J Shoulder Elbow Surg (2020) 29, 2097–2103

ELSEVIER

Journal of Shoulder and Elbow Surgery

www.elsevier.com/locate/ymse

Cemented vs. uncemented glenoid fixation in total shoulder arthroplasty for osteoarthritis: a New Zealand Joint Registry study

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Background: Total shoulder arthroplasty (TSA) is commonly performed for shoulder osteoarthritis (OA). Uncemented metal-backed (MB) glenoid components were introduced in an attempt to avoid glenoid loosening. New Zealand and Australian Joint Registry studies have shown significantly higher revision rates when uncemented MB glenoids are used. We used the New Zealand Joint Registry (NZJR) to compare all-cause revision rates and functional scores for TSA and investigated the trends of glenoid fixation used in New Zealand.
Methods: The NZJR was accessed for all primary TSA undertaken for OA from January 2000 to December 2017. Patient demographics were collated. All-cause revision rates were reported as rate per 100 component-years. Analysis was repeated excluding the uncemented SMR L2 glenoid (LimaCorporate), as it was a potential confounder. Kaplan-Meier survival analysis was performed. Oxford Shoulder Scores at both 6 months and 5 years were analyzed.
Results: A total of 2613 TSAs were performed for OA during the study period, representing 85.0% of all TSAs in New Zealand. Overall, 62.1% of the patients were female. In addition, 69.6% of glenoids were cemented and 30.4% uncemented. The most common uncemented MB glenoid was SMR 86.6% (LimaCorporate), and cemented was Global (DePuy) 49.8%. The revision rate for TSA with uncemented glenoids was significantly higher at 2.03 compared with cemented at 0.41 per 100 component-years ($P < .001$). Hazard ratio 5.0 for revision of uncemented glenoids. No significant difference was found in Oxford Scores at 6 months (39.7 vs. 40.3, $P = .13$) or 5 years (42.1 vs. 42.8, $P = .22$). The most common mode of failure was glenoid loosening in cemented glenoids (44.4%), and component failure in uncemented (34.8%). Revision for rotator cuff, deep infection, and instability were comparable between groups. When excluding SMR L2, uncemented MB glenoid all-cause revision rates remained significantly higher than cemented (1.42 vs. 0.41 per 100 component-years, $P < .001$). SMR L1 uncemented MB glenoids had a higher revision rate than the non-SMR uncemented glenoids (1.61 vs. 0.18 per 100 component-years, $P = .009$). Uncemented glenoid use peaked in New Zealand in 2011 at 46.7% of TSAs but declined to 20.1% in 2017.
Conclusions: In the NZJR, primary TSAs undertaken for OA have a significantly higher all-cause revision rate when the glenoid component is uncemented. Uncemented glenoids have a 5.0 times higher revision rate. Excluding SMR L2 glenoids from the analysis, the significantly higher revision rate remained for uncemented glenoids. These data reaffirm that uncemented MB glenoids are associated with higher revision rates.
Level of evidence: Level III; Retrospective Cohort Comparison using Large Database; Treatment Study

Keywords: Shoulder joint; arthroplasty; replacement; glenoid cavity; osteoarthritis; joint registry; revision rate

No formal institutional review board (IRB) approval was required as this was a review of the New Zealand Joint Registry, which has IRB approval for publication of results stored in its registry.

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https://doi.org/10.1016/j.jse.2020.03.008

Total shoulder arthroplasty (TSA) is a successful treatment modality for glenohumeral osteoarthritis (OA); however, TSA commonly fails because of glenoid component loosening.[2,4,10,13,14] In an effort to avoid loosening of cemented glenoids, uncemented metal-backed (MB) components have been used with the goal of achieving biological fixation.[2,6,7] In addition, another perceived benefit of MB glenoids is the suggestion that the modularity will allow an easy conversion from TSA to reverse TSA, if the TSA requires revision.[3,5,9] Unfortunately, multiple studies have found that uncemented MB glenoids are prone to increased revision rates compared to their cemented counterparts.[2,4,6,7] A recent study from the Australian Orthopaedic Association National Joint Replacement Registry (AOANJRR) found a higher revision rate for TSA undertaken for OA using uncemented glenoids: 17.9% compared with 3.7%, with a hazard ratio of 4.77.[9]

New Zealand Joint Registry (NZJR) data published by Clitherow in 2014 showed that TSA revision rates were 4.4 times higher when using uncemented MB glenoids at 3.5 years.[3] This was potentially a sentinel paper for shoulder arthroplasty practice in New Zealand, and we wanted to investigate (1) the trend of uncemented MB component use in New Zealand since Clitherow's publication, and (2) the NZJR data on revision rate for the cemented and uncemented TSA groups 5 years on.

Materials and methods

This study is a large retrospective cohort study using the NZJR data for patients who underwent conventional primary TSA for osteoarthritis.

New Zealand Joint Registry

The NZJR started collecting data on shoulder arthroplasty on January 1, 2000. Data are obtained for patients in both the public and private hospital systems throughout New Zealand, with a reported compliance rate of more than 95%. By the end of 2017, a total of 9250 shoulder arthroplasties had been recorded, representing a total of more than 47,000 observed component-years. Anatomic TSA represents 26% of all shoulder arthroplasties on the registry.[8] The NZJR is unique in that Oxford Shoulder Scores (OSSs) are collected at 6 months and 5 years postoperatively to assess patient-reported functional outcomes. Preoperative scores are not collected. The NZJR has been granted ethical approval to collect patient data since the registry was founded in 1998. Data from the NZJR is publicly available through their annual reports. The NZJR reports on implant survival by calculating the revision rate per 100 component-years. This provides a means to compare components that have been implanted for varying periods of time.[8]

The NZJR data were used to identify all primary TSA procedures undertaken for OA between January 1, 2000, and December 31, 2017. Revision was defined as the exchange of a component, and all revisions during this period were analyzed. Procedures were categorized according the method of fixation of the glenoid component—cemented or uncemented. Patient demographics were recorded, as well as the implants used, and the Oxford scores at 6 months and 5 years. The reason for surgery was recorded for all revision procedures, and revision rates were calculated.

During the study period, the SMR L2 prosthesis (LimaCorporate, Udine, Italy) was widely used in New Zealand and was subsequently withdrawn from the market because of high rates of implant failure. This was seen as a potential confounder against uncemented glenoids, so a subanalysis was performed excluding these prostheses.

Statistical analysis

The revision rates for the cemented and uncemented glenoids are reported as the rate per 100 component-years, with 95% confidence intervals calculated using a Poisson approximation. The rates are compared using Cox proportional hazard regressions. The implant survival to revision are shown graphically using Kaplan-Meier curves. Comparison of Oxford Shoulder Scores between groups was undertaken using 1-way analysis of variance. The threshold for statistical significance was set at a P value of $<.05$.

Results

Eight-five percent of the TSA performed in New Zealand during the study period were for OA. This totaled 2613 primary surgeries, of which 1819 (69.6%) used cemented glenoids and 794 (30.4%) uncemented. There was a female predominance of 62.1%, with most falling into the 65-75-year age bracket (Table I). The mean follow-up was 5.9 years overall, with a mean of 5.5 years for uncemented and 6.0 years for cemented. The most commonly used prostheses are summarized in Table II. There was a marked decline in the use of uncemented MB glenoid components in New Zealand, from peak use of 46.7% in 2011, down to just 20.1% in 2017 (Fig. 1). Mean OSS functional outcome scores showed no statistical difference between groups at either 6 months (39.7 cemented vs. 40.3 uncemented) or 5 years (42.1 cemented vs. 42.8 uncemented) (Table III).

All-cause revision rates are summarized in Table IV. Revision rates for cemented glenoids were significantly lower at 0.41/100 component-years (95% CI 1.63-2.50)

Table I Patient Demographics (N = 2613)

	n (%)
Sex	
Male	991 (37.9)
Female	1622 (62.1)
Age, yr	
<55	118 (4.5)
55-65	604 (23.1)
65-75	1171 (44.8)
≥75	720 (27.6)

Table II Glenoid components used

Cemented (n = 1819)		Uncemented (n = 794)	
Component	n (%)	Component	n (%)
Global	906 (49.8)	SMR	688 (86.6)
Aequalis	453 (24.9)	Bigliani-Flatlow	52 (6.5)
Bigliani-Flatlow	193 (10.6)	Aequalis	44 (5.5)
Other	267 (14.7)	Other	10 (1.3)

Component Manufacturers: Aequalis—Tornier, Edina, MN, USA; Bigliani-Flatlow—Zimmer Inc, Warsaw, IN, USA; Global—DePuy, Warsaw, IN, USA; SMR—LimaCorporate, Udine, Italy.

compared with uncemented at 2.03/100 component-years (95% CI 0.30-0.55) ($P < .001$). The hazard ratio for revision of uncemented compared to cemented was 5.0 (95% CI 3.5-7.2). The revision rates were higher for the uncemented group than the cemented in every age group category (Table V). Kaplan-Meier survival analysis showed divergence of the 2 groups, with cemented outperforming uncemented glenoids (Fig. 2). This persisted when the SMR L2 glenoids (LimaCorporate) were excluded from analysis (Fig. 3). The most common reason for revision for cemented glenoids was glenoid loosening (44.4%), whereas for uncemented glenoids component failure was the most common cause (34.8%). There was no difference between the 2 groups with respect to rotator cuff failure, deep infection, and dislocation (Table VI). The SMR L1 and L2 glenoids displayed differing modes of failure, with the L1 glenoids revised for rotator cuff failure in 50% (20/40) of their revisions and the L2 glenoids most commonly revised for component failure, in 55.7% (27/49).

Exclusion of SMR L2 glenoids for subanalysis showed that a significant difference in revision rate persisted between cemented at 0.41 and uncemented at 1.42 per 100 component-years ($P < .001$). When a comparison was made within the uncemented group, SMR L1 glenoids had a revision rate of 1.61, compared with just 0.18 per 100 component-years for all non-SMR glenoids ($P = .009$).

Discussion

Our study consisted of 2613 primary TSA procedures undertaken for OA. The main finding was that TSAs with uncemented glenoid components were 5 times more likely to undergo revision surgery. This corroborates the findings of the AOANJRR, published in 2018 by Page et al.[9] Their cohort consisted of 10,805 primary TSAs performed for OA. At the 5-year follow-up, they found a hazard ratio of 4.77 for revision when using uncemented glenoids compared with cemented.[9] This is consistent with Clitherow et al,[3] who compiled 1596 primary TSAs undertaken for degenerative OA from the NZJR at the 3.5-year follow-up and found a 4.4 times higher revision rate for uncemented glenoids. There seems to be little doubt that the uncemented MB glenoids are underperforming in the Australian and New Zealand experience.

The cemented glenoid has long been the Achilles heel of TSA, and in the effort to reduce glenoid loosening, surgeons looked toward uncemented glenoids to emulate the success of uncemented hip arthroplasty components. The goal was for solid primary fixation of the glenoid through bony ingrowth.[2,6,7] The warning signs were clear in 2002 when Pascal Boileau's randomized controlled trial had to be stopped early because of the inferior performance of the uncemented MB components, which ultimately led to him abandoning the use of uncemented MB glenoids.[2]

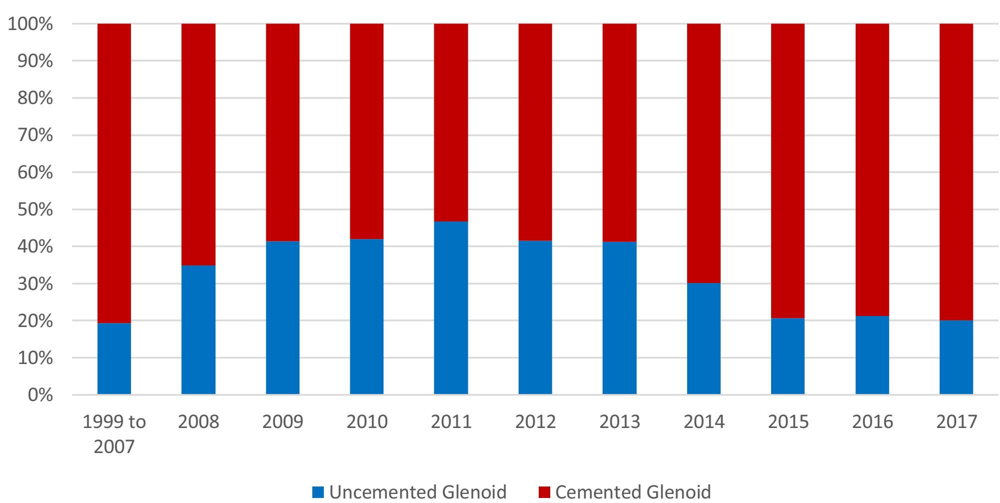

Figure 1 Annual trends for choice of glenoid fixation in conventional total shoulder arthroplasty (TSA).

Table III Oxford Shoulder Scores

Glenoid	6 mo		5 yr	
	Mean (SD)	n	Mean (SD)	n
Cemented	40.31 (7.93)	549	42.81 (7.04)	250
Uncemented	39.71 (7.74)	1275	42.10 (7.48)	471
Overall	39.89 (7.80)	1824	42.35 (7.33)	721
P value	.129		.215	

SD, standard deviation.

The New Zealand experience is heavily influenced by the performance of the SMR system (Lima Corporate), which has dominated the New Zealand market with 86.6% of the uncemented MB components used. The peak use of uncemented MB glenoids in New Zealand was in 2011 and coincided with the evolution of the reverse total shoulder in the market. The modularity of the SMR system, and the perception of an easier conversion from anatomic to reverse TSA, if required, may have played a part in the rapid uptake. The change from the SMR L1 to the SMR L2 glenoid in 2009, and the subsequent withdrawal of SMR L2 from the market in 2012, gave New Zealand surgeons an impetus to critically assess their practice. This was potentially further reinforced by Clitherow's publication. Whatever the trigger, the use of uncemented MB glenoids in New Zealand dropped from 46.7% of procedures in 2011 down to just 20.1% in 2017.

When the previously withdrawn SMR L2 glenoids were excluded from our analysis, a significant difference in the revision rates of the uncemented and cemented glenoids persisted (0.41 and 1.42 per 100 component-years, respectively). Page et al also found that when they excluded the SMR L2 on subgroup analysis, the higher revision rate persisted for uncemented glenoids on the AOANJRR, with a hazard ratio of 3.17.[9] These data suggest that the poor performance of uncemented glenoids cannot be solely attributed to the failure of the SMR L2 components.

The mode of failure for the TSAs in our study differed between the 2 groups. In TSAs with cemented glenoids, 46.7% of those requiring revision cited glenoid loosening as the indication. This could be anticipated from the experience in the literature, where multiple studies have cited loosening of cemented glenoid components as being the major driver for revision procedures.[1,2,4,10,13,14] For TSAs with uncemented glenoids, our data identified component failure as the most common reason for revision (34.8%), which was heavily influenced by the SMR L2 glenoid failures. When comparing the mode of failure between the L1 and L2 components there was a distinct difference, with 55.7% of L2 glenoids revised for component failure, whereas 50% of L1 components were revised for rotator cuff failure. Several studies have cited rotator cuff failure as a common reason for revision in uncemented MB prostheses, in part because of increased strain on the cuff from overstuffing the glenohumeral joint.[2,9,11] A recent cadaveric study found that rotator cuff tendon contact pressures were significantly increased with an uncemented MB TSA compared with a native joint, and that this may contribute to rotator cuff failure in addition to increased loading from joint lateralization.[12] In this study, we found no difference in the rates of revision for rotator cuff failure, deep infection, or dislocation between the 2 groups. In the Australian registry, the most common reason for revision for cemented was glenoid loosening (34.1%) and rotator cuff failure for uncemented (28.2%).[9]

There are limitations to our study, particularly surrounding the nature of registry data. Revision is used as a proxy for arthroplasty failure, which unfortunately does not account for those that have failed but for whatever reason have not been revised. The NZJR does not collect radiographic data, and the complexity of the case is not recorded in the registry. Although the reasons for revision are specified by the surgeon, more than 1 reason can be recorded for each procedure. Although the NZJR does use the Oxford Shoulder Score to assess the patient's functional

Table IV Revision-free survival by glenoid fixation

Glenoid type	n	Sum of component years	Revisions	Rate*	Lower 95% CI	Upper 95% CI	*P* value
All types							
Uncemented	794	4376	89	2.03	1.63	2.50	<.001
Cemented	1819	10,989	45	0.41	0.30	0.55	
Overall	2613	15,365	134	0.87	0.73	1.03	
All types, excluding SMR L2							
Uncemented—excluding SMR L2	591	3228	46	1.42	1.04	1.90	<.001
Cemented	1819	10,989	45	0.41	0.30	0.55	
Overall	2410	14,217	91	0.64	0.52	0.79	
Uncemented, excluding SMR L2							
Uncemented—non-SMR	106	546	1	0.18	0.00	1.02	.009
Uncemented—SMR L1 only	420	2484	40	1.61	1.13	2.17	
Overall	526	3030	41	1.35	0.96	1.82	

* Revisions per 100 component-years.

Table V Revision-free survival by patient age and glenoid fixation

Age group, yr	Glenoid fixation	Procedures	Sum of component years	Revisions	Rate*	Lower 95% CI	Upper 95% CI
<55	Uncemented	31	179	7	3.92	1.58	8.08
	Cemented	87	415	4	0.96	0.26	2.47
	Overall	118	594	11	1.85	0.87	3.21
55-64	Uncemented	163	873	24	2.75	1.76	4.09
	Cemented	441	2728	21	0.77	0.48	1.18
	Overall	604	3601	45	1.25	0.91	1.67
65-74	Uncemented	357	1959	42	2.14	1.55	2.90
	Cemented	814	5071	14	0.28	0.14	0.45
	Overall	1171	7029	56	0.80	0.60	1.03
≥75	Uncemented	243	1366	16	1.17	0.67	1.90
	Cemented	477	2775	6	0.22	0.08	0.47
	Overall	720	4140	22	0.53	0.33	0.80

CI, confidence interval.
* Rate reported as revisions per 100 component-years.

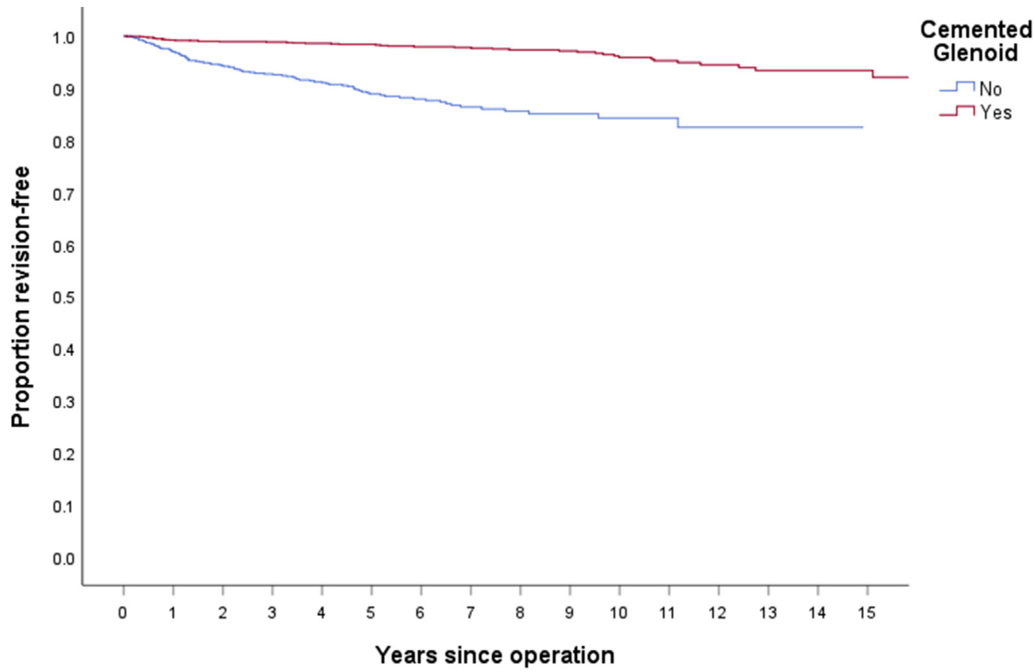

Figure 2 Kaplan-Meier survival analysis.

outcome postoperatively, these operated shoulders are not scored preoperatively. Similarly, the preoperative status of the patient's rotator cuff is not recorded on the registry.

Conclusion

In the NZJR, primary TSAs undertaken for OA have a significantly higher all-cause revision rate when uncemented MB glenoid components are used, with a hazard ratio of 5.0. The significantly higher rate persisted despite subanalysis excluding the previously recalled SMR L2 glenoids. Based on these data, we would caution against the use of uncemented MB glenoid components in primary TSA.

Disclaimer

The authors, their immediate families, and any research foundations with which they are affiliated have not

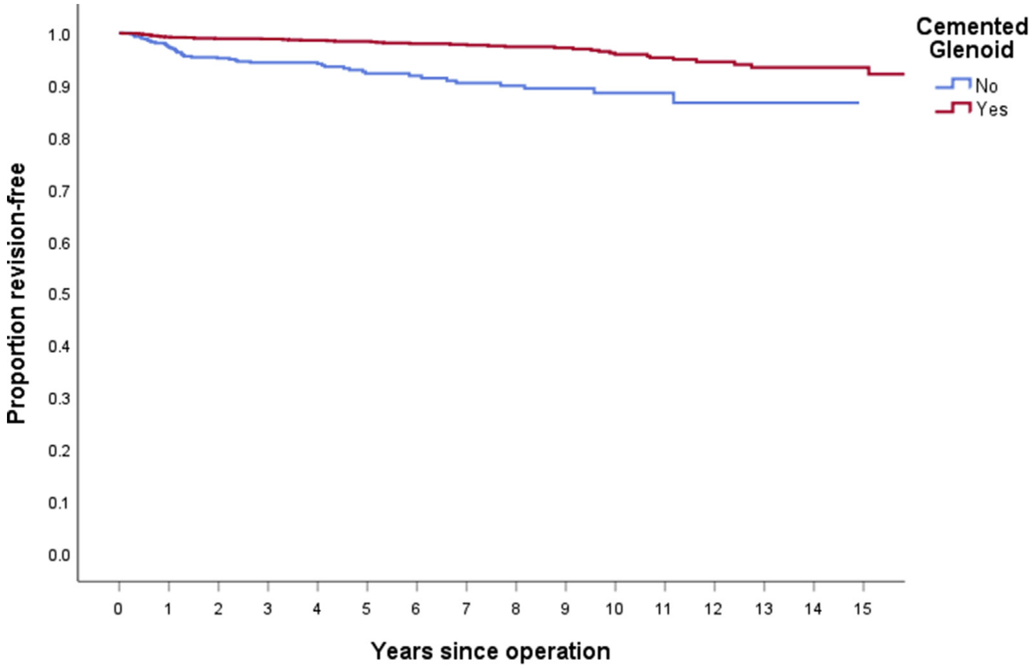

Figure 3 Kaplan-Meier survival analysis with SMR L2 excluded from analysis.

Table VI The most frequently cited reasons for undergoing a revision procedure

Cemented (n = 45)			Uncemented (n = 89)		
Component	n (%)	Mean time to revision,* yr	Component	n (%)	Mean time to revision,* yr
Glenoid loosening	20 (44.4)	7.17 (0.61-15.10)	Component failure	31 (34.8)	3.20 (0.42-7.22)
Subacromial/cuff	15 (33.3)	4.94 (0.46-12.74)	Subacromial/cuff	30 (33.7)	2.60 (0.23-9.57)
Pain	9 (20.0)	6.37 (0.33-15.10)	Dislocation/anterior instability	13 (14.6)	1.92 (0.19-6.50)
Dislocation/anterior instability	7 (15.6)	4.19 (0.06-12.40)	Pain	6 (6.7)	2.75 (0.77-6.79)
Deep infection	2 (4.4)	1.21 (0.49-1.93)	Deep infection	4 (4.5)	2.77 (0.96-7.69)
Overall		5.07 (0.06-15.10)	Overall		2.81 (0.15-11.17)

More than 1 reason can be given per revision procedure.
* Mean time to revision for those revised, reported as mean and range.

received any financial payments or other benefits from any commercial entity related to the subject of this article.

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