



Original Article

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INTRODUCTION

Age is a known risk factor for increased mortality and poor outcomes following surgery.¹⁻⁶ The presence of multiple comorbidities and reduced functional reserves are common among the elderly which can complicate management.⁵ There is some reluctance amongst spine surgeons to operate on elderly patients due to these perceived risks.

Over the past 10 years, geriatric patient populations have increased and the average lifespan of Asian patients is amongst the longest in the world (Korea, Japan, Singapore, Hong Kong), with citizens living well into their eighties.⁷ Along with this increased life expectancy, spine surgeons will inevitably find themselves operating on older patients.^{8,9}

Is Spinal Surgery Safe for Elderly Patients Aged 80 and Above? Predictors of Mortality and Morbidity in an Asian Population

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Objective: We aimed to determine the 2-year mortality and morbidity rates following spine surgery in elderly patients (age ≥ 80 years) and to study the associated risk factors.

Methods: The records of patients ≥ 80 years of age who underwent spine surgery during the years 2003–2015 at Tan Tock Seng Hospital, Singapore were retrospectively reviewed. Information was collected on their demographic characteristics, comorbidities, diagnosis, general and neurological status, type of surgery, and outcomes. The mortality and morbidity rates over a 2-year period were analyzed. Bivariate analyses were carried out to identify factors associated with mortality.

Results: We selected 47 patients (mean age, 83.3 years; range, 80–91 years) who were followed up for a mean duration of 27.7 months. The mortality rates at 30 days, 6 months, 1 year, and 2 years following surgery were 2.1%, 8.5%, 10.6%, and 12.8%, respectively. The factors significantly associated with mortality included multiple comorbidities, nondegenerative aetiology, and vertebral fractures. The overall morbidity rate was 48.9%, and 17% of this cohort had major complications.

Conclusion: Surgeons should strategize management protocols with due consideration of the mortality and morbidity rates, and be wary of operating on patients with multiple comorbidities, nondegenerative conditions, and vertebral fractures.

Keywords: 80 and over aged, Morbidity, Mortality, Risk factors, Spine

Knowledge on the mortality rate among local elderly patients following spine surgeries and the risk factors associated with it can better guide treatment. To the best of our knowledge, only a few have reported the mortality outcomes in the Asian elderly population undergoing spine surgery.

Therefore, we aim to address the following key questions,

- (1) What is the mortality rate amongst patients ≥ 80 years of age undergoing spine surgery?
- (2) What is the morbidity rate amongst patients ≥ 80 years of age undergoing spine surgery?
- (3) What are the risk factors associated with mortality?
- (4) Do comorbidities, nature and length of surgery influence mortality?

MATERIALS AND METHODS

Records of elderly patients ≥ 80 years of age who underwent spine surgery during the years 2003–2015 at Tan Tock Seng Hospital, Singapore and followed up for a minimum of 2 years were retrospectively reviewed. Surgeries were performed by both orthopaedic and neuro surgeons for various spinal conditions occurring due to degeneration, trauma, malignancies, and infection.

Data that was extracted include demographic characteristics, comorbidities, diagnosis, activities of daily living (ADL) status, American Society of Anesthesiologists (ASA) physical status classification, American Spinal Injury Association neurological impairment grade, type of surgery, length of hospital stay, outcomes, and complications encountered.

We primarily assessed the mortality and morbidity rates at 30 days, 6 months, 1 year, and 2 years following surgery. For assessment of postoperative morbidity, complications were classified into major and minor based on the grading's suggested by Dindo et al.¹⁰ According to this grading, major complications included sepsis, pneumonia, deep surgical site infection, cerebrovascular accidents, myocardial infarction, pulmonary embolism, acute renal failure requiring dialysis and, nerve injury; minor complications included urinary tract infection, blood transfusion, mild renal insufficiency, deep vein thrombosis and, superficial surgical site infection.

To identify risk factors, the selected cohort was grouped into those with mortality and without mortality. Bivariate comparisons were done to check if there was significant difference between the groups in relation to any of the extracted parameters.

All data were analyzed using IBM SPSS Statistics ver. 23.0 (IBM Co., Armonk, NY, USA). Chi-square test was used to calculate the significance of difference between categorical variables and independent t-test or Mann-Whitney U-test was used to calculate the significance of difference between continuous variables. A p-value < 0.05 was considered statistically significant.

This study (Ref: 2016/00743) was exempted from formal review by the domain-specific review board, National Healthcare Group, Singapore and was performed in accordance with the ethical standards mentioned in the most recent version of the 1964 declaration of Helsinki.

RESULTS

A total of 47 older patients who underwent spine surgery were

Table 1. Patient demographics (n = 47)

Demographic	Value
Age (yr), mean (range)	83.3 (80–91)
Sex	
Male	19
Female	28
Length of stay (day), mean (range)	24.6 (3–95)
Operative site	
Cervical spine only	14
Thoracic spine only	3
Lumbar spine only	26
Multiple segments	4
Comorbidities, n (%)	
Diabetes mellitus	11 (23.4)
Hypertension	33 (71.7)
Hyperlipidemia	21 (44.7)
Cardiac disease	11 (23.9)
Stroke	7 (15.2)
Pulmonary disease	2 (4.3)
Multiple comorbidities*	16 (34)
Etiology	
Degenerative spine disease	32 (68)
Trauma	10 (21.3)
Malignancy	2 (4.3)
Infection	3 (6.4)
ASA PS classification	
I	0
II	24
III	22
IV	1
Preoperative ASIA score	
A	0
B	0
C	3
D	27
E	17
No fracture	36
Vertebrae fracture (pathological and traumatic)	11
Cervical	4
Thoracic	3
Lumbar	3
Thoracolumbar	1
Emergency operation	18
Elective operation	29

ASA PS, American Society of Anesthesiologists physical status; ASIA, American Spinal Injury Association.

*Three or more comorbidities with at least 1 major comorbidity being diabetes mellitus, cardiac disease, stroke, chronic renal disease, chronic obstructive lung disease.

Table 2. Primary outcomes – mortality

Mortality	No. (cumulative %)	Diagnosis	Cause of death	In-hospital mortality
Intraoperative	0 (0)			
30 Days	1 (2.1)	Central cord syndrome	Pneumonia	1 Patient
3 Months	2 (6.4)	Odontoid process #, pathological L1 #	Pneumonia	1 Patient
6 Months	1 (8.5)	C6 pathologic #	Pneumonia	Nil
1 Year	1 (10.6)	Cervical cord injury	Pneumonia	Nil
2 Years	1 (12.8)	Degenerative L45 stenosis	Unknown	Nil
Overall	6 (12.8)			

analyzed in the study. There were 19 males and 28 females with a mean age of 83.3 years (range, 80–91 years) (Table 1). These patients had one or more medical comorbidities such as diabetes mellitus, hypertension, hyperlipidaemia, cardiac disease, pulmonary disease, and stroke. Multiple comorbidities (≥ 3 or more) were present in 34% of the patients.

Surgeries were done for various conditions of the cervical spine (14 patients, 29.8%), thoracic spine (3 patients, 6.4%), lumbar spine (26 patients, 55.3%) and multisegment problems (4 patients, 8.5%). Among the patients with multiple segment problems, 1 patient had cervical and lumbar segment surgery, while 3 others had thoracic and lumbar segment surgery. The average length of hospital stay was 24.6 days and the average length of follow-up was 27.7 months.

1. Primary Outcome 1: Mortality

Overall postoperative mortality rate for elderly patients undergoing spinal surgery at 30 days, 6 months, 1 year, 2 years were 2.1%, 8.5%, 10.6%, and 12.8% respectively. Six patients died with pneumonia being the most common (5 patients) cause of death. Among those who died, 2 patients who underwent emergency operation for traumatic cervical spine injury died during inpatient stay (Table 2).

Our results showed that (1) multiple comorbidities, (2) non-degenerative etiology (includes trauma, infection, malignancy), and (3) vertebral fracture (traumatic and pathological) were significantly associated with mortality (Table 3). There was also a trend towards higher mortality in patients who underwent cervical segment operation and emergency operation (6.9% vs. 22.2% in elective and emergency operation respectively).

2. Primary Outcome 2: Morbidity

In this study, the overall complication rate was 48.9% (23 patients). Of these, major complication rate was 17% and minor complication rate was 31.9% (Table 4). Sepsis and pneumonia

Table 3. Bivariate analysis of factors associated with mortality

Variable	Mortality	No mortality	p-value
Cervical segment (n = 47)			0.072
Yes	4	11	
No	2	30	
Multiple comorbidities* (n = 47)			0.013
Yes	5	11	
No	1	30	
Premorbid function (n = 47)			0.925
ADL independent	1	7	
ADL dependent	4	25	
ASA PS classification (n = 47)			0.416
Low (1 or 2)	2	22	
High (3 or 4)	4	19	
Severe neurologic deficit			0.343
Yes (ASIA A–C)	1	2	
No (ASIA D & E)	5	39	
Emergency operation (n = 47)			0.19
Yes	4	14	
No	2	27	
Etiology (n = 47)			0.009
Degenerative	1	31	
Nondegenerative	5	10	
Vertebrae fracture (n = 47)			0.021
Yes	4	7	
No	2	34	

ADL, activities of daily living; ASA PS, American Society of Anesthesiologists physical status; ASIA, American Spinal Injury Association. *Three or more comorbidities with at least 1 major comorbidity being diabetes mellitus, cardiac disease, stroke, chronic renal disease, chronic obstructive lung disease.

were the most common major complication, while urinary tract infection and blood transfusion were the most common minor complications. Three patients (6.4%) underwent reoperation

Table 4. Primary outcomes – major morbidity

Major complication*	No. (%)
Inpatient	4
3-Month postoperation	3
6-Month postoperation	0
1-Year postoperation	1
2-Year postoperation	0
Overall major complications	8 (17)

*Sepsis, pneumonia, deep surgical site infection, pulmonary embolism, myocardial infarction, stroke, acute renal failure requiring dialysis, peripheral nerve injury.

for deep surgical site infection, restenosis, and implant loosening. One patient also developed deep surgical site infection but declined surgery. A summary of the complications was tabulated (Table 5).

Among patients who underwent elective surgery and emergency surgery, the risk of major morbidity was 6.9% and 33.3%, respectively ($p=0.041$). Major morbidity rates in patients without multiple comorbidities and patients with multiple comorbidities were 16.1% and 18.8% respectively ($p=1.00$). With regards to operative time, increased length of surgery demonstrated a trend towards increased major morbidity rates although this was not significant (major morbidity rate of <2 hours vs. 2–4 hours vs. >4 were 7.1% vs. 15.8% vs. 28.6%, respectively, $p=0.14$).

DISCUSSION

It is established in the literature that mortality rates in older patients with spine surgery are higher than the general population.^{1–6} Understanding the risks of older patients undergoing spinal surgery is necessary to counsel patients regarding the risks of operation. This can affect both surgeons' preference to operate on their patients and help patients make an informed decision since spine surgeries are generally high-risk. Some argue that surgical techniques, spinal instrumentation, and general anesthesia have improved over the last decade, making spinal surgery safer and allowing our threshold to operate on the elderly to become lower.^{8,11–14}

Desai et al.² reviewed all patients who underwent spine surgery in their institution. A subgroup analysis of 617 patients above 60 years revealed a 30-day postoperative mortality rate of 1.9%. They concluded that the cohort with mortality had a significantly higher age. Jackson et al.³ reviewed 64 patients above 65 years with cervical spine injuries treated surgically, and re-

Table 5. Major and minor complications

Complication	No. (%)
Major complications	8 (17.0)
Sepsis	4*
Pneumonia	3
Deep surgical site infection	2
Pulmonary embolism	1
Myocardial infarction	0
Stroke	0
Acute renal failure requiring dialysis	0
Peripheral nerve injury	0
Minor complications	15 (31.9)
Urinary tract infection	9*
Blood transfusion	6
Mild renal insufficiency	3
Restenosis	2
Implant loosening	1
Superficial surgical site infection	0
Deep vein thrombosis	0
Patients with multiple complications*	7
Total number of patients with complications	23 (48.9)

*One patient had sepsis with pneumonia and urinary tract infection (UTI), 1 patient had pneumonia and pulmonary embolism, 2 patients had sepsis and UTI, 1 patient had sepsis and restenosis requiring re-operation, 1 patient had pneumonia and UTI, 1 patient had UTI and mild renal impairment postop and was readmitted for UTI 1 month after discharge.

ported the initial hospitalization mortality as 12.2%, regardless of neurologic involvement. Sander et al.⁵ evaluated the 3-month and 1-year mortality in patients 65 years of age or older, who have undergone surgical treatment for cervical fractures. The in-hospital mortality was 21.7%, mortality at 3 months after injury was 26.1%, and 1-year mortality was 29%.

In our study, the mortality rate at 30 days postoperatively was 2.1%, but increased to 8.5%, 10.6%, and 12.8% at 6 months, 1 year and 2 years follow-up, respectively. Pneumonia was the most common cause of death. Inpatient mortality rate was only 4.3% (2 patients) – 1 developed pneumonia after surgery and 1 at 62 days postoperatively. While previous studies reported lower mortality rates, it should be noted that they either included patients younger than 80 years, or have only looked at mortality up to 30 days postoperatively. The heterogeneity of our study population may also contribute to the differences in mortality rates. The risk of mortality and in elective surgery was 6.9% compared to 22.2% in emergency surgery.

Common risk factors for mortality reported by other authors in the literature include: old age (commonly studied age groups include ≥ 65 , ≥ 75 , and ≥ 85 years), spinal cord injury, longer operation time, emergency operation, traumatic cases, nondegenerative etiology (cf. trauma and malignancy), multiple comorbidities, cervical segment operation, postoperative sepsis.^{1-6,15,16} From our study, we found having multiple comorbidities, nondegenerative etiology, and vertebral fracture as risk factors for mortality. Surprisingly, ASA physical status classification was not found to be associated with mortality, which may be due to the small sample size and most of them being ASA physical status classification II or III.

The overall morbidity rate in this population was 48.9% with 17% of patients having at least 1 major complication. We choose 2-year follow-up period considering that recurrence and implant-related complications may occur late after surgery. The higher rate of morbidity found in our study could be due to the older population, longer follow-up time for up to 2 years and the difference in definition of 'morbidity.' For instance, Balaud et al.¹⁷ did not consider blood transfusion as a complication. It was interesting to note that no patients in our cohort suffered from cardiopulmonary event including myocardial infarction and stroke. This may be due to prudent patient selection. The risk of major morbidity differed significantly between elective surgery (6.9%) compared to emergency surgery (33.3%).

This study has certain limitations due to its retrospective nature and small sample size. As such, only a bivariate analysis rather than a multivariate analysis could be performed which may not reveal independent risk factors. Also, our long follow-up (2 years) may have potentially overestimated the mortality and morbidity rates, as complications not related to surgery may have influenced our results.

CONCLUSION

Mortality and morbidity rates in patients aged ≥ 80 years following spinal surgery are not low. Proper patient selection is required, and surgeons should be wary of operating on patients with risk factors such as multiple comorbidities, nondegenerative conditions, and vertebral fractures. Careful patient counseling and strategizing management protocols should be considered before surgery.

CONFLICT OF INTEREST

The authors have nothing to disclose.

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