

Patterns of Depressive Symptoms Before and After Surgery for Osteoarthritis: A Descriptive Study

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Objective. To examine patterns of depressive symptoms before and over the year following osteoarthritis (OA) surgery, stratified by joint and postsurgical outcome.

Methods. Participants were hip (n = 287), knee (n = 360), and lumbar spine (n = 100) OA patients scheduled for joint replacement or decompression surgery with or without fusion. One pre- and 4 postsurgery questionnaires were completed. Depressive symptoms were quantified using the Hospital Anxiety and Depression Scale (HADS). One-year outcomes were based on Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) pain scores for hip and knee patients and Oswestry Disability Index (ODI) scores for spine patients and were categorized as “worse” (top score tertile) vs. “better” outcomes (first, second tertiles). Plots over time were generated by joint and outcome: 1) mean pain/disability and depression scores and 2) percentage of patients meeting HADS cut-off for depression “caseness,” reporting depression diagnosis and treatment.

Results. There were notable decreases in depression scores for patients with better outcomes. For those with worse outcomes, decreases were smaller for hip patients and were not significant for knee and spine patients. Among those with poorer outcomes, 25% of spine and knee patients were depression “cases” pre- and postsurgery; an additional 16% of spine and 10% of knee patients developed new “caseness” postsurgery. The proportion of these patients deemed depression cases by score was much higher than the proportion reporting diagnosis/treatment.

Conclusion. Although depressive symptoms decrease overall in OA patients postsurgery, degrees of change vary by joint and surgical outcome. Greater attention to mental health postsurgery is warranted and may lead to improved surgical outcomes, particularly among knee and spine patients.

INTRODUCTION

Osteoarthritis (OA) ranks among the top 10 causes of disability worldwide (1). With the aging of the population, the prevalence and impact of OA are projected to greatly increase (2,3). Current treatments for OA focus on symptom management. When conservative treatment fails, end-stage disease often leads to surgical total joint replacement (TJR) for hip and knee OA and decompression with or without fusion procedures for lumbar spine OA.

Hip and knee TJR are highly cost effective (4,5), with more than a million procedures performed in the United States annually (6). In 2014–2015, there were over 110,000 TJRs performed in Canada, representing an approximate 20% increase over 5 years (7). Increases in surgical volume are expected to continue, with US

estimates predicting nearly 4 million annual procedures by 2030 (8). Although pain and decreased function are the primary targets of these interventions, OA impacts many aspects of quality of life. Previous studies have reported high prevalence and adverse impacts of psychologically based disorders, particularly depression, in people living with OA (9,10). It seems reasonable, therefore, to postulate that improvements in pain and function following OA surgeries would be accompanied by concomitant improvements in psychological symptoms. However, this has not been well studied, and reported findings have varied. A 2016 meta-analysis (11) concluded that hip and knee TJR patients appear to have higher pre- and postsurgery rates of depression than the general population and that only a modest improvement in depression severity during the year postsurgery was supported by the limited data.

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SIGNIFICANCE & INNOVATIONS

- Research on depression in osteoarthritis (OA) surgical patients has primarily focused on the impact of presurgical depression on surgical outcomes. Much less is known about the impact of surgery on depressive symptoms.
- Despite the relatively high effectiveness of OA surgeries, a significant proportion of patients report long-term residual pain. The impact of poorer outcomes on depressive symptoms may be different than that associated with better outcomes. Combining these patient groups, as has been the approach in available research, could obscure distinct patterns of depressive symptoms postoperatively.
- Our study demonstrates that although depressive symptoms in hip, knee, and lumbar spine OA patients decrease following surgery overall, patterns and degrees of change vary by anatomical site and surgical outcome. We found that postsurgical improvements in mean depression scores and rates of depression “caseness” were greatest among hip patients. For those with worse outcomes, decreases were smaller for hip patients and were not significant for knee and spine patients. For these two latter groups, the proportion deemed depression “cases” by symptom score was much higher than the proportion reporting depression diagnosis and treatment.
- Findings highlight a need for greater attention to mental health in OA patients, including during the postsurgical recovery period and particularly among knee and spine patients who report residual pain-related symptoms. Given the close interrelationship between pain and depression, appropriate assessment and treatment of depression in OA patients may lead to improved surgical outcomes.

A complicating factor for understanding depressive symptoms in postsurgical OA patients is that available studies have typically considered patients as a single group. However, not all patients experience similar symptom outcomes. Despite the relatively high effectiveness of TJR, as many as 20% of patients continue to report long-term residual pain (12). Following surgeries for spine OA or spinal stenosis, this proportion has been reported to range from 20% to as high as 40% (13–15). The impact of poorer outcomes on depressive symptoms may be considerably different than that associated with better outcomes. Combining these groups could obscure what may be distinct patterns of depressive postoperative symptoms. Furthermore, most research on depression following surgery for OA has focused on small samples of knee OA patients and only considered relatively short-term outcomes with a limited number of time points. As depression and pain are highly interrelated (16,17), better management of postsurgical depressive symptoms could potentially reduce the prevalence of residual postsurgical pain. A more comprehensive understanding of patterns of depressive symptoms after OA

surgery may help identify key time points at which depression assessment may be particularly warranted.

The objective of this study was to examine patterns of depressive symptoms before and over the year following OA surgery by considering four postsurgical time points in hip, knee, and lumbar spine patients, stratified by 1-year outcome. We hypothesized that 1) depressive symptoms in patients with worse 1-year postsurgical outcomes would increase during the year following surgery and that 2) depressive symptoms in patients with better 1-year postsurgical outcomes would decrease and plateau over the course of the year following surgery. We additionally examined patterns of self-reported depression diagnoses and treatment.

METHODS

The current analysis is a substudy of an ongoing prospective study (Longitudinal Evaluation in the Arthritis Program [LEAP-OA]). Patients with end-stage OA scheduled for orthopaedic surgery are consecutively recruited from the Toronto Western Hospital in Toronto, Canada. Eligibility criteria include 18 years of age or older and the ability to read and comprehend English. Individuals undergoing revision procedures and those with posttraumatic or inflammatory arthritis are excluded. For the current analysis, patients recruited between November 2013 and May 2016 with available data at 1-year postsurgery were included. Eighty-seven percent of eligible patients ($n = 859$) agreed to participate in presurgery and 87% ($n = 747$) of these participants provided the required data and were included in the analyses. Participants were 287 hip and 360 knee OA patients scheduled for unilateral TJR and 100 patients with lumbar spine OA scheduled for decompression surgery with or without fusion. The study was approved by the University Health Network Research Ethics Board (16-5759.2). Written informed consent was obtained from all patients.

Participants completed a presurgery baseline questionnaire within the 3 weeks prior to surgery and follow-up questionnaires at four time points postsurgery (6 weeks, 3 months, 6 months, 1 year).

Patient-reported depression measures. At each study time point, data on depressive symptoms were collected using the seven-item depression subscale of the Hospital Anxiety and Depression Scale (HADS) (18). This measure has been found to be a reliable and valid measure for assessing the severity of emotional distress in medical populations. In addition to providing a continuous score, a cut-off of 8/21 on this measure has a sensitivity of 0.79 and a specificity of 0.83 for identifying “caseness” of depression (19). Responses to the comorbidity questionnaire on the presence and treatment of depression (yes/no items) were also examined.

Patient-reported surgical outcomes. The most frequently used and accepted patient-reported outcome meas-

ures specific to each of the anatomical surgical subgroups were administered at each of the study time points. For hip and knee patients, the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) pain subscale was used (20,21). Scores were computed based on responses to five questions that assess hip or knee pain levels during the past week with different activities. Scores range from 0-20. The WOMAC has been validated and used extensively in lower-extremity OA populations (20–23). For spine patients, the Oswestry Disability Index (ODI) was used to assess disability that is due to low back pain. The measure consists of 10 questions and is considered the gold standard for outcome measures used in the management of spinal disorders (24–26). Scores on the ODI range from 0-100. To facilitate interpretation and plotting of outcome scores, WOMAC and HADS scores were rescaled to 0-100 throughout; higher scores represent greater severity. The WOMAC and ODI do not directly assess analogous constructs and therefore direct comparison of scores between hip/knee and spine patients are not intended.

Other study variables. Baseline data included age, sex, education, income, and smoking status. A comorbidity count variable was derived from yes/no responses to an extended list of 20 conditions based on the American Academy of Orthopedic Surgeon's Comorbidity scale (27) and was dichotomized as 0-1 vs. 2+ comorbidities. Data on height and weight were used to compute body mass index (BMI) in kg/m².

Analysis. Descriptive statistics were generated for sociodemographic and health status variables by anatomical site. Within each site group, we sought to stratify patients by their respective outcome status scores. We examined potentially utilizing quartiles or tertiles of scores and proceeded with tertiles based on the relative variations in depressive symptoms between the examined groups and considering available sample size. Patients were thus stratified by their respective 1-year outcome score, which was categorized as “worse” (top tertile of outcome score) vs. “better” 1-year outcome score (first and second tertiles of outcome score), including means and the percentage of patients with scores indicative of “caseness” of depression. Based on relative depression “caseness” presurgery and 1-year postsurgery, patients were categorized as “never depressed,” “no longer depressed,” “always depressed,” or “newly depressed.” Mean change in depressive symptom score (1-year—baseline) was calculated for each site and outcome group. For all descriptive statistics, means and standard deviations were calculated for continuous variables, frequencies, and percentages for categorical variables. Differences between outcome groups on baseline and 1-year depressive symptom and outcome scores, as well as changes in depression category (pre- vs. 1-year postsurgery) were assessed using *t* tests and χ^2 tests, as appropriate.

To further explore the relationship between outcomes and depressive symptoms over the year following surgery, plots were

generated for each anatomical site stratified by 1-year outcome. These consist of mean outcome (WOMAC, ODI) and mean depressive symptom (HADS) scores as well as the percentage of patients who 1) met the HADS cut-off for “caseness” of depression, 2) reported a depression diagnosis, and 3) reported receiving depression treatment.

In sensitivity analyses, 1-year outcome status was alternatively defined based on published minimal clinically important differences for the respective measures and groups (28–31).

Supplemental regression analyses were conducted to further analyze the association between surgical outcome and postsurgical depressive symptom level. Linear regression models were estimated with 1-year postsurgical depression scores as the dependant variable and 1-year surgical outcome (WOMAC pain or ODI pain-related disability) as the independent variable of interest, controlling for age, sex, and presurgical depression level.

RESULTS

Patient characteristics by surgical site. Just over half of study participants were female in the hip and knee OA groups, whereas there were slightly more males in the spine group. Mean age was approximately 65 years for hip and knee patients and 66 years for spine patients (Table 1).

Baseline and 1-year depressive symptom scores. Patients with worse outcomes had scores indicative of greater depression compared with those with better outcomes, both in terms of significantly higher mean depressive symptom scores and higher proportions of patients meeting the cut-off for depression “caseness.” Presurgery, approximately 40% of hip, knee, and spine patients who had poorer outcomes were depression “cases” compared with about 20% of spine and hip patients and 15% of knee patients who had better outcomes. At 1-year after surgery, only 2.0% of hip, 5.7% of knee, and 2.9% of spine patients had HADS scores indicative of depression among the better outcome group. In contrast, among those in the worse outcome group, these proportions were 17.6%, 36.1%, and 40.6%, respectively (Table 2).

Changes in depressive symptom scores (1 year vs. baseline). Mean changes in depressive symptom scores were greatest for hip patients and significantly higher ($P < 0.001$) in the better vs. worse outcome groups for each joint. For hip patients, mean changes were notable for both the better and worse outcome groups at $-16.3/100$ and $-11.9/100$, respectively. For knee and spine OA patients with worse outcomes, mean changes were not significantly different from 0 ($P > 0.05$).

There were significantly ($P < 0.0001$) higher proportions of patients who were “always” or “newly depressed” postsurgery in the worse outcome groups, again particularly among the knee and spine patients. A quarter of these patients were “always

Table 1. Patient characteristics

Variable	Mean (SD) or Frequency (%)		
	Hip OA (N = 287)	Knee OA (N = 360)	Lumbar Spine OA (N = 100)
Sex			
Female	161 (56.1%)	206 (57.2%)	47 (47.0%)
Male	126 (43.9%)	154 (42.8%)	53 (53.0%)
Age			
Mean	64.8 (9.6)	65.1 (8.6)	66.1 (9.5)
<65 years	138 (48.1%)	168 (46.7%)	37 (37.0%)
65+ years	149 (51.9%)	192 (53.3%)	63 (63.0%)
Income			
<\$45 000	56 (21.7%)	72 (23.2%)	13 (14.8%)
\$45 000-\$100 000	101 (39.1%)	127 (40.8%)	32 (36.4%)
>\$100,000	101 (39.1%)	112 (36.0%)	43 (48.9%)
Education			
≤Highschool	66 (23.9%)	111 (32.2%)	21 (21.2%)
>Highschool	210 (76.1%)	234 (67.8%)	78 (78.8%)
BMI			
Mean	28.8 (6.1)	30.7 (6.4)	27.3 (4.4)
Underweight/normal	70 (26.5%)	57 (17.1%)	25 (29.1%)
Overweight	100 (37.9%)	114 (34.2%)	41 (47.7%)
Obese	94 (35.6%)	162 (48.6%)	20 (23.3%)
Smoking status			
Never smoker	141 (49.8%)	173 (49.1%)	45 (46.4%)
Former smoker	109 (38.5%)	143 (40.6%)	46 (47.4%)
Current smoker	33 (11.7%)	36 (10.2%)	6 (6.2%)
Number of comorbidities			
0-1	158 (55.1%)	165 (45.8%)	46 (46.0%)
2+	129 (44.9%)	195 (54.2%)	54 (54.0%)

Abbreviation: BMI, body mass index; OA, osteoarthritis.

depressed,” and an additional 10.3% of knee and 15.6% of spine patients were “newly depressed” postsurgery. However, there was also a notable proportion of patients in each joint and outcome group that were “no longer depressed” postsurgery, particularly among hip patients (Table 2).

Hip OA patients. Improvements in pain scores were marked at 6 weeks postsurgery for patients in both hip outcome groups and were accompanied by improvements in depression scores (Figure 1A and B). Although all scores were worse in the poorer hip outcome group (Figure 1B), the general pattern of improvement was similar. The overall decreases in percentage of mean depression scores for the “better” (Figure 1A) and “worse” (Figure 1B) hip outcome groups were 69% and 39%, respectively. There were also large decreases in the percentage of patients deemed depression cases based on their HADS scores by 6 weeks postsurgery, from 38% to 20%

in the worse hip outcome group (Figure 1D) and 21% to 5% in the better hip outcome group (Figure 1C). Presurgery, rates of depression “caseness” were approximately double those of reported depression diagnoses and treatment in both outcome groups. Postsurgery, the reverse was true in the better outcome group (Figure 1C) such that the HADS depression rate was lower than that for diagnosis and treatment. In the worse outcome group (Figure 1D), the three rates were more similar.

Knee OA patients. For the knee group with better 1-year outcomes, there were steady improvements in mean pain and depression scores over the study period (Figure 2A). For those with poorer outcomes (Figure 2B), the decrease was much smaller. The overall percentage decreases in mean depression scores for the “better” and “worse” knee outcome groups were 55% and 10%, with no significant difference between presurgery and 1-year postsurgery scores

Table 2. Baseline (presurgery) and 1-year postsurgery outcome^a and depressive symptom scores^b

	Mean (SD) or N (%)					
	Hip OA		Knee OA		Lumbar Spine OA	
	By 1-year outcome		By 1-year outcome		By 1-year outcome	
	Better (N = 196)	Worse (N = 91)	Better (N = 263)	Worse (N = 97)	Better (N = 68)	Worse (N = 32)
Baseline WOMAC/ODI						
Mean	50.5 (17.4)	59.9 (17.7) ^c	46.7 (17.4)	61.7 (17.1) ^c	36.8 (13.2)	51.5 (14.5) ^c
Baseline depressive symptoms						
Mean	23.6 (15.6)	30.9 (17.3) ^c	22.1 (17.1)	31.9 (20.4) ^c	22.5 (14.8)	35.7 (18.1) ^c
Not depressed	155 (79.1%)	56 (61.5%)	223 (84.8%)	58 (59.8%)	55 (80.9%)	19 (59.4%)
Depressed ^f	41 (20.9%)	35 (38.5%) ^d	40 (15.2%)	39 (40.2%) ^c	13 (19.1%)	13 (40.6%) ^e
One-year WOMAC/ODI						
Mean	2.7 (3.6)	27.6 (15) ^c	9 (8.3)	46 (14.2) ^c	14.9 (10.6)	50.8 (13.7) ^c
One-year depressive symptoms						
Mean	7.3 (10.8)	19 (15.7) ^c	9.9 (12.7)	28.8 (21) ^c	8.9 (10.3)	35.6 (22.8) ^c
Not depressed	192 (98.0%)	75 (82.4%)	248 (94.3%)	62 (63.9%)	66 (97.1%)	19 (59.4%)
Depressed ^f	4 (2.0%)	16 (17.6%) ^c	15 (5.7%)	35 (36.1%) ^c	2 (2.9%)	13 (40.6%) ^c
Mean change in depressive symptoms ^g	-16.3 (14.8)	-11.9 (16.4) ^e	-12.2 (15.2)	-3.1 (17.7) [†]	-13.6 (14.5)	-0.1 (19.3) ^c
Change in depression category						
Never depressed	155 (79.1%)	51 (56.0%) ^c	217 (82.5%)	48 (49.5%) ^c	54 (79.4%)	14 (43.8%) ^c
No longer depressed	37 (18.9%)	24 (26.4%)	31 (11.8%)	14 (14.4%)	12 (17.6%)	5 (15.6%)
Always depressed	4 (2.0%)	11 (12.1%)	9 (3.4%)	25 (25.8%)	1 (1.5%)	8 (25.0%)
Newly depressed	0 (0%)	5 (5.5%)	6 (2.3%)	10 (10.3%)	1 (1.5%)	5 (15.6%)

Abbreviation: OA, osteoarthritis; ODI, Oswestry Disability Index; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index. ^aOutcome scores are derived from the WOMAC pain scale for hip/knee OA and from the ODI for pain-related disability in lumbar spine OA. ^bDepressive symptom scores were derived from the Hospital Anxiety and Depression Scale (HADS). Scores for depressive symptoms, pain and disability range from 0 to 100 with a higher score indicating greater symptom severity. Comparing patients with better vs. worse 1-year outcome: ^c $p < 0.001$; ^d $p < 0.01$; ^e $p < 0.05$. ^fDepressed refers to “caseness” of depression defined as HADS scores $\geq 38.1/100$, equivalent to 8/21 before rescaling. ^gMean change in HADS depressive symptom score (1 year – baseline). Mean changes for each group are statistically significant ($p < 0.001$) with the exception of the worse outcome groups for knee and lumbar spine OA patients ($p > 0.05$).

For knees (Figure 2C) in the better outcome group, declines in the percentage of depression cases were somewhat slower than for hips. Presurgery, the percentage of patients with HADS scores indicative of depression “caseness” was greater than that for reported depression diagnosis or treatment. By 6 weeks postsurgery, the rate of “caseness” was lower than that for diagnosis and treatment. In contrast, there was a large difference between the percentage of knees (Figure 2D) in the poorer outcome group deemed depression cases and those reporting depression diagnoses and treatment at each study time point. This is evident by the gap between the top and bottom two lines in Figure 2D. Furthermore, there was little variation in these proportions. Presurgery and 1-year postsurgery, rates of depression “caseness” were 40% and 36%, respectively (Figure 2D).

Spine OA patients. For spine patients in the “better” outcome group, there were also steady decreases in mean ODI and depression scores over the year postsurgery (Figure 3A). How-

ever, for those with poorer outcomes (Figure 3B), mean scores were fairly constant over time, with no significant difference between presurgery and 1-year postsurgery scores.

For spine patients in the better outcome group (Figure 3C), the percentage of patients that met criteria for depression “caseness” was greater than that for depression diagnosis or treatment until 3 months after surgery. For the poorer spine outcome group, presurgery and 1-year postsurgery rates of depression “caseness” were both approximately 40% (Figure 2D). Furthermore, at each study time point, there was a large difference between the percentage of patients (Figure 3D) deemed depression cases and those who reported depression diagnoses and treatment. Again, this is illustrated by the large gap between the top and bottom two lines in Figure 2D.

It is notable that in each of the study plots considered (Figures 1–3), depression-related findings differ considerably by pain/disability outcome, particularly for knee and spine patients.

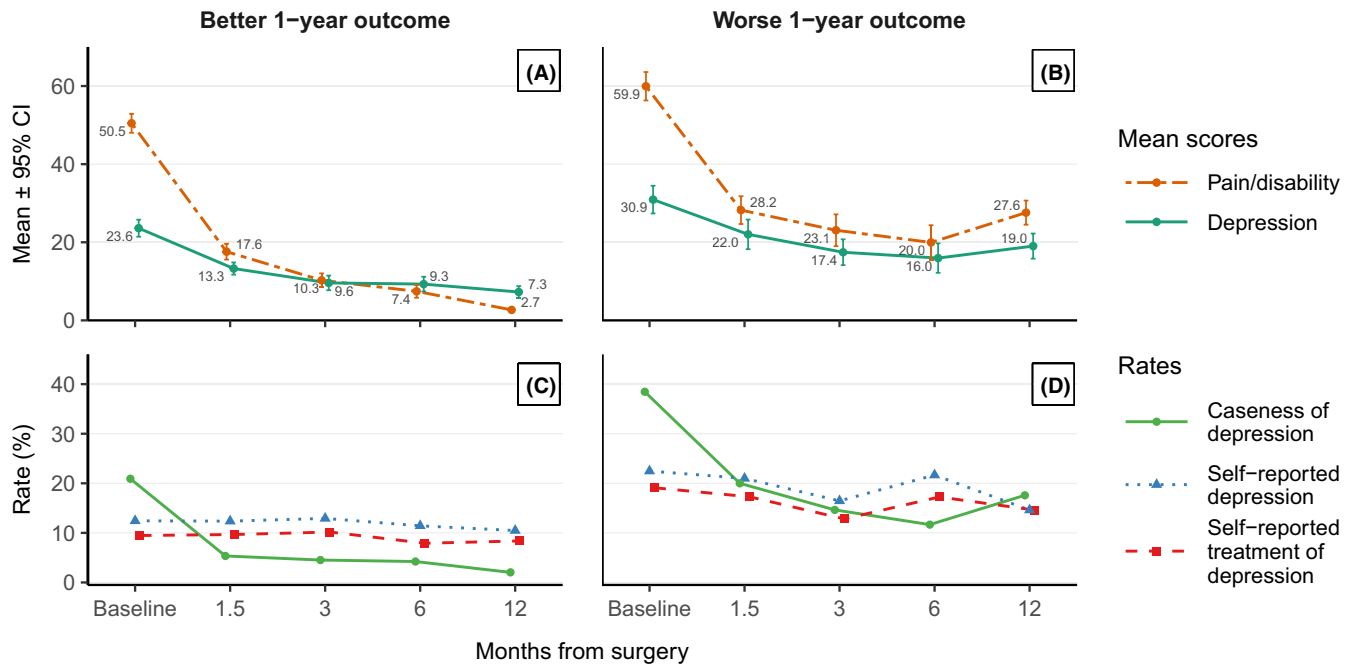


Figure 1. Hip OA patients. **A** and **B**, Trajectories of mean depressive symptom and pain scores. Depressive symptom scores derived from the Hospital Anxiety and Depression Scale (HADS). Pain scores are derived from the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) pain scale. Scores for depressive symptoms and pain range from 0 to 100 with a higher score indicating greater symptom severity. **C** and **D**, Trajectories of HADS caseness of depression, self-reported depression, and treatment for depression. Caseness of depression defined as HADS scores $\geq 38.1/100$, equivalent to 8/21 before rescaling. All are measured stratified by 1-year postsurgical outcome.

Supplemental Regression Analyses. In regression models for each joint group (supplemental file available), 1-year postsurgical outcome score was significantly associated with 1-year depression score ($P < 0.0001$), controlling for age, sex, and presurgical depression level. For each joint group, presurgical depression level was significantly associated with postsurgical depression level.

DISCUSSION

This study demonstrates that although depressive symptoms in hip, knee, and lumbar spine OA patients decrease following surgery overall, patterns and degrees of change vary by anatomical site and surgical outcome. We found that postsurgical improvements in mean depression scores and rates of depression “caseness” were greatest among hip patients. Patients who had poorer outcomes had smaller improvements than those with better outcomes, particularly among knee and spine patients for whom there was not a significant mean change over the study year. For the two latter groups, the proportion that were deemed depression “cases” by symptom score was much higher than the proportion that reported depression diagnosis and treatment. Findings support that a greater attention to mental health postsurgery is warranted.

It has been estimated that the prevalence of depression in the adult Canadian population is approximately 5% (32), which is

significantly less than estimates in chronic pain populations, which range from 11% (33) to 35% (34). Depression in OA specifically has not been well studied, but primary care and population-based studies have estimated that approximately 20% of people with OA have moderately severe depression (10,35). We found that approximately 26% of hip and lumbar spine patients and 22% of knee patients had HADS scores indicative of depression before surgery. We suspect that our somewhat higher estimates for hip and spine patients could reflect greater disease severity among surgical patients and the fact that we calculated joint-specific rates in addition to differences in depression definitions. Duivenvoorden et al (36) examined rates of depression before and after hip and knee TJR using the same depression definition as that in used in our study and similarly found that presurgical rates were higher in hip patients compared with knee patients (26% vs. 20%).

Research on depression in OA surgical patients has primarily focused on the impact of presurgical depression on surgical outcomes, finding that presurgical psychological symptoms are associated with poorer outcomes (9,37–41). Much less is known about the impact of surgery on depression, particularly the impact of a poor surgical outcome on depression. We are not aware of any studies analogous to ours that included hip or knee patients, but we did identify some relevant work in spine populations. Havakeshian and Mannion (42) reported that psychological disturbance postoperatively improved in patients undergoing spinal decompression surgery for spinal stenosis/herniated disc with

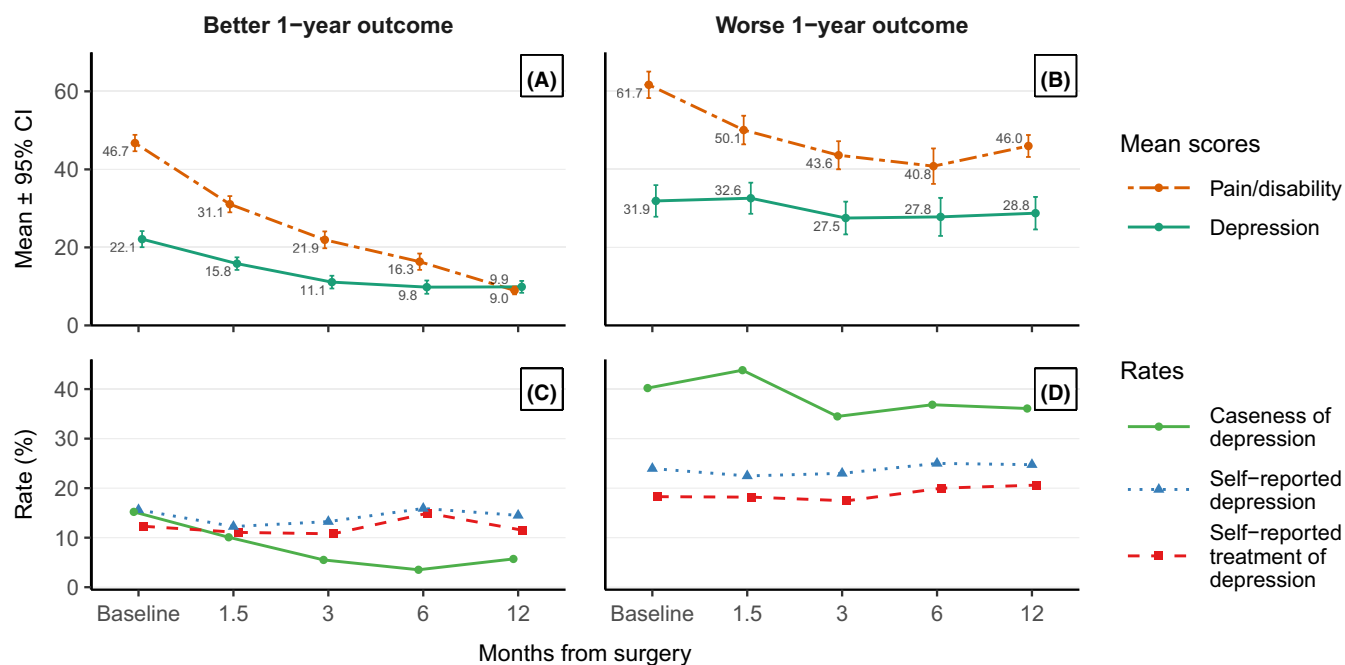


Figure 2. Knee patients. **A** and **B**, Trajectories of mean depressive symptom and pain scores. Depressive symptom scores derived from the Hospital Anxiety and Depression Scale (HADS). Pain scores are derived from the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) pain scale. Scores for depressive symptoms and pain range from 0 to 100 with a higher score indicating greater symptom severity. **C** and **D**, Trajectories of HADS caseness of depression, self-reported depression, and treatment for depression; Caseness of depression defined as HADS scores $\geq 38.1/100$, equivalent to 8/21 before rescaling. All are measured stratified by 1-year postsurgical outcome.

a good surgical outcome but worsened in those with a poor outcome. We hypothesized that patients who had relatively worse outcomes would report a steady worsening of depressive symptoms and those with better outcomes would report improvements. Our findings, however, were not wholly consistent with our hypotheses. Although the magnitude of improvement was greater in those with better outcomes, there were overall improvements in mean depressive symptom scores for hip patients with worse outcomes. Furthermore, a notable percentage of patients, even in the poorer outcome groups, who were depressed presurgery, were no longer depressed 1 year postsurgery in each of the joint groups. It may be that these patients experienced sufficient OA symptom improvement to positively impact depressive symptoms. It could also be that some of these patients were experiencing depressive symptoms unrelated to OA that subsequently resolved. For others, it may be that seeking and receiving treatment had a beneficial impact on their mental health, regardless of the impact on OA symptoms. For hip patients, an additional contributing factor was that most patients did quite well overall; the lowest score in the top (worse) tertile of 1-year pain scores was 11/100. Also notable is that mean pain scores for the “worse” hip group were quite similar to the better knee group for the first 3–6 months after surgery. These factors potentially contribute to the relatively small differences in our depression-related findings comparing the better vs. worse hip outcome groups as opposed to the greater differences for knee and spine patients.

There are many factors that may influence variation in surgical outcomes by OA site. Our findings related to hip replacement patients doing relatively better overall than knee replacement patients were not entirely unexpected. Rates of long-term residual pain postsurgery in knee patients have been reported to be greater than those in hip patients (12). It has also been reported that preoperative status influences postoperative status more strongly in knee patients compared with hip patients (43). Anatomically, the hip joint is a simpler ball-and-socket joint compared with the knee, which is a hinge joint; hip replacement is generally considered a more straightforward procedure with less involvement and impact on the surrounding soft tissues. Variation between joint groups related to both physical and mental health outcomes after surgery is likely influenced by many patient and surgical characteristics and is an area that generally requires further study.

For patients in our study reporting relatively poorer outcomes, increases in mean depressive symptom scores and “caseness” rates were not as evident as we had hypothesized. However, scores and rates were fairly stable among spine patients, and there were small decreases in rates among knee patients. Furthermore, approximately a quarter of these spine and knee patients were “always depressed” and an additional 16% of spine and 10% of knee patients developed new depression “caseness” postsurgery compared with 2% to 3% of spine and knee patients with better postsurgical outcomes. Although these percentages need to be

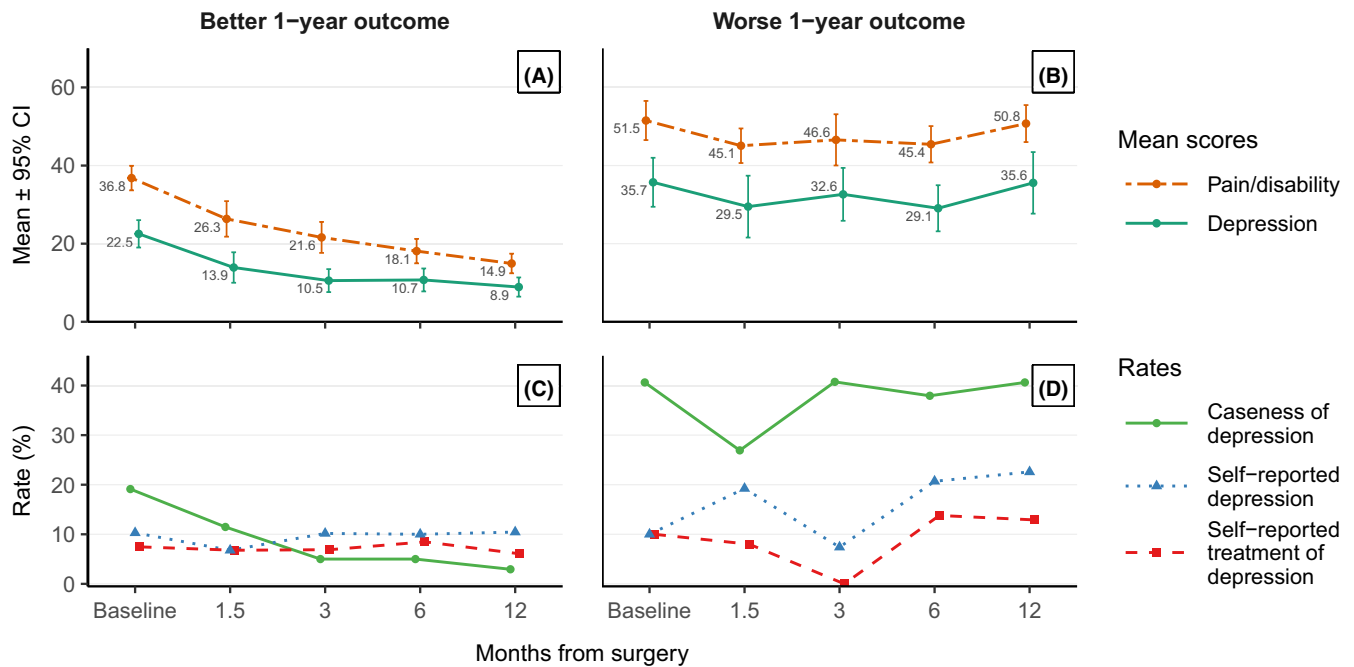


Figure 3. Lumbar spine patients. **A** and **B**, Trajectories of mean depressive symptom and pain-related disability scores; depressive symptom scores derived from the Hospital Anxiety and Depression Scale (HADS). Pain-related disability scores are derived from the Oswestry Disability Index (ODI). Scores for depressive symptoms and pain-related disability range from 0 to 100, with a higher score indicating greater symptom severity. **C** and **D**, Trajectories of HADS caseness of depression, defined as HADS scores $\geq 38.1/100$ and equivalent to 8/21 before rescaling, self-reported depression, and treatment for depression. All are measured stratified by 1-year postsurgical outcome.

interpreted with caution because of small numbers, they suggest that not all patients experience improvements in mental health after OA surgery and that for some, poorer outcomes may actually result in depression. This finding is similar to that of Gornet et al (44), who reported that 8% of their cervical spine patients undergoing disc arthroplasty were newly depressed at 12 months postsurgery and that it was these patients who experienced the smallest improvements in pain and disability.

Among patients who experienced postsurgical improvements in depression, the majority of improvement occurred by 3 months, following similar trajectories as those for the respective outcomes. Our group has previously reported (45) that 80% of changes in pain and function in knee TJR patients occur by 3 months postsurgery and that levels of these variables at 3 months strongly predict levels at 2 years postsurgery. These findings taken together suggest that this early time period in recovery, which typically includes scheduled follow-up appointments, may be an important and opportune time to assess mental health status in addition to pain and function so that necessary interventions, including appropriate referrals, can occur. In the current sample, the percentage of knee and spine patients with poorer outcomes who had HADS scores indicative of depression “caseness” was significantly lower than the percentage reporting diagnosis or treatment. Although HADS scores are not diagnostic of depression, this finding coupled with available literature that suggests physicians underdiagnose and treat depression in

OA patients generally (9,35,46,47), suggests greater assessment of mental health in OA patients, including postsurgical patients is warranted.

The strong association between pain and depression is the result of a complex bidirectional relationship. (16,17). Pain may cause depression, pain may be a somatic representation of depression, and depression and pain may be influenced by common genetic, developmental, and environmental factors (48). There are likely concurrent, short-term, and long-term impacts of pain on depression and vice versa. Because of this complexity, it is difficult to definitively disentangle these factors. For example, in our study, those who were classified as “always depressed” may be more likely to report and experience poor pain-related outcomes because of their depression, or their depression may not have resolved after surgery as a result of residual postsurgical pain, or both may be the case to some extent. The advantage of this complexity is that assessment and treatment of depression in surgical patients may have physical as well as mental health benefits. Furthermore, as depression in clinical populations has been associated with poorer medical treatment adherence (49), including to physiotherapy specifically (50), improved management of depressive symptoms in OA surgical patients may result in improved adherence to postoperative exercise and rehabilitation protocols, thereby positively impacting recovery.

We used postsurgical status based on WOMAC pain and ODI scores for hip/knee and spine patients, respectively, rather

than dividing patients based on a certain degree of change, such as a minimally clinically important difference (MCID). Status defined in this way is readily apparent at clinical follow-up. We examined potentially utilizing quartiles or tertiles of outcome status scores and proceeded with tertiles based on the relative variations in depressive symptoms between the examined groups and in consideration of the available sample size. We used the bottom tertile to represent relatively “worse” outcomes and combined the top two tertiles to represent relatively “better” outcomes. The latter combination was on account of the similarity in depressive symptom patterns observed between these two groups. We purposely did not use the terms “responder” vs. “nonresponder” or “satisfactory” vs. “unsatisfactory” for our outcome groups so as to not imply achieving a specific clinical cut-point postsurgery. We conducted sensitivity analyses that considered varying the outcome definitions based on MCID values (28–31), and overall conclusions were unchanged from the primary analysis. In either case, patients who were deemed poor surgical responders based on these MCID values or those who were deemed to have a “worse” outcome status, had higher depressive symptom scores pre- and postsurgery. This was particularly true for spine and knee patients, and among these patients, the proportion deemed depression “cases” by symptom score was much higher than the proportion that reported depression diagnosis and treatment, again suggesting the potential of unmet need for depression care regardless of how outcome was defined.

Our study is mainly descriptive in nature and is somewhat limited by sample size, particularly in the lumbar spine group. Future work with larger samples will be needed to better understand the impacts of poor OA surgical outcomes on mental health. Although our limited supplemental regression models support an association between postsurgical outcome and postsurgical depression levels, future work should include longitudinal multivariable analyses that consider additional factors that may influence postsurgical depressive symptoms, such as other sociodemographic, physical, and mental health characteristics. Although at an individual hospital level the number of patients with poor surgical outcomes and depressive symptoms may be relatively small, the large and increasing number of OA-related surgical procedures generally means that the population impact may be significant. Better understanding and addressing of mental health issues in OA surgical patients is highly relevant within clinical and research settings.

Our work adds to a growing body of literature that documents the impact of surgical OA care on depression and highlights that this impact varies substantially by outcome, an observation that has otherwise been obscured by the typical approach of considering these clinical samples as a combined group. It also highlights a need for greater attention to mental health in OA patients, including during the postsurgical recovery period and particularly among knee and spine patients who report residual pain-related symptoms. Given the close interrelationship between pain and depres-

sion, appropriate assessment and treatment of depression in OA patients may lead to decreases in postsurgical pain and improved surgical outcomes in addition to better overall quality of life.

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AUTHOR CONTRIBUTIONS

Dr. Power drafted the article; all remaining authors critically revised the manuscript for important intellectual content; and all authors were responsible for the final approval of the manuscript.

Study conception and design. Power, Gandhi.

Acquisition of data. Mahomed, Rampersaud, Gandhi.

Analysis of data. Power, Kudesia, Nadeem, Perruccio, Sundararajan, Mahomed, Rampersaud, Gandhi.

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