"Together, We Can Go Further"
KSES 2026
The 33rd Annual International Congress of the Korean Shoulder and Elbow Society
March 27(Fri) ~ 28(Sat), 2026
BEXCO, Busan, Korea

- Abstract No. : F-0067
- Category : Shoulder
- Detail Category : arthroplasty

Inlay versus Onlay Humeral Stems in Reverse Total Shoulder Arthroplasty: An Effective Analysis Using Component Mix-Matching

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Introduction and Background

In reverse total shoulder arthroplasty (RTSA), the humeral stem is typically designed as either an inlay or onlay configuration. Previous comparative studies have been limited by differences in glenoid components, creating potential confounding effects. This study aimed to compare the clinical and radiologic outcomes of inlay and onlay humeral stems while controlling for glenoid-related variables by using a single standardized glenosphere design.

Material and Method

A retrospective review was conducted on patients who underwent RTSA for irreparable massive rotator cuff tear or cuff tear arthropathy between January 2018 and December 2024 at three institutions. Importantly, Only cases using the same glenosphere (Trabecular Metal Reverse Plus) with either an inlay stem (Trabecular Metal Reverse Plus) or onlay stem (Biomet Comprehensive) were included. Final analyses included 20 inlay cases and 28 onlay cases. Clinical outcomes included preoperative and postoperative range of motion (ROM), VAS pain score, and ASES score. Radiologic evaluations addressed scapular notching, glenosphere inferior overhang and inclination, and acromial or scapular spine fractures.

Results

The mean follow-up duration was 21.5 months. Baseline demographics, preoperative ROM, and patient-reported outcome measures (PROMs) were comparable between the groups. At final follow-up, the inlay group demonstrated significantly greater abduction than the onlay group (158.75° vs. 142.86°, $p = 0.007$). No significant differences between two groups were found in other ROM parameters or PROMs. Scapular notching occurred in 25% (inlay) and 17.9% (onlay) of patients, with no significant difference. Acromial fractures occurred in 15% (inlay) and 10.7% (onlay) without difference between groups, and all were managed conservatively.

Conclusions

When controlling for glenoid components, inlay humeral stems demonstrated superior postoperative abduction compared with onlay stems, suggesting potential advantages for patients with pseudoparalysis or pseudoparesis. Other ROM measures, PROMs, and complication rates were similar between groups. Individualized implant selection based on patient anatomy and biomechanical considerations remains important.

Figure & Table 1.

Table 1. Baseline Demographics and Characteristics

Variable	Inlay type	Onlay type	p-value
Age	73.35±3.88	71.75±7.53	0.343
Sex (Male/Female)	1/19	5/23	0.379
Body mass index (kg/m^2)	24.35±2.64	23.67±4.01	0.509
Comorbidities			
Hypertension	14 (70)	15 (53.6)	0.370
Diabetes mellitus	7 (35)	7 (25)	0.528
Rheumatoid arthritis	1 (5)	5 (17.9)	0.379
Chronic kidney disease	2 (10)	1 (3.6)	0.563
Ischemic heart disease	3 (15)	6 (21.4)	0.716
Chronic obstructive pulmonary disease	2 (10)	2 (7.1)	1.000
ROM			
FF (°)	86.00±9.02	98.93±8.29	0.528
Abd (°)	88.50±11.22	89.11±7.14	0.628
ERs (°)	47.75±3.79	48.04±3.97	0.960
ERa (°)	53.25±5.78	47.86±3.91	0.344
IRp	4.30±0.62	4.11±0.74	0.457
Preoperative PROMs			
VAS score	5.60±0.35	5.71±0.41	0.774
ASES score	25.00±13.57	22.50±13.51	0.447
Radiographic evaluation			
Acromiohumeral distance (mm)	3.89±1.99	4.73±2.19	0.182
Scapular neck length (mm)	12.55±3.59	12.48±3.82	0.952
Glenoid erosion (Favard classification)			0.256
E0	12 (60)	23 (82.1)	
E1	3 (15)	1 (3.6)	
E2	2 (10)	2 (7.1)	
E3	3 (15)	1 (3.6)	
E4	0 (0)	1 (3.6)	

Values are presented as mean±standard deviation, or number (%).

ROM, range of motion; FF, forward flexion; Abd, abduction; ERs, external rotation with arm at the side; ERa, external rotation with arm at 90° abduction; IRp, internal rotation to posterior (level of vertebrae in which thigh = 0, buttock = 1, L5 = 2, and T1 = 18); PROMs, patient-reported outcome measures; VAS, Visual Analog Scale; ASES, American Shoulder and Elbow Surgeons.

Figure & Table 2.

Table 2. Postoperative Outcomes at the Final Follow-up

Variable	Inlay type	Onlay type	p-value
ROM			
FF (°)	142.50±16.82	151.25±23.67	0.064
Abd (°)	140.50±19.59	152.68±24.78	**0.039**
ERs (°)	54.25±12.28	51.54±13.59	0.629
ERa (°)	62.45±22.16	63.93±20.74	0.759
IRp	3.65±2.46	3.75±3.18	0.699
PROMs			
VAS score	1.70±1.53	2.46±1.62	0.082
ASES score	72.50±12.51	70.36±12.32	0.565
Radiographic evaluation			
Inferior overhang (mm)	4.01±1.55	5.08±1.53	**0.022**
Inferior tilting (mm)	1.28±7.86	3.92±4.58	0.272
Scapular notching	5 (25)	5 (17.9)	0.339
Acromial fracture	3 (15.0)	3 (10.7)	0.683

Table 3. Subgroup Analysis Comparing Preoperative and Postoperative Outcomes in Each Group

Variable	Inlay type			Onlay type		
	Preoperative	Postoperative	p-value	Preoperative	Postoperative	p-value
ROM						
FF (°)	86.00±40.32	142.50±16.82	**<0.001**	98.93±43.91	151.25±23.67	**<0.001**
Abd (°)	88.50±50.19	158.75±22.35	**<0.001**	89.11±37.76	142.86±21.28	**<0.001**
ERs (°)	47.75±16.97	54.25±12.28	0.173	48.04±21.01	51.54±13.59	0.300
ERa (°)	53.25±25.87	62.45±22.16	0.257	47.86±20.70	63.93±20.74	**0.005**
IRp	4.30±2.76	3.65±2.46	0.529	4.11±3.91	3.75±3.18	0.986
PROMs						
VAS score	5.60±1.57	1.70±1.53	**<0.001**	5.71±2.16	2.46±1.62	**<0.001**
ASES score	25.00±13.57	72.50±12.51	**<0.001**	22.50±13.51	70.36±12.32	**<0.001**

Values are presented as mean±standard deviation.

ROM, range of motion; FF, forward flexion; Abd, abduction; ERs, external rotation with arm at the side; ERa, external rotation with arm at 90° abduction; IRp, internal rotation to posterior (level of vertebrae in which thigh = 0, buttock = 1, L5 = 2, and T1 = 18); PROMs, patient-reported outcome measures; VAS, Visual Analog Scale; ASES, American Shoulder and Elbow Surgeons.