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Increased Prevalence of Depressive Symptoms in Patients Undergoing Revision for Periprosthetic Joint Infection

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ABSTRACT

Background: Periprosthetic joint infection (PJI) is a devastating complication after total joint arthroplasty. Patients undergoing revision for PJI may experience psychological distress and symptoms of depression, both of which are linked to poor postoperative outcomes. We, therefore, aim to identify the prevalence of depression and depressive symptoms in patients before treatment for PJI and their link to functional outcomes.

Methods: Patients undergoing either debridement with implant retention (DAIR) or 2-stage exchange for PJI with minimum 1-year follow-up were retrospectively reviewed. The 2-stage (n = 37) and single-stage (n = 39) patients that met inclusion criteria were matched based off age (±5 years), gender, and body mass index (±5) to patients undergoing aseptic revisions. Outcomes evaluated included a preoperative diagnosis of clinical depression and preoperative and postoperative Veterans RAND 12 Item Health Survey mental component score and physical component score.

Results: Compared to matched controls, the prevalence of depressive symptoms was significantly greater in patients undergoing 2-stage exchange preoperatively (40.5% vs 10.8%, $P < .01$) but not postoperatively (21.6% vs 10.8%, $P = .20$). Patients undergoing DAIR with either preoperative depressive symptoms (31.3 vs 40.9, $P = .05$) or a preoperative diagnosis of depression (27.7 vs 43.1, $P < .01$) had significantly lower physical component scores postoperatively.

Conclusions: Patients undergoing 2-stage exchange for PJI have a four times higher prevalence of preoperative depressive symptoms than patients undergoing aseptic revision. Patients undergoing DAIR with depression or preoperative depressive symptoms have lower functional scores postoperatively. Orthopedic surgeon screening of PJI patients with referral for treatment of depression may help improve outcomes postoperatively.

Introduction

Periprosthetic joint infection (PJI) is a devastating complication after total joint arthroplasty (TJA), resulting in revision surgeries, prolonged antibiotic therapy, and extended disability and rehabilitation [1]. A mortality rate of up to 7% has been reported in patients between the first and second stages of a two-stage exchange arthroplasty [2,3]. Despite advances in the prevention of PJI, as the number of TJA continues to rapidly rise, the number of PJI cases is estimated to increase from 17,000 in 2005 to greater than 266,000

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by 2030 [4]. Therefore, in addition to continuing to study PJI prevention, identifying modifiable risk factors to reduce complications in patients who ultimately do require revision for PJI has recently gained interest.

One such risk factor that has been studied extensively in primary TJA is psychological distress and depressive symptoms, which have been associated with increased complications, health-care utilization, readmission rates, and cost [5-15]. These patients typically report higher levels of postoperative pain and consume larger amounts of opioids [16-22]. Interestingly, when patients with depressive symptoms are treated with either medication or psychotherapy perioperatively, there is evidence that they demonstrate greater improvements in physical function scores, lower narcotic use, and a lower rate of revision than those without documented treatment [23-25].

In the context of PJI, prior literature has established that up to 58% of patients risk depressive symptoms throughout their course of treatment and 21.9% report symptoms of anxiety and depression even up to an average of 5 years after eradication of their PJI [26,27]. The odds ratio of developing a new mental health diagnosis after undergoing revision surgery for PJI is as high as 2.10 and can range from 1.55 to 1.82 when examining new-onset depression in the total knee (TKA) and total hip arthroplasty (THA) populations, respectively [28-30].

To the authors knowledge, studies examining depressive symptoms in revision TJA, and PJI in particular, are limited. Therefore, the aim of this study is to determine the prevalence of clinical depression and depressive symptoms in patients with PJI undergoing either debridement with implant retention (DAIR) or two-stage revision compared to patients undergoing an aseptic revision TJA and to identify the relationship between depressive symptomatology and function before and after the treatment for PJI. Our hypothesis is that the considerable disability associated with PJI will result in a higher prevalence of depressive symptoms than the aseptic revision TJA population. In addition, we believe patients with depressive symptoms will have worse functional outcome scores both preoperatively and at 1 year postoperatively after a revision for PJI.

Material and methods

This study was approved by our institutional review board before initiation. We used our institution's prospective, longitudinally maintained TJA database to retrospectively identify all patients undergoing revision for PJI between September 2008 and October 2018 with a minimum 1-year follow-up. All procedures were performed by fellowship-trained arthroplasty surgeons. Patients with incomplete data or those undergoing an additional arthroplasty procedure within 1 year of their revision for PJI were excluded. Eighty patients met the aforementioned criteria and were included in the analysis.

Demographic data collected from the database included age, gender, and body mass index (BMI). A supplementary chart review was also used to determine if patients had a preexisting diagnosis of clinical depression before their revision surgery and what medications were prescribed. At the preoperative and 1-year postoperative appointments, all patients received the Veterans RAND 12 Item Health Survey (VR-12). This was used to assess a patient's overall perspective of their health. Answers were summarized into two scores, a physical component score (PCS) and a mental component score (MCS), which then provided an assessment of the respondents' physical and psychological health status [31]. Prior literature has established a VR-12 MCS below 42 as a positive screen for symptoms of depression [32-34]. Based on this, patients in this study were considered to have depressive symptoms if their preoperative VR-12 MCS was below 42, irrespective of a preexisting diagnosis of clinical depression.

Patients were grouped into those undergoing either a DAIR or two-stage exchange arthroplasty for PJI. Patients undergoing single-stage procedures were excluded because of low numbers (n = 2). The indication for a two-stage vs DAIR procedure was based on surgeon preference. The two-stage (n = 39) and DAIR (n = 41) patients who met the inclusion criteria were then matched based on age (±5 years), gender, BMI (±5), and location of surgery (hip vs knee) to patients undergoing an aseptic revision TJA. Patients undergoing reoperations outside of their expected revision procedures within 1 year postoperatively were excluded from both the study and control groups. Two patients in each group were also excluded after matching because no matches were identified in the database. The final two-stage exchange arthroplasty (n = 37) and DAIR (n = 39) patient cohorts were analyzed against their matched aseptic revision cohorts.

Outcomes evaluated included a history of a diagnosis of a major depressive disorder before their revision surgery, as well as preoperative and postoperative VR-12 MCS and PCS. Postoperative VR-12 was collected 1 year after the second stage for patients in the two-stage cohort. Continuous variables were analyzed using the Mann-Whitney U test or Student's t test. Categorical variables were analyzed using the Chi-squared test. In the event of less than 5 occurrences for a given variable, Fisher's exact test was used instead. All statistical analyses were performed using SPSS, version 26.0 (SPSS Inc., Chicago, IL).

Table 1
Demographic data.

Demographic variables	DAIR cohort			2-Stage exchange cohort		
	DAIR (N = 39)	Aseptic revision matches (N = 39)		2-Stage exchange (N = 37)	Aseptic revision matches (N = 37)	
Age	66.1 ± 8.6[a]	66.2 ± 8.0[a]	$P = .96$	63.6 ± 8.9[a]	64.1 ± 8.5[a]	$P = .80$
Gender	Male: (21) 53.9% Female: (18) 46.1%	Male: (21) 53.9% Female: (18) 46.1%		Male: 28 (75.7%) Female: 9 (24.3%)	Male: 28 (75.7%) Female: 9 (24.3%)	
BMI	29.5 ± 7.0[a]	29.4 ± 6.7[a]	$P = .95$	30.0 ± 6.4[a]	30.0 ± 6.4[a]	$P = .99$
Follow-up	2.7 ± 2.2 (1.0 − 9.1)[b]	2.6 ± 2.0 (1.0 − 10.4)[b]	$P = .85$	2.3 ± 1.3 (1.1 − 5.6)[b]	2.2 ± 1.1 (1 − 4.9)[b]	$P = .56$
Surgery type	THA: 10 (25.6%) TKA: 29 (74.4%)	THA: 10 (25.6%) TKA: 29 (74.4%)		THA: 15 (40.5%) TKA: 22 (59.5%)	THA: 15 (40.5%) TKA: 22 (59.5%)	
Clinical depression	10 (25.6%)	13 (33.3%)	$P = .46$	11 (29.7%)	11 (29.7%)	$P = 1.00$
Preop DS	8 (20.5%)	5 (12.8%)	$P = .36$	15 (40.54%)	4 (10.8%)	$P < .01$
Postop DS	6 (15.3%)	6 (15.3%)	$P = 1.00$	8 (21.6%)	4 (10.8%)	$P = .20$

Preop DS, preoperative depressive symptoms; postop DS, postoperative depressive symptoms.
[a] Values are presented as mean ± standard deviation.
[b] Values are presented as mean ± standard deviation (range).

Table 2
Modes of failure in aseptic revision matches.

Revision TKA			Revision THA		
	DAIR aseptic revision matches	2-Stage exchange aseptic revision matches		DAIR aseptic revision matches	2-Stage exchange aseptic revision matches
Polyethylene wear	3 (10.3%)	2 (9.0%)	Polyethylene wear	5 (50%)	4 (26.7%)
Instability	15 (51.7%)	10 (45.5%)	Metallosis	2 (20%)	5 (33.3%)
Aseptic loosening	7 (24.1%)	6 (27.3%)	Instability	2 (20%)	3 (20%)
Arthrofibrosis	4 (13.8%)	4 (18.2%)	Aseptic loosening	1 (10%)	3 (20%)

Results

The study sample included 152 patients, with 39 patients in the DAIR cohort with 39 matched aseptic revision controls, and 37 patients in the two-stage exchange arthroplasty cohort with 37 matched aseptic revision controls. The mean age was 65.0 ± 8.5 (range: 35 − 85 years). There was no difference in age, gender, BMI, or length of follow-up between groups (Table 1). In the DAIR cohort, 25.6% (n = 10) of patients had an infection after THA, and 74.4% (n = 29) had an infection after TKA. In the 2-stage exchange arthroplasty cohort, 40.5% (n = 15) had an infection after THA, and 59.5% (n = 22) had an infection after TKA. The modes of failure for the aseptic revision matches are listed in Table 2.

The average preoperative VR-12 MCS score was significantly lower for patients undergoing 2-stage exchange arthroplasty for PJI (47.6 vs 54.5, $P = .01$) than that for aseptic revision-matched controls (Table 3). At the latest follow-up visit postoperatively, the average VR-12 MCS score was no different between the two groups (51.6 vs 54.1, $P = .33$). When examining the VR-12 PCS scores, the average preoperative score was also significantly lower for the 2-stage exchange arthroplasty group than that for aseptic revision matched controls (31.6 vs 36.0, $P = .05$). Postoperatively, the difference was not significant (40.0 vs 39.7, $P = .90$). The change in both VR-12 PCS and MCS scores between the preoperative and postoperative time points in the 2-stage exchange arthroplasty group approached significance (MCS: 3.9 vs -0.4, $P = .07$; PCS: 8.4 vs 3.7, $P = .10$).

There was no difference between the average preoperative (53.9 vs 54.9, $P = .72$) and postoperative (53.0 vs 54.2, $P = .63$) VR-12 MCS scores at the latest follow-up visit in the DAIR group compared to aseptic revision matched controls. There was also no difference between the average preoperative (34.8 vs 34.0, $P = .78$) and postoperative (38.6 vs 39.4, $P = .79$) VR-12 PCS scores. Finally, the change in VR-12 PCS and MCS scores between the preoperative and postoperative time points for the DAIR group (MCS: -1.0 vs -0.7, $P = .91$; PCS: 3.9 vs 5.4, $P = .57$) was also not significant.

Depressive symptoms

Compared to aseptic revision matched controls, the prevalence of depressive symptoms identified by MCS < 42 was significantly higher in the 2-stage exchange arthroplasty group preoperatively (40.54% [15] vs 10.8% [4], $P < .01$), but not postoperatively (21.6% [8] vs 10.8% [4], $P = .20$) (Table 1). There was no difference in the preoperative PCS (31.5 vs 31.7, $P = .47$), postoperative PCS (38.3 vs 41.2, $P = .21$), or change in PCS (6.8 vs 9.5, $P = .18$) between patients with preoperative depressive symptoms and those without (Table 4). Interestingly, patients with preoperative depressive symptoms who continued to have depressive symptoms (n = 6) postoperatively had significantly lower postoperative PCS than patients without preoperative depressive symptoms (32.4 ± 10.4 vs 41.2 ± 10.3, $P = .05$).

There was no difference in the prevalence of depressive symptoms in the DAIR cohort compared to the aseptic revision matched controls either preoperatively (20.5% [8] vs 12.8% [5], $P = .36$) or postoperatively (15.3% [6] vs 15.3% [6], $P = 1.00$). There was also no difference in the preoperative PCS (30.4 vs 35.8, $P = .23$) between patients with preoperative depressive symptoms and those without. However, patients with preoperative depressive symptoms did have a significantly lower postoperative PCS (31.3 vs 40.9, $P = .05$) and change in PCS (0.86 vs 5.30, $P = .05$) in the DAIR cohort. Patients with preoperative depressive symptoms who continued to have depressive symptoms (n = 2) postoperatively also had significantly lower postoperative PCS than patients without preoperative depressive symptoms (39.6 ± 2.5 vs 54.2 ± 12.3, $P < .01$).

Clinical depression

A diagnosis of clinical depression and the prescribed medications was obtained based on the patient's reported past medical history. These data were obtained by the internal medicine team as a part of their preoperative history and physical for medical clearance. The prevalence of a preoperative diagnosis of clinical

Table 3
Average preoperative and postoperative VR-12 scores.

VR-12	DAIR cohort			2-Stage exchange cohort		
	DAIR	Aseptic revision matches		2-Stage exchange	Aseptic revision matches	
VR-12 MCS Preop	53.9 ± 11.7	54.9 ± 10.8	$P = .72$	47.6 ± 13.2	54.5 ± 10.0	$P = .01$
VR-12 MCS Postop	53.0 ± 12.0	54.2 ± 10.2	$P = .63$	51.6 ± 11.6	54.1 ± 10.5	$P = .33$
VR-12 PCS Preop	34.8 ± 11.4	34.0 ± 10.7	$P = .78$	31.6 ± 7.5	36.0 ± 11.2	$P = .05$
VR-12 PCS Postop	38.6 ± 13.1	39.4 ± 11.9	$P = .79$	40.0 ± 10.6	39.7 ± 11.5	$P = .90$
Change in VR-12 MCS	-1.0 ± 13.8	-0.7 ± 10.9	$P = .91$	3.9 ± 11.9	-0.4 ± 8.7	$P = .07$
Change in VR-12 PCS	3.9 ± 11.1	5.4 ± 11.6	$P = .57$	8.4 ± 9.6	3.7 ± 14.3	$P = .10$

Values are presented as mean ± standard deviation.

Table 4
VR-12 physical component scores based on preoperative depressive symptoms.

VR-12 PCS	2-Stage exchange			DAIR		
	PDS	No PDS		PDS	No PDS	
Preoperative PCS	31.5 ± 7.4	31.7 ± 7.7	$P = .47$	30.4 ± 5.6	35.8 ± 12.3	$P = .23$
Postoperative PCS	38.3 ± 11.2	41.2 ± 10.3	$P = .21$	31.3 ± 14.0	40.9 ± 12.3	$P = .05$
Change in PCS	6.8 ± 7.6	9.5 ± 10.8	$P = .18$	0.86 ± 10.7	5.30 ± 10.4	$P = .05$

PDS, preoperative depressive symptoms.

depression was 25.6% (n = 10) in the DAIR cohort and 29.7% (n = 11) in the 2-stage exchange arthroplasty cohort (Table 1). There was no difference in the prevalence of a preoperative diagnosis of clinical depression within the DAIR (25.6% [10] vs 33.3% [13], $P = .46$) or the 2-stage exchange (29.7% [11] vs 29.7% [11], $P = 1.00$) matched cohort. All patients with a preoperative diagnosis of clinical depression were receiving treatment with at least one prescribed medication. In the 2-stage exchange cohort, there was no difference in preoperative PCS (29.8 vs 32.4, $P = .33$), postoperative PCS (37.1 vs 41.3, $P = .10$), and change in PCS (7.3 vs 8.8, $P = .67$) between patients with a preoperative diagnosis of depression and those without (Table 5). Patients in the DAIR cohort with a preoperative diagnosis of clinical depression did have a significantly lower preoperative PCS (28.0 vs 37.1, $P = .03$), postoperative PCS (27.7 vs 43.1, $P < .01$), and change in PCS (-0.4 vs 6.0, $P = .05$) than those without.

There was no correlation between preoperative depressive symptoms and a preoperative diagnosis of clinical depression in both the 2-stage exchange arthroplasty ($P = .69$) and DAIR groups ($P = .16$) (Table 6).

Discussion

To our knowledge, this is the first study to specifically examine the prevalence of clinical depression and depressive symptoms among patients undergoing DAIR and 2-stage exchange arthroplasty for PJI compared to aseptic revision controls and assess their effect on functional outcomes. Although there was no difference in the prevalence of preoperatively diagnosed clinical depression among the groups, the 2-stage exchange arthroplasty group had an almost four times higher prevalence rate of preoperative depressive symptoms than matched aseptic revision controls. Depressive symptoms in patients did not correlate to a preoperative diagnosis of depression. Patients in the DAIR cohort who had either a preoperative diagnosis of clinical depression or preoperative depressive symptoms had significantly less improvement in their postoperative PCS than those without. In both groups, patients who continued to have depressive symptoms postoperatively also continued to have significantly lower postoperative PCS. Similar to the primary TJA literature, it appears that a diagnosis of clinical depression or depressive symptoms can impact functional outcomes [20,35].

The prevalence of preoperatively diagnosed depression in the 2-stage exchange arthroplasty (29.7%) and the DAIR (25.6%) groups is considerably higher than the national prevalence of depression (5.9%), the prevalence found in the primary arthroplasty population (10%-11%), and the prevalence reported in the aseptic revision population (13.1%-14.4%) [5,17,36,37]. This may be partially explained by selection bias, as a preoperative diagnosis of depression has been associated with an increased risk of PJI [10,38,39]. The aseptic revision cohorts in this study also had an elevated prevalence of preoperative depression (29.7-33.3%) compared to the prevalence previously reported for the aseptic revision population. This may be secondary to demographic matching to the PJI cohorts, which may have biased selection of patients to those with preoperative depression. Regardless, it appears in this study that the prevalence of depression in patients undergoing PJI revisions is similar to that in those undergoing aseptic revisions, even though considerably higher than normal population.

When examining preoperative depressive symptoms, the significantly higher rate (40.5%) in the two-stage exchange arthroplasty group may reflect the extended period of disability and the additional surgical procedure required for these patients compared to patients undergoing an aseptic revision arthroplasty or DAIR procedure [40-42]. Patients undergoing two-stage exchange have also likely had a longer preoperative duration of symptoms resulting from their infection than patients undergoing a DAIR procedure. This rate of preoperative depressive symptoms is considerably higher than the previously published rate in the primary arthroplasty literature of 26.8%, although it is comparable to that in previous literature examining patients with PJI, in which 58% of patients had depressive symptoms [27,43]. Interestingly, there was no correlation between preoperative depressive symptoms and a preoperative diagnosis of depression. All patients with a preoperative diagnosis of depression in this study were receiving treatment with at least one prescribed medication; therefore, some patients may not have been clinically symptomatic at the time of the screening. In addition, prior literature has shown that the diagnostic recognition of psychiatric conditions in nonpsychiatric settings is poor [44]. This emphasizes the importance of screening for symptoms of psychological distress preoperatively rather than screening only for a preexisting diagnosis of depression, as not all patients with psychological disorders are presumed to be in psychological distress, and vice versa [35].

Table 5
VR-12 physical component scores based on preoperative diagnosis of depression.

VR-12 PCS	2-Stage exchange			DAIR		
	Depression	No depression		Depression	No depression	
Preoperative PCS	29.8 ± 5.5	32.4 ± 8.2	$P = .33$	28.0 ± 3.3	37.1 ± 11.9	$P = .03$
Postoperative PCS	37.1 ± 7.4	41.3 ± 11.7	$P = .10$	27.7 ± 11.0	43.1 ± 11.4	$P < .01$
Change in PCS	7.3 ± 4.3	8.8 ± 11.1	$P = .67$	-0.4 ± 12.1	6.0 ± 9.6	$P = .05$

Table 6
Comparison of VR-12 MCS < 42 and preoperative diagnosis of depression.

2-Stage exchange	Preoperative depression	No preoperative depression	
VR-12 MCS < 42	5 (13.5%)	10 (27.0%)	$P = .69$
VR-12 MCS ≥ 42	6 (16.2%)	16 (43.2%)	
DAIR			
VR-12 MCS < 42	3 (7.69%)	3 (7.69%)	$P = .16$
VR-12 MCS ≥ 42	7 (17.95%)	26 (66.67%)	

Although the preoperative VR-12 MCS and PCS scores were significantly lower in the 2-stage exchange arthroplasty cohort preoperatively, there were no differences in the MCS or PCS scores postoperatively. The change in MCS and PCS were not significant between the two groups, although the differences did approach significance for both, indicating considerable improvement in the 2-stage exchange arthroplasty cohort. These findings are similar to a study published by Ghanem et al. who also found that patients undergoing 2-stage exchange arthroplasty had lower preoperative function and a trend toward worse baseline mental health [40]. In their study, there was no difference in postoperative mental and functional scores, and the improvement in mental health in the 2-stage exchange arthroplasty group approached three times that of the noninfected group. A second study, by Patil et al., also showed that septic revisions had a greater improvement in postoperative Knee Society Scores and SF-36 Mental and Physical Scores than aseptic revisions [45]. Similar to the present study, Ghanem et al. determined that preoperative depressive symptoms did not predict postoperative function after 2-stage exchange arthroplasty [40]. Taken together, it is evident that intervention for patients undergoing 2-stage exchange arthroplasty for PJI decreases depressive symptoms and can have a beneficial effect on patients' mental health and physical function postoperatively, although a causative effect of depressive symptoms on functional outcomes has not been found.

This is in contrast to the DAIR cohort, in which patients with either a preoperative diagnosis of depression or preoperative depressive symptoms had both less improvement in their PCS and lower PCS postoperatively. The differences in PCS and change in PCS between the two groups also either approached or exceeded what is considered the minimal clinically important difference for the VR-12, which is 5.0 [46]. This is largely consistent with the preexisting literature examining depression in primary and aseptic revision arthroplasty, which found an association with increased pain, PJI, revision rates, medical complications, health-care utilization, and hospital costs, as well as worse functional outcomes [5,10,12-14,17,18,36,38,39,47-53]. Although this effect can be partially explained by the high comorbidity burden and immune changes associated with a diagnosis of depression, evidence that selective serotonin reuptake inhibitors reduce the risk of revision indicate that effective management may mitigate adverse effects to some degree [54,55]. This is especially relevant considering prior literature has demonstrated that the odds ratio of new-onset depression after undergoing surgery for PJI can range from 1.55 to 1.82 in the TKA and THA populations, respectively [29,30]. It is important to note that although patients with a preoperative diagnosis of depression were all undergoing treatment with at least one medication in this study, functional outcomes postoperatively were still significantly worse.

There are several limitations to this study. This is a retrospective matched case control study and thus suffers from inherent bias, although great effort was made to match the patients within groups to minimize this bias as much as possible. The authors acknowledge that matching by age, gender, and BMI does not necessarily capture all the potentially confounding factors that contribute to depressive symptoms but believe additional, more stringent matching criteria may have further decreased the cohorts available for analysis. Second, this study was performed at an urban tertiary referral center, and thus, the results may not be generalizable across all practice settings. Mental and physical function evaluations were not performed after the first stage of the two-stage exchange arthroplasty, so this study cannot comment on the mental or physical function of patients at that intermediate time point. The authors realize there are different classifications of depression within The *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-V)* that may have accounted for these differences that were unable to be accounted for in this study. Finally, the number of patients in each group may have been underpowered to detect differences within certain parameters (ie, duration of depressive symptoms before surgery). In addition, patients could not be stratified according to infecting organism, and so the effect of organisms' virulence on patients' mental state either before or after undergoing revision for PJI could not be evaluated. Another consequence of a smaller sample size in each group is the inability to separately evaluate patients who underwent revision THA and TKA. Minimum 1-year follow-up was chosen to increase the number of patients available for analysis. Recent data from the study by Xu et al. suggest that reporting outcomes of THA and TKA revisions for PJI together, as well as reporting minimum 1-year follow-up, is reliable when tracking outcomes [56]. The authors believe this provides justification for grouping patients who underwent THA and TKA together, thereby maximizing the sample size. Despite the aforementioned limitations, we feel this is a valuable contribution to the literature in understanding one potential modifiable risk factor for poor outcomes after PJI.

Conclusions

This study demonstrates that the prevalence of depressive symptoms is greater than 40% in patients undergoing 2-stage exchange arthroplasty. In addition, patients undergoing DAIR with preoperative depressive symptoms or a preoperative diagnosis of depression have a significantly lower improvement in postoperative physical function. Prior literature has established that surgical outcomes could be further improved if orthopedic surgeons appropriately screened patients undergoping arthroplasty for depressive symptoms and referred them to appropriate care preoperatively [57]. Thus, the results of this study may help increase awareness of the high prevalence of depressive symptoms in patients undergoing revision for PJI and ensure that this modifiable risk factor is addressed. Further study is required to prospectively evaluate the role of depression as a modifiable risk factor in the treatment of PJI to help improve outcomes postoperatively.

Conflicts of interest

D. A. Dennis received royalties from DePuy, a Johnson & Johnson Company; is in the speakers' bureau or gave paid presentations to and is a paid consultant for Corin U.S.A. and DePuy, a Johnson & Johnson Company; has stock or stock options in Corin U.S.A. and Joint Vue; receives research support from DePuy, a Johnson & Johnson Company, Corin U.S.A., and Porter Adventist Hospital; receives royalties and financial or material support from Wolters Kluwer Health—Lippincott Williams & Wilkins; and is in the editorial or governing board of Clinical Orthopaedics and Related

Research, Jounal of Arthroplasty, Journal of Bone and Joint Surgery—American, and Orthopedics Today. J. M. Jennings is a paid consultant for Total Joint Orthopedics and Xenex; has stock or stock options in Xenex; and receives research support from DePuy, a Johnson & Johnson Company, Corin U.S.A., and Porter Adventist Hospital.

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