

Complications in Patients with Humeral Head Osteonecrosis After Shoulder Arthroplasty: A Propensity Matched Cohort Study

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INTRODUCTION: Total shoulder arthroplasty (TSA) is an effective surgical option for managing advanced osteonecrosis (ON) of the humeral head, a condition characterized by vascular disruption and bone necrosis. TSA has demonstrated excellent outcomes, providing significant pain relief, improved range of motion, and durable implant survivorship. Despite this, ON accounts for fewer than 5% of all indications for shoulder arthroplasty, and much of the existing literature is limited to small case series, precluding generalizability to broader populations. This study aimed to evaluate healthcare utilization, systemic complications, and implant-related outcomes in patients undergoing TSA with and without ON.

METHODS: The TriNetX Research Database containing 138 million patients across 101 healthcare organizations was queried to identify patients undergoing TSA between 2002 and 2022. Patients were divided into two cohorts: those with ON (TSA + ON) and those without ON (TSA-only). Propensity score matching was utilized to balance comorbidities. Covariates included in the matching process were age, sex, race, ethnicity, diabetes mellitus, liver disease, nicotine dependence, sickle-cell disorders, coagulation disorders, antiphospholipid syndrome, long-term steroid use, and kidney disease. Cohort characteristics before and after matching are provided in Table 1. Postoperative outcomes, including emergency department (ED) visits, readmissions, adverse events, and prosthetic complications, were analyzed at 30 days, 90 days, and 1 year. Adverse events were classified as severe or minor. Severe adverse events included sepsis, myocardial infarction, deep vein thrombosis, pulmonary embolism, and cardiac arrest. Minor adverse events included pneumonia, acute kidney injury, urinary tract infection, transfusion, wound dehiscence, and hematoma. Orthopedic implant related complications included prosthetic joint infections, surgical site infections (superficial and deep), dislocations, periprosthetic fractures, prosthesis mechanical loosening, hardware breakage, and revision TSA. Pairwise analyses were performed between groups, and Z-tests were used to determine the significance of risk differences. Statistical significance was set at a threshold of $P < 0.05$.

RESULTS:

The query identified 1,281 patients with ON undergoing primary TSA and 71,201 patients without ON undergoing primary TSA. After matching, the groups each consisted of 1218 patients and there were no significant differences between the two cohorts (Table 1). Patients with ON exhibited significantly higher rates of emergency department (ED) visits compared to patients without ON at all postoperative time points, while significant differences in readmission rates were observed at both 90 days and 1 year. At 30 days, higher proportion of TSA + ON group returned to the ED compared with TSA-only group (odds ratio [OR] = 0.611; $P = 0.018$). This difference persisted at 90 days (OR = 0.747; $P = 0.048$), and at 1 year (OR = 0.778; $P = 0.019$). Readmission rates were significantly elevated in the TSA + ON cohort at 1 year, (OR = 0.714; $P = 0.006$). This increase was also observed at the 90-day time point (OR = 0.717; $P = 0.026$) (Table 2).

Patients with ON exhibited significantly higher rates of severe adverse events at all postoperative time points compared to the TSA-only cohort including at 30 days, (OR = 0.448; $P = 0.009$), with this difference persisting at 90 days (OR = 0.629; $P = 0.049$) and 1 year (OR = 0.710; $P = 0.039$). Minor adverse events were also more frequent in the TSA + ON cohort, particularly at 90 days (OR = 0.684; $P = 0.014$) and 1 year (OR = 0.771 ; $P = 0.021$). Specific complications such as acute kidney failure and pneumonia were significantly elevated in the TSA + ON cohort, with acute kidney failure occurring more frequently at 90 days (OR = 0.382; $P = 0.002$) and 1 year (OR = 0.616; $P = 0.010$), and pneumonia being more prevalent at 90 days (OR = 0.536 ; $P = 0.028$) and 1 year (OR = 0.619 ; $P = 0.015$). Additionally, deep vein thrombosis at 1 year was more common in the TSA + ON cohort (OR = 0.494 ; $P = 0.029$). Overall, the cumulative rate of any adverse event was significantly higher in TSA + ON patients compared to TSA-only patients at both 90 days (OR = 0.688 ; $P = 0.007$) and 1 year (OR = 0.788 ; $P = 0.024$). (Table 3). The rates of prosthetic joint infections, prosthesis dislocations, periprosthetic fractures, prosthesis mechanical loosening, broken prostheses, superficial and deep surgical site infections, and revision TSA were not significantly different between the TSA + ON and TSA-only cohorts at any time point.

DISCUSSION AND CONCLUSION: ON is associated with significantly higher rates of healthcare utilization and postoperative systemic complications following TSA, emphasizing the need for tailored perioperative care. Despite these challenges, TSA remains a durable and effective treatment for ON, with comparable implant-related outcomes to non-ON patients. Future studies should explore patient-specific factors influencing outcomes to optimize care strategies for this high-risk population.

Table I Characteristics of patients in TSA-only and TSA-ON cohorts before and after matching

	Before Matching			After Matching		
	TSA-only (n=1,201)	TSA-ON (n=1,201)	P Value	TSA-only (n=1,218)	TSA-ON (n=1,218)	P Value
White	57,627 (81.3)	842 (66.4)	<0.001	858 (70.4)	842 (69.1)	0.480
Black or African American	4,097 (5.8)	215 (16.9)	<0.001	168 (13.8)	179 (14.7)	0.524
Hispanic or Latino	2,349 (3.3)	34 (2.7)	0.211	23 (1.9)	33 (2.7)	0.176
Not Hispanic or Latino	50,114 (70.7)	819 (64.5)	<0.001	803 (65.9)	786 (64.5)	0.470
Male	30,688 (43.3)	430 (33.9)	<0.001	389 (31.9)	414 (34.0)	0.281
Female	38,362 (54.1)	815 (64.2)	<0.001	807 (66.5)	780 (64.0)	0.251
Diabetes	11,253 (15.9)	198 (15.6)	0.799	201 (16.5)	198 (16.3)	0.870
Nicotine dependence	4,213 (5.9)	182 (14.3)	<0.001	191 (15.7)	173 (14.2)	0.306
Acute kidney injury	5,839 (8.2)	153 (12.1)	<0.001	144 (11.8)	144 (11.8)	1.000
Long-term steroid use	1,482 (2.1)	99 (7.8)	<0.001	85 (7.0)	94 (7.7)	0.485
Diseases of the liver	2,426 (3.4)	85 (6.7)	<0.001	83 (6.7)	83 (6.8)	0.872
Sickle-cell disease	95 (0.1)	116 (9.1)	<0.001	54 (4.4)	66 (5.4)	0.261
Congestive disorders	330 (0.5)	10 (0.8)	0.096	10 (0.8)	10 (0.8)	1.000
Antiphospholipid syndrome	128 (0.2)	10 (0.9)	<0.001	10 (0.8)	10 (0.9)	0.827

TSA, total shoulder arthroplasty; ON, osteoneurosis; OR, odds ratio; CI, confidence interval

Table II 30 day, 90 day, and 1 year healthcare utilization for matched TSA-only and TSA-ON cohorts

	TSA-only (n=1,218)	TSA-ON (n=1,218)	OR (95% CI)	P Value
ED Visit				
30 d	38	61	0.611 (0.404 - 0.923)	0.018
90 d	88	115	0.747 (0.559 - 0.998)	0.048
1 y	191	235	0.778 (0.631 - 0.950)	0.019
Readmission				
30 d	69	91	0.744 (0.538 - 1.028)	0.072
90d	84	114	0.717 (0.535 - 0.962)	0.026
1 y	135	181	0.714 (0.563 - 0.907)	0.006

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Table III 30-day, 90-day, and 1 year systemic complications for matched TSA-only and TSA-ON cohorts

	TSA-only (n=1,218)	TSA-ON (n=1,218)	OR (95% CI)	P Value
Sepsis				
30 d	<10	<10	-	-
90 d	<10	<10	-	-
1 y	22	26	0.840 (0.475 - 1.496)	0.560
Myocardial Infarction				
30 d	<10	<10	-	-
90d	<10	13	0.767 (0.355 - 1.757)	0.53
1 y	15	30	0.494 (0.264 - 0.922)	0.024
Pulmonary Embolism				
30 d	<10	12	0.835 (0.384 - 1.923)	0.668
90d	11	15	0.731 (0.334 - 1.593)	0.43
1 y	23	27	0.849 (0.484 - 1.489)	0.568
Deep Vein Thrombosis				
30 d	<10	<10	1.000 (0.415 - 2.411)	1.000
90d	<10	14	0.722 (0.315 - 1.689)	0.412
1 y	14	28	0.494 (0.259 - 0.943)	0.029
Surgical Site Infection				
30 d	0	0	-	-
90d	0	0	-	-
1 y	<10	<10	-	-
Cardiac Arrest				
30 d	<10	<10	-	-
90d	<10	<10	-	-
1 y	<10	<10	-	-
Pneumonia				
30 d	15	21	0.711 (0.365 - 1.385)	0.314
90d	19	35	0.536 (0.305 - 0.942)	0.028
1 y	43	68	0.619 (0.419 - 0.915)	0.015
Urinary Tract Infection				
30 d	<10	<10	-	-
90d	18	29	0.615 (0.340 - 1.113)	0.105
1 y	62	67	0.921 (0.646 - 1.314)	0.651
Transfusion				
30 d	17	18	0.944 (0.484 - 1.840)	0.865
90d	24	26	0.925 (0.526 - 1.616)	0.775
1 y	44	46	0.955 (0.627 - 1.455)	0.830
Wound Dehiscence				
30 d	<10	<10	-	-
90d	<10	<10	-	-
1 y	11	<10	1.103 (0.467 - 2.606)	0.824
Hematoma				
30 d	<10	<10	-	-
90d	<10	<10	-	-
1 y	11	<10	1.101 (0.466 - 2.602)	0.827
Acute Kidney Failure				
30 d	<10	15	0.664 (0.297 - 1.484)	0.315
90d	14	36	0.382 (0.203 - 0.712)	0.002
1 y	48	76	0.610 (0.426 - 0.893)	0.010
Severe Adverse Events				
30 d	15	33	0.448 (0.242 - 0.829)	0.009
90d	30	47	0.629 (0.393 - 1.002)	0.049
1 y	66	91	0.710 (0.511 - 0.984)	0.039
Minor Adverse Events				
30 d	50	61	0.812 (0.554 - 1.190)	0.285
90d	76	108	0.684 (0.504 - 0.928)	0.014
1 y	166	207	0.771 (0.617 - 0.962)	0.021
Any Adverse Events				
30 d	62	83	0.733 (0.523 - 1.029)	0.072
90d	97	136	0.688 (0.524 - 0.905)	0.007
1 y	200	243	0.785 (0.641 - 0.959)	0.024

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 *Tables does not include exact numbers of less than 10 to prevent serious identification.