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Total shoulder arthroplasty in patients with dementia or mild cognitive impairment

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Background: Anatomic total shoulder arthroplasty (ATSA) and reverse total shoulder arthroplasty (RTSA) reliably alleviate pain and restore shoulder function for a variety of indications. However, these procedures are not well-studied in patients with neurocognitive impairment. Therefore, the purpose of this study was to investigate whether patients with dementia or mild cognitive impairment (MCI) have increased odds of surgical or medical complications following arthroplasty.

Methods: The PearlDiver database was queried from 2010 through October 2021 to identify a cohort of patients who underwent either ATSA or RTSA and had a minimum 2-year follow-up. Current Procedural Terminology and International Classification of Diseases codes were used to stratify this cohort into three groups: (1) patients with dementia, (2) patients with MCI, and (3) patients with neither condition. Surgical and medical complication rates were compared among these three groups.

Results: The overall prevalence of neurocognitive impairment among patients undergoing total shoulder arthroplasty was 3.0% in a cohort of 92,022 patients. Patients with dementia had increased odds of sustaining a periprosthesis humerus fracture (odds ratio [OR] = 1.46, $P < .001$), developing prosthesis instability (OR = 1.72, $P < .001$), and undergoing revision arthroplasty (OR = 1.55, $P = .003$) after RTSA compared to patients with normal cognition. ATSA patients with dementia did not have an elevated risk of surgical complications or revision. Conversely, RTSA patients with MCI did not have an elevated risk of complications or revision, although ATSA patients with MCI had greater odds of prosthesis instability (OR = 2.51, $P = .008$). Additionally, patients with neurocognitive impairment had elevated odds of medical complications compared to patients with normal cognition, including acute myocardial infarction and cerebrovascular accident.

Conclusion: Compared to patients with normal cognition, RTSA patients with preoperative dementia and ATSA patients with preoperative MCI are at increased risk for surgical complications. Moreover, both ATSA and RTSA patients with either preoperative MCI or dementia are at increased risk for medical complications. As the mean age in the U.S. continues to rise, special attention should be directed towards patients with neurocognitive impairment to minimize postoperative complications aftertotal shoulder arthroplasty, and the risks of this surgery more carefully discussed with patients and their families and caretakers.

The number of total shoulder arthroplasty (TSA) procedures continues to increase worldwide due to an aging population, with the demand for primary arthroplasty projected to increase by at least 300% by 2030.[12,40] This trend is most evident in the elderly, for whom utilization has increased at the greatest rate.[40]

Neurocognitive impairment is a relatively common diagnosis in the United States elderly population, with dementia having a prevalence of 10% and mild cognitive impairment (MCI) having a prevalence of 22% in those aged 65 years or older.[32] Despite this, the outcomes of patients with dementia or MCI undergoing TSA remain poorly characterized.

Most of the orthopedic literature on patients with neurocognitive impairment has been focused on arthroplasty of the lower extremities. Though total hip arthroplasty (THA) and total knee arthroplasty alleviate patient pain and improve quality of life, these procedures result in comparatively worse postoperative functional status and lower independence in activities of daily

Institutional review board approval was not required for this study, as it uses deidentified data from an administrative claims database.

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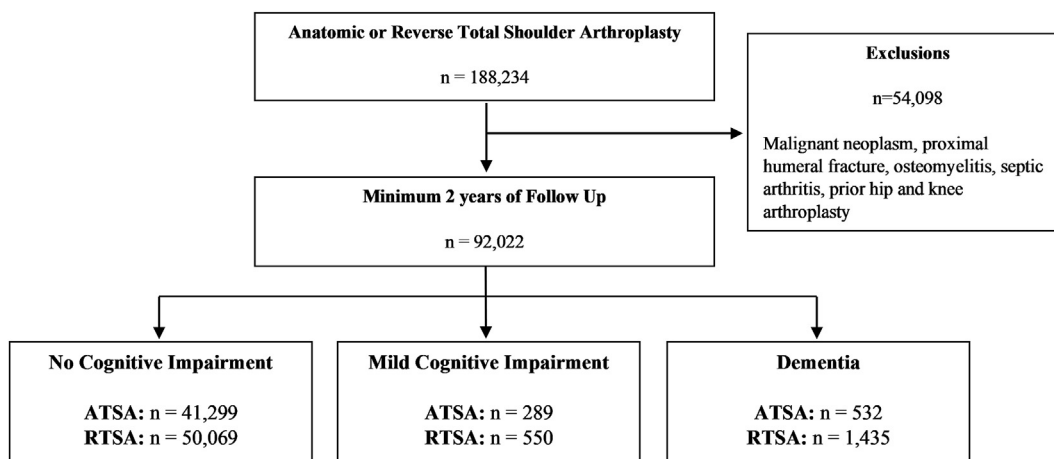
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Figure 1 Strengthening of the reporting of observational studies in epidemiology (STROBE) diagram depicting selection and grouping of patients included in this study. *ATSA*, anatomic total shoulder arthroplasty; *RTSA*, reverse total shoulder arthroplasty.

living (ADLs) in patients with preoperative cognitive impairment.[3,27,57] Lower satisfaction rates among patients with preoperative cognitive impairment may be attributable to these factors, along with a high risk of postoperative delirium that can delay rehabilitation.[53,55,57] Moreover, patients with MCI and dementia are more likely to have gait disorders and increased fall risk, which may contribute to a higher risk of implant failure requiring revision.[2,19]

Available literature examining shoulder arthroplasty in patients with dementia is scarce and limited to retrospective case series or short-term perioperative outcomes.[4] Furthermore, the outcomes of patients with MCI after TSA have not yet been studied. As the prevalence of dementia is projected to double by 2050, it will be increasingly important to characterize the risks associated with shoulder arthroplasty among patients with neurocognitive impairment.[38] Therefore, the purpose of this study is to use a national claims database to evaluate the surgical and medical complications of patients with neurocognitive impairment undergoing TSA. We hypothesized that patients with cognitive impairment would have increased complication rates compared to patients with normal cognition, with increasing rates observed in patients with more severe impairment.

Methods

Study design

A retrospective cohort study was performed using the PearlDiver software (PearlDiver, Colorado Springs, CO, USA) to query the Mariner database.[46] Mariner is an administrative claims database of private and public payers in the United States that comprises over 157 million individuals and longitudinally tracks individual patient diagnoses and procedures.[46] The database was queried from 2010 to October 2021 to identify patient cohorts. This study utilizes deidentified data and was exempt from Institutional Review Board approval at our institution.

Patient selection

International Classification of Diseases (ICD), Ninth and Tenth Revision codes were used to identify patients who underwent either a primary anatomic total shoulder arthroplasty [ATSA] (9th: 81.80; 10th: 0RRJ0JZ, 0RRK0JZ) or reverse total shoulder arthroplasty [RTSA] (9th: 81.88; 10th: 0RRJ00Z, 0RRK00Z) with minimum

follow-up of 2-years (Fig. 1). Patients with history of septic arthritis or osteomyelitis of the shoulder, malignant neoplasm of the upper extremity, or proximal humeral fracture were excluded. Patients with THA and total knee arthroplasty before or after TSA were also excluded due to lack of ICD-9 and 10 complication codes specific to the shoulder.

To determine the effects of the severity of preoperative cognitive impairment, patients were divided into three groups (1: normal cognition, 2: MCI, and 3: dementia) using ICD-9 and 10 codes. Patients who had records of both MCI and dementia were categorized as having dementia given that neurocognitive impairment is a progressive disease.

Identification of patient comorbidities

Comorbid conditions were identified using ICD-9 and ICD-10 codes (Supplementary Table S1). Any patient whose medical history included one of the diagnostic codes for a comorbidity within a year prior to surgery was classified as having that respective comorbidity. Factors that have been reported in the literature to affect cognition in this patient population—including anxiety, depression, and psychiatric disorders—were also assessed.[23,30,31,37] Chronic use of oral sleep aids (zolpidem tartrate, eszopiclone) was defined as having multiple prescriptions filled in the past year and at least one in the 3 months leading up to surgery.

Identification of surgical complications, medical complications, and revision arthroplasty

Surgical complications were tracked for a minimum of two years and included shoulder prosthetic joint infection, prosthesis instability, component loosening, periprosthetic fracture, and revision shoulder arthroplasty (Supplementary Table S2). Medical complications were tracked for 90 days after surgery using ICD-9 and 10 codes (Supplementary Table S3). Postoperative delirium and discharge to a skilled nursing facility (SNF) were tracked for 7 days after surgery.

Statistical analysis

All statistical analyses were performed using R statistical software version 4.1 integrated with PearlDiver (R Foundation for Statistical Computing, Vienna, Austria). Descriptive statistics including means, standard deviations, frequency, and proportions

were reported as appropriate. Bivariate analyses were performed using Fisher's exact or Chi-square testing for categorical variables and One-way analysis of variance testing for continuous variables. Multivariate logistic regression models were performed to assess the impact of covariates on postoperation surgical complications following ATSA and RTSA. Covariates with clinical relevance based on previous literature were entered into the model and removed with a backward selection method. Covariates included ADL dependence, psychotic disorders, other psychiatric conditions, depression, anxiety, osteoporosis, age, gender, tobacco use disorder and chronic oral sleep aid use. Results were reported as adjusted odds ratios (ORs) with 95% confidence intervals (CIs). Significance was set at $P < .05$. The forest plot in Fig. 2 was made using the R package "Forester.".[5]

Results

Patient demographics

Demographics of patients undergoing TSA are shown in Table I. There were 42,120 patients who underwent ATSA and 52,054 patients who underwent RTSA (Fig. 1). Of these, 2.0% and 3.8% of patients had some degree of neurocognitive impairment in the ATSA and RTSA groups, respectively. Patients with dementia (72.7 ± 6.2 years) were significantly older than both patients with MCI (70.4 ± 7.5 years, $P < .001$) and normal cognition (67.8 ± 8.3 years, $P < .001$). Patients with dementia also had higher Charlson Comorbidity Index scores (3.7 ± 3.2) than both patients with MCI (3.3 ± 3.0, $P < .001$) and normal cognition (2.0 ± 2.4, $P < .001$).

Patients with dementia had higher preoperative rates of anxiety, depression, psychotic disorders and other psychiatric conditions, and osteoporosis compared to other groups.

Surgical complications

Postoperative surgical complications for patients undergoing ATSA and RTSA are shown in Tables II and III, respectively. Among both patients undergoing ATSA and RTSA, the three cognition subgroups differed significantly in postoperative rates of prosthesis instability and periprosthetic fracture.

More specifically, in patients undergoing ATSA, dementia was associated with a significantly increased odds of experiencing a periprosthetic fracture compared to patients with normal cognition [OR = 2.20 (95% CI: 1.20-4.03), $P = .039$]. Similarly, patients with MCI who underwent ATSA were significantly more likely to sustain a dislocation [OR = 2.53 (95% CI: 1.30-4.94), $P = .012$]. In patients undergoing RTSA, dementia was likewise associated with increased odds of periprosthetic fracture compared to patients with normal cognition [OR = 1.70 (95% CI: 1.37-2.11), $P < .001$]; in addition, these patients were also more likely to sustain a dislocation [OR = 1.68 (95% CI: 1.30-2.16), $P < .001$] and require revision arthroplasty [OR = 1.36 (95% CI: 1.03-1.80), $P = .029$]. However, there was no difference in surgical complication rates between patients with MCI and normal cognition undergoing RTSA.

Medical complications

The rates of postoperative medical complications for TSA patients are shown in Fig. 2. Overall, patients with dementia [OR = 2.41 (95% CI: 2.15-2.70), $P < .001$] or MCI [OR = 1.51 (95% CI: 1.23-1.84), $P < .001$] who underwent TSA had greater odds of experiencing any medical complication compared to patients with normal cognition. During the postoperative hospitalization, patients with dementia were more likely to experience delirium and be discharged to SNF compared to patients with normal cognition

($P < .001$). At 90-days, patients with dementia were more likely to have a visitation to the emergency department (ED) or experience an acute myocardial infarction (MI), cerebrovascular accident (CVA), sepsis, pneumonia, aspiration pneumonia, acute renal failure or urinary tract infection ($P < .001$). Patients with MCI likewise were significantly more likely to experience postoperative delirium ($P = .019$), be discharged to an SNF, have an ED visit, and experience a CVA ($P < .001$).

Multivariate analysis of postsurgical complications in TSA patients

On multivariate analysis, there was no difference in ATSA complication rates between patients with dementia and normal cognition (Table IV). Interestingly, patients with MCI had greater odds of prosthesis instability compared to patients with normal cognition [OR = 2.51 (95% CI: 1.18-4.63, $P = .008$)].

Similarly, RTSA patients with dementia were more likely to sustain a dislocation [OR = 1.72 (95% CI: 1.31-2.22), $P < .001$], develop a periprosthetic fracture [OR = 1.46 (95% CI: 1.16-1.82), $P < .001$] or require revision arthroplasty [OR = 1.55 (95% CI: 1.15-2.04), $P = .003$] compared to patients with normal cognition. However, RTSA patients with MCI did not have an increased risk of complications compared to patients with normal cognition.

Discussion

In the present study, the overall prevalence of TSA patients with neurocognitive impairment was 3.0%. These patients had a higher rate of surgical complications, medical complications, and healthcare utilization, including postoperative discharge to SNF and 90-day ED visits. Moreover, patients with more advanced disease had the greatest risk of surgical complications after RTSA. As the mean age in the U.S. increases, it is likely that not only will the frequency of TSA in general rise, but so too will the number of patients with dementia and MCI undergoing the procedure.[59] Thus, it will be increasingly important for both patients and their families and providers to be aware of the surgical and medical complications associated with TSA.

Preexisting dementia in patients was associated with increased odds of postoperative periprosthetic humerus fracture (PPF). Patients with dementia undergoing ATSA experienced a periprosthetic fracture at an incidence of 2.1% compared to 1.0% in patients with normal cognition. Likewise, patients with dementia undergoing RTSA sustained a periprosthetic fracture at an incidence of 6.3% compared to 3.8% in patients with normal cognition. Similar findings have been observed in patients with other neurocognitive disorders such as Parkinson's Disease (PD). In a case-control study of 4199 TSA patients with PD, Burrus et al showed an increased risk of humerus fractures compared to controls at 1-year.[7] Several studies in the hip and knee literature have shown similar trends, including a higher rate of periprosthetic hip fracture in patients with dementia undergoing THA.[1,19,18] The higher rates of postoperative fracture may be due to the increased gait instability and higher fall risk among patients with neurocognitive impairment.[2,17] Furthermore, these patients have higher rates of osteoporosis due to decreased physical activity and greater dependence on others for ADLs.[11,15,52,60,61] The higher rates of PPF in patients with neurocognitive impairment may consequently contribute to a higher risk of revision.[7,19] Periprosthetic humeral fractures are devastating to the patient as many of them use assistive devices and require their upper extremity to ambulate. Preoperative visual acuity and home evaluations as well as referrals to a neurologist to maximize disease control should be offered to patients to minimize the risk of falls.[9]
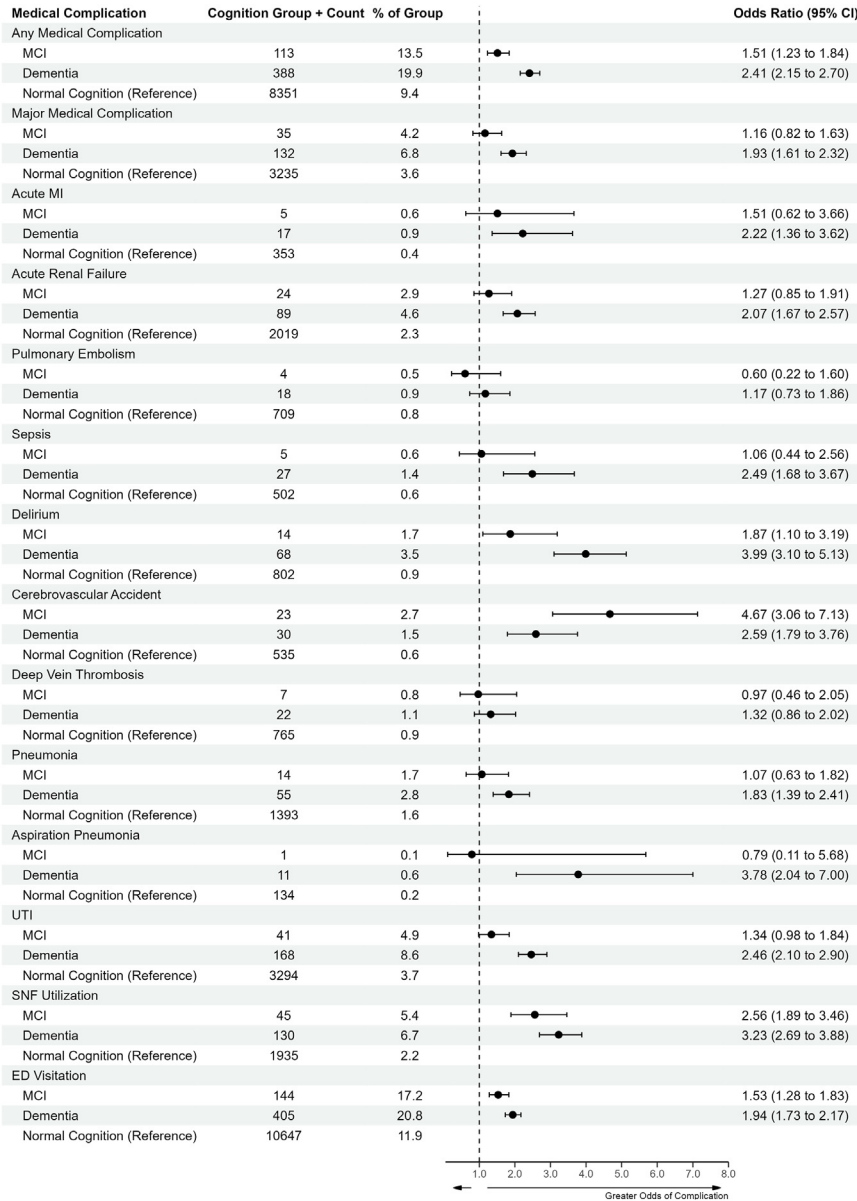
Figure 2 Forest Plot of Medical Complications in Total Shoulder Arthroplasty Patients. *CI*, confidence interval; *MCI*, mild cognitive impairment; *MI*, myocardial infarction; *UTI*, urinary tract infection; *SNF*, skilled nursing facility; *ED*, emergency department. Data is in aggregate for both anatomic and reverse total shoulder arthroplasty. Major medical complication defined as: acute MI, acute renal failure, pulmonary embolism, sepsis. SNF utilization and ED visitation are not considered in the overall medical complication rate.

The higher rates of prosthesis instability may be attributed to the lack of neuromuscular control among patients with neurocognitive disease.[7,9,24,34] Moreover, these patients may be less compliant with postoperative immobilization, as a shoulder immobilizer may be perceived as a restraint. A systematic review of patients with PD showed higher rates of prosthesis instability compared to normal cognition, with one included study placing incidence at 4.0% and 5.6% for these patients when undergoing ATSA or RTSA, respectively.[7,9] A recent retrospective cohort study by Papalia et al also demonstrated higher risk of shoulder dislocation in patients with PD compared to controls.[42] As with PPF, risk of prosthesis instability can contribute to the observed elevated rates of revision arthroplasty. Given the higher rate of instability in patients with cognitive disorders, special consideration should be directed towards mitigating this risk at the time of the index procedure. One possible option is to use a constrained liner, which potentially improves stability without sacrificing motion.[16]

However, a cause for concern with these constrained liners is the greater wear and volume loss they undergo compared to nonconstrained liners, which can potentially lead to aseptic loosening as a long-term complication.[8,16] RTSA with subscapularis repair should also be considered, as prior studies have shown reduced dislocation rates.[35] We do not routinely recommend lateralizing or distalizing the glenoid due to the risk of acromial stress fracture in this older population with a high prevalence of osteoporosis.[25] However, the surgeon may consider humeral lateralization to increase the deltoid wrapping effect and potentially increase stability.[28,44,51]

Postsurgical complications in patients with MCI, a population that to our knowledge has not been studied for longitudinal outcomes following TSA, were less pronounced than for dementia. Patients with MCI undergoing RTSA did not have a statistically significantly increased risk of prosthesis instability, periprosthetic fracture or revision compared to patients with normal cognition. This may suggest that there is a cognitive threshold at which the

Table I
Patient demographics.

	Dementia (n = 1947)	MCI (n = 839)	Normal cognition (n = 89,236)
Age	72.7 (6.2)	70.4 (7.5)	67.8 (8.3)
CCI	3.7 (3.2)	3.3 (3.0)	2.0 (2.4)
Female gender	1253 (64.4%)	480 (57.2%)	49,300 (55.2%)
Obesity	286 (14.7%)	162 (19.3%)	16,208 (18.2%)
Chronic oral sleep medication use	91 (4.67%)	44 (5.2%)	4944 (5.5%)
Comorbid conditions			
Anxiety	546 (28.0%)	244 (29.1%)	15,353 (17.2%)
Depression	779 (40.0%)	327 (39.0%)	19,575 (21.9%)
Psychotic disorders	91 (4.7%)	13 (1.6%)	674 (0.8%)
Other psychiatric conditions	118 (6.1%)	26 (3.1%)	1833 (2.1%)
Osteoporosis	284 (14.6%)	99 (11.8%)	7949 (8.9%)
Tobacco use disorder	487 (25.0%)	269 (32.1%)	20,821 (23.3%)

MCI, mild cognitive impairment; *CCI*, Charlson comorbidity index.
Data expressed as count (%) or mean (standard deviation). Psychotic disorders includes: schizophrenic disorders, schizoaffective disorders, delusional disorders. Other psychiatric conditions include episodic mood disorders.

Table II
ATSA surgical complications.

	Dementia (n = 532)	MCI (n = 289)	Normal cognition (n = 41,299)	*P* value
Prosthetic joint infection	8 (1.5%)	6 (2.1%)	547 (1.3%)	.410
Prosthesis instability	11 (2.1%)	9 (3.1%)	518 (1.3%)	**.008**
Component loosening	7 (1.3%)	5 (1.7%)	444 (1.1%)	.371
Periprosthetic fracture	11 (2.1%)	3 (1.0%)	393 (1.0%)	**.039**
Revision arthroplasty	15 (2.8%)	8 (2.8%)	804 (2.0%)	.172

ATSA, anatomic total shoulder arthroplasty; *MCI*, mild cognitive impairment.
Data expressed as count (%). Bolded *P* values denote significance.

Table III
RTSA surgical complications.

	Dementia (n = 1435)	MCI (n = 550)	Normal cognition (n = 50,069)	*P* value
Prosthetic joint infection	22 (1.5%)	11 (2.0%)	922 (1.8%)	.663
Prosthesis instability	65 (4.5%)	21 (3.8%)	1378 (2.8%)	**<.001**
Component loosening	27 (1.9%)	4 (0.7%)	758 (1.5%)	.167
Periprosthetic fracture	91 (6.3%)	26 (4.7%)	1921 (3.8%)	**<.001**
Revision arthroplasty	53 (3.7%)	16 (2.9%)	1369 (2.7%)	.090

RTSA, reverse total shoulder arthroplasty; *MCI*, mild cognitive impairment.
Data expressed as count (%). Bolded *P* values denote significance.

risk of complication increases, with effects potentially becoming more severe with greater cognitive impairment. Unfortunately, due to the lack of specificity of ICD codes, we were not able to categorize the severity of dementia. However, ATSA patients with MCI did have higher odds of prosthesis instability compared to patients with normal cognition, whereas patients with dementia did not. This may be due to insufficient power, as there was a trend towards significance among patients with dementia. The higher rate of instability after ATSA may be attributed to decreased compliance with postoperative immobilization, resulting in subscapularis failure.[14,26]

Unsurprisingly, patients with neurocognitive impairment also have a higher rate of medical complications following TSA, including acute MI, sepsis and CVA. The overall rate of medical complications was 19.9%, 13.5% and 9.4% in patients with dementia, MCI and normal cognition, respectively. Patients with dementia moreover had 93% greater odds of experiencing a major medical complication (acute MI, acute renal failure, pulmonary embolism, or sepsis) compared to patients with normal cognition. The increased rates of medical complications may have to do with reduced ability to communicate symptoms by patients with neurocognitive impairment.[22,29,49] Additionally, risk factors including dysphagia and anti-psychotic use in patients with dementia may also contribute to medical complications following

TSA.[21,22,29,41,43,48,54] Importantly, we found significantly higher rates of postoperative delirium in patients with either dementia or MCI compared to patients with normal cognition. These findings are consistent with prior hip and knee literature in patients with cognitive impairment.[19,18,29,62] The high rates of observed postoperative delirium are problematic for recovery following TSA, and especially so for patients who undergo ATSA since increased noncompliance with a brace can stress repair of the subscapularis.[14,26] Delirium rates should, therefore, be mitigated through methods focused on prevention and early management, including early mobilization and appropriate analgesia such as regional nerve blocks.[20,26,56]

Although TSA can reliably restore function and alleviate pain in patients with cognitive impairment, these patients are at an increased risk of postoperative surgical complications—such as revision, prosthesis instability and periprosthetic fracture—and medical complications, such as sepsis. The risk of revision shoulder arthroplasty in patients with dementia undergoing ATSA or RTSA was 2.8% and 3.7%, respectively, in this cohort. These rates are similar to those seen in patients with BMI over 30 kg/m^2 and hemoglobin A1c greater than 7.0%, though slightly lower than in patients with opioid dependence.[6,10,36] Similarly, the risk of periprosthetic fracture in patients with dementia undergoing ATSA or RTSA was 2.1% and 6.3%, respectively, in this study, which is

Table IV

Multivariate analysis of surgical complications in patients with dementia, mild cognitive impairment, and normal cognition undergoing anatomic or reverse total shoulder arthroplasty.

Predictor	Prosthesis instability		Periprosthetic fracture		Revision arthroplasty	
	OR (95% CI)	*P* value	OR (95% CI)	*P* value	OR (95% CI)	*P* value
ATSA patients						
Dementia	1.70 (0.87, 2.99)	.091	1.65 (0.84, 2.92)	.112	1.43 (0.81, 2.33)	.186
Mild cognitive impairment	2.51 (1.18, 4.63)	**.008**	0.93 (0.23, 2.45)	.898	1.39 (0.63, 2.64)	.366
Normal cognition	Reference	–	Reference	–	Reference	–
RTSA patients						
Dementia	1.72 (1.31, 2.22)	**<.001**	1.46 (1.16, 1.82)	**<.001**	1.55 (1.15, 2.04)	**.003**
Mild cognitive Impairment	1.43 (0.89, 2.17)	.111	1.25 (0.82, 1.82)	.279	1.11 (0.64, 1.78)	.681
Normal cognition	Reference	–	Reference	–	Reference	–

OR, odds ratio; *CI*, confidence interval; *ATSA*, anatomic total shoulder arthroplasty; *RTSA*, reverse total shoulder arthroplasty.
Bolded *P* values denote significance.

higher than seen in patients with BMI over 30 kg/m^2, metabolic syndrome (including A1c >6.5%), or opioid dependence.[6,10,33] Finally, we found that patients with dementia had a dislocation risk of 2.1% in ATSA and 4.5% in RTSA. These findings for ATSA are similar to those seen in patients with BMI >30 kg/m^2 and A1c >6.5%, but higher than in patients with opioid dependence; for RTSA patients, the risk of instability is higher compared to all three of these other comorbid conditions.[6,10,13]

To minimize postoperative complications in patients with cognitive impairment, increased focus should be placed on mitigating factors, including delirium management and measures to minimize fall risk. Care teams should attempt to achieve minimal depth of intraoperative sedation while also ensuring adequate preoperative and postoperative anesthesia, as such measures can mitigate postoperative delirium.[50] Similarly, physicians should avoid overprescribing narcotics to prevent oversedation; multimodal management should instead be utilized to control postoperative pain.[45] Thus, in the perioperative period, a team-based approach involving the orthopedic surgeons, geriatric specialists, physiotherapists and pain management specialists should be considered to manage the acute postoperative care of these patients[19,29,50] Regarding fall risk, comprehensive preoperative assessment of patient cognition as well as home evaluation of risks can help to mitigate falls.[29,47] Moreover, patient sensory and mobility interventions, including corrective lenses, hearing aids, mobility aids and improved footwear, are also beneficial to prevent falls.[39,58]

The present study has several limitations. The major limitation is that it was a retrospective study utilizing the large PearlDiver administrative database, meaning that accurate results are dependent on the quality and accuracy of billing codes. Miscoding or noncoding by providers may introduce error and decrease the power of the study. Additionally, some codes may be nonspecific to shoulder arthroplasty only, though we attempted to maximize specificity for TSA by excluding other total joint arthroplasties preceding and following TSA. Moreover, information about prosthesis design for RTSA could not be determined, and the effect of factors that increase stability, such as lateralization or polyethylene thickness, could not be adjusted for in our analysis. Another limitation was the small number of patients with neurocognitive impairment who underwent ATSA and RTSA. As such, we may have been insufficiently powered to detect a difference in complications between groups. This may explain why multivariate analysis found elevated rates of complications only for patients with MCI and not dementia in the ATSA cohort, as there was a trend toward significance.

Conclusion

Compared to patients with normal cognition, RTSA patients with preoperative dementia and ATSA patients with preoperative MCI are at increased risk for surgical complications. Moreover, both ATSA and RTSA patients with either preoperative MCI or dementia are at increased risk for medical complications. As the mean age in the U.S. increases and the prevalence of both MCI and dementia rises, special attention will need to be directed towards patients with neurocognitive impairment undergoing total shoulder arthroplasty.

References

1. Ahluwalia SS, Lugo JD, Gordon AM, Golub IJ, Razi AE, Feliccia J, et al. The association of dementia on perioperative complications following primary total hip arthroplasty for femoral neck fractures. Eur J Orthop Surg Traumatol 2022;33:971-6. https://doi.org/10.1007/s00590-022-03236-9.
2. Allali G, Verghese J. Management of gait changes and fall risk in MCI and dementia. Curr Treat Options Neurol 2017;19:29. https://doi.org/10.1007/s11940-017-0466-1.
3. de Beer J, Petruccelli D, Adili A, Piccirillo L, Wismer D, Winemaker M. Patient perspective survey of total hip vs total knee arthroplasty surgery. J Arthroplasty 2012;27:865-869.e5. https://doi.org/10.1016/j.arth.2011.12.031.
4. Bot AG, Menendez ME, Neuhaus V, Ring D. The influence of psychiatric comorbidity on perioperative outcomes after shoulder arthroplasty. J Shoulder Elbow Surg 2014;23:519-27. https://doi.org/10.1016/j.jse.2013.12.006.
5. Boyes R. Forester: an R package for creating publication-ready forest plots. R package version 0.3.0. Available at: https://github.com/rdboyes/forester; 2021. Accessed June 10, 2023.
6. Brandner GT, Guareschi AS, Eichinger JK, Friedman RJ. Impact of opioid dependence on outcomes following total shoulder arthroplasty. J Shoulder Elbow Surg 2023. https://doi.org/10.1016/j.jse.2023.05.040.
7. Burrus MT, Werner BC, Cancienne JM, Gwathmey FW, Brockmeier SF. Shoulder arthroplasty in patients with Parkinson's disease is associated with increased

complications. J Shoulder Elbow Surg 2015;24:1881-7. https://doi.org/10.1016/j.jse.2015.05.048.

8. Carpenter S, Pinkas D, Newton MD, Kurdziel MD, Baker KC, Wiater JM. Wear rates of retentive versus nonretentive reverse total shoulder arthroplasty liners in an in vitro wear simulation. J Shoulder Elbow Surg 2015;24:1372-9. https://doi.org/10.1016/j.jse.2015.02.016.

9. Carroll PJ, Sheth U, Henry P. A systematic review of shoulder arthroplasty in Parkinson's disease. J Shoulder Elb Arthroplast 2023;7;24715492231162302. https://doi.org/10.1177/24715492231162302.

10. Cogan CJ, Flores SE, Freshman RD, Chi HM, Feeley BT. Effect of obesity on short- and long-term complications of shoulder arthroplasty. J Shoulder Elbow Surg 2023;32:253-9. https://doi.org/10.1016/j.jse.2022.07.028.

11. Desai AK, Grossberg GT, Sheth DN. Activities of daily living in patients with dementia. CNS Drugs 2004;18:853-75. https://doi.org/10.2165/00023210-200418130-00003.

12. Dillon MT, Chan PH, Inacio MCS, Singh A, Yian EH, Navarro RA. Yearly trends in elective shoulder arthroplasty, 2005–2013. Arthritis Care Res 2017;69:1574-81. https://doi.org/10.1002/acr.23167.

13. Duey AH, White CA, Levy KH, Li T, Tang JE, Patel AV, et al. Diabetes increases risk for readmission and infection after shoulder arthroplasty: a national readmissions study of 113,713 patients. J Orthop 2023;38:25-9. https://doi.org/10.1016/j.jor.2023.03.003.

14. Fleischhacker E, Gleich J, Smolka V, Neuerburg C, Böcker W, Helfen T. The influence of adherence to orthosis and physiotherapy protocol on functional outcome after proximal humeral fracture in the elderly. J Clin Med 2023;12:1762. https://doi.org/10.3390/jcm12051762.

15. Friedman SM, Menzies IB, Bukata SV, Mendelson DA, Kates SL. Dementia and hip fractures: development of a pathogenic framework for understanding and studying risk. Geriatr Orthop Surg Rehabil 2010;1:52-62. https://doi.org/10.1177/2151458510389463.

16. Goodloe JB, Denard PJ, Lederman E, Gobezie R, Werner BC. No difference in range of motion in reverse total shoulder arthroplasty using standard or constrained liners: a matched cohort study. JSES Int 2022;6:929-34. https://doi.org/10.1016/j.jseint.2022.07.004.

17. Henry-Sánchez JT, Kurichi JE, Xie D, Pan Q, Stineman MG. Do elderly people at more severe activity of daily living limitation stages fall more? Am J Phys Med Rehabil 2012;91:601-10. https://doi.org/10.1097/PHM.0b013e31825596af.

18. Hernandez NM, Cunningham DJ, Jiranek WA, Bolognesi MP, Seyler TM. Total knee arthroplasty in patients with dementia. J Knee Surg 2022;35:26-31. https://doi.org/10.1055/s-0040-1712086.

19. Hernandez NM, Cunningham DJ, Jiranek WA, Bolognesi MP, Seyler TM. Total hip arthroplasty in patients with dementia. J Arthroplasty 2020;35:1667-1670.e2. https://doi.org/10.1016/j.arth.2020.01.070.

20. Holroyd-Leduc JM, Khandwala F, Sink KM. How can delirium best be prevented and managed in older patients in hospital? CMAJ 2010;182:465-70. https://doi.org/10.1503/cmaj.080519.

21. Horner J, Alberts MJ, Dawson DV, Cook GM. Swallowing in Alzheimer's disease. Alzheimer Dis Assoc Disord 1994;8:177-89.

22. Hu C-J, Liao C-C, Chang C-C, Wu C-H, Chen T-L. Postoperative adverse outcomes in surgical patients with dementia: a retrospective cohort study. World J Surg 2012;36:2051-8. https://doi.org/10.1007/s00268-012-1609-x.

23. Jankowski CJ, Trenerry MR, Cook DJ, Buenvenida SL, Stevens SR, Schroeder DR, et al. Cognitive and functional predictors and sequelae of postoperative delirium in elderly patients undergoing elective joint arthroplasty. Anesth Analg 2011;112:1186-93. https://doi.org/10.1213/ANE.0b013e318211501b.

24. Kim YE, Jeon BS. Musculoskeletal problems in Parkinson's disease. J Neural Transm 2013;120:537-42. https://doi.org/10.1007/s00702-012-0960-2.

25. King JJ, Dalton SS, Gulotta LV, Wright TW, Schoch BS. How common are acromial and scapular spine fractures after reverse shoulder arthroplasty?: a systematic review. Bone Joint J 2019;101-B:627-34. https://doi.org/10.1302/0301-620x.101b6.Bjj-2018-1187.R1.

26. Kirsch JM, Namdari S. Rehabilitation after anatomic and reverse total shoulder arthroplasty: a critical analysis review. JBJS Rev 2020;8;e0129. https://doi.org/10.2106/JBJS.RVW.19.00129.

27. Krishnan S, Brovman EY, Urman RD. Preoperative cognitive impairment as a perioperative risk factor in patients undergoing total knee arthroplasty. Geriatr Orthop Surg Rehabil 2021;12;21514593211004533. https://doi.org/10.1177/21514593211004533.

28. Liou W, Yang Y, Petersen-Fitts GR, Lombardo DJ, Stine S, Sabesan VJ. Effect of lateralized design on muscle and joint reaction forces for reverse shoulder arthroplasty. J Shoulder Elbow Surg 2017;26:564-72. https://doi.org/10.1016/j.jse.2016.09.045.

29. Luan Erfe BM, Boehme J, Erfe JM, Brovman EY, Bader AM, Urman RD. Postoperative outcomes in primary total knee arthroplasty patients with preexisting cognitive impairment: a systematic review. Geriatr Orthop Surg Rehabil 2018;9;2151459318816482. https://doi.org/10.1177/2151459318816482.

30. Lunati MP, Wilson JM, Farley KX, Gottschalk MB, Wagner ER. Preoperative depression is a risk factor for complication and increased health care utilization following total shoulder arthroplasty. J Shoulder Elbow Surg 2021;30:89-96. https://doi.org/10.1016/j.jse.2020.04.015.

31. Ma J, Li C, Zhang W, Zhou L, Shu S, Wang S, et al. Preoperative anxiety predicted the incidence of postoperative delirium in patients undergoing total hip arthroplasty: a prospective cohort study. BMC Anesthesiol 2021;21:48. https://doi.org/10.1186/s12871-021-01271-3.

32. Manly JJ, Jones RN, Langa KM, Ryan LH, Levine DA, McCammon R, et al. Estimating the prevalence of dementia and mild cognitive impairment in the US: the 2016 health and retirement study harmonized cognitive assessment protocol project. JAMA Neurol 2022;79:1242-9. https://doi.org/10.1001/jamaneurol.2022.3543.

33. Marigi E, Marigi I, Crowe MM, Ortiguera CJ, Ledford CK, Werthel J-D, et al. Primary reverse shoulder arthroplasty in patients with metabolic syndrome is associated with increased rates of deep infection. J Shoulder Elbow Surg 2021;30:2032-40. https://doi.org/10.1016/j.jse.2020.12.025.

34. Marigi EM, Shah H, Sperling JW, Hassett LC, Schoch BS, Sanchez-Sotelo J, et al. Parkinson's disease and shoulder arthroplasty: a systematic review. JSES Int 2022;6:241-6. https://doi.org/10.1016/j.jseint.2021.11.004.

35. Matthewson G, Kooner S, Kwapisz A, Leiter J, Old J, MacDonald P. The effect of subscapularis repair on dislocation rates in reverse shoulder arthroplasty: a meta-analysis and systematic review. J Shoulder Elbow Surg 2019;28:989-97. https://doi.org/10.1016/j.jse.2018.11.069.

36. McElvany MD, Chan PH, Prentice HA, Paxton EW, Dillon MT, Navarro RA. Diabetes disease severity was not associated with risk of deep infection or revision after shoulder arthroplasty. Clin Orthop Relat Res 2019;477:1358-69. https://doi.org/10.1097/corr.0000000000000642.

37. Mollon B, Mahure SA, Ding DY, Zuckerman JD, Kwon YW. The influence of a history of clinical depression on peri-operative outcomes in elective total shoulder arthroplasty. Bone Joint J 2016;98-B:818-24. https://doi.org/10.1302/0301-620X.98B6.37208.

38. Nichols E, Steinmetz JD, Vollset SE, Fukutaki K, Chalek J, Abd-Allah F, et al. Estimation of the global prevalence of dementia in 2019 and forecasted prevalence in 2050: an analysis for the Global Burden of Disease Study 2019. Lancet Public Health 2022;7:e105-25. https://doi.org/10.1016/S2468-2667(21)00249-8.

39. Ogliari G, Ryg J, Qureshi N, Andersen-Ranberg K, Scheel-Hincke LL, Masud T. Subjective vision and hearing impairment and falls among community-dwelling adults: a prospective study in the Survey of Health, Ageing and Retirement in Europe (SHARE). Eur Geriatr Med 2021;12:1031-43. https://doi.org/10.1007/s41999-021-00505-4.

40. Padegimas EM, Maltenfort M, Lazarus MD, Ramsey ML, Williams GR, Namdari S. Future patient demand for shoulder arthroplasty by younger patients: national projections. Clin Orthop Relat Res 2015;473:1860-7. https://doi.org/10.1007/s11999-015-4231-z.

41. Pantoni L. Antipsychotics and cerebrovascular accidents: taking or not the risk? J Am Med Dir Assoc 2017;18:651-2. https://doi.org/10.1016/j.jamda.2017.05.028.

42. Papalia AG, Kingery MT, Romeo PV, Simcox T, Lin C, Anil U, et al. Inpatient charges, complication, and revision rates for shoulder arthroplasty in Parkinson's disease: a regional database study. J Shoulder Elbow Surg 2023;32:2043-50. https://doi.org/10.1016/j.jse.2023.04.003.

43. Pariente A, Fourrier-Réglat A, Ducruet T, Farrington P, Béland SG, Dartigues JF, et al. Antipsychotic use and myocardial infarction in older patients with treated dementia. Arch Intern Med 2012;172:648-53. https://doi.org/10.1001/archinternmed.2012.28.

44. Parry S, Stachler S, Mahylis J. Lateralization in reverse shoulder arthroplasty: a review. J Orthop 2020;22:64-7. https://doi.org/10.1016/j.jor.2020.03.027.

45. Patel MS, Abboud JA, Sethi PM. Perioperative pain management for shoulder surgery: evolving techniques. J Shoulder Elbow Surg 2020;29:e416-33. https://doi.org/10.1016/j.jse.2020.04.049.

46. PearlDiver mariner patient claims database. Colorado Springs, CO, USA: PearlDiver Technologies; 2023.

47. Pynoos J, Steinman BA, Nguyen AQ. Environmental assessment and modification as fall-prevention strategies for older adults. Clin Geriatr Med 2010;26:633-44. https://doi.org/10.1016/j.cger.2010.07.001.

48. Ridgeway S, Wilson J, Charlet A, Kafatos G, Pearson A, Coello R. Infection of the surgical site after arthroplasty of the hip. J Bone Joint Surg Br 2005;87:844-50. https://doi.org/10.1302/0301-620x.87b6.15121.

49. Ritchie K, Lovestone S. The dementias. Lancet 2002;360:1759-66. https://doi.org/10.1016/S0140-6736(02)11667-9.

50. Rizk P, Morris W, Oladeji P, Huo M. Review of postoperative delirium in geriatric patients undergoing hip surgery. Geriatr Orthop Surg Rehabil 2016;7:100-5. https://doi.org/10.1177/2151458516641162.

51. Roche CP. Reverse shoulder arthroplasty biomechanics. J Funct Morphol Kinesiol 2022;7:13. https://doi.org/10.3390/jfmk7010013.

52. Seitz DP, Adunuri N, Gill SS, Rochon PA. Prevalence of dementia and cognitive impairment among older adults with hip fractures. J Am Med Dir Assoc 2011;12:556-64. https://doi.org/10.1016/j.jamda.2010.12.001.

53. Shirley ED, Sanders JO. Patient satisfaction: implications and predictors of success. J Bone Joint Surg Am 2013;95:e69. https://doi.org/10.2106/JBJS.L.01048.

54. Tsuda Y, Yasunaga H, Horiguchi H, Ogawa S, Kawano H, Tanaka S. Association between dementia and postoperative complications after hip fracture surgery in the elderly: analysis of 87,654 patients using a national administrative database. Arch Orthop Trauma Surg 2015;135:1511-7. https://doi.org/10.1007/s00402-015-2321-8.

55. Vajapey SP, Cvetanovich GL, Bishop JY, Neviaser AS. Psychosocial factors affecting outcomes after shoulder arthroplasty: a systematic review. J Shoulder Elbow Surg 2020;29:e175-84. https://doi.org/10.1016/j.jse.2019.09.043.

56. Vaurio LE, Sands LP, Wang Y, Mullen EA, Leung JM. Postoperative delirium: the importance of pain and pain management. Anesth Analg 2006;102:1267-73. https://doi.org/10.1213/01.ane.0000199156.59226.af.

57. Viramontes O, Luan Erfe BM, Erfe JM, Brovman EY, Boehme J, Bader AM, et al. Cognitive impairment and postoperative outcomes in patients undergoing

primary total hip arthroplasty: a systematic review. J Clin Anesth 2019;56:65-76. https://doi.org/10.1016/j.jclinane.2019.01.024.

58. Von Renteln-Kruse W, Krause T. Incidence of in-hospital falls in geriatric patients before and after the introduction of an interdisciplinary team–based fall-prevention intervention. J Am Geriatr Soc 2007;55:2068-74. https://doi.org/10.1111/j.1532-5415.2007.01424.x.

59. Wagner ER, Farley KX, Higgins I, Wilson JM, Daly CA, Gottschalk MB. The incidence of shoulder arthroplasty: rise and future projections compared with hip and knee arthroplasty. J Shoulder Elbow Surg 2020;29:2601-9. https://doi.org/10.1016/j.jse.2020.03.049.

60. Yaffe K, Browner W, Cauley J, Launer L, Harris T. Association between bone mineral density and cognitive decline in older women. J Am Geriatr Soc 1999;47:1176-82.

61. Zhao Y, Shen L, Ji HF. Alzheimer's disease and risk of hip fracture: a meta-analysis study. ScientificWorldJournal 2012;2012, 872173. https://doi.org/10.1100/2012/872173.

62. Zhou Q, Zhou X, Zhang Y, Hou M, Tian X, Yang H, et al. Predictors of post-operative delirium in elderly patients following total hip and knee arthroplasty: a systematic review and meta-analysis. BMC Musculoskelet Disord 2021;22:945. https://doi.org/10.1186/s12891-021-04825-1.