SHOULDER AND ELBOW

The influence of a history of clinical depression on peri-operative outcomes in elective total shoulder arthroplasty

A TEN-YEAR NATIONAL ANALYSIS

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Aims
Depression can significantly affect quality of life and is associated with higher rates of medical comorbidities and increased mortality following surgery. Although depression has been linked to poorer outcomes following orthopaedic trauma, total joint arthroplasty and spinal surgery, we wished to examine the impact of depression in elective total shoulder arthroplasty (TSA) as this has not been previously explored.

Patients and Methods
The United States Nationwide Inpatient Sample (NIS) was used to identify patients undergoing elective TSA over a ten-year period. Between 2002 and 2012, 224,060 patients underwent elective TSA.

Results
Among the identified patients who had undergone TSA, 12.4% had a diagnosis of a history of depression. A diagnosis of depression was twice as common in women compared with men (16.0% vs 8.0%, p < 0.001), and more frequent in those with low income and Medicaid insurance (p < 0.001). A diagnosis of depression was an independent risk factor for post-operative delirium (odds ratio (OR) 2.29, p < 0.001), anaemia (OR 1.65, p < 0.001), infection (2.09, p = 0.045) and hospital discharge to a placement other than home (OR 1.52, p < 0.001).

Conclusion
A history of clinical depression is present in 12.4% of patients undergoing elective TSA and the disease burden is projected to increase further in the future. Depression is often underdiagnosed and pre-operative screening and appropriate peri-operative management of patients is encouraged.

Take home message: The awareness that clinical depression is associated with increased complications following total shoulder arthroplasty provides physicians an opportunity for early intervention in this at-risk population.

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Depression is one of the most commonly diagnosed psychiatric illnesses in the world, with prevalence rates of 16.9% in the general population of the United States and a higher incidence, 20% to 80%, in those with chronic medical conditions. The consequences of depression extend beyond changes in mood and have been found to impact negatively on clinical outcomes in a variety of elective and emergency orthopaedic procedures. Current literature suggests that depression may negatively impact patient-reported outcomes, adversely affect post-operative pain and is associated with increased peri-operative complications following hip and knee arthroplasty. Overall healthcare costs are higher in orthopaedic patients with clinically significant depression compared with those without depression. Clinical depression has not been consistently found to be an independent risk factor for mortality following hip and knee arthroplasty procedures.

In patients with shoulder disease, depression may adversely affect the results of non-operatively treated adhesive capsulitis, and reduces patient satisfaction in the treatment of rotator cuff pathology. The requirement and demand for total shoulder arthroplasty (TSA) and prevalence of depression are projected to increase significantly over the next decade. We sought to gain a better understanding of the effect that depression plays on outcomes in elective shoulder arthroplasty. We hypothesised that clinical depression would
increase the risk of post-operative complications and result in greater length hospital stay following elective TSA.

**Patients and Methods**

The Nationwide Inpatient Sample (NIS) was used to identify patients undergoing elective TSA in the United States between 2002 and 2012. The NIS is a publically available, inpatient database developed as part of the Healthcare Cost and Utilization Project (HCUP) by the Agency for Healthcare Research and Quality (AHRQ), which captures all patients regardless of their form of insurance. The NIS is a stratified 20% sample of approximately eight million annual inpatient hospital discharges and covers an estimated 95% of the population of the United States.19

Patients treated by TSA were identified using International Classification of Diseases 9th Revision (ICD-9) procedure codes 81.80 and 81.88.20 Patients undergoing revision surgery or those with a primary diagnosis for fracture, infection, tumour, or previous surgical complications were excluded. Sampling weights provided by the NIS were used to generate national estimates.21

With the exception of obstructive sleep apnoea (for which we used the code ICD-9 327.23, identifying it also as an important comorbidity), the Elixhauser index could be used to identify medical comorbidities, including a history of clinical depression.22 Post-operative complications were identified similar to previous NIS studies.12

**Statistical analysis.** Continuous data were reported as mean and standard deviation (SD), while categorical data were reported as frequencies and percentages. Student’s t-tests were used for continuous variables and chi-squared analysis for dichotomous variables. Multivariate logistic regression analysis was performed to determine the association of a diagnosis of clinical depression as an independent risk factor for adverse outcomes. As the mean length of stay (LOS) and 75th percentile LOS (three days), showed no significant difference, we used the 95th percentile (four days) to indicate an “extended LOS.” SAS Version 9.3 software (SAS Inst., Cary, North Carolina) was used for all analyses, with a p-value < 0.05 indicating statistical significance.

**Results**

In all, 224,060 patients underwent elective TSA between 2002 and 2012 in the United States. Mean patient age was 69.3 years (SD 10.0) and 55.3% of the sample was female. A diagnosis of clinical depression was identified from the coding as a comorbidity in 12.4% of all patients during the ten-year study period. Rates of recorded depression increased during the study period, from 5.1% in 2002 to 15.4% in 2012 for all patients undergoing TSA (Fig. 1).

![Graph showing the percentage of patients undergoing total shoulder arthroplasty (TSA) with a recorded diagnosis of depression: 2002 to 2012.](image)

Baseline demographic differences between those with and without a coded diagnosis of depression are listed in Table I. Patients with a history of depression, undergoing elective TSA, tended to be younger (mean ages 67.3 SD 9.6 versus 69.5 SD 10.0 years, p < 0.001; Students’ t-test), while females demonstrated rates of depression twice of that of male patients (16.0% versus 8.0%, p < 0.001; Fisher’s exact test). Lower income status and Medicaid insurance were associated with higher rates of depression, while diagnosed depression was most common amongst Caucasians (p < 0.001 for all; chi-square). With the exception of coagulopathy, peripheral vascular disease and AIDS, greater rates for nearly all measured medical comorbidities were observed in patients with a history of depression (Fig. 2).

Patients undergoing TSA, with a history of depression, had slightly longer hospital stays (mean 2.5 SD 1.6 versus 2.2 SD 1.6 days, p < 0.001; Student’s t-test) and were more likely to be discharged to a destination other than home (16.6% versus 11.8%; p < 0.001; Fisher’s exact test) when compared to patients without a history of depression. In-hospital mortality rates did not differ between groups (0.05% versus 0.08%, p = 0.617; Fisher’s exact test). A history of depression was associated with higher rates of post-operative complications following TSA as shown in Table II.
Results from the multivariate analysis can be found in Figure 3. A history of depression was independently associated with the following in-hospital complications after TSA: delirium (odds ratio (OR) 2.29, 1.68 to 3.1, p < 0.001), infection (OR 2.09, 1.02 to 4.71, p = 0.045), anaemia (OR 1.65; 1.51 to 1.80; p < 0.001) and acute renal failure (OR 1.37; 1.07 to 1.77; p = 0.012). Additionally, depression was associated with greater odds of hospital discharge to a location other than home (OR 1.52; 1.40 to 1.66; p < 0.001) and length of stay in the 95th percentile (OR 1.37; 1.25 to 1.50; p < 0.001).

Discussion

The results from our retrospective analysis of a national inpatient database suggest that:

- a history of depression is present in 12.4% of patients undergoing elective TSA and that prevalence has increased significantly over a ten-year period;
- diagnosed clinical depression was more common in female patients and those of lower socio-economic status;
- patients with a history of depression were more likely to experience post-operative complications including delirium, post-operative infection and post-operative anaemia requiring blood transfusion;
- in-hospital mortality rates showed no difference or effect;
- patients with a history of depression had marginally longer hospital stays and significantly higher rates of hospital discharge to locations other than home than patients without a history of depression.

Over the ten-year period of our study the recorded diagnosis of depression in patients undergoing elective TSA has increased from 5.1% to 15.4%. These results parallel prior studies which have reported substantial increases in the prevalence of depression within the general population over ten and 20 year periods.23,24 In addition to being aware of the increasing prevalence of depression in society in general, orthopaedic surgeons should recognise that depression is often underdiagnosed and under-reported, particularly in the elderly.25 Crabb and Hunsley26 reported that compared with younger individuals, patients over 65 years of age were less likely to consult a healthcare professional regarding their mental well-being. Additionally, the lower rates of diagnosed depression observed amongst minority groups, could reflect the cultural stigma and under-reporting of psychiatric symptoms and disorders within these different sections of society.27,28 Our observations that female gender, lower income status and Medicaid insurance correlate with a history of depression, in the setting of elective TSA, are supported by previous studies.1,29 Awareness that these patient groups, often have limited access to care, weaker social support systems and may

Table I. Baseline demographic details of patients with and without depression undergoing total shoulder arthroplasty in the United States from 2002 to 2012

<table>
<thead>
<tr>
<th>Demographic variable</th>
<th>History of depression</th>
<th>No depression</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>n (total = 224 060) (%)</td>
<td>27 964 (12.5)</td>
<td>196 096 (87.5)</td>
<td></td>
</tr>
<tr>
<td>Age, yrs</td>
<td>Mean (SD)</td>
<td>67.3 (9.6)</td>
<td>69.5 (10.0)</td>
</tr>
<tr>
<td>Gender</td>
<td>Number (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>8037 (8.0)</td>
<td>92 117 (92.0)</td>
<td>&lt; 0.001†</td>
</tr>
<tr>
<td>Female</td>
<td>19 925 (16.0)</td>
<td>103 979 (84.0)</td>
<td></td>
</tr>
<tr>
<td>Income quartile</td>
<td>Number (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; $39 000 (USD)</td>
<td>6140 (13.0)</td>
<td>41 201 (87.0)</td>
<td>&lt; 0.001‡</td>
</tr>
<tr>
<td>$39 000 to $47 999 (USD)</td>
<td>7631 (12.3)</td>
<td>49 922 (86.7)</td>
<td></td>
</tr>
<tr>
<td>$48 000 to $62 999 (USD)</td>
<td>7517 (12.5)</td>
<td>52 833 (87.5)</td>
<td></td>
</tr>
<tr>
<td>$63 000 + (USD)</td>
<td>6676 (11.4)</td>
<td>52 140 (88.6)</td>
<td></td>
</tr>
<tr>
<td>Primary payer</td>
<td>Number (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medicare</td>
<td>18 541 (12.0)</td>
<td>135 668 (88.0)</td>
<td>&lt; 0.001‡</td>
</tr>
<tr>
<td>Medicaid</td>
<td>758 (18.9)</td>
<td>3 252 (81.1)</td>
<td></td>
</tr>
<tr>
<td>Private</td>
<td>7 493 (13.1)</td>
<td>49 872 (86.9)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>1 172 (13.8)</td>
<td>7 304 (86.2)</td>
<td></td>
</tr>
<tr>
<td>Ethnicity</td>
<td>Number (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caucasian</td>
<td>25 475 (12.8)</td>
<td>176 209 (87.4)</td>
<td>&lt; 0.001‡</td>
</tr>
<tr>
<td>African American</td>
<td>940 (10.1)</td>
<td>8 340 (89.9)</td>
<td></td>
</tr>
<tr>
<td>Hispanic American</td>
<td>863 (12.2)</td>
<td>6 192 (87.8)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>6 86 (11.4)</td>
<td>53 55 (88.6)</td>
<td></td>
</tr>
</tbody>
</table>

* Student’s t-test
† Fisher’s exact test
‡ chi-square test
report poorer subjective outcomes, provides orthopaedic surgeons an opportunity to discuss discharge planning, improve patient education and set realistic functional goals that may improve overall patient satisfaction following treatment.30-32

Our results have shown that a history of depression conferred a greater risk of in-hospital infection after TSA and are similar to the findings of Bozic et al,13,33 who found depression to be an independent predictor of periprosthetic joint infection following total hip and knee arthroplasty. Whilst aetiology is likely to be complex, depression has been linked to cytokine dysfunction and neurochemical changes that can cause dysregulation of the immune system.34,35 Additionally, certain forms of antidepressant medication have been found to have immunosuppressive effects,36 further increasing potential susceptibility to infection in the post-operative setting. Further studies in this area are required however to establish a definitive causal association.

Patients, with a history of depression, in our cohort had increased odds of post-operative anaemia (OR 1.65) and blood transfusion requirement (OR 1.30). Patients with significant depressive illness are often prescribed selective-serotonin re-uptake inhibitors (SSRI),37 which can inhibit platelet aggregation and potentiate post-operative bleeding.38,39 Furthermore, previous authors have noted that the
symptoms of depression, such as fatigue and altered mood can mimic anaemia\textsuperscript{11,40}, and that the combination of these effects, could explain greater rates of symptomatic post-operative anaemia and subsequent blood transfusion.

Post-operative delirium can result in significant morbidity, mortality and increased healthcare costs.\textsuperscript{41,42} Advanced age, pain, opioid analgesic requirement, infection, blood transfusion and other medical comorbidities can contribute to the development of post-operative delirium.\textsuperscript{42,43} Our observation that a history of depression was associated with an increased post-operative delirium OR of 2.29, is in keeping with previous reports; that patients with depressive illness are 1.74 to 2.5 times more likely to develop delirium following surgery.\textsuperscript{23,44} Validated pre-operative screening tools for depressive illness have been shown to help decrease post-operative delirium and their routine use to identify patients with significant depressive symptoms prior to shoulder arthroplasty is encouraged.\textsuperscript{45,46}

Although univariate analysis found that a history of depression was associated with increased respiratory complications, multivariate analysis did not demonstrate significance. One hypothesis is that due to high rates of concomitant obstructive sleep apnoea, depressed patients should receive additional monitoring of pulmonary status, thus reducing complication rates.

The moderate increase in LOS (0.3 days) may indicate an immediate impact on the healthcare system of patients who require treatment for depression following TSA. A more accurate assessment of the healthcare burden can be drawn from the higher rate of hospital discharge to placements other than home and greater in-hospital complications associated with depression. Discharge to a skilled nursing facility significantly increases the healthcare costs to both the individual and government.\textsuperscript{47,48} Furthermore, discharge from hospital to other than home and in-hospital infection and delirium are all risk factors for both 30-day readmission and mortality, events which further increase healthcare expenditures.\textsuperscript{49-51} Although we could not measure any difference regarding in-hospital mortality in patients with a history of depression undergoing TSA, other studies have reported that patients with depressive illnesses have higher mortality rates after discharge, compared with patients without depression.\textsuperscript{33,52}

\begin{table}
\centering
\caption{Comparison of outcomes for patients with a history of depression and without depression}
\begin{tabular}{|l|c|c|c|}
\hline
 & History of depression & No depression & p-value \\
\hline
Mean (SD) & & & \\
\hline
Length of stay (days) & 2.5 (1.6) & 2.2 (1.6) & <0.001* \\
In-hospital mortality & 0.05 & 0.08 & 0.617† \\
Discharge destination & & & \\
Homebound & 83.4 & 88.2 & <0.001† \\
Non-homebound & 16.6 & 11.8 & \\
Post-operative complications & & & \\
Delirium/altered mental status & 1.0 & 0.50 & <0.001† \\
Neurological & 0.04 & 0.13 & 0.061† \\
Cardiac & 0.55 & 0.48 & 0.476† \\
Peripheral vascular & 0.05 & 0.03 & 0.438† \\
Respiratory & 1.1 & 0.68 & 0.002† \\
Gastrointestinal & 0.19 & 0.23 & 0.657† \\
Genitourinary & 0.51 & 0.54 & 0.847† \\
Wound haematoma or seroma & 0.39 & 0.38 & 0.906† \\
Wound dehiscence & 0.04 & 0.02 & 0.653† \\
Post-operative infection & 0.17 & 0.06 & 0.013† \\
Pulmonary embolism & 0.3 & 0.2 & 0.064† \\
Deep vein thrombosis & 0.28 & 0.18 & 0.105† \\
Post-operative anaemia & 14.9 & 9.2 & <0.001† \\
Acute renal failure & 1.60 & 1.03 & <0.001† \\
Received transfusion & 8.0 & 5.8 & <0.001† \\
Overall number of post-operative complications (%) & & & \\
No complications & 82.3 & 88.3 & <0.001‡ \\
1 complication & 15.6 & 10.5 & \\
2 or more complications & 2.1 & 1.2 & \\
\hline
\end{tabular}
\footnotesize{* Student’s t-test \\
† Fisher’s exact test \\
‡ chi-square test}
\end{table}
within the contexts of a healthcare team and recognise the potential for the increased risk of complications during both the immediate and longer-term post-operative periods in patients with a history of depression.

Our study has limitations inherent with large databases. The potential for errors in ICD-9 codes could result in misdiagnosis and reduce the accuracy of results. The coding does not stratify for disease severity or disease activity. As the NIS only captures a single-inpatient admission, we were unable to account for potential costs associated with revision surgery, readmission, or mortality after discharge. Well-designed case-control studies are better suited to address these questions, and potential areas for future research.

In conclusion, a diagnosis of depression was made in 12.4% of patients undergoing elective TSA between 2002 and 2012, and the prevalence of concomitant depression increased over this ten-year period, in line with the changes in society as a whole. As the population ages, depression is projected to be the second leading cause of worldwide disability by 2020. Depression is associated with a variety of medical comorbidities and remained an independent risk factor for post-operative delirium, infection, anaemia and blood transfusion. Patients undergoing TSA, with a history of depression had a slightly greater LOS and greater rates of hospital discharge to locations other than home. The symptoms of depression are often underdiagnosed and can manifest in a variety of post-operative complications following TSA. This may allow the orthopaedic surgeon an early opportunity to engage both the patient and other multi-disciplinary teams, to discover how best to optimise outcomes and to improve quality of care and satisfaction for patients.

**Author contributions:**

B. Mollon: Writing paper, Design.

S. A. Mahure: Writing paper, Data collection, Data analysis, Design.

D. Y. Ding: Writing paper, Design.

J. D. Zuckerman: Design, Writing paper, Detailed expert review.


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Predictors of pain medication use for arthroplasty pain

Depression is associ-

Use of mental health-related services

Nationwide Inpatient Sample


Alternative projections of mortality and disability by cause

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