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Long-term follow-up of total shoulder replacement surgery with inset glenoid implants for arthritis with deficient bone

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Background: Total shoulder replacement surgery has been a successful treatment for patients with shoulder arthritis. However, long-term results are limited by complications such as glenoid loosening, wear, and instability. Also, glenoid bone deficiency limits available treatment options and outcomes. Successful short-term outcomes have been reported previously using inset glenoid implants for deficient arthritic bone, but long-term outcomes have not been reported using this technique.

Methods: A retrospective analysis was performed on 21 of 24 consecutive patients treated with inset glenoid implants for severe glenohumeral joint arthritis with bone deficiency with prospectively collected data. Inclusion criteria were patients with shoulder arthritis and severe glenoid bone deficiency, defined by perpendicular glenoid vault depth less than 15 mm. No bone grafts were used. All patients were evaluated preoperatively and after surgery with physical examination, radiographic studies, and outcome measures. There were 10 males and 11 females, 17 cases with osteoarthritis and 4 with inflammatory arthritis, and 5 patients with rotator cuff tears (3 full thickness and 2 partial tears). Mean age was 68 years.

Results: There were no surgical complications. At a mean follow-up of 8.7 years, there were statistically significant improvements ($P < .001$) in visual analog pain scores (7.7 to 0.1), American Shoulder and Elbow Surgeons outcome scores (23 to 95), and range of motion. There were no loose glenoids. No patients required any revision surgery.

Conclusions: This study documents the long-term efficacy and safety of total shoulder replacement surgery with inset glenoid implants used to reconstruct deficient, arthritic glenoid bone.

Level of evidence: Level IV; Case Series; Treatment Study

Keywords: Inset; glenoid; deficient bone; shoulder replacement; bone loss

Shoulder replacement surgery has consistently provided successful results for patients with painful, debilitating shoulder arthritis.[3,8,12,23] However, glenoid bone deficiency limits treatment options and clinical results due to lack of bony support for the glenoid implant.[1,22,31] Glenoid bone loss commonly progresses in the posterior and medial direction, and it can wear all the way back to the scapular spine. Because this arthritic process destroys the structural support for traditional glenoid implants, it poses reconstructive challenges in shoulder replacement surgery.

Historically, severe glenoid bone deficiencies were treated with bulk bone grafts along with standard glenoid

This study received IRB approval from Sterling International Review Board (IRB Study Number: ID 6073).

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implants.[13,22,31] Patient outcomes were worse in this patient population than the outcomes in patients with adequate glenoid bone. For this reason, most surgeons prefer to avoid structural bone grafts. Hemiarthroplasty thus gained popularity as an alternative solution in this patient subgroup instead of resurfacing the glenoid. However, subsequent literature showed relatively worse results with hemiarthroplasty than total shoulder replacement in patients with advanced shoulder arthritis. Therefore, most current shoulder surgeons avoid performing hemiarthroplasty in the setting of a nonconcentric glenoid with bone loss.[9,12,16,18] Another treatment option used for this challenging patient population is the ream and run technique popularized by Dr. Matsen. This involves removing more glenoid articular surface bone with a spherical type of reamer to create a symmetrically concave glenoid socket. The goal of this procedure is to stabilize and contain a humeral hemiarthroplasty implant.[2] This is a simple, reproducible procedure in patients with adequate bone stock, but there is concern about further progression of glenoid bone loss that may cause pain and limit any further reconstructive options.

More recent developments include both the use of augmented glenoid implants to buttress posterior bone loss and correct version, and the potential use of reverse ball and socket replacement as a salvage surgery.[19,21,33] There is no clear consensus on a best practice treatment algorithm for patients with arthritis with severe glenoid bone loss and intact rotator cuff.

Our senior author published successful short-term outcomes in a small cohort of patients with severely deficient glenoid bone using inset glenoid implants in 2012.[10] There are no published long-term outcomes using this new technique in the shoulder arthroplasty literature. The purpose of this study was to evaluate long-term efficacy, safety, and validated outcomes in a larger cohort of patients from the original study population with inset glenoid total shoulder replacement surgery performed between 2005 and 2009.

Materials and methods

We retrospectively studied 24 patients on whom the senior author performed total shoulder replacement with inset glenoid implants for severely deficient bone between 2005 and 2009. Twenty-one of these patients were still alive and available for follow-up. Minimum follow-up was 6 years. Fourteen patients returned to clinic for full clinical follow-up including final XRs, and 7 patients could only be reached by phone for final outcome scores. Two patients died during the study period, and 1 patient was lost to follow-up. All patients had severely deficient bone as defined by a minimum neutral glenoid vault depth of less than 15 mm. The initial measurements were performed on 2-dimensional computed tomography (CT) scan images. Retroversion was measured using the Friedman technique, and then glenoid vault depth was measured from a neutral version line at the most deficient area on the articular surface to simulate reaming down the high side of the worn glenoid surface.[6,10] Secondly, the bone deficiency was evaluated on 3-dimensional (3D) CT images. The third and final method of glenoid vault depth evaluation was performed by direct examination of stereolithographic (SLA) rapid prototype plastic 3D models that were created from the 3D CT scans. Figure 1 shows a CT scan image and an SLA model from 2 of our patients.

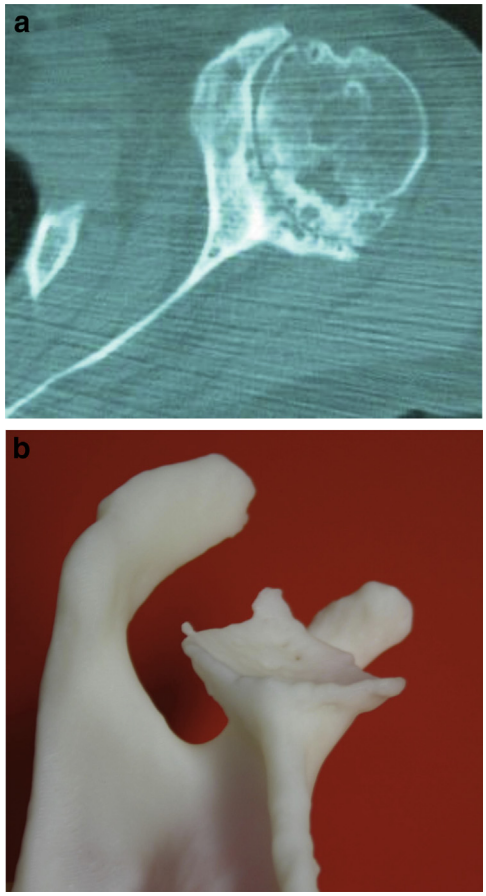

Figure 1 (**a**) Computed tomography scan and (**b**) stereolithographic model from 2 separate patients in this series.

After careful preoperative planning was performed regarding the volume and geometry of the glenoid vault, inset glenoid all-polyethylene implants were placed directly inside the glenoid vault supported by a circumferential rim of sclerotic cortical bone (Fig. 2). The implants were manufactured by Biomet, Inc. (Warsaw, IN, USA). All of the implants were polyethylene and had a single central posterior peg less than 1 cm. No bone grafts were used.

Clinical assessments including physical examination, radiographic studies, and outcome measures were performed preoperatively and then postoperatively at 3 months, 6 months, 9 months, and then yearly. Active range of motion in forward elevation and external rotation with the arm adducted were measured with a goniometer. Internal rotation was measured with a scale related to the vertebral spine level. Self-assessed

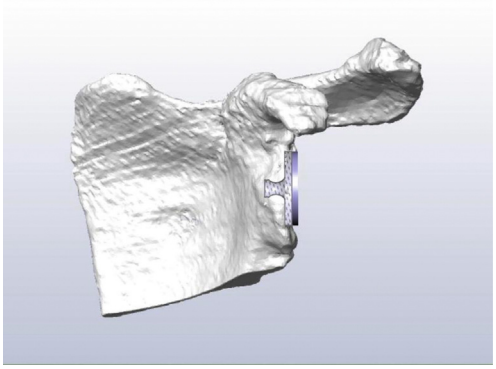

Figure 2 Computer representation of an inset glenoid implant indeficient glenoid bone.

patient outcome measures were recorded using the American Shoulder and Elbow Surgeons (ASES) validated scoring system, measuring both the ASES outcome score and the visual analog pain score.

Radiographic analysis

Preoperative radiographs and CT scans were performed in all patients in this series. The radiographs were (1) AP x-ray taken in the plane of the glenohumeral joint (perpendicular to the scapular body) and (2) axillary x-ray. The CT scans were performed with both 2D and 3D renderings. A General Electric workstation with special bone windows was used for precise measurements of glenoid version and the depth of the glenoid vault. These measurements were performed by the senior author (S.B.G.) in collaboration with an independent orthopedic surgeon (William W. Bowen, MD). 3D plastic SLA models were then created using computerized solid modeling software and SLA rapid prototyping.

Postoperative fluoroscopic images were performed in the same plane as the preoperative radiographs 1 week, 6 months, and then yearly after surgery (Fig. 3). They were all evaluated for implant-bone interface lucent lines, subsidence, or tilt in position of the implant. The maximum thickness of the lucent lines was measured to within 0.5 mm thickness as described previously by Sperling et al.[30] The lead author and 1 independent orthopedic surgeon compared radiographic immediate postoperative views and final follow-up views to detect any subsidence or tilt of the glenoid implant within the glenoid vault as well as measuring lucent lines when present. The previously published radiographic classification scheme, developed specifically for inset glenoids by our senior author in collaboration with Dr. Cofield based on Dr. Cofield's established classification system for onlay glenoids,[10,30] was used to accurately measure any potential lucent lines or glenoid loosening of these inset implants. Implants were divided into 5 separate zones for the measurement of periprosthetic lucency (Fig. 4, *a*). Within each zone, points are assigned based on the thickness of any lucent line: 0 points for no lucency, 1 point for line 1 mm or less in thickness, 2 points for line greater than 1 mm and up to 1.5 mm thickness, and 3 points for line greater than 1.5 mm thickness. A compilation of points in the 5 zones represents a risk analysis for potential loosening of the glenoid implants with low risk for 0-5 points, moderate risk for 6-10 points, and high risk for either 11-15 points or any implant tilt or subsidence noted by either one of the 2 reviewers.

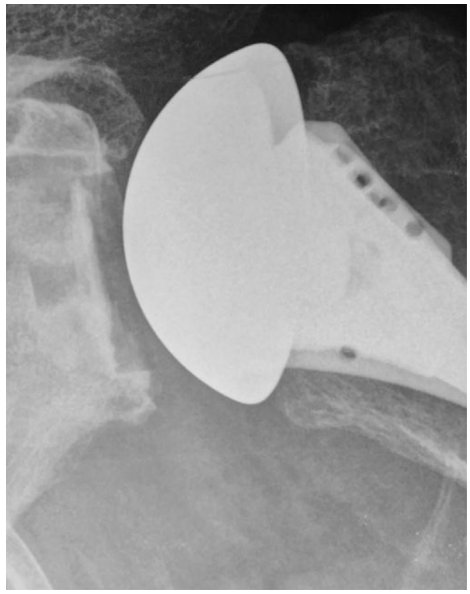

Figure 3 Postoperative x-ray for the evaluation of lucent lines, subsidence, and positioning of the implant.

Operative technique

The operative technique was published in detail in our initial, short-term clinical study in 2012.[10] The differences between standard shoulder arthroplasty techniques and the senior author's surgical technique are several. First, the capsule was mostly incised instead of excised to gain motion but retain stabilizing ligaments. Second, any healthy, intact peripheral labrum was maintained instead of excised. Because the glenoid was inset with 2-mm peripheral bone left intact along the perimeter, removing all of the normal, peripheral soft tissue constraints in the glenohumeral joint was unnecessary. Therefore, this tissue was left intact for additional soft tissue containment and conformity to maintain postoperative shoulder joint stability and minimize polyethylene implant edge loading. This modified technique, in theory, could help protect the glenoid implant from both implant loosening and polyethylene wear. Third, and most importantly, a custom guide and reamer were used to ream an inset pocket in the glenoid bone instead of reaming the entire glenoid surface and laying an implant on top of the articular surface (Fig. 5). The process of imprinting the new glenoid implant 2-3 mm into the strong, sclerotic, severely arthritic bone was designed and performed by the senior surgeon to increase the fixation strength, allow simple version correction, and save the hard, sclerotic bone instead of reaming it away. These surgeries were all performed with patient-specific preoperative planning using both 3D CT scans and 3D printed SLA plastic models. For patients with the most severe posterior wear and bone loss, the end result was a partial correction of the retroversion deformity.

Statistical analysis

The Wilcoxon signed-rank test was used to measure the significance of the effect of surgery by measuring preoperative to postoperative values. Statistical testing was 2-sided and a P value of .05 was set as the determination of statistical significance.

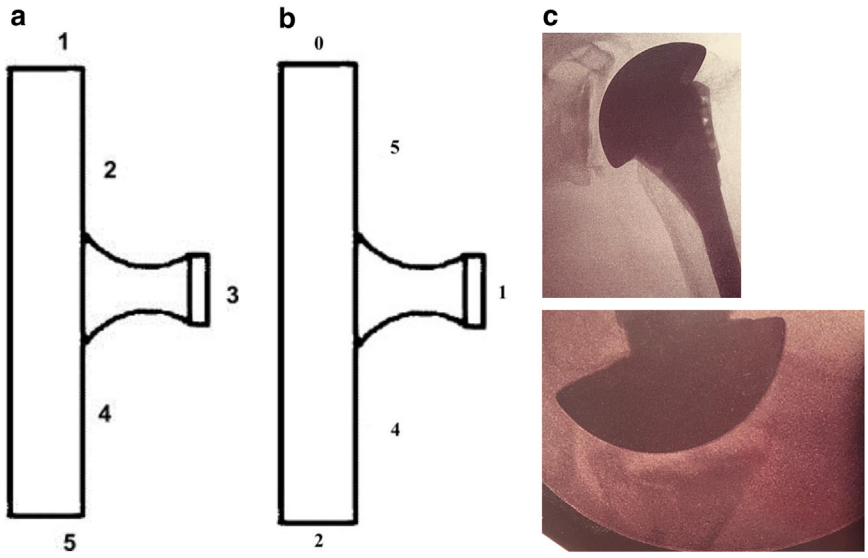

Figure 4 (**a**) Glenoid component-bone interface is divided into 5 radiographic grading zones. (**b**) Distribution of periprosthetic lucencies among glenoid components. Numerals refer to numbers of components having lucency in each zone. (**c**) Radiographs showing a nonprogressive lucent line in zone 2, 8.5 years after surgery.

Results

In this cohort of 24 consecutive surgeries performed with inset glenoid implants for deficient bone between 2005 and 2009, 21 patients were located for the final follow-up. Mean follow-up on these 21 patients was 104 months (range, 76-142 months). All patients were right hand dominant. The affected shoulders were the right dominant shoulder in 6 cases and left in 15 (Table I). Patient age ranged from 49 to 83 years with a mean age of 68 years. The average retroversion was 18° and the average glenoid vault depth was 12 mm. Patients with previous arthroplasty surgery were excluded. One patient had a chronic, massive rotator cuff tear, 2 patients had 2- to 2.5-cm supraspinatus tears, and 2 patients had partial rotator cuff tears. One patient had 2 previous arthroscopic débridement surgeries by another surgeon, and 3 other patients had 1 arthroscopic débridement surgery by another surgeon. No patients had any history of instability. The final follow-up included active motion, radiographic analysis, and outcome measures in the 14 patients who returned to clinic, and the other 7 patients were contacted by phone for final outcome scores (Table II).

Patient outcome

There were no surgical complications. At a mean follow-up of 8.7 years, the mean ASES score improved by 72 points (23 ± 12.6 to 95 ± 3.9) (Fig. 6), which is statistically significant ($P < .001$). There were statistically significant ($P < .001$) improvements in range of motion: forward flexion 36° (95° to 131°), external rotation 31° (18° to 49°), and internal rotation of 5 spinal levels. There was also a statistically significant ($P < .001$) improvement in visual analog pain scores (7.7 ± 1.6 to 0.1 ± 0.3). Subgroup analysis of the 6 most severely deficient glenoid bone cases, defined as perpendicular glenoid depth 10 mm or less, showed a mean final ASES score of 96 at a mean follow-up of 7.4 years. None of the 4 of 6 cases with the final XR follow-up were either loose or "at risk" of loosening.

Radiographic assessment

Seven of the 21 patients did not have radiographs at the final follow-up. Of the remaining 14 patients, 8 patients showed no evidence of any lucent lines. In the other 6 patients, the radiolucent line scores by reviewer 1 were 5, 2, 3, 1, 0, and 1. Reviewer 2 graded these same patients 5, 3, 3, 2, 1, 0. The maximum radiographic score was 5, which equates to "low risk" for glenoid implant loosening. No lucent lines were noted in zone 1 for any patient, and there were only 2 patients with less than 1 mm lucent lines in zone 5 and 1 patient with a 1-mm line in zone 3. Most of the lucent lines occurred in zones 2 and 4, along the back of the implant (Fig. 4, *b* and *c*). The 2 radiographic reviewers found no evidence of shift or subsidence of the glenoid implant in any patient. There was 94.3% agreement of the radiographic assessment grades by the 2 reviewers.

Discussion

This long-term study is a retrospective review of 21 of 24 consecutive surgeries with inset glenoid implants performed in patients with shoulder arthritis and severely deficient glenoid bone between 2005 and 2009. Our previous short-term study on a smaller cohort of patients with a

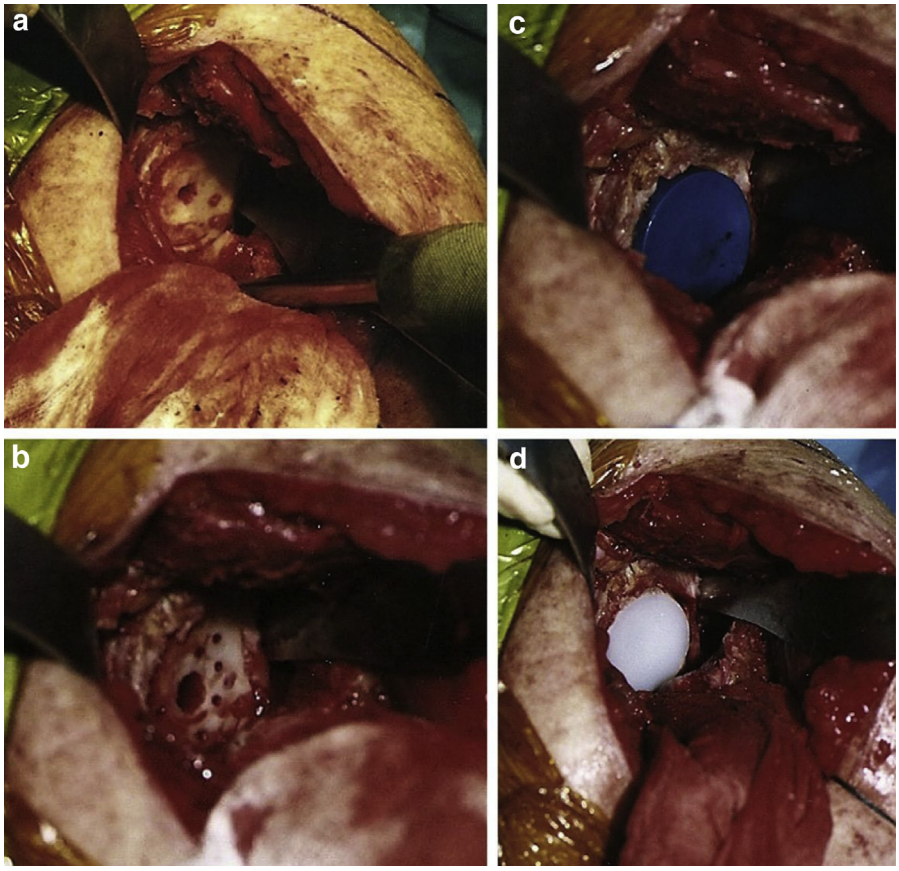

Figure 5 Glenoid bone is reamed intraoperatively for an inset implant (**a** and **b**) Initial reaming and bone preparation. (**c**) Trial implant. (**d**) Final glenoid implant.

minimum 3-year follow-up showed excellent results on these difficult patients,[10] but there are no long-term results available in the literature using this new inset technique. The goal of this study was to evaluate the long-term results of inset fixation for cases with glenoid bone deficiency so severe that standard onlay glenoid implants are contraindicated.

Historically, there have been limited treatment options for shoulder replacement surgery in patients with severely deficient glenoid bone. Neer and Morrison[22] were the first to report clinical results in this challenging subset of shoulder arthroplasty surgery. There was no quantification of version or bone loss. In the 19 patient follow-up group, there were several complications including broken screws and screws worn by contact with the humeral head. Another retrospective review of bone grafting and glenoid implantation was performed by Hill and Norris[13] in 2001. They reported on 21 cases in which either the humeral head or the iliac crest autograft was used for fixation. Of the 17 patients available for the final follow-up, there were only 3 excellent results. There were multiple complications and 5 revision surgeries. A report by Steinmann and Cofield[32] identified 31 patients with structural glenoid grafting and total shoulder replacements out of a database of 953 shoulder arthroplasty surgeries performed at Mayo Clinic between 1976 and 1992. Clinical outcomes of 28 of these patients were retrospectively reviewed at an average of 5.3 years after surgery. There were 13 of 28 patients with excellent results. There were 4 loose glenoids, 2 patients with instability, and 1 patient with persistent pain. One recent report by Nicholson et al[24] showed uniform graft incorporation in 34 patients at a minimum 2-year follow-up. There were 5 broken or displaced screws and 3 broken glenoid central pegs.[24] An article by Sabesan et al[28] in 2013 reported generally good results in 12 patients treated with bone grafting and all polyethylene glenoid implants, but there were 2 revision surgeries performed at mid-term follow-up for broken screws and failed graft incorporation. A 2014 Mayo Clinic study also showed generally good clinical results in 24 patients at a mean clinical follow-up of 8.7 years, but there were 2 revision surgeries performed for glenoid loosening.[17] There were also 10 glenoids ''at risk'' for loosening including 6 glenoids that shifted in position. Thus, there were 40% adverse radiographic outcomes. The authors also note that the use of this bone grafting technique within the Mayo Clinic shoulder registry decreased from 3% reported in 2000 to 1% reported in 2014. This may relate, as they suggest, to a ''lack of ongoing security of glenoid fixation over time.''

Table I Initial preoperative clinical patient information including glenoid type and bone loss

Patient	Age	Sex	Dominant hand	Operative shoulder	ROM			VAS	ASES	Glenoid type	Retroversion (°)	Glenoid vault depth (mm)
					Forward flexion (°)	ER (°)	IR					
1	59	M	R	L	90	25	Buttock	8	13	A2	7	14
2	59	F	R	L	80	12	Buttock	7	17	B3	16	12
3*	74	F	R	L	100	28	L5	6	30	A2	2	14
4	81	M	R	L	115	15	Buttock	8	16	B2	13	14
5	60	F	R	L	82	23	Sacrum	7	20	B1	7	12
6†	77	M	R	L	78	2	Lat. Hip	10	25	A2	15	14
7‡	81	F	R	L	96	18	Buttock	5	60	A2	14	13
8	80	M	R	L	105	30	Buttock	8	21	A2	8	14
9	64	F	R	R	122	31	Sacrum	5	45	B3	21	11
10	61	M	R	R	131	41	Buttock	7	40	B1	16	13
11	66	M	R	R	98	7	Buttock	8	20	B1	14	11
12	83	F	R	L	100	25	Sacrum	9	7	C	69	9
13	75	M	R	L	128	16	Sacrum	10	13	B3	24	11
14	83	F	R	L	82	60	Sacrum	10	15	B3	16	9
15	63	F	R	L	71	38	Buttock	8	17	A2	4	12
16	61	M	R	L	73	−18	Sacrum	10	9	B3	24	9
17	49	F	R	R	100	32	L1	7	22	A2	14	10
18	63	M	R	R	120	−20	Sacrum	5	30	C	50	10
19‡	71	F	R	R	88	12	Lat. Hip	8	29	B3	17	13
20†	71	M	R	L	90	0	Lat. Hip	7	20	B3	16	7
21	49	F	R	L	60	7	Sacrum	8	20	A2	5	12

M, male; *F*, female; *ROM*, range of motion; *ER*, external rotation; *IR*, internal rotation; *VAS*, visual analog pain score; *ASES*, American Shoulder and Elbow Surgeons.

* Massive rotator cuff tear.

† Partial rotator cuff tear.

‡ 2- to 2.5-cm supraspinatus tear.

There have also been reports in the literature that include some patients with deficient bone included in a larger series of patients without glenoid bone loss.[3,12,20] There is also a report by Edwards et al[5] describing a group of patients with congenitally deficient glenoids that were treated with either total shoulder replacement without version correction or hemiarthroplasty. It is difficult to make any conclusions about the treatment of deficient glenoid bone with total shoulder replacement from these publications.

It is possible to provide good short-term results by eccentrically reaming a deficient glenoid to correct version and then implanting a standard glenoid implant in shoulders with sufficient bone in the glenoid vault to hold a keel or multiple pegs.[26] However, our case series in this study was defined by patients with inadequate bone in the glenoid vault to hold any standard onlay glenoid implant because the perpendicular glenoid vault bone was less than 15 mm in each case. Clavert et al[1] concluded that glenoid retroversion greater than 15° could not be corrected with simple reaming of the high side when using a standard glenoid implant with multiple pegs. The risks of glenoid vault penetration in deficient bone cases were also corroborated by other authors using computer modeling of 3D CT scan images.[14,25] Thus, standard onlay glenoid implants were contraindicated in our patients because of the high risk of broaching through the back of the glenoid vault with potential harm to the rotator cuff and neurovascular structures with a drill bit or heated cement.

Relatively new solutions have been augmented glenoid implants, porous ingrowth designs, and reverse shoulder arthroplasty options. The goal of the augmented glenoid designs is to replace the deficient glenoid bone with a polyethylene augment on the backside of the glenoid implant to correct the altered joint surface without using a bone graft. There are finite element analyses and short-term outcome studies showing promise for this method of treatment.[15,33] However, there are other studies showing increased complication rates and inferior fixation strength with this technique.[27,34] Therefore, long-term studies will be required to demonstrate whether or not adding extra polyethylene on to the surface of a deficient glenoid vault can provide long-term implant fixation and joint stability. Reverse ball and socket arthroplasty surgery is a viable option for older patients with severely deficient bone, especially if there are concurrent rotator cuff tears. Regarding our 1 patient with a massive rotator cuff tear along with her severely deficient bone, our senior author would offer a similar patient today a modern RSA because

Table II Final follow-up clinical, radiographic, and outcome data

Patient	ROM			XR score		Risk of loosening	VAS	ASES	Final follow-up (mo)
	Forward flexion (°)	ER (°)	IR	Orthopedist 1	Orthopedist 2				
1	103	48	Buttock	0	0	Low	0	97	120
2	135	80	T9	0	0	Low	0	100	142
3	69	34	L1	0	0	Low	0	88	100
4	–	–	–	–	–	–	0	91	141
5	134	36	T11	5	5	Low	0	100	125
6	–	–	–	–	–	–	0	95	115
7	–	–	–	–	–	–	0	96	114
8	142	54	L2	0	0	Low	0	100	134
9	141	36	L1	2	3	Low	1	95	107
10	–	–	–	–	–	–	0	96	110
11	155	65	L4	3	3	Low	0	90	112
12	–	–	–	–	–	–	0	96	94
13	129	29	L4	1	2	Low	0	96	81
14	142	61	T11	0	1	Low	0	100	80
15	144	71	T9	1	0	Low	0	100	101
16	146	41	L1	0	0	Low	1	95	94
17	124	35	L1	0	0	Low	0	96	90
18	–	–	–	–	–	–	0	100	89
19	–	–	–	–	–	–	0	88	76
20	118	23	L5	0	0	Low	0	92	84
21	141	59	T9	0	0	Low	0	95	85

ROM, range of motion; *ER*, external rotation; *IR*, internal rotation; *XR*, x-ray; *VAS*, visual analog pain score; *ASES*, American Shoulder and Elbow Surgeons.

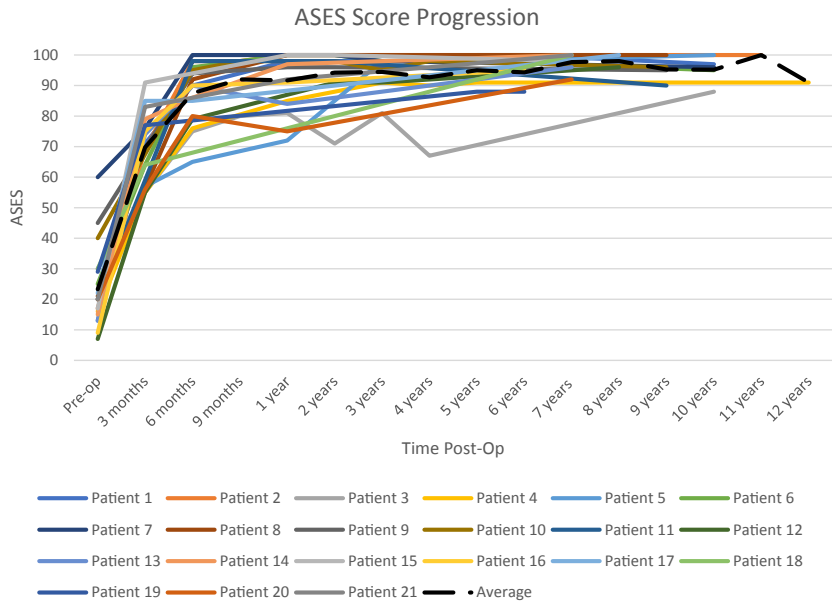

Figure 6 American Shoulder and Elbow Surgeons (ASES) scores over time.

of the potential for increased function. However, the previous RSA designs 9-10 years ago, if performed in this patient, might possibly have failed within this 10-year timeframe. It is also interesting to note that this patient did not sustain any complications, and she does not have any pain at the final follow-up almost 10 years after her TSR with inset glenoid and partial rotator cuff repair. Also, the rocking horse effects of superior translation did not loosen her inset glenoid. Reverse shoulder arthroplasty can also be used for arthritis with severely deficient bone even

if there is no rotator cuff pathology. There is 1 study showing successful short-term results with RSA in this patient population.[19] However, proceeding with a salvage procedure with extra bone removal for a primary case is probably best avoided if there are successful primary surgical options that might offer better long-term results and provide for a more simple revision surgery when necessary.

There is current evidence in the literature supporting inset glenoid fixation with both short-term clinical studies and scientific laboratory testing. The original cohort of 7 patients from this same study population with severe arthritis and glenoid bone loss with inset implants, published in 2012, showed excellent clinical and radiographic results at an average follow-up of 4.3 years. There were statistically significant improvements in motion, pain, and ASES outcome scores, and there were no complications, no loose implants, and no revision surgery.[10] These excellent short-term results were then further validated 4 years later in a study by Davis et al,[4] who followed 7 patients with severe glenoid dysplasia and/or severe medial bone loss for a minimum of 2 years after total shoulder implants with inlay glenoid implants. There were statistically significant improvements in pain, motion, and outcome scores, and there were no loose implants. Also, 2 laboratory studies showed superior mechanical glenoid fixation with inset fixation vs. classic onlay fixation.[7,11] Scientific analysis on inset fixation, published in 2012, showed statistically significant reductions in glenoid implant edge distraction with the inset vs. the standard onlay keel and peg designs using standard American Society for Testing and Materials (ASTM) mechanical testing methods. There was also 87% reduction in edge displacement with finite element analysis.[11] These results were validated by Gagliano et al[7] in 2017. Their matched pair cadaver-based mechanical test showed uniform implant loosening in all 8 of the onlay glenoid implants at a mean of 1126 cycles, whereas none of the 8 inset glenoid implants showed any signs of loosening.[7]

The potential advantages of inset fixation vs. onlay fixation in these challenging cases are the following: first, the fixation is rigid even though the bone is deficient because the implant is fixed within a circumferential rim of hard sclerotic surface bone.[11] This strong, thick, extremely hard peripheral bone, quantified in a recent glenoid subchondral bone density study by Simon et al,[29] is used as a buttress to increase fixation strength instead of reaming it away. Second, there is no worry about glenoid onlay implant overhang over unsupported bone as a source of rocking horse loosening, because the implant is partially imprinted (inset) into the bone. Third, this is a technique that allows partial or full correction of version without reaming down the entire high side of the glenoid. This simple version correction technique can also be used to correct posterior subluxation in a B1 or B2 glenoid. This is performed by placing the initial drill guide at a predetermined angle to the articular surface. Then, the drill and reamer follow that specified angle that creates an asymmetric reaming further into the high side than the more worn side of the glenoid. The high side bone can also be partially reamed before performing inset glenoid reaming to maximize the version correction. Fourth, the procedure is safe and avoids the potential complications of drilling or broaching deep into the glenoid vault. Because the entire peripheral rim of the implant is set within the sclerotic surface bone, significant backside fixation with a 15-mm or longer keel or pegs is not required. In fact, these inset implants have posterior peg fixation less than 1 cm in depth. Finally, this type of fixation can also be performed in severely deficient glenoid bone without any structural bone grafting.

This study demonstrates many potential advantages of inset glenoid fixation, but there are limitations of this study. First, this is a relatively small cohort of patients, with 21 patients available for the final outcome analysis at a mean of 8.7 years. Also, we were unable to bring 7 of these patients back into clinic for the final radiographic analysis at a mean of 8.7 years because of the limitations of travel due to their age and medical comorbidities. Third, there was no comparison group of patients treated with another technique such as bone grafting or augmented glenoid implants. Finally, all of these procedures were performed by 1 single surgeon (S.B.G.), so there is no guarantee that these results would be duplicated by a mixed group of surgeons.

Conclusion

This inset glenoid fixation technique offers an innovative approach to a difficult clinical conundrum of shoulder arthritis with deficient glenoid bone. In this series, there were no complications, no cases of glenoid implant loosening, and no revision surgeries performed at a mean 8.7-year follow-up. This technique is also safe, because there is only minimal penetration of the glenoid surface bone. Finally, the technique is simple and easily reproducible. It is a reasonable alternative to other current techniques available for patients with shoulder joint arthritis, severe bone deficiency, and an intact rotator cuff.

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Disclaimer

Stephen B. Gunther is founder and partial owner of Shoulder Innovations, Inc., which owns intellectual property related to the subject of this article.

Sterling K. Tran and his immediate family, and any research foundations with which he is affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

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