outcomes, and complication rates.

Results: Postoperatively, there were no statistically significant differences in patient satisfaction, shoulder function, pain scoring, the Simple Shoulder Test, the Constant score, the American Shoulder and Elbow Surgeons score, the University of California—Los Angeles score, nor the Shoulder Pain and Disability Index, between the two cohorts. There were no significant differences in adverse events ($P = .791$) or revision rates ($P = .592$). At the final radiographic follow-up, there were no significant differences between the two groups with regard to the incidence of radiolucent lines on the glenoid ($P = .210$) or humeral side ($P = .282$).

Conclusion: At a minimum of 5-year follow-up, aTSA with a press-fit glenoid implant demonstrates no difference in clinical or radiographic outcomes when compared with a glenoid cohort where the peripheral pegs are cemented. In addition, there is no increased rate of aseptic glenoid loosening or need for revision surgery between the two groups with a lower rate of radiolucency detected than prior midterm data studies. Uncemented press-fit glenoid fixation with a cage component appears to be a safe and effective treatment option for patients undergoing primary aTSA at a minimum of 5-year follow-up.

© 2021 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/).

Anatomic total shoulder arthroplasty (aTSA) was designed to provide improved function and pain relief for patients with symptomatic osteoarthritis and a functioning rotator cuff.[3,13] Aseptic glenoid loosening with cemented glenoid implants remains one of the most frequent causes of pain and implant failure.[2,6] A recent study showed 100% glenoid loosening at 20 years, suggesting that a cemented all-polyethylene glenoid may not be the best choice in younger patients.[7] Various glenoid constructs were developed to provide adequate long-term fixation, often with little success. Metal-backed glenoid components were used for a brief period, but this transition was short lived as poor outcomes and complications arose.[1,10,15] Over the past ten years, hybrid glenoid constructs consisting of a polyethylene glenoid melded with metal on the backside, which allows for bony ingrowth or on-growth, with a central cage/peg and cementation of peripheral pegs have been developed. Clinical trials found good clinical

This study received approval by the Medical University of South Carolina Institutional Review Board for Human Research (proposal no. Pro00030914).

*Corresponding author: Richard J. Friedman, MD, FRCSC, Professor of Orthopaedics and Physical Medicine, Medical University of South Carolina, 96 Jonathan Lucas Street, CSB 708, MSC 622, Charleston, SC 29425, USA.

E-mail address: friedman@musc.edu (R.J. Friedman).

https://doi.org/10.1016/j.jseint.2021.09.009

2666-6383/© 2021 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/).

outcomes overall, however, with varying degrees (29%-93%) of osseointegration of the central peg.[4,5,9,14,16,19] All the previous studies cemented the peripheral pegs.

More recently, surgeons used a modified technique in which aTSA is performed with implantation of a monoblock hybrid glenoid without the use of peripheral cementation of the peripheral pegs.[9,11,17] The theoretical advantages of this technique include less operative time, reduction in possible heat-induced necrosis, and potentially reduced complications in the revision setting. However, there are limited data regarding the clinical and radiographic outcomes when using a press-fit uncemented technique. In addition, there are few data thus far to support hybrid glenoids beyond five years, with existing data having mixed results.[4,11]

The purpose of this study is to compare the minimum 5-year clinical and radiographic outcomes of cemented peripheral pegs versus press-fit uncemented glenoid constructs in aTSA. We hypothesize that there will be no clinical or radiographic differences between the two cohorts. In addition, this study will document the clinical and radiographic outcomes of an uncemented glenoid component and cemented peripheral peg glenoid component with midterm follow-up and determine how these results compare with previously published short-term results.

Materials and methods

An international multi-institutional database was queried between January 2013 and December 2015. One hundred sixty-nine patients who underwent primary aTSA, with a minimum follow-up period of 5 years and an average age of about 65 years, were identified and included in the study. All patients underwent primary aTSA with a hybrid cage glenoid (Equinoxe platform shoulder system; Exactech, Gainesville, FL, USA), which incorporates a titanium plasma–coated central cage that is a clean room assembled with a 4-mm–thick molded, all-polyethylene, 4-peg glenoid component.[9] The two glenoid implantation techniques utilized an identical peg pattern and were prepared with the same instrumentation. All caged glenoids were implanted using the same instrumentation. All patients received the same humeral component. These procedures were performed by six different fellowship-trained surgeons. The only difference during the implantation process was whether cement was utilized in the three peripheral peg holes during fixation of the glenoid component. Two of the surgeons performed only the uncemented press-fit technique, and four surgeons performed the hybrid cemented technique.

All patients underwent evaluation and scoring preoperatively for demographic information including age, sex, body mass index, prior injections, and prior surgery. Preoperative and postoperative active range of motion (ROM) measures included forward elevation, active abduction, external rotation, and internal rotation. Forward elevation and external rotation were measured in degrees using a goniometer. Internal rotation was measured by the vertebral level reached by the thumb using the scale of Flurin et al.[8] This scale assigns the following measurements to each score, 0 = 0 degrees, 1 = hip, 2 = buttocks, 3 = sacrum, 4 = L4-L5, 5 = L1-L3, 6 = T8-T12, and 7 = T7 or higher. All measurements were performed in the clinic by a member of the research team. All patients underwent evaluation and scoring preoperatively and at the latest follow-up using the Simple Shoulder Test (SST), University of California Los Angeles (UCLA), American Shoulder and Elbow Surgeons (ASES), Constant, and Shoulder Pain and Disability Index (SPADI) scoring metrics. Subjective shoulder function was measured on a scale from 1-10, with a score of 10 signifying an asymptomatic, fully functional shoulder. Each patient was asked to rate the operative shoulder at the latest follow-up relative to their preoperative condition as "much better", "better", "unchanged", or "worse". Pain was rated on a scale from 1 to 10, with 10 indicating severe pain. These data were analyzed to assess patient satisfaction between cohorts.

Standardized radiographs, including a Grashey and axillary lateral, were obtained preoperatively and at scheduled follow-up visits. Before surgery, computed tomography scans and/or magnetic resonance images were also obtained to assess glenoid morphology. Radiographs were evaluated and graded by the operating surgeon for the presence and degree of glenoid radiolucent lines (RLLs) as per the Lazarus scale.[12] In addition, postoperative complications and revisions were reviewed and documented as well.

All statistical analyses were performed using SPSS, version 27 (IBM, Armonk, NY, USA). Differences in preoperative functionality and pain scores, and postoperative outcomes, between the press-fit glenoids and hybrid cemented glenoids were evaluated. Continuous dependent variables were analyzed using the t-test or the Mann Whitney-U test when the data were nonparametric. Binary dependent variables were analyzed using the chi-squared test or Fisher's exact test when appropriate. $P < .05$ denoted a significant difference.

Results

There were 61 press-fit glenoids and 108 peripheral cemented glenoids. The average age of the press-fit group was 65 years, and there were 53% women. The average age of the hybrid cemented glenoid group was 65 years, with 48% being women. The mean follow-up was 6 years (range: 5-8 years) for both groups ($P = .557$). All patients in the press-fit group were indicated based on a diagnosis of osteoarthritis (100%). In the cemented group, 93% of patients had a diagnosis of osteoarthritis. There were no statistically significant differences between the two groups in terms of age, gender, body mass index, previous shoulder surgery, primary diagnosis, and mean follow-up period (Table I).

With regard to preoperative ROM, there were significant differences between the two groups in terms of active abduction ($P = .003$) and internal rotation ($P = .004$), with higher values in the press-fit group. However, they did not exceed the minimal clinically important difference (MCID).[18] Similarly, preoperative shoulder function, SST, ASES, and SPADI scores were statistically significantly higher in the uncemented group, but these significant differences did not exceed the MCID deemed to be clinically relevant.[18] There were no differences among Constant scores ($P = .063$), UCLA scores ($P = .077$), and pain scores ($P = .349$) between the two cohorts preoperatively (Table II).

Postoperatively, both groups had statistically significant improvements that exceeded the MCID for all ROM measurements, all five outcome scores, pain scores, and shoulder function. When comparing the two groups, press-fit aTSA had significantly higher active abduction ($P < .001$) and internal rotation ($P < .001$) that exceeded the MCID, likely reflecting the pre-existing preoperative differences. However, there were no statistically significant differences in patient outcome scores between the two cohorts for the SST ($P = .790$), Constant score ($P = .288$), ASES score ($P = .077$), UCLA score ($P = .554$), or SPADI scores ($P = .204$). There were no statistically significant differences in terms of pain scores, shoulder function, or patient satisfaction postoperatively between the two cohorts ($P = .083$, $P = .904$, and .096, respectively) (Table III).

At the final radiographic follow-up, glenoid RLLs were present in 5.7% of the press-fit glenoids with a mean RLL grade of 0.2 and

Table I
Demographics.

Glenoid technique	Age (yrs)	Gender	BMI	Previous shoulder surgery	Primary diagnosis %	Mean follow-up (yrs)
Uncemented n = 61	65	53% female	31	16%	OA 100 RA 0 ON 0	6
Cemented n = 108	65	48% female	30	21%	OA 93 RA 6 ON 1	6
P-value	0.513	0.510	0.279	0.490	0.124	0.557

BMI, body mass index; *OA*, osteoarthritis; *RA*, rheumatoid arthritis; *ON*, osteonecrosis.
Uncemented = press-fit glenoids, cemented = hybrid cemented glenoids, N = number.

Table II
Preoperative functional outcomes.

Glenoid technique	Shoulder function	Pain score	SST	Constant	ASES	UCLA	SPADI
Uncemented							
Mean +/- SD	4.9 ± 2.1	6.6 ± 2	5.1 ± 2.7	41.2 ± 12.5	38.3 ± 13.9	14.9 ± 3.4	75.3 ± 20.6
Cemented							
Mean +/- SD	3.9 ± 1.9	6.8 ± 2	3.7 ± 3.1	36.5 ± 13.0	32.1 ± 17.1	13.7 ± 4.0	88.0 ± 28.1
P value	**0.025**	0.349	**0.007**	0.063	**0.048**	0.077	**0.002**

SD, standard deviation; *SST*, Simple Shoulder Test; *UCLA*, University of California, Los Angeles; *ASES*, American Shoulder and Elbow Surgeons; *SPADI*, Shoulder Pain and Disability Index.
Bolded *P* values are significant.

Table III
Postoperative functional outcomes.

Glenoid technique	Patient satisfaction	Shoulder function	Pain score	SST	Constant	ASES	UCLA	SPADI
Uncemented								
Mean +/- SD	88%	8.1 ± 2.4	1.7 ± 2.5	9.8 ± 3.2	71.3 ± 16.9	80.5 ± 21.4	29.7 ± 6.2	22.9 ± 26.6
Cemented								
Mean +/- SD	95%	8.4 ± 2.1	1.2 ± 2.1	10.3 ± 2.3	68.9 ± 13.4	85.6 ± 19.1	30.5 ± 5.5	18.0 ± 23.6
P value	0.096	0.904	0.083	0.790	0.288	0.077	0.554	0.204

SD, standard deviation; *SST*, Simple Shoulder Test; *UCLA*, University of California, Los Angeles; *ASES*, American Shoulder and Elbow Surgeons; *SPADI*, Shoulder Pain and Disability Index.

Table IV
Adverse outcomes.

Glenoid technique	Presence of humeral RLLs	Presence of glenoid RLLs	Average grade of glenoid RLLs	Complications	Revision surgery
Uncemented	13.5%	5.7%	0.2 ± 0.90	8.2%	6.6%
Cemented	6.1%	14.3%	0.4 ± 1.24	5.6%	4.6%
P values	0.282	0.210	0.227	0.791	0.592

RLLs, radiolucent lines.
Uncemented = press-fit glenoids, cemented = hybrid cemented glenoids.

14.3% of the hybrid cemented cohort with a mean RLL grade of 0.4 ($P = .210$ and $P = .227$, respectively). There was no significant difference in the incidence of humeral RLLs between the two cohorts (13.5% vs. 6.1%, $P = .282$) (Table IV).

In the press-fit aTSA group, there were 5 complications, with three patients revised due to aseptic loosening of the glenoid component, one patient had a dissociation of the components, and one patient had a stroke postoperatively. In the cemented group, there were 6 complications. Three patients were revised because of aseptic loosening of the glenoid component, one patient was revised because of a deep prosthetic infection, and one patient had radiographic findings and pain suggestive of an acute rotator cuff tear and was subsequently revised to a reverse TSA. One patient had continued pain along the lateral aspect of the upper arm, but no revision surgery was performed on this patient. There were no significant differences in adverse events ($P = .791$) or revision rates ($P = .592$) between the two groups (Table IV).

Discussion

Aseptic glenoid loosening remains an unsolved problem in aTSA. This is the largest cohort of patients to date with a hybrid glenoid component in aTSA, with a minimum 5-year follow-up, evaluating differences in clinical and radiographic outcomes between cementing the peripheral pegs versus press-fit fixation. These data show that in direct comparison with a cemented glenoid construct, there is no difference in clinical or radiographic outcomes compared with patients who underwent an uncemented press-fit cage glenoid in aTSA. In addition, there was no increase in the incidence of aseptic glenoid loosening or need for revision surgery. Using press-fit glenoid components can be valuable as it can improve operative time and potentially reduce unwanted complications associated with a cemented technique.

This study builds on the prior study by Friedman et al that evaluated a hybrid cage glenoid compared with a fully cemented

glenoid of the same design in aTSA with a minimum of two-year follow-up. That study demonstrated comparable clinical outcomes, a significant reduction in the incidence of glenoid RLLs, and a significantly lower revision rate of hybrid cage glenoids than the age-matched, sex-matched, and follow-up–matched cemented glenoid cohort.[9] The present study shows that those short-term results, both clinical and radiographic, become nonsignficiant 5 to 8 years after surgery. There were similar clinical ROM and patient-reported outcome scores, as well as no significant changes in the radiographic appearance with regard to RLLs or RLL grades. A high percentage of patients in both groups continued to rate their aTSA as much better or better than their preoperative status.

As hybrid and press-fit glenoid components continue to gain popularity, there have been some controversial data emerging regarding the clinical and radiographic midterm outcomes. Chen et al reported on 55 aTSAs using second-generation hybrid trabecular metal implants with minimum 5-year follow-up. Patients were divided into two matched cohorts: peripheral peg cementation versus press-fit glenoid fixation. Excellent clinical and patient-reported outcomes were demonstrated in both cohorts; however, the press-fit group demonstrated higher rates of RLLs (64%) than the cemented group (24%). No patients in either group required revision surgery or had evidence of component fracture or gross loosening.[4] The results in the present study reflect those seen by Chen et al, except for those regarding higher rates of RLLs.

Jacxsens et al performed a cohort study of 35 aTSAs undergoing uncemented implantation of a cage glenoid component with a minimum 5-year follow-up and mean follow-up of 100 months. Their results demonstrated significant improvements in clinical outcomes that were comparable with their short-term data. However, 31% of the glenoid components were considered radiographically loose.[11] These rates of RLLs are significantly higher than the rates in the present study, both for the uncemented press-fit group and the peripheral peg cemented cohort. No components in this study were radiographically loose.

Schoch et al published a case series with patients who underwent press-fit implantation of the same cage glenoid component used in this study, with 51 patients over a 3-year period. They demonstrated that press-fit glenoid components do not lead to early loosening, allowing time for bony ingrowth to occur. They concluded that press-fit fixation is a safe option for those undergoing TSA.[17] However, their study did not included a comparative group, and the mean follow-up was only 3 years, whereas the present study contains a cemented control cohort and a minimum follow-up of 5 years

The present study is not without limitations. This study lacked randomization and utilized data from six different orthopedic surgeons which potentially introduces differences in surgical technique. However, the same shoulder arthroplasty implant was used, and the same instrumentation was used for each case, yet there may still be variability in technique. In addition, the use of a single implant does not make these findings generalizable to all aTSAs. Furthermore, there is inherent bias in the operating surgeon evaluating their own radiographic results. In order for more critical, unbiased assessment, future work should include independent evaluators for radiographic analysis. There was a difference in the patient population between the two groups, with the cemented group having a higher incidence of patients with inflammatory arthritis. This may have accounted for the statistical differences seen preoperatively but did not appear to affect the postoperative clinical or radiographic outcomes. There was no preoperative assessment for humeral head subluxation or glenoid wear pattern evaluation, which may predict postoperative results in aTSA. Finally, longer-term clinical and radiographic follow-up will only provide better information in terms of long-term implant survivorship.

Conclusion

At a minimum 5-year follow-up, there are equivalent clinical outcomes, radiographic outcomes, complication rates, and revision rates using a hybrid cage glenoid with or without the use of cement in the peripheral pegs in aTSA. The clinical and radiographic outcomes are similar to previously published studies with a shorter follow-up period, demonstrating that the results continue over time. The incidence of glenoid RLLs within this cohort is lower than that in other recently published studies with minimum 5-year follow-up. This study supports the continued use of a hybrid cage glenoid in aTSA and that using cement for the peripheral pegs is not required. Longer-term clinical and radiographic follow-up is needed to determine whether these midterm radiographic improvements will correlate with lower rates of aseptic glenoid loosening and better long-term implant survivorship.

Disclaimers:

Funding: There was no funding for this study.
Conflicts of interest: Dr. Friedman reports grants and personal fees from Exactech, Inc. Dr. Eichinger reports grants and nonfinancial support from Exactech, Inc. as well as personal fees from FH Ortho outside the submitted work. The other authors, their immediate families, and any research foundation with which they are affiliated did not receive any financial payments or other benefits from any commercial entity related to the subject of this article.

References

1. Boileau P, Moineau G, Morin-Salvo N, Avidor C, Godeneche A, Levigne C, et al. Metal-backed glenoid implant with polyethylene insert is not a viable long-term therapeutic option. J Shoulder Elbow Surg 2015;24:1534-43. https://doi.org/10.1016/j.jse.2015.02.012.
2. Bonnevialle N, Melis B, Neyton L, Favard L, Mole D, Walch G, et al. Aseptic glenoid loosening or failure in total shoulder arthroplasty: revision with glenoid reimplantation. J Shoulder Elbow Surg 2013;22:745-51. https://doi.org/10.1016/j.jse.2012.08.009.
3. Castagna A, Randelli M, Garofalo R, Maradei L, Giardella A, Borroni M. Mid-term results of a metal-backed glenoid component in total shoulder replacement. The J bone Jt Surg Br 2010;92:1410-5. https://doi.org/10.1302/0301-620X.92B10.23578.
4. Chen RE, Brown AM, Greenstein AS, Miller RJ, Mannava S, Voloshin I. Cemented versus uncemented fixation of second generation trabecular metal glenoid components: minimum 5-year outcomes. J Shoulder Elbow Surg 2021;30:e147-e56. https://doi.org/10.1016/j.jse.2020.07.025.
5. Churchill RS, Zellmer C, Zimmers HJ, Ruggero R. Clinical and radiographic analysis of a partially cemented glenoid implant: five-year minimum follow-up. J Shoulder Elbow Surg 2010;19:1091-7. https://doi.org/10.1016/j.jse.2009.12.022.
6. Clitherow HD, Frampton CM, Astley TM. Effect of glenoid cementation on total shoulder arthroplasty for degenerative arthritis of the shoulder: a review of the New Zealand National Joint Registry. J Shoulder Elbow Surg 2014;23:775-81. https://doi.org/10.1016/j.jse.2013.08.022.
7. Evans JP, Batten T, Bird J, Thomas WJ, Kitson JB, Smith CD. Survival of the Aequalis total shoulder replacement at a minimum 20-year follow: a clinical and radiographic study. J Shoulder Elbow Surg 2013;71(Suppl 2):101-7. https://doi.org/10.1016/j.jse.2021.01.038.
8. Flurin PH, Marczuk Y, Janout M, Wright TW, Zuckerman J, Roche CP. Comparison of outcomes using anatomic and reverse total shoulder arthroplasty. Bull Hosp Jt Dis (2013) 2013;71:101-7.
9. Friedman RJ, Cheung E, Grey SG, Flurin PH, Wright TW, Zuckerman JD, et al. Clinical and radiographic comparison of a hybrid cage glenoid to a cemented polyethylene glenoid in anatomic total shoulder arthroplasty. J Shoulder Elbow Surg 2019;28:2308-16. https://doi.org/10.1016/j.jse.2019.04.049.
10. Gauci MO, Bonnevialle N, Moineau G, Baba M, Walch G, Boileau P. Anatomical total shoulder arthroplasty in young patients with osteoarthritis: all-polyethylene versus metal-backed glenoid. Bone Joint J 2018;100-B:485-92. https://doi.org/10.1302/0301-620X.100B4.BJJ-2017-0495.R2.
11. Jacxsens M, Dayerizadeh N, Vandenbosch D, Van Tongel A, De Wilde L. Clinical and radiographic outcomes of an all-polyethylene fluted central peg glenoid

component, implanted utilizing an off-label, uncemented technique, at a minimum 5-year follow-up. J Shoulder Elbow Surg 2020;29:2292-8. https://doi.org/10.1016/j.jse.2020.02.027.
12. Lazarus MD, Jensen KL, Southworth C, Matsen FA 3rd. The radiographic evaluation of keeled and pegged glenoid component insertion. J Bone Joint Surg Am 2002;84:1174-82. https://doi.org/10.2106/00004623-200207000-00013.
13. Neer C 2nd, Watson K, Stanton F. Recent experience in total shoulder replacement. JBJS 1982;64:319-37.
14. Noyes MP, Meccia B, Spencer EE Jr. Five- to ten-year follow-up with a partially cemented all-polyethylene bone-ingrowth glenoid component. J Shoulder Elbow Surg 2015;24:1458-62. https://doi.org/10.1016/j.jse.2015.02.018.
15. Papadonikolakis A, Matsen FA 3rd. Metal-backed glenoid components have a higher rate of failure and Fail by different Modes in comparison with all-polyethylene components: a Systematic review. J Bone Joint Surg Am 2014;96:1041-7. https://doi.org/10.2106/JBJS.M.00674.
16. Parks DL, Casagrande DJ, Schrumpf MA, Harmsen SM, Norris TR, Kelly JD. 2nd. Radiographic and clinical outcomes of total shoulder arthroplasty with an all-polyethylene pegged bone ingrowth glenoid component: prospective short- to medium-term follow-up. J Shoulder Elbow Surg 2016;25:246-55. https://doi.org/10.1016/j.jse.2015.07.008.
17. Schoch BS, Zarezadeh A, Priddy M, King JJ, Wright TW. Uncemented fixation of a monoblock ingrowth polyethylene glenoid: early follow-up. J Shoulder Elbow Surg 2020;29:968-75. https://doi.org/10.1016/j.jse.2019.09.034.
18. Simovitch R, Flurin PH, Wright T, Zuckerman JD, Roche CP. Quantifying success after total shoulder arthroplasty: the substantial clinical benefit. J Shoulder Elbow Surg 2018;27:903-11. https://doi.org/10.1016/j.jse.2017.12.014.
19. Wijeratna M, Taylor DM, Lee S, Hoy G, Evans MC. Clinical and radiographic results of an all-polyethylene pegged bone-ingrowth glenoid component. J Bone Joint Surg Am 2016;98:1090-6. https://doi.org/10.2106/JBJS.15.00475.