Clinical Study

Postoperative complications in adult spinal deformity patients with a mental illness undergoing reconstructive thoracic or thoracolumbar spine surgery

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ABSTRACT

BACKGROUND CONTEXT: Previous studies have found an association between mental illness and poor outcomes in spine surgery, but little is known about the effects of depression and/or anxiety on the adult spinal deformity population. In addition, most relevant studies exclusively focused on the lumbar spine and had relatively small patient sizes.

PURPOSE: The aim of this study was to investigate whether adult spinal deformity patients with depression and/or anxiety have an increased risk of postoperative complications and reoperation following posterior thoracolumbar spinal surgery.

STUDY DESIGN/SETTING: Retrospective database study.

METHODS: Adult patients (over 18 years of age) with a diagnosis of spinal deformity undergoing any reconstructive thoracic or thoracolumbar spinal procedure with a posterior approach between 2007 and 2015 Q2 were identified using Current Procedural Terminology codes to query the Pearl Diver patient record database (Pearl Diver Technologies, West Conshohocken, PA, USA). The database includes records of approximately 18 million patients across the United States having Humana insurance. Further selection of patients with depression and/or anxiety and their associated postoperative complications were identified using ICD-9 and ICD-10 diagnosis codes (International Classification of Diseases 9th-10th edition). The mental illness cohort was matched to a control group according to age, sex, and Charlson Comorbidity Index. Patient data was analyzed for reoperation rates and incidence of common postoperative complications.

RESULTS: Multilevel posterolateral fusion was the most common included posterior thoracic reconstructive surgery. The mental illness cohort (n = 327) had significantly increased rates of infection (odds ratio [OR] = 1.743, p = .022) and respiratory complications (OR = 1.492, p = .02) at the 90-day postoperative period. The rates of incision and drainage (OR = 1.379, p = .475) and pneumonia (OR = 1.22, p = .573) were increased in the mental illness cohort at the 90-day postoperative period, but not significantly. There were no significant differences in complication and reoperation rates at 1-year postoperatively.

CONCLUSIONS: Patients with spinal deformity and pre-existing depression and/or anxiety treated with a posterior thoracolumbar reconstructive spinal surgery had significantly elevated risk of postoperative infections and respiratory complications when compared with the control group.   © 2018 Elsevier Inc. All rights reserved.

Introduction

The incidence of adult spinal deformity is increasing due to a growing elderly patient population that often has iatrogenic flat back and worsening spondylosis. The prevalence of scoliosis in the adult population is estimated to be around 1.4%−32%, whereas in the elderly population−specifically those greater than 60 years old−the prevalence may be as high as 68% [1,2]. Moreover, the incidence of adult spinal deformity surgeries has dramatically outpaced other spine surgeries over the last decade [3]. The clinical presentation of adult spinal deformity ranges from asymptomatic to severe back pain with disability, and may sometimes include symptoms of neural compression [4]. Although reconstructive deformity correction procedures have become an increasingly safe treatment option, they have been associated with worse outcomes in adult spinal deformity patients with comorbidities such as obesity and depression [5]. Consequently, it is imperative that both surgeons and patients are aware of these risk factors in order to preoperatively address or minimize them.

Mental illness is one of the most common risk factors for poor outcomes following spine surgery [6]. Numerous studies have shown that depression negatively impacts postoperative health-related quality of life (HRQoL), pain, and disability outcomes in patients undergoing lumbar spine surgery [5,7−10]. In addition, a national trends study using hospital discharge data found a significantly higher incidence of depression in patients undergoing revision spinal fusions compared with those undergoing primary spinal fusions [11]. Finally, a study focused on US workers' compensation patients found that presurgical depression is highly predictive of poor outcomes in lumbar fusion [12].

Most surgeons recommend patients undergo screening for psychiatric disorders before spinal surgery. However, little is known about the postoperative effect of psychiatric disorders on surgical outcomes in an adult spinal deformity population [13]. One study using national hospital discharge data found that patients with psychiatric disorders had increased perioperative complications following major spine surgery, but they were unable to analyze complications that arose after initial discharge [14]. Interestingly,

another study found that adult spinal deformity patients with poor mental component summary (using SF-36) and physical health scores have a significantly improved HRQoL on 2-year follow-up, suggesting a substantial benefit of surgical reconstruction even in potentially high-risk patients [15]. However, there is a paucity of data on how depression and anxiety affect postoperative outcomes following reconstructive surgery in the thoracic and thoracolumbar spine. The aim of the current study was to analyze how depression and anxiety affect postoperative outcomes following reconstructive posterior thoracolumbar spine surgeries in adult spinal deformity patients.

Materials and methods

The PearlDiver Patient Records Database (www.pearldiverinc.com; Pearl Diver Technologies, West Conshohocken, PA, USA) was retrospectively analyzed in this study. This commercially available database was queried using the International Classification of Disease, Ninth and Tenth Revisions (ICD-9 and ICD-10) and the Current Procedural Terminology (CPT) codes billed to the insurance provider Humana Inc. The Humana database comprises medical records of over 20 million patients of all ages nationwide having Humana insurance. Although individual patient information is not available in order to protect patient privacy, aggregate data on patient demographics and medical diagnoses can be queried.

The database was queried for records of patients over 18 years of age undergoing any reconstructive posterior thoracolumbar spine procedure from 2007 to 2015 Q2 using the CPT codes in Table 1. Anterior thoracolumbar spinal procedures were excluded to remove the potentially confounding additional risk associated with these procedures. Using specific ICD-9 codes (Table 2), these patients were then filtered to provide a cohort of patients with adult spinal deformity. Patients were then divided into mental illness and nonmental illness cohorts by ICD-9 codes for depression and anxiety (Table 2). To qualify into the mental illness cohort, patients must have had an active diagnosis of a mental illness anytime between 6 months preoperatively to the day of the operation. The mental illness cohort was then

Table 1
CPT codes for thoracic and thoracolumbar spinal procedures

Procedures	Codes
Thoracic lateral extracavitary arthrodesis	CPT-22532
Multilevel posterolateral fusion (PLF)	CPT-22610 and CPT-22614
Posterior arthrodesis for spinal deformity, less than 7 segments	CPT-22800
Posterior arthrodesis for spinal deformity, 7 - 12 segments	CPT-22802
Posterior arthrodesis for spinal deformity, greater than 12 segments	CPT-22804

Table 2

ICD-9, ICD-10, and CPT codes for mental illnesses, complications, and reoperations

Complications	Codes
Anxiety	ICD-9-D-30000, ICD-9-D-30001, ICD-9-D-30002, ICD-9-D-30009, ICD-9-D-30010, ICD-9-D-30011, ICD-9-D-30012, ICD-9-D-30013, ICD-9-D-30014, ICD-9-D-30015, ICD-9-D-30016, ICD-9-D-30019, ICD-9-D-30020, ICD-9-D-30021, ICD-9-D-30022, ICD-9-D-30023, ICD-9-D-30029, ICD-9-D-3003, ICD-9-D-3004, ICD-9-D-3005, ICD-9-D-3006, ICD-9-D-3007
Depression	ICD-9-D-29620, ICD-9-D-29621, ICD-9-D-29622, ICD-9-D-29623, ICD-9-D-29624, ICD-9-D-29630, ICD-9-D-29631, ICD-9-D-29632, ICD-9-D-29633, ICD-9-D-29634, ICD-9-D-29682, ICD-9-D-311, ICD-9-D-3004
Nervous system	ICD-9-D-7244, ICD-9-D-7243, ICD-9-D-7292, ICD-9-D-99700, ICD-9-D-99701, ICD-9-D-99709, ICD-9-D-3534, ICD-9-D-59654, ICD-9-D-3446, ICD-9-D-78760 ICD-10-D-M5414, ICD-10-D-M5430, ICD-10-D-M5410, ICD-10-D-G9781, ICD-10-D-G970, ICD-10-D-G9782 ICD-10-D-G544, ICD-10-D-N319, ICD-10-D-R159
Infection	ICD-9-D-99859, ICD-9-D-99669, ICD-9-D-9993, ICD-9-D-99591, ICD-9-D-99592, ICD-9-D-9985, ICD-9-D-99830, ICD-9-D-99831, ICD-9-D-99832, ICD-9-D-99883, ICD-9-D-9986, ICD-9-D-99660, ICD-9-D-99663, ICD-9-D-99667 ICD-10-D-K6811, ICD-10-D-T814XXA, ICD-10-D-T8579XA, ICD-10-D-A419, ICD-10-D-R6520, ICD-10-D-T8130XA, ICD-10-D-T8132XA, ICD-10-D-T8131XA, ICD-10-D-T8133XA, ICD-10-D-T8183XA, ICD-10-D-T847XXA
Hematoma	ICD-9-D-99812, ICD-9-D-99851, ICD-9-D-99813, ICD-9-D-9981, ICD-9-D-99811 ICD-10-D-D7801, ICD-10-D-T814XXA, ICD-10-D-T888XXA, ICD-10-D-D7802, ICD-10-D-D7821, ICD-10-D-D7822, ICD-10-D-G9731, ICD-10-D-G9732, ICD-10-D-G9751, ICD-10-D-G9752
Incision & drainage	CPT-10060, CPT-10061, CPT-10140, CPT-10160, CPT-10180, CPT-11000, CPT-97597, CPT-97598, CPT-11042, CPT-11043, CPT-11044, ICD-9-P-8622, ICD-9-P-8604
Pneumonia	ICD-9-D-480, ICD-9-D-481, ICD-9-D-482, ICD-9-D-483, ICD-9-D-484, ICD-9-D-485, ICD-9-D-486, ICD-9-D-99731, ICD-9-D-4800, ICD-9-D-4801, ICD-9-D-4802, ICD-9-D-4803, ICD-9-D-4809 ICD-10-D-J120, ICD-10-D-J13, ICD-10-D-J181 ICD-10-D-J150, ICD-10-D-J157, ICD-10-D-J95851, ICD-10-D-J121, ICD-10-D-J122, ICD-10-D-J1281, ICD-10-D-J1289, ICD-10-D-J129

Table 2 (*Continued*)

Complications	Codes
Respiratory	ICD-9-D-5180, ICD-9-D-5185, ICD-9-D-51881, ICD-9-D-51882, ICD-9-D-7860, ICD-9-D-9973, ICD-9-D-99739 ICD-10-D-J9811, ICD-10-D-J9600, ICD-10-D-J951, ICD-10-D-J952, ICD-10-D-J953, ICD-10-D-J95822, ICD-10-D-J9620, ICD-10-D-J9690, ICD-10-D-J80, ICD-10-D-R069, ICD-10-D-J95851, ICD-10-D-J9589, ICD-10-D-J95859
Thromboembolic	ICD-9-D-4151, ICD-9-D-41511, ICD-9-D-41512, ICD-9-D-41513, ICD-9-D-41519, ICD-9-D-45340, ICD-9-D-45341, ICD-9-D-45342, ICD-9-D-4538, ICD-9-D-45389, ICD-9-D-4539, ICD-9-D-45111, ICD-9-D-45119, ICD-9-D-45181, ICD-9-D-4519 ICD-10-D-I2699, ICD-10-D-I2690, ICD-10-D-T800XXA, ICD-10-D-T81718A, ICD-10-D-T8172XA, ICD-10-D-T82817A, ICD-10-D-T82818A, ICD-10-D-I2692, ICD-10-D-I82409, ICD-10-D-I82419, ICD-10-D-I82429, ICD-10-D-I82439, ICD-10-D-I824Y9, ICD-10-D-I82449, ICD-10-D-I82499, ICD-10-D-I82890, ICD-10-D-I8291, ICD-10-D-I8010, ICD-10-D-I80209, ICD-10-D-I80219, ICD-10-D-I809
Urinary tract infection	ICD-9-D-5990 ICD-10-D-N390
Urinary Retention	ICD-9-D-78820, ICD-9-D-78821, ICD-9-D-78829 ICD-10-D-R339, ICD-10-D-R3914, ICD-10-D-R338
Pseudoarthrosis	ICD-9-D-73382 ICD-10-D-S0291XK
Novel spinal pathology	ICD-9-D-72401, ICD-9-D-72211, ICD-9-D-72272, ICD-9-D-72282, ICD-9-D-72251, ICD-9-D-7384 ICD-10-D-M4804, ICD-10-D-M5124, ICD-10-D-M5125, ICD-10-D-M5104, ICD-10-D-M5105, ICD-10-D-M961, ICD-10-D-M5134, ICD-10-D-M5135, ICD-10-D-M4300, ICD-10-D-M4310
Osteomyelitis	ICD-9-D-73005, ICD-9-D-73008, ICD-9-D-73015, ICD-9-D-73018, ICD-9-D-73025, ICD-9-D-73028, ICD-9-D-73095, ICD-9-D-73098 ICD-10-D-M86159, ICD-10-D-M86259, ICD-10-D-M8618, ICD-10-D-M8628, ICD-10-D-M86659, ICD-10-D-M8668, ICD-10-D-M869, ICD-10-D-M4620, ICD-10-D- M4630, ICD-10-D-R159, ICD-10-D-B0601
Gastrointestinal	ICD-9-D-56983, ICD-9-D-56981, ICD-9-D-5601, ICD-9-D-00845 ICD-10-D-K631, ICD-10-D-K632, ICD-10-D-B0601, ICD-10-D-A047
Reoperation	CPT-22633, CPT-22614, CPT-63046, CPT-63087, CPT-63101, CPT-22212, CPT-22532, CPT-22610, CPT-22800, CPT-22802, CPT-22804, CPT-63085

ICD-9, International Classification of Diseases−9th edition; ICD-10, International Classification of Diseases−10th edition; CPT, Current procedural terminology.
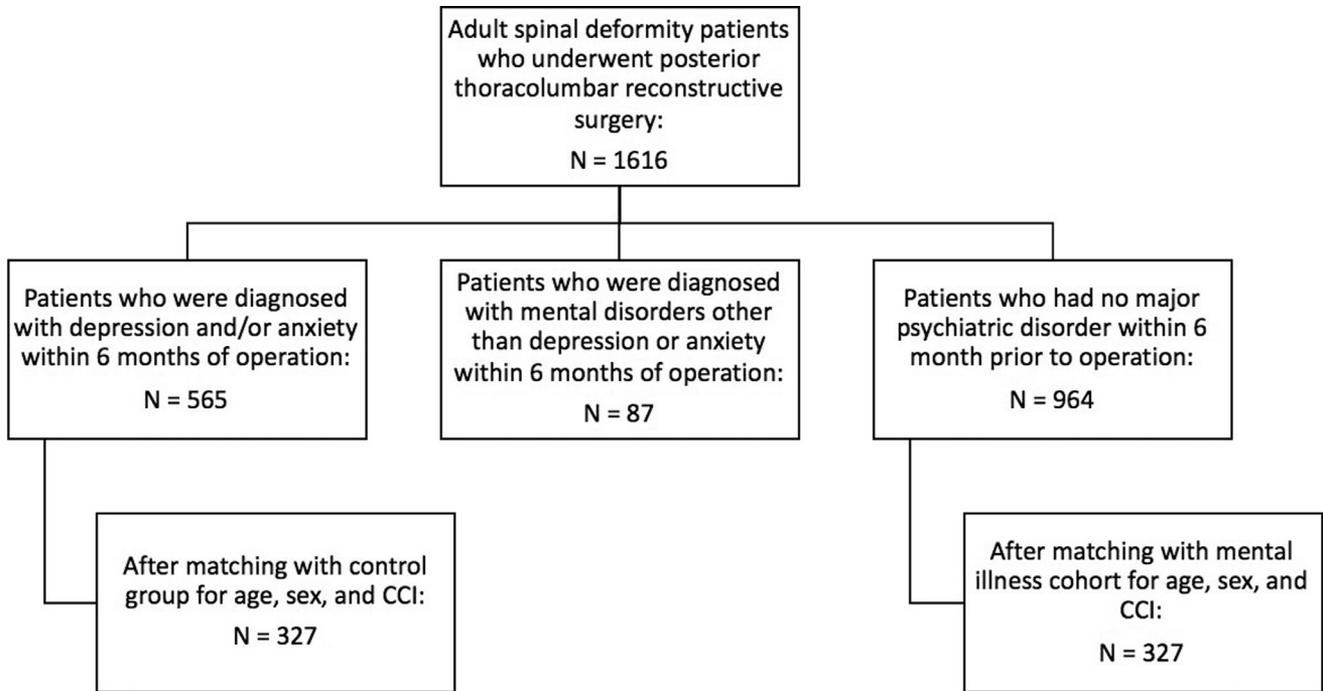
Fig. 1. Study Groups. Both cohort populations were 327 after matching. Charlson Comorbidity Index (CCI).

matched to a control group of adult spinal deformity patients with respect to age, sex, and Charlson comorbidity index (CCI) (Fig. 1). CCI has previously been found to be useful and predictive of postoperative complications following spine surgery [16,17]. CCI is a measure of an individual's aggregate chronic disease burden [17]. Matching by this score helps eliminate confounding comorbidities such as smoking and diabetes that may influence complication and reoperation rates.

The mental illness and control cohorts were queried for postoperative complications. In order to comply with the Health Insurance Portability and Accountability Act, the PearlDiver database cannot disclose queries that yield fewer than 11 patients. In order to obtain usable data, complications were merged into several groups, including neurologic, infectious, thrombotic, respiratory, and gastrointestinal. The complication type "infection" only included surgical site infections and sepsis. Infection and hematoma were queried out to 30 and 90 days postoperatively. Other complication groups were queried out to 90 days and/or 12 months postoperatively, depending on a complication type. Reoperation rates were analyzed at 12 months postoperatively. The ICD-9, ICD-10, and CPT codes for each complication are listed in Table 2.

Statistical analysis of the cohort demographics and odds ratios (OR) of postoperative complications and reoperation was performed using Pearson chi-square analysis. Odds ratios with 95% confidence intervals were calculated for each complication and reoperation rate between the mental illness and nonmental illness cohorts using SPSS Version 23.0 (IBM, NY, USA). p Values less than .05 were considered significant.

Results

Demographics

General trends for incidence of the included thoracic and thoracolumbar surgeries are shown in Fig. 2. Multilevel posterolateral fusion was the most common posterior thoracolumbar surgery in this study with a significant increase in incidence over years. Demographics for both cohorts are provided in Table 3. There were 327 patients in each cohort. 73.7% of patients with an adult spinal deformity who underwent a reconstructive posterior thoracolumbar spinal procedure were female. The average CCI for both cohorts was 1.89 ± 2.13.

Table 3
Demographic profile. Mental illness and control cohorts were matched for age and sex. Charlson comorbidity index (CCI) for both cohorts were 1.89 ± 2.13

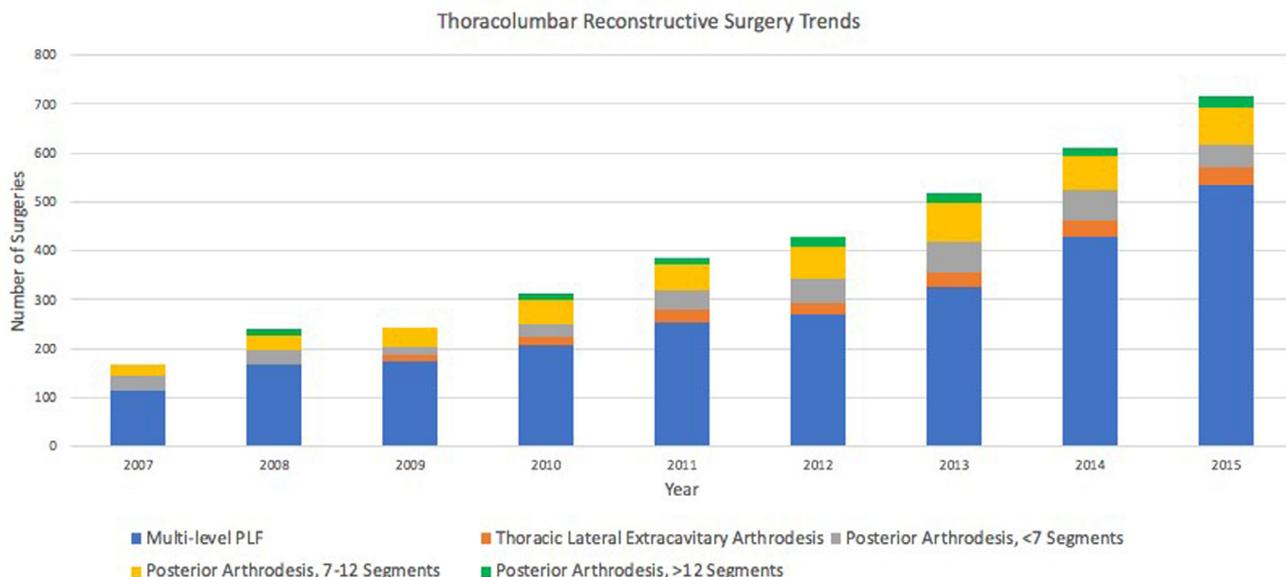|	Adult spinal deformity	
	n	Percentage of total
Total number	327	−
Males	86	26.3
Females	241	73.7
Age (years)		
45−49	13	4.0
50−54	16	4.9
55−59	28	8.6
60−64	46	14.1
65−69	91	27.8
70−74	72	22.0
75−79	30	9.2

Fig. 2. General Trends for posterior thoracolumbar reconstructive spinal surgeries from 2007 to 2015. Posterolateral fusion (PLF).

Psychiatric disorders

In this study, there were 565 patients who were diagnosed with depression and/or anxiety within 6 months before their operation (Fig. 1). Among the 565 patients, there were 248 exclusive diagnoses of depression and 141 exclusive diagnoses of anxiety, with 176 patients having both diagnoses. After exact matching for age, sex, and CCI score, 327 patients remained. Other psychiatric disorders such as dementia (n = 11), schizophrenia (n < 11), and bipolar disorder (n = 46) were not

included in the complications analysis due to significantly lower incidences (Fig. 1).

Postoperative complications

30- and 90-day postoperative complication rates for both cohorts are shown in Table 4. No significant differences were found between rates of infection or hematoma at 30 days. At 90 days, adult spinal deformity patients with depression and/or anxiety were more likely to experience respiratory complications (OR = 1.532, p = .005) and infection

Table 4
30-day and 90-day complications

Complication Type	Mental illness		Matched controls		Statistical comparison		
	n (T = 327)	%	n (T = 327)	%	OR	95% CI	p
30-day complications							
Infection	39	11.93	27	8.26	1.505	0.898−2.522	0.153
Hematoma	17	5.20	19	5.81	0.864	0.453−1.743	0.864
90-day complications							
CNS	14	4.28	27	8.26	0.497	0.256−0.966	0.052
Respiratory	124	37.92	95	29.05	1.492	1.076−2.069	0.02*
Thromboembolic	32	9.79	31	9.48	1.036	0.616−1.741	1
UTI	57	17.43	55	16.82	1.044	0.695−1.568	0.917
Pseudoarthrosis	29	8.87	32	9.79	0.897	0.529−1.521	0.788
Novel thoracolumbar spine pathology	51	15.60	50	15.29	1.024	0.67−1.565	1
Gastrointestinal	30	9.17	29	8.87	1.038	0.608−1.772	1
Hematoma	17	5.20	19	5.81	0.864	0.453−1.743	0.864
Infection	55	16.82	34	10.40	1.743	1.102−2.756	0.022*
Incision and drainage	19	5.81	14	4.28	1.379	0.679−2.8	0.475
Pneumonia	30	9.17	25	7.65	1.22	0.701−2.124	0.573
Urinary retention	20	6.12	20	6.12	1	0.527−1.896	1
Total	293	89.60	289	88.38	1.133	0.694−1.85	0.708

CNS, central nervous system, UTI, urinary tract infection.
* Statistically significant difference (p value of less than .05) by using Pearson chi-square analysis.

Table 5
1-year complications

Complication type	Mental illness		Matched controls		Statistical comparison		
	n (T = 327)	%	n (T = 327)	%	OR	95% CI	p
CNS	26	7.95	35	10.70	0.721	0.423−1.227	0.282
Pseudoarthrosis	36	11.01	35	10.70	1.032	0.631−1.689	1
Novel thoracolumbar spine pathology	64	19.57	60	18.35	1.083	0.732−1.601	0.765
Reoperation	36	11.01	28	8.56	1.321	0.786−2.221	0.357

CNS, central nervous system.

(OR = 1.525, p = .04) than those without mental illness. At 90 days, the rates of incision and drainage (OR = 1.379, p =.475) and pneumonia (OR = 1.22, p = .573) were increased in the mental illness cohort, but not significantly. No other significant differences were found at the 30- and 90-day intervals. No significant differences were found between complication or reoperation rates at 1-year (Table 5).

Discussion

The present study found that adult spinal deformity patients with depression and/or anxiety had significantly increased risk of respiratory complication and infections at 90 days when compared with a matched control cohort. Although there was not a statistically significant difference in reoperation rates for irrigation and debridement in the mental illness cohort, there was a trend for increased rates of debridement. With rising health care costs, analyzing complication rates is a necessary endeavor to provide safer, more consistent, and cost-effective surgical outcomes. Surgeries to correct spinal deformity are becoming increasingly popular due to increase in the geriatric population, iatrogenic deformities, and body of research showing the benefits of sagittal balance for HRQoL [18]. There have been few studies that analyze surgical outcomes in adult spinal deformity patients with depression and/or anxiety following reconstructive surgery, and to our knowledge, none have focused on the thoracolumbar region of the spine.

In this study, there were no significant differences in total complication rates between patients who were diagnosed with depression and/or anxiety to matched controls. However, the complication rates were significantly higher than other studies have reported. Our total complication rates for both populations, in which we included patients who obtained any queried complication, averaged to 89% at 90 days. Previous studies have estimated an overall complication rate of 37% to 86% for reconstructive surgery of adult spinal deformity [19−21,22]. We hypothesize that our high total complication rates may be due to the extensive number of complications, both major and minor, that were included in our study query. In addition, operations on the thoracic spine may have increased complication rates due to their proximity to the pleural space [23,24]. Of note, we excluded adult spinal deformity patients who did not have an exact match in the opposing cohort with respect to

age, gender, and CCI. Thus, the true complication rates in this population may differ. In addition, many medical complications may occur coincidentally rather than as a direct result of the spinal deformity procedure, owing to prolonged follow-up periods in elderly patients with multiple comorbidities [20].

Most complication rates in this study corresponded to those in the current literature. Our infectious, renal, neurological, and gastrointestinal complication rates were within the ranges reported in a systematic review by Drazin et al., analyzed complication rates following adult spinal deformity surgery in elderly patients [25]. However, our mean respiratory complication rate of 33.48% at 90 days was significantly greater than the range of 0.1%−11% reported by Drazin et al. [25]. Our increased rate may be due to our exclusive focus on surgeries of the thoracolumbar spine, which may be most closely associated with respiratory complications. Resnick and Benzel found a similar rate of 36.36% for pulmonary complications in patients undergoing lateral extracavitary approaches for trauma to the thoracic spine [26]. A study by Jules-Elysee et al. found a respiratory complication rate of 64% in patients who underwent anterior-posterior thoracic lumbar fusions [27]. Their significantly increased respiratory complication rate may be attributed to the inclusion of thoracic spine surgeries that utilized an anterior approach, which often requires invasion of the thoracic cavity.

In our study, the mental illness cohort had several differences in complication rates when compared with its matched control. At 90 days, there was an increased risk of developing surgical site infection and sepsis in the mental illness cohort. Increased postoperative infection rates in patients with depression have also been reported following surgeries such as coronary artery bypass, total knee arthroplasty, and craniotomies [8,28−30]. We hypothesize that this relative increase may be attributed to poor nutritional status and poor compliance to proper wound care. In addition, a review by Ghoneim et al. suggests a genetic association between depression and poor immunity, which may contribute to the increased risk of postoperative infection [8]. Furthermore, the link between psychotropic medications and complication rates is unclear. One study found that anxiolytic medications are an independent risk factor for major postoperative morbidity and mortality 30 days after surgery, but excluded orthopedic procedures from its

analysis [31]. Another study found that preoperative use of antidepressants had no association with postoperative length of stay in patients who underwent elective noncardiac surgery [32]. Medication adherence to antibiotics may also play a role, as patients with depression and/or anxiety are known to have poorer medication compliance [33].

The relative increase in postoperative respiratory complication rates in adult spinal deformity patients with depression and/or anxiety has not been previously reported. Previous studies have found no clear risk factors for the development pulmonary complications following thoracic spinal surgery [24,27]. We hypothesize that the increase in respiratory complications may be attributed to poor postoperative compliance in using an incentive spirometer and following other prophylactic measures. A study by Hassan-zadeh et al. found that only 10% of patients undergoing elective spinal surgery met the recommended usage level of an incentive spirometer, and that compliance was significantly lower in patients undergoing spinal surgery compared with total hip or knee arthroplasty [34]. They hypothesized that postoperative fatigue and pain diminished patients' motivation to follow proper incentive spirometer protocol [34]. Numerous studies have shown an association between preoperative depression and/or anxiety and increased postoperative symptom severity following cervical and lumbar spinal surgery [7,10,12,35,36]. Therefore, the mental illness cohort may experience increased symptom severity postoperatively, which results in decreased incentive spirometer compliance and increased respiratory complication rates. Differences in smoking rates may also contribute to the significant differences in respiratory and infectious complications. Although we were not able to ascertain smoking rates within each cohort, matching by CCI score mitigates this potentially confounding factor. The CCI accounts for past history of asthma, chronic lung disease, chronic bronchitis, and emphysema, which are all potential sequelae of chronic smoking [17]. Furthermore, a previous study has shown that CCI scores are independently associated with smoking status in patients with late-stage nonsmall cell lung cancer [37].

There are several advantages to this study. By querying a large database, we were able to obtain a uniform cohort and match each patient to a control according to age, sex, and CCI. This allowed for high statistical power that mitigated confounding factors that significantly limit smaller studies. Unfortunately, retrospective database studies have their inherent limitations as well. In using ICD-9, ICD-10, and CPT codes, we cannot account for miscoding of procedures and diagnoses, which may result in incidences and complication rates that differ from the true values. However, the intent of this study was to elucidate differences between adult spinal deformity patients with depression and/or anxiety and their respective controls, which should prevent any substantial bias when determining OR. Data were collected through billing codes so medical records are not available, which imposes several limitations. Although analyzing data

from the Humana database offers longitudinal insight into a heterogeneous population of over 20 million patients across the United States, we cannot guarantee this population is representative of patients who are uninsured or insured by another company. By only including patients with depression and/or anxiety within 6 months preoperatively, we were able to generate a large enough matched sample size to elucidate differences in complication rates. However, this criterion does not eliminate potentially confounding factors such as severity of preoperative pain, which has been shown to significantly correlate with preoperative depression [38]. However, one of the major indications for adult spinal deformity surgery is significant pain not reduced by conservative treatment. In addition, our study reduces the confounding effect of preoperative pain by matching all patients by CCI score, which significantly correlates with severity of preoperative back pain [38]. Another limitation is the lack of access to medical records, preventing analysis of severity of the deformity which may be correlated with preoperative depression. However, the fact that all included patients underwent a highly invasive surgery suggests a minimum threshold of deformity, which should at least partially negate this confounding factor. Furthermore, after matching patients based on age, sex, and CCI score, our final sample population had significantly more females (73.7%) than males, so our findings may not be generalizable to the male population. Despite these limitations, this is the first study to show that patients with preexisting depression and/or anxiety are more prone to developing postoperative infectious and respiratory complications following posterior thoracolumbar spine surgery.

Data from this study indicates that more research is needed to further elucidate the relationship between mental health disorders and complications following reconstructive surgery for adult spinal deformity. These results also indicate that increased preoperative screening and treatment for depression and anxiety might significantly reduce postoperative complications, and should be considered when deciding whether to proceed with surgery or pursue conservative treatment.

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