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Original Article

The impact of stratified hypoalbuminemia and dialysis on morbidity/mortality after posterior spinal fusion surgery: An ACS-NSQIP study

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ABSTRACT

Background: Preoperative optimization in patients undergoing posterior spinal fusion is essential to limit the number and severity of postoperative complications. Here, we, additionally, evaluated the impact of hypoalbuminemia on morbidity and mortality after posterior spinal fusion surgery.

Methods: This retrospective analysis was performed using data from a prospective multicentric database (ACS-NSQIP:2015–2020) regarding patients undergoing posterior spinal fusions. Factors studied included; baseline demographics and 30-day postoperative complications (i.e., reoperations, readmissions, and mortality rates).

Results: There were 6805 patients who met the inclusion criteria. They averaged 62 years of age and had an average BMI of 30.2. Within the 30-day postoperative period, 634 (9.3%) sustained complications; 467 (6.9%) were readmitted, 263 (3.9%) required reoperations, and 37 (0.5%) expired. Although multiple preoperative risk factors were analyzed, hypoalbuminemia, severe hypoalbuminemia, and dialysis were the strongest independent risk factors associated with complications (i.e., reoperations, readmissions, and mortality).

Conclusion: Hypoalbuminemia, severe hypoalbuminemia, and dialysis were significant predictors for morbidity and mortality after posterior spinal fusion surgery.

Keywords: Adverse events, Complications, Dialysis, Hypoalbuminemia, Fusion surgery, Mortality, Readmission, Severe hypoalbuminemia

INTRODUCTION

Multiple preoperative risk factors have already been identified as contributing to postoperative complications following posterior spinal fusions.[1,3,4] These have typically included; older age, elevated BMI, and multiple medical comorbidities. Here, however, we, additionally, analyzed the negative impact of hypoalbuminemia/severe hypoalbuminemia on the 30-day postoperative reoperation, readmission, and mortality rates following posterior spinal fusions.

MATERIALS AND METHODS

Study design and criteria

This was a descriptive retrospective study performed using the American College of Surgeons' National Surgical Quality Improvement Program (ACS-NSQIP) database for patients undergoing posterior spinal fusions for degenerative disease/deformity between 2015 and 2020. Patients were selected based on primary Current Procedural Terminology codes, then further filtered based on International Classification of Diseases 9 and 10 codes [Table 1]. Exclusion criteria included simultaneous anterior spinal fusions or insufficient perioperative/postoperative data.

Baseline characteristics

Between 2015 and 2020, 6805 of 16,219 patients from the NSQIP database undergoing posterior spinal fusion met our inclusion criteria. The 3455 males and 3350 females averaged 62 years of age [Table 2]. Multiple clinical and preoperative comorbidities were identified, including dialysis status. Patients were classified based on preoperative albumin levels into three groups; normoalbuminemia, ≥3.5 g/dL; mild hypoalbuminemia, <3.5 and >2.5 g/dL; and severe hypoalbuminemia ≤2.5 g/dL. The most common spinal fusion location was the lumbar followed by the cervical spine. The overall complication rate, unplanned readmission rate, reoperation rate, and mortality rates occurring within 30 days postoperatively were all recorded [Table 3].

Statistical analysis

Outcomes were analyzed utilizing univariate analysis based on demographics, preoperative comorbidities, and other surgical variables. Comparisons were performed using Chi-square tests, Fisher's exact tests, or Student *t*-tests.

Table 1: ICD 9th and 10th codes and CPT codes.

Codes	Definition
Included	
CPT: 22590, 22595, 22600	Posterior spinal fusion—Cervical region
CPT: 22610	Posterior spinal fusion—Thoracic region
CPT: 22612, 22630	Posterior spinal fusion—Lumbar region
ICD-9: 81.0*, 81.3*, 81.62-64, 721.0-4, 9*, 722.0-7, 9*, 723.0-4, 6, 8-9*, 724*	Fusion of spine, spondylosis, cervical disc disorders, thoracic, thoracolumbar, and lumbosacral intervertebral disc disorders, Other and unspecified dorsopathies, not elsewhere classified, Dorsalgia.
ICD-10 codes M43.2*, M47*, M50-54	
Excluded	
CPT: 22551, 22554, 22556, 22558, 22548	Anterior fusion, lateral fusion

ICD: International Classification of Diseases, CPT: current procedural terminology

RESULTS

Overall complications, wound-related complications, and mortality

Notably, 634 patients (9.3%) suffered at least one postoperative complication [Table 2]. The three most common complications included; wound-related complications in 167 patients (2.3%; superficial wound infections comprising 1.3% of these), urinary tract infections (1.7%), and pneumonia (1.3%). Univariate analysis showed significant differences in complication rates among patients in the mild hypoalbuminemia and severe hypoalbuminemia groups versus those with normoalbuminemia [Table 3]. Multivariate analysis demonstrated that mild and severe hypoalbuminemia were also significantly associated with overall complications, but not with significant wound complications [Table 4]. The mortality rate was 0.5% (i.e., 37 patients) within 30 days postoperatively and was significantly associated with mild hypoalbuminemia (OR = 3.4), severe hypoalbuminemia (OR = 8.9), and dialysis (OR = 4.5) [Table 4].

Reoperation and readmission

There were 467 patients (6.9%) who had unplanned readmissions within the 30-postoperative days, with 263 (3.9%) requiring reoperations. Dialysis was the main risk factor for both readmissions (OR = 5.4, $P = 0.00$) and reoperations (OR = 3, $P = 0.025$) while hypoalbuminemia was not (i.e., based upon multivariate analysis) [Table 5].

DISCUSSION

Albumin's role in healing process

In our study, mild hypoalbuminemia and severe hypoalbuminemia were significantly associated with higher rates of overall complications and mortality compared with normoalbuminemic patients undergoing posterior spinal fusions. These findings are consistent with existing literature.[5,10] However, we did not find an association between hypoalbuminemia and wound-related complications on multivariate analysis. Gelfand *et al.*[4] analyzed the impact of hypoalbuminemia and severe hypoalbuminemia in 700 patients undergoing surgery for metastatic spine disease; they found a direct correlation between lower albumin levels and 30-day mortality rates.

Other studies have demonstrated albumin's role in the healing process and associated hypoalbuminemia with wound-related complications.[6,8] He *et al.* showed a significant

Table 2: Baseline general and per group parameters.

Variable	Total	Group 1	Group 2	Group 3	*P*
Number of cases	6805	6028 (88.6%)	701 (10.4%)	76 (1.1%)	-
Age	62 (53–70)	62 (52–70)	65 (57–72)	67.5 (59.25–74)	-
BMI	30.24 (26.36–34.67)	30.23 (26.43–34.54)	30.8 (26–36.2)	27.22 (23.63–31)	-
Obese	3498 (51.4%)	3099 (51.4%)	375 (53.5%)	24 (31.6%)	0.001
Female	3350 (49.2%)	2930 (48.6%)	391 (55.8%)	29 (38.2%)	<0.001
Male	3455 (50.8%)	3098 (51.4%)	310 (44.2%)	47 (61.8%)	<0.001
ASA ≥3	4048 (59.5%)	3415 (56.7%)	565 (80.6%)	68 (89.5%)	<0.001
Cervical	1708 (25.1%)	1416 (23.5%)	251 (35.8%)	41 (53.9%)	<0.001
Thoracic	339 (5%)	293 (4.9%)	40 (5.7%)	6 (7.9%)	0.313
Lumbar	4758 (69.9%)	4319 (71.6%)	410 (58.5%)	29 (38.2%)	<0.001
Operative Time	177 (127–242)	179 (128–244)	170 (128–231)	159.5 (134.25–216)	-
Length of Stay	4 (2–6)	3 (2–6)	6 (3–11)	8 (6–19)	-
Dependent status	257 (3.8%)	176 (2.9%)	62 (8.8%)	19 (25%)	<0.001
Dyspnea	420 (6.2%)	357 (5.9%)	60 (8.6%)	3 (3.9%)	0.018
Smoke	1438 (21.1%)	1238 (20.5%)	182 (26%)	18 (23.7%)	0.001
COPD	392 (5.8%)	314 (5.2%)	74 (10.6%)	4 (5.3%)	<0.001
CHF	39 (0.6%)	25 (0.4%)	9 (1.3%)	5 (6.6%)	<0.001
Renal Failure	13 (0.2%)	5 (0.1%)	7 (1%)	1 (1.3%)	<0.001
Dialysis	48 (0.7%)	18 (0.3%)	26 (3.7%)	4 (5.3%)	<0.001
Disseminated cancer	26 (0.4%)	16 (0.3%)	8 (1.1%)	2 (2.6%)	<0.001
Steroid use	356 (5.2%)	298 (4.9%)	54 (7.7%)	4 (5.3%)	0.008
Transfusion	16 (0.2%)	7 (0.1%)	5 (0.7%)	4 (5.3%)	<0.001
Diabetes	1564 (23%)	1325 (22%)	214 (30.5%)	25 (32.9%)	<0.001

Group 1: Normoalbuminemia, Group 1: hypoalbuminemia (2.6–3.4 g/dl), Group 3: severe hypoalbuminemia (<2.6 g/dl)

Table 3: Univariate analysis of complications, reoperation, and readmission.

Outcomes	Total	Group 1	Group 2	Group 3	*P*
Overall Complications	634 (9.3%)	534 (8.9%)	83 (11.8%)	17 (22.4%)	<0.001
Wound-related complications	167 (2.5%)	140 (2.3%)	22 (3.1%)	5 (6.6%)	0.027
30-day reoperation	264 (3.9%)	222 (3.7%)	36 (5.1%)	6 (7.9%)	0.032
30-day readmission	467 (6.9%)	385 (6.4%)	71 (10.1%)	11 (14.5%)	<0.001
30-day mortality	37 (0.5%)	19 (0.3%)	13 (1.9%)	5 (6.6%)	<0.001

Group 1: Normoalbuminemia, Group 2: hypoalbuminemia, Group 3: severe hypoalbuminemia

Table 4: Multivariate analysis of overall complications and mortality.

Variable	OR	95% CI lower	95% CI upper	*P*
Overall complications				
Age	1.021	1.02	1.03	0.001
Male sex	0.809	0.67	0.96	0.017
Dialysis	4.259	2.04	8.86	0.001
Severe hypoalbuminemia	2.822	1.56	5.01	0.001
Operative time (min)	1.007	1	1.01	0.001
Thoracic	1.895	1.39	2.57	0.001
Mortality				
Age	1.041	1.01	1.08	0.022
Dialysis	4.505	1.19	16.92	0.026
Mild Hypoalbuminemia	3.486	1.58	7.67	0.002
Severe hypoalbuminemia	8.933	2.75	28.96	0.001

Table 5: Multivariate analysis for reoperation and unplanned readmission.

Variable	OR	95% IC lower	95% CI upper	*P*
Reoperation				
Dyspnea	1.696	1.09	2.63	0.019
Functional status	1.788	1.09	2.92	0.021
Dialysis	3.007	1.15	7.86	0.025
ASA III-IV	1.373	1.02	1.84	0.036
Operative time	1.02	1.01	1.03	0.001
Thoracic	1.572	1.02	2.46	0.049
Unplanned readmission				
Age	1.01	1.002	1.0019	0.02
Diabetes	1.322	1.06	1.64	0.012
Dyspnea	1.416	1.007	1.99	0.045
Dialysis	5.428	2.67	11.01	0.001
Operative time	1.002	1.001	1.003	0.001

correlation between lower albumin levels and delayed wound healing in 554 patients undergoing single-level posterior lumbar fusion surgery.[6] Others found low albumin levels contributed to higher risks of major complications in spine surgery.[9]

No association between hypoalbuminemia and reoperations/unplanned readmission

Interestingly, we found no significant association between hypoalbuminemia and reoperations or unplanned readmissions. Alternatively, Phan *et al.*,[9] in an ACS-NSIQP study of 2410 patients undergoing elective posterior lumbar fusions, found significantly higher unplanned readmission rates, hospital length of stay, and perioperative complications for those with low albumin levels, while others viewed similar findings with cervical surgery.[8]

Impact of dialysis

In our study, dialysis was an independent risk factor significantly contributing to complication, readmission, reoperation, and mortality, rates. These findings have been reported in other studies.[2,8]

Risk factors increasing mortality rates for spinal fusions

We found other independent risk factors such as operative time, ASA III-IV, thoracic location, and diabetes that increased mortality rates for spinal fusions. However, these factors demonstrated a weaker significant association when compared to hypoalbuminemia and dialysis. These finding were also previously reported in the literature.[7]

CONCLUSION

Mild hypoalbuminemia, severe hypoalbuminemia, and dialysis significantly increase morbidity and mortality rates for patients undergoing posterior spinal fusions. These results support the fact that albumin levels should be optimized in the preoperative setting to improve outcomes.

Declaration of patient consent

Patients' consent not required as patients' identities were not disclosed or compromised.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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