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.

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.[10] 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 1: ICD 9th and 10th codes and CPT codes.

| Codes | Definition |
|-------|------------|
| Included | Posterior spinal fusion—Cervical region |
| CPT: 22590, 22595, 22600 | |
| CPT: 22610 | Posterior spinal fusion—Thoracic region |
| CPT: 22612, 22630 | Posterior spinal fusion—Lumbar region |
| ICD-9: 81.0*, 81.3*, 81.6-64, 721.0-4, 9*, 722.0-7, 9*, 723.0-4, 6, 8-9*, 724* | Fusion of spine, spondylolysis, 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 | Anterior fusion, lateral fusion |
| CPT: 22551, 22554, 22556, 22558, 22548 | |

ICD: International Classification of Diseases, CPT: current procedural terminology
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|
| 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 (3.2%)      | 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 2: 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 |
correlation between lower albumin levels and delayed wound healing in 554 patients undergoing single-level posterior lumbar fusion surgery. 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-NSQIP 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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**Conflicts of interest**

There are no conflicts of interest.

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