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ORIGINAL ARTICLE - SPINE

Medical complications and mortality in octogenarians undergoing elective spinal fusion surgeries

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Abstract

Background The consequences of suffering postoperative complications in elderly undergoing spinal surgeries may be different compared to younger patients. The primary objective of this study was to identify the types and frequency of medical complications and mortality rates in patients 80 years of age or older undergoing elective spinal fusion surgeries for degenerative spinal disease.

Methods A prospective observational study with a retrospective chart review was performed, which included all consecutive patients ≥80 years old undergoing elective spinal fusion surgeries from May 2012 to August 2015. We identified a total of 95 patients, of which 39 cervical and 56 lumbar surgeries were performed. There were 41 female and 54 male patients with the mean age of 82.8 years (range, 80–91). The perioperative complications were allocated into the following categories: infection, pulmonary, cardiac, gastrointestinal, hematologic, urologic, neurovascular, thromboembolic, and other. Baseline and postoperative clinical outcome scores were compared to evaluate efficacy.

Results The mean follow-up time was 14.8 months (range, 5 days to 37 months) with an overall mortality rate of 8.4%. The 30-day, 90-day, and 1-year mortality rates were 2.1, 2.1, and 4.2%, respectively. There were 53.9 and 71.4% patients with complications in the cervical and lumbar patient groups, respectively. The presence of general comorbidities and the number of intervertebral levels predicted the occurrence of perioperative complications. Also, longer OR times were associated with a higher number of complications per patient and the occurrence of a UTI. Dysphagia was a significant predictor in developing pneumonia and atelectasis.

Conclusions The incidence of perioperative medical complications and mortality rates in octogenarians undergoing elective spinal surgeries are quite high. The benefits of having surgery must be weighed against the risks of not only surgical but also adverse medical events. An informed decision-making process should include discussion of potential postoperative morbidity specific to this patient population in order to guide patient's acceptance of higher risks and expectations postoperatively. It is also important to identify potential complications and adapt preventive measures in order to help minimize them in this patient population.

Keywords Complications · Elective spine surgery · Mortality · Octogenarians

Abbreviations

ALIF	Anterior lumbar interbody fusion
ASA	American Society of Anesthesiologists
EBL	Estimated blood loss
MCS	Mental component summary
ODI	Oswestry Disability Index
OR	Operating room
PCS	Physical component summary
SF-36	Short-Form Health Survey
UTI	Urinary track infection
VAS	Visual analog scale

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Background

Age plays an important role in patient selection for spinal surgeries and was reported to be associated with increased morbidity and mortality in the elderly patient population [25, 39, 37, 46]. Furthermore, consequences of suffering postoperative complications in elderly patients undergoing spinal surgeries may be different compared to younger patients. Among the particular challenges that often predispose elderly patients to increased risks of perioperative complications are significant comorbidities, polypharmacy, mental and physical impairment, and reduced physiologic reserve of vital organs [16, 23, 29, 30, 33, 39]. What is generally considered a minor complication in younger adult patients and may produce only transient adverse effects (e.g., pneumonia, UTI), may have much more severe consequences in the elderly patients [26]. It may result in a significantly prolonged hospitalization, increased cost of care, decline in physical and mental status, or even death [32].

The primary objective of this study was to identify perioperative medical complications and mortality rates in patients 80 years of age or older undergoing elective spinal fusion surgeries for degenerative spinal disease.

Methods

A prospective observational study with a retrospective chart review was performed, which included all consecutive patients ≥80-years-old undergoing elective spinal fusion surgeries from May 2012 to August 2015. Patients who required surgery due to trauma, infection, or tumor were not included in this analysis. We identified 95 patients who met these criteria.

Decompression with posterolateral fusion was usually performed to treat lumbar spinal stenosis for the patients in the lumbar group, but a majority of patients also required transforaminal lumbar interbody fusion (TLIF), because they either had degenerative instability, scoliosis, low back pain, adjacent segment disease and were undergoing revision surgery, or extensive facet resection was performed.

ACDF was performed for patients with anterior pathology who required a decompression with stabilization. Posterior cervical fusion was added to correct anatomical deformity or for the patients with poor bone quality. Any posterior cervical surgery, in which is foraminotomy alone would not adequately address the pathology, consisted of a posterior decompression with stabilization and/or fusion surgery.

Medical complications that developed during surgery or in the immediate postoperative period (0 to 90 days) were reported. All complications were stratified into the following categories: infection, pulmonary, cardiac, gastrointestinal, hematologic, urologic, neurovascular, thromboembolic, and other. Mortality rates were reported as overall, 30-day, 90-day, and 1-year.

The comorbidities were allocated into four categories: general (e.g., obesity, diabetes, cancer, or liver or renal disease), addiction and mental health (e.g., depression, drug or alcohol abuse), cardiac (e.g., congestive heart failure, myocardial infarction, or arrhythmias), and circulatory and vascular comorbidities (e.g., cerebrovascular or coronary artery disease).

Although this was not the primary objective of the study, baseline and postoperative clinical scores were compared. The standardized clinical outcome questionnaires included the 36-Item Short Form Health Survey (SF-36) to evaluate health-related quality of life and functional outcomes. Two scores within the scoring algorithm were analyzed: the physical component summary (PCS) and the mental component summary (MCS). The Oswestry Disability Index (ODI) was used to evaluate chronic disability and activities of daily living. The severities of low-back and leg pain were measured with visual analog scales (VASs). Patient satisfaction with results surveys were also completed and answers scored on a scale from 0 to 100: 100 = very satisfied/much better/definitely yes; 75 = somewhat satisfied/better/probably yes; 50 = do not know/same/do not know; 25 = somewhat dissatisfied/worse/probably no; 0 = dissatisfied/much worse/definitely no. A total score was calculated for each patient by averaging the scores from all three responses.

Statistical analysis

The correlation coefficient (R) was calculated to describe relationships between the occurrence or the number of the perioperative complications per patient and independent variables including age, sex, cervical or lumbar surgery, surgeon, BMI, previous fusion or non-fusion surgeries, comorbidities, American Society of Anesthesiologists (ASA) scores, intervertebral and posterolateral fusion levels, operating room (OR) time, and estimated blood loss (EBL). The relationship between two variables was expressed as +1 and −1, where 1 is total positive correlation, 0 is no correlation and −1 implies total negative correlation. The final multivariate logistic regression model was used to test associations between the occurrence of complications and included the variables with correlation coefficient $R \geq 0.2$.

Results

Demographic, clinical, and surgical parameters

The mean age was 82.8 years (range, 80–91) with 41 female and 54 male patients. The baseline demographic, clinical

Table 1 Selected demographic, clinical, comorbidities, and surgical parameters

	Cervical	Lumbar	Total
Demographics			
N	39	56	95
Age	82.5 (80–88)	83.0 (80–91)	82.9 (80–91)
F/M ratio	17/22	24/32	41/54
Clinical			
Diagnosis			
Stenosis	27 (69%)	44 (79%)	
Myelopathy	30 (77%)		
HNP	10 (26%)	19 (34%)	
Deformity	3 (8%)		
Spondylolisthesis		27 (48%)	
Deformity		17 (30%)	
FBSS		2 (4%)	
Previous fusion	5 (13%)	13 (23%)	
Previous non-fusion surgeries	4 (10%)	5 (9%)	
Comorbidities			
General	36 (92%)	56 (100%)	92 (97%)
Addiction and mental health	16 (41%)	25 (45%)	41 (43%)
Cardiac	19 (49%)	18 (32%)	37 (39%)
Circulatory and vascular	32 (82%)	36 (64%)	68 (72%)
ASA score	2.8 ± 0.6 (2–4)	2.8 ± 0.5 (2–4)	
Surgical			
Procedure			
ACDF	23 (59%)		
Levels	1.8 (1–4)		
PCF	11 (28%)		
Levels	5.5 (4–7)		
ACDF/PCF	5 (13%)		
Levels	2 (2–2)/5 (4–7)		
Decompression and PL fusion with or w/o instrumentation		12 (21%) 2.6 (2–5)	
Levels			
TLIF		30 (54%)	
Levels		1.8 (1–4)	
TLIF with additional decompression w/instrumentation		8 (14%) 1 (1–2)/3.5 (2–6)	
Levels			
TLIF with additional decompression		3 (5%) 1 (1–3)/3.7 (3–4)	
Levels			
ALIF/XLIF + TLIF		3 (6%) 3 (2–4) +	
Levels		3 (1 patient)	
EBL (ml)	148 (10–750)	247 (25–1000)	
OR time (min)	157 (54–289)	222 (78–480)	
LOS (days)	5.1 (0.5–27)	4.6 (1–13)	
Discharge			
Home	13 (33%)	19 (34%)	
Rehabilitation facility	18 (46%)	20 (36%)	
Nursing facility	8 (21%)	17 (30%)	

Values are presented as means (ranges/percentages/standard deviations) when appropriate. *ACDF* anterior cervical discectomy and fusion, *ALIF* anterior lumbar interbody fusion, *ASA* American Society of Anesthesiologists, *EBL* estimated blood loss, *F* female, *FBSS* failed back surgery syndrome, *HNP* herniated nucleus pulposus, *LOS* length of stay, *M* male, *PCF* posterior cervical fusion, *PL* posterolateral, *OR* operating room, *TLIF* transforaminal lumbar interbody fusion, *XLIF* extreme lateral interbody fusion

parameters, comorbidities, and surgical characteristics of all patients are presented in Table 1. A total of 39 cervical and 56 lumbar surgeries were performed.

The average ASA scores were identical (2.8) in both patient groups due to prevalent general or circulatory and vascular comorbidities. Discharge locations were recorded as home in 33 vs. 34%, rehabilitation facility 46 vs. 36%, and nursing facility in 21 vs. 30% of patients in the cervical and lumbar patient groups, respectively.

Mortality

The mean follow-up was 14.8 months (range, 5 days to 37 months) with an overall mortality rate of 8.4% (8 patients). The 30-day, 90-day, and 1-year mortality rates were 2.1, 2.1, and 4.2%, respectively. There were a total of five and three deaths in the cervical and lumbar patient groups, respectively.

Two patients in the cervical group died within a 30-day period: one patient died on the 5th postoperative day due to pulmonary embolism, another on the 9th day from respiratory failure due to aspiration. Two patients in the cervical group died within a year: one patient developed aspiration pneumonia postoperatively and eventually died at 7 months, the other patient died at 12 months due to unknown causes. The second patient did not have any known postoperative complications. One more patient died of unknown causes at 37 months in this group.

Of the patients in the lumbar group who died within the follow-up period, one patient had an acute cerebrovascular accident on the 2nd postoperative day and died 21 months later; one patient was diagnosed with acute congestive heart failure 4 weeks postoperatively and died 21 months later; one patient developed a postoperative hematoma and died at 17 months. Although some of these later deaths were not directly related to the surgery performed, they may have unfavorably influenced the development of events and contributed to the fatal outcome.

Complications

All perioperative complications are presented in Table 2. A higher percentage of patients undergoing lumbar surgeries encountered complications - 40 patients (71.4%) compared with 21 patients (53.9%) undergoing cervical procedures.

The presence of general comorbidities (p = 0.019; R = 0.24; OR = 0.8, 95% CI, 0.42–0.94) and the number of intervertebral levels (p = 0.008; R = 0.27; OR = 1.3, 95% CI, 0.82–1.89) significantly predicted the occurrence of perioperative complications. In addition, lumbar vs. cervical surgery (p = 0.08; R = 0.18; OR = 2.14, 95% CI, 0.91–5.04) and BMI (p = 0.09; R = 0.2; OR = 1.10, 95% CI, 0.98–1.22) did not quite reach statistical significance and only had weak relationship, however, when included in the final multivariate logistic regression model along with comorbidities and surgical levels, were predictive of the complication occurrence (p = 0.012; χ^2 = 16.25).

The occurrence and number of complications per patient was also related to the length of hospitalization (p < 0.0001; R > 0.4; OR <2.03, 95% CI, 1.42–2.89), which is a dependable variable. Further, patients were less likely to be discharged home if they had complications (p = 0.04; R = −0.2; OR = 0.4, 95% CI 0.17–0.97); instead they were discharged either to a nursing home or a rehabilitation facility.

A longer OR time was also associated with the higher number of perioperative complications per patient (p = 0.037; R = 0.22; OR = 0.32, 95% CI, 0.99–1.01).

One-third of patients undergoing cervical procedures (13 patients) developed dysphagia and two patients died due to aspiration or aspiration pneumonia. Dysphagia was a significant predictor (p < 0.0001; R = 0.60; OR = 0.46, 95% CI 0.22–0.72) in developing pneumonia or atelectasis.

We encountered a high incidence of either urinary retention (10.7%) or urinary tract infections (16.1%) in the lumbar patient group. The occurrence of urinary tract infections was associated with a longer OR time (p = 0.04; R = 0.38; OR = 1.02, 95% CI 1.00–1.03).

The development of anemia was related to the estimated loss of blood (p = 0.0096; R = 0.28, OR =1.004, 95% CI, 1.001 – high 1.007).

Clinical outcomes

There was a highly statistically and clinically significant improvement observed in all clinical outcome measures, except SF-36 MCS scores in the lumbar patient group. There were no statistically significant changes in clinical outcomes noted for the patients in the cervical group (Table 3).

Readmissions and reoperations

Three patients were readmitted to the hospital in the cervical group within the 30-day period for an additional 1 to 3 days. One patient was treated for pneumonia, another was readmitted due to transient ischemic attack, and the third patient was diagnosed with retropharyngeal seroma. In addition, two patients required surgery for complications: one underwent an emergent posterior cervical hematoma evacuation, and another patient had a surgical site infection, requiring surgical drainage and repair of an esophageal perforation caused by hardware failure.

In the lumbar patient group, a total of seven patients were readmitted to the hospital within the 30-day period for the following reasons: urinary tract infection (n = 3), urinary retention, bilateral pulmonary embolism, pneumonia, and sepsis. The readmission diagnoses within the 60-day period (n = 3) were for pulmonary embolism, anemia, and congestive heart failure. In addition, four patients underwent surgery for complications or required reoperation: retroperitoneal abscess evacuation after anterior lumbar interbody fusion (ALIF) surgery, kyphoplasty for compression fracture, incision and drainage for deep subfascial wound infection, and revision for pseudoarthrosis and adjacent level disease. These patients were hospitalized for an average of 3.8 (range, 1–6) days. There were no mortalities among the patients who were readmitted to the hospital or underwent reoperations.

Discussion

A group of patients who were 80 years or older was chosen for this analysis. According to the study which stratified 8,632,979 surgical cases by age categories [17], the percentage of patients undergoing spinal fusion surgeries varies between 2.7% and 3.2% in all age groups but diminishes significantly after the age of 80. The reasons for this reduction are most likely multifactorial and include the risk-benefit assessment, potentially choosing a more palliative route of treatment or the fact that spinal stenosis, which is one of the most often encountered conditions in the elderly patients, progresses a decade earlier. Regardless, during the previous decade (2000–2009) the rates of elective major spine surgeries in octogenarians has increased from 40 to 102 per 100,000 per year [49].

The main purpose of our study was to identify some of the safety concerns by examining medical complications in octogenarians undergoing elective spinal fusion surgeries for cervical and lumbar degenerative spinal disease.

Although perioperative complications in the elderly negatively affect clinical outcomes [32], there is no doubt that surgical treatment is effective in reducing pain, disability and improving the quality of life in octogenarians undergoing

Table 2 Complications

Complications	Cervical, $N = 49$	Lumbar, $N = 83$	Total, $N = 132$
N (mean)	1.3 (0–6)	1.5 (0–9)	1.4 (0–9)
Patients w/complications (%)	21 (53.9%)	40 (71.4%)	61 (64.2%)
Infection	**2 (5.1%)**	**8 (14.3%)**	**10 (10.5%)**
Surgical infection	1 (2.6%)	4 (7.1%)	5 (5.3%)
Bacteremia, sepsis	–	2 (3.6%)	2 (2.1%)
Seroma	1 (2.6%)	1 (1.8%)	2 (2.1%)
Retroperitoneal abscess	–	1 (1.8%)	1 (1.1%)
Pulmonary complications	**13 (33.3%)**	**7 (12.5%)**	**20 (21.1%)**
Airway edema required tracheostomy	1 (2.6%)	–	1 (1.1%)
Pneumonia	5 (12.8%)	3 (5.4%)	8 (8.4%)
Bronchitis	–	1 (1.8%)	1 (1.1%)
Acute respiratory failure	3 (7.7%)	–	3 (3.2%)
Pulmonary edema	2 (5.1%)	1 (1.8%)	3 (3.2%)
Atelectasis	2 (5.1%)	2 (3.6%)	4 (4.2%)
Cardiac complications	**3 (7.7%)**	**6 (10.7%)**	**9 (9.5%)**
Acute myocardial ischemia	1 (2.6%)	–	1 (1.1%)
Atrial fibrillation	1 (2.6%)	2 (3.6%)	3 (3.2%)
Tachycardia	1 (2.6%)	–	1 (1.1%)
Hypotension	–	3 (5.4%)	3 (3.2%)
Congestive heart failure	–	1 (1.8%)	1 (1.1%)
Gastrointestinal complications	**16 (41.0%)**	**5 (8.9%)**	**21 (22.1%)**
Dysphagia	9 (23.1%)	2 (3.6%)	11 (11.6%)
Dysphagia w/PEG	4 (10.3%)	–	4 (4.2%)
Esophageal perforation due to instrumentation failure	1 (2.6%)	–	1 (1.1%)
Ileus	1 (2.6%)	–	1 (1.1%)
Mallory-Weiss tear	1 (2.6%)	–	1 (1.1%)
Rectal prolapse	–	1 (1.8%)	1 (1.1%)
Pseudomembranous colitis	–	2 (3.65)	2 (2.1%)
Hematologic complications	**3 (7.7%)**	**14 (21.5%)**	**17 (17.9%)**
Anemia	2 (5.1%)	10 (17.9%)	12 (12.6%)
Anemia requiring transfusion	1 (2.6%)	4 (7.1%)	5 (5.3%)
Urologic complications	**2 (5.1%)**	**17 (26.2%)**	**19 (20.0%)**
Acute renal insufficiency/failure	2 (5.1%)	2 (3.6%)	4 (4.2%)
Urinary retention	–	6 (10.7%)	6 (6.3%)
UTI	–	9 (16.1%)	9 (9.5%)
Neurovascular complications	**1 (2.6%)**	**3 (5.4%)**	**4 (4.2%)**
Acute cerebrovascular vascular accident (CVA)	–	2 (3.6%)	2 (2.1%)
Transient ischemic attack (TIA)	1 (2.6%)	1 (1.8%)	2 (2.1%)
Thromboembolic complications	**2 (2.6%)**	**5 (8.9%)**	**7 (7.4%)**
Pulmonary embolism	1 (2.6%)	4 (7.1%)	5 (5.3%)
DVT	–	1 (1.8%)	1 (1.1%)
Thrombophlebitis w/cephalic vein clot	1 (2.6%)	–	1 (1.1%)
Miscellaneous complications	**6 (15.4%)**	**19 (29.2%)**	**25 (26.3%)**
Hematoma w/evacuation	1 (2.6%)	1 (1.8%)	2 (2.1%)
Hematoma w/o evacuation	–	1 (1.8%)	1 (1.1%)
Hyponatremia/SIADH	–	3 (5.4%)	3 (3.2%)
Hyponatremia	–	5 (8.9%)	5 (5.3%)
Postoperative cognitive dysfunction/mental status deterioration/ delirium	3 (7.7%)	3 (5.4%)	6 (6.3%)
Postop narcotic overdose/hypoxia	–	2 (3.6%)	2 (2.1%)
Gout attack	–	1 (1.8%)	1 (1.1%)
Durotomy/CSF leak	2 (5.1%)	3 (5.4%)	5 (5.3%)

Values are presented as means (ranges/percentages). *CSF* cerebrospinal fluid, *DVT* deep venous thrombosis, *SIADH* syndrome of inappropriate antidiuretic hormone secretion

spine surgeries [24, 27, 34–36, 40–42]. Our results reiterated these findings by demonstrating significantly improved pain, ODI and even SF-36 PCS scores for the patients undergoing lumbar surgeries. Unfortunately, the same results cannot be demonstrated for the patients in the cervical group where a greater proportion of patients were undergoing surgery for myelopathy.

Although perioperative morbidity is generally higher in elderly patients according to the postoperative complication rates reported in the literature [7, 29, 49], it varies significantly from 6.0 to 28.4% in patients undergoing cervical procedures [5, 14, 34, 46] compared with 4.0–79.6% undergoing lumbar procedures [1, 4, 8, 10, 14, 18, 24, 25, 27, 28, 30, 38, 39, 41–43, 45, 48]. Some studies did not detect any increase in the complication rates in elderly patients. Rihn et al. [40] analyzed the Spine Patient Outcomes Research Trial (SPORT) data and reported the largest prospective cohort to date ($n = 58$) of patients 80 years and older undergoing surgeries for spinal stenosis and spondylolisthesis. The authors concluded that there was no increase in complication rates compared to younger patients. It is important to note that the authors reported only surgical technique-related complications and that the groups differed in the percentage of fusion surgeries (32% compared with 53% in octogenarians and <80-year-olds, respectively). For this reason, the authors acknowledged the difference in fusion surgeries as one of the limitations and noted that "the complication rate in the octogenarian age group would potentially have been higher if a similar proportion had undergone arthrodesis." Although many subsequent publications have referenced this article as "no difference in complication rates", in our opinion, surgical-technique-related complications are not the main concern for this patient population and, indeed, may not differ significantly. Similarly, Bydon et al. [8] reported higher complication rates in patients

older than 65 years of age undergoing instrumented lumbar fusions, but concluded that comorbidities and patients' general preoperative characteristics (e.g., chronic steroid use) were responsible for this increase rather than age as an independent risk factor. Furthermore, the authors reported the lowest complication rate in a cohort of patients older than 85 years of age.

The complication rates in elderly increase with comorbidities [5, 10, 14, 15, 18, 30, 37, 39, 43, 47], gender [14], added fusion and/or instrumentation [1, 4, 10, 11, 18, 20, 21, 39], number of levels [10, 11, 15, 39], increased blood loss and OR time [1, 10, 15, 39, 47, 48], and revision surgeries [12]. According to Boakye et al., comorbidities play a more significant role than age as they found similar complication rates for an 84-year-old patient with no comorbidities and a 40-year-old with two comorbidities undergoing posterior cervical fusion [5]. Unfortunately, the octogenarians without any comorbidities are an exception to the rule, rather than the norm. Our study also found that the presence of general comorbidities, the number of intervertebral levels, lumbar vs. cervical surgery, BMI, and longer OR time were predictive of complication occurrence. In addition, dysphagia was a significant predictor to develop pneumonia or atelectasis and longer OR time significantly predicted urinary tract infections in this patient population.

Most of the existing literature that analyzed complications in octogenarians reported either a small sample size [24, 27, 34, 39, 42, 48], did not report medical complications [40], excluded fusion surgeries or the majority of patients underwent decompression surgeries [1, 42], or predominantly used administrative data to analyze the incidence of complications [7, 14, 18, 29, 30, 38, 43, 49]. Administrative databases give researchers an advantage of a large sample size, but at the same time, underestimate the incidence of complications (e.g., Medicare or PearlDiver database only track complications in a limited number of categories), generally lack quality control, and potentially have reliability and validity issues. A recent paper by Puvanesarajah et al. [38] compared 90-day complication and mortality rates based on the PearlDiver database in patients over 80 vs. 65–79 years of age undergoing two to three-level posterolateral lumbar fusion surgery. The following complications were analyzed: acute renal failure, myocardial infarction, cerebrovascular accident, respiratory failure, surgical site infection, blood transfusion, UTI, durotomy, and thromboembolic complications. The overall complication rate was 13.9% in patients over 80-years-old. Although the complication rates were significantly higher in octogenarian patients, they were still much lower that the rates reported in this study. If we only included the complication categories tracked by PearlDiver, our complication rate would be 34.9% excluding a lot of minor complications, but also such complications as sepsis and pneumonia. Higher complication and mortality rates in our study may also be explained by more complex surgeries performed. Similarly, in a study by Chikuda et al. [14], which was based on a Japanese patient classification system, only 6.0, 5.0, and 6.7% complication rates were reported in patients older than 80 undergoing cervical laminoplasty, lumbar decompression, and lumbar arthrodesis, respectively. Therefore, underreporting may be a common issue for all studies based on administrative data.

Some papers included patients older than 65 years of age to represent the elderly patient population [10, 15, 25]. Glassman et al. [25] reported no statistically significant differences in clinical outcomes between the 65-and-older age group vs. under-65 age group and claimed that the occurrence of perioperative complications did not affect clinical outcomes, but they also encountered approximately 3 times higher complication rates in older patients.

Shabat et al. [42] defined complications similarly to our study: the authors reported any perioperative adverse event related to surgery or exacerbation in chronic condition for up to 1 month postoperative. Although they did not include any fusion surgeries, the total complication rate was 52% for patients undergoing decompression for lumbar spinal stenosis.

One of the most important aspects that surgeons should keep in mind is that even minor complications in elderly may have much more severe consequences compared with younger patients. Manku et al. [32] analyzed the impact of perioperative complications on long-term survival in patients ≥70 years of age undergoing non-cardiac surgeries. Compared with the general population, the risk of 3-month mortality was seven times greater for the patients with postoperative complications. This study emphasizes the significance of

Table 3 Clinical outcomes

Lumbar	Baseline	Post-operative	P
Back pain VAS	6.2 ± 1.6	1.6 ± 1.6	< 0.0001
Leg pain VAS	6.6 ± 3.1	1.1 ± 1.3	< 0.0001
ODI	39.9 ± 16.9	16.9 ± 12.6	0.003
SF-36 MCS	54.7 ± 8.0	58.0 ± 7.4	0.296
SF-36 PCS	27.2 ± 10.9	38.7 ± 12.5	0.026
Satisfaction		85.6 ± 21.4	
Cervical			
Neck pain VAS	4.5 ± 3.5	3.0 ± 3.8	0.449
Arm pain VAS	1.2 ± 1.5	2.6 ± 4.0	0.432
NDI	27.8 ± 19.6	29.7 ± 19.7	0.841
SF-36 MCS	48.3 ± 10.8	48.2 ± 12.0	0.989
SF-36 PCS	34.8 ± 10.7	34.0 ± 15.5	0.089
Satisfaction		81.9 ± 17.8	

Values presented as means ± SD; *p* values were determined with Student's *t* tests. *MCS* Mental Component Summary, *NDI* Neck Disability Index, *ODI* Oswestry Disability Index, *PCS* Physical Component Summary, *SF-36*, Short Form Health Survey, *VAS* Visual Analog Scale

postoperative complications because the estimated relative risk of death was 6.2 vs. 1.7 in octogenarian patients with and without complications, respectively.

A similar increase was reported for mortality rates [7, 15, 30, 37, 46] in elderly patients undergoing cervical or lumbar surgeries, especially in patients undergoing fusion surgeries. Rodgers et al. [41] reported very high 3-month and 1-year mortality rates of 15 and 25%, respectively, for octogenarians patients undergoing posterior lumbar interbody fusions. The 1-year mortality rate of 4.2% was also quite high in our study, but was comparable to 0–10.4% [1, 37–39, 48] reported by other authors.

Complication prevention

A one-third of the patients in our study undergoing cervical procedures developed dysphagia. It is a well-known complication encountered after ACDF surgery and elderly patients are predisposed to develop dysphagia symptoms postoperatively [2]. Furthermore, a statistical analysis demonstrated that it was a significant predictor to develop pneumonia or atelectasis in our cohort of patients. A total of 8.4% patients had pneumonia in our study compared with the incidence of 5.3 aspiration pneumonia events per 1000 cases in a retrospective national database analysis [22]. In addition, two patients died due to aspiration or aspiration pneumonia. The association of swallowing dysfunction with increased risk of pneumonia [31] and mortality [9] in elderly has been documented previously, therefore, early recognition and preventative efforts [44] should be employed to reduce morbidity and mortality in this patient population.

Another concerning factor that we encountered was a high incidence of either urinary retention (10.7%) or urinary tract infections (16.1%) in the lumbar patient group. It was significantly higher than the reported 1.8% rate in the general patient population, and even higher than three times the risk in ≥70 years old compared with younger patients [6]. There were no urinary tract infections in the cervical patient group and this could be explained by the fact that patients undergoing lumbar surgeries received intrathecal morphine injections for postoperative pain management. In addition, the main difference in the cervical versus lumbar patients was the higher use of Foley catheters during lumbar procedures. The occurrence of urinary tract infections was also associated with a longer OR time. Besides the recommendation to avoid opioid medications [3], removing the catheter as soon as possible and following other standard preventative strategies for urinary tract infections, Bohl et al. identified some of the modifiable risk factors for the elderly patients undergoing posterior lumbar fusions. They recommended optimizing nutritional status, better controlling blood glucose levels, along with carefully monitoring patients after discharge from the hospital [6].

Infection rates were 5.1 and 14.3% in the cervical and lumbar group, respectively, which is also much higher compared to the general patient population. The lack of independence with activities of daily living was reported as one of the predicting factors for surgical site infections due methicillin-resistant *Staphylococcus aureus* in the elderly [13]. Identifying causes of functional impairment (e.g., depression, malnutrition) and preoperatively optimizing functional status may decrease the incidence of infections in elderly undergoing elective spine surgeries.

It is not clear whether excessive blood loss affects complication rates in elderly [10, 11, 15], but we did not identify this association. It may be due to the fact that EBL was significantly lower (247 ml on average) compared with 679 ml in elderly patients undergoing posterior lumbar decompression with arthrodesis where increased risk of complications in patients with significant blood loss was reported [10]. However, it was not surprising that development of postoperative anemia was related to EBL in our study. As it was previously concluded by Young [50], patients on chronic anticoagulation lose twice as much blood while undergoing lumbar spine surgeries and require transfusions even if anticoagulation treatment was discontinued before surgery and the INR values normalized. Due to a widespread prevalence of anticoagulation therapy in octogenarians, spine surgeons should be aware of this and minimize the risk when possible, because perioperative anemia can increase the risk for pneumonia and mortality [19].

In summary, comprehensive preoperative geriatric assessments should be employed to identify such conditions as malnutrition, frailty, independence with activities of daily living, or cognitive decline. Efforts should be made to eliminate modifiable risk factors and optimize patient status before undergoing elective spinal procedures. Postoperative care, including a routine admission to higher level care units, with those predisposing factors in mind, can also help to minimize medical complications and improve clinical outcomes in this patient population.

Conclusions

The incidence of perioperative medical complications and mortality rates in octogenarians undergoing elective spinal surgeries are quite high. The benefits of having surgery must be weighed against the risks of not only surgical but also adverse medical events. An informed decision-making process should include discussion of potential postoperative morbidity specific to this patient population in order to guide patient's acceptance of higher risks and expectations postoperatively. It is also important to identify potential complications and adapt preventive measures to minimize them in this patient population.

Compliance with ethical standards

Conflict of interest None.

Ethical approval Formal consent was not required.

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