Risk factors of cervical surgery related complications in patients older than 80 years

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Abstract:

Introduction: With an aging population, the proportion of patients aged ≥80 years requiring cervical surgery is increasing. Surgeons are concerned with the high incidence of complications in this population, because "age" itself has been reported as a strong risk factor for complications. However, it is still unknown which factors represent higher risk among these elderly patients. Therefore, this study was conducted to identify the risk factors related to surgical complications specific to elderly patients by analyzing the registry data of patients aged ≥80 years who underwent cervical surgery.

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Methods: We retrospectively studied multicenter collected registry data using multivariate analysis. Sixty-six patients aged ≥80 years who underwent cervical surgery and were followed up for more than one year were included in this study. Preoperative patient demographic data, including comorbidities and postoperative complications, were collected from multicenter registry data. Complications were considered as major if they required invasive intervention, caused prolonged morbidity, or resulted in prolongation of hospital stay. Logistic regression analysis was performed to analyze the risk factors for complications. A *p*-value of <0.05 was considered as statistically significant.

Results: The total number of patients with complications was 21 (31.8%), with seven major (10.6%) and 14 minor (21.2%) complications. Multivariate logistic regression analysis, after adjusting for age, revealed two significant risk factors: preoperative cerebrovascular disorders (OR, 6.337; p=0.043) for overall complications and cancer history (OR, 8.168; p= 0.021) for major complications. Age, presence of diabetes mellitus, and diagnosis were not significant predictive factors for complications in this study.

Conclusions: Preoperative cerebrovascular disorders and cancer history were risk factors for complications after cervical surgery in patients over 80 years old. Surgeons should pay attention to these specific risk factors before performing cervical surgery in elderly patients.

Keywords:

elderly, complications, cervical surgery, risk factor, cancer history, cerebrovascular disorders, comorbidity

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Introduction

According to World Health Organization reports[1], the mean life expectancy in 28 countries, such as Japan, Switzerland, Singapore, Australia, and Spain, etc., were over 80 years in 2015. Additionally, "healthy life expectancy", which indicates the average number of years that a person can expect to live in full health, is getting longer. As the population ages, the number of patients with degenerative spinal diseases, such as cervical spondylotic myelopathy (CSM), is increasing. Some may need surgery at around 80 years old in severe cases[2-4] owing to recent advances in surgical techniques and general anesthesia. Furthermore, clinical results of surgery for the aged population were reported to not be inferior compared to that in young patients[5,6]. Therefore, surgeons must prepare for the expected future increase in aged patients who will need cervical spine surgery.

What concerns surgeons when performing cervical surgery on an elderly patient is the increased incidence of complications, because "age" itself is considered a strong risk factor for complications[7-9]. It is widely accepted that once complications occur, the health-related quality of life (HRQOL) will remarkably decrease and large additional costs will be needed[10,11]. Other factors were reported to relate to complications, such as diabetes mellitus (DM)[12], operative time[9], surgical procedure[9], and the number of comorbidities[8]. However, the subjects studied in these reports were of various ages, and the risk factors specific to the elderly patients are still unknown. Based on this background, this study was conducted to identify the risk factors specific to the elderly through analyzing the data of patients aged ≥80 years who underwent cervical surgery.

Materials and Methods

Study Design

This study retrospectively analyzed registry data of patients aged ≥80 years at 35 facilities belonging to the Japan Association of Spine Surgeons with Ambition in 2015.

Patient Population

We conducted our survey from January to March of 2015. The inclusion criteria were patients who were aged ≥80 years when they underwent spinal surgery, who have been followed up more than one year postoperatively, who agreed to participate in our study, and who answered the questionnaires about surgical outcomes. The patients who underwent surgery for cancer-related spinal stenosis or instability, as well as those in which perioperative information could not be completely determined, were excluded. Thus, 262 patients were registered for this multicenter survey. Fifteen patients with thoracic spine disease, 179 with lumbar spine disease, two with traumatic cervical injury and cervical spine benign tumors were excluded. Finally, 66 patients diagnosed with degenerative cervical myelopathy, who underwent cervical surgery, were enrolled in this study (Fig. 1). The data of preoperative comorbidities were collected from medical records and were divided into "cancer history", "cardiac disorders", "cerebrovascular disorders", "respiratory disorders", "renal disorders", "gastro-intentional disorders", "DM", "hypertension", and "dementia".

Definitions of complications

All reported adverse events were reviewed, and each adverse event was judged as to whether it constituted a potential complication related to the surgical procedure by a panel of two physicians (HT and KT). Complications were further

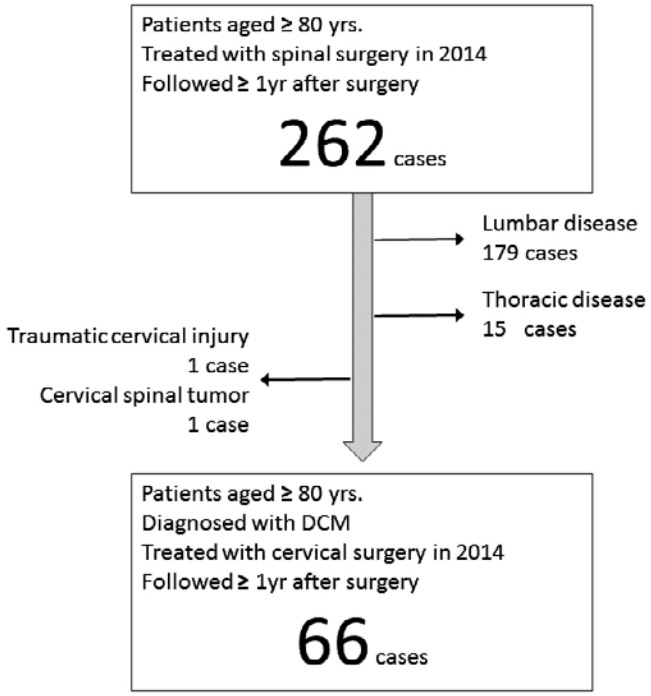

Figure 1. Inclusion and exclusion criteria.

classified as minor or major. The major complications were defined as if they required invasive intervention, resulted in permanent or prolonged morbidity, or resulted in substantial prolongation of hospital stay[9,13]. Based on this definition, epidural hemorrhage, cerebral infarction, systemic edema, arrhythmia, acute respiratory disorders, and epileptic seizures were classified as major complications; delirium, C5 nerve root palsy, urinary tract infection, temporal neurological deterioration, and dural tear were classified as minor complications.

Statistical Analysis

Data were analyzed using Statistical Package for Social Sciences (SPSS) software, version 23.0 (IBM Inc, Chicago, IL, USA). Univariate analyses were performed to identify correlations between complications and prognostic factors. The chi-square test was used to assess categorical variables. A proportional odds model was used to compute odds ratios (OR) and 95% confidence intervals (95% CI). The following variables were examined: age, gender, disease duration, smoking status, diagnosis (CSM, ossification of the posterior cervical longitudinal ligament [OPLL] and atlantoaxial dislocation [AAD]), drug use (anti-osteoporosis agents and anticoagulants), cancer history, and comorbidities (cardiac disorders, cerebrovascular disorders, respiratory disorders, renal disorders, gastrointestinal disorders, DM, hypertension and dementia). Continuous variables were categorized as follows: age, less than 85 years or more; and disease duration, less than 12 months or longer. Variables with a p value <0.05, as per univariate analysis, were included in the multivariate logistic regression model, which was adjusted to age (less than 85 years or more). A p-value <0.05 was considered as statistically significant for multivariate logistic regression.

Table 1. Patient's Demographics.

	Number
Total number	66
Age (yr)	83.4 (80-91)
Gender (male/ female)	31/35
Disease duration (month)	24.1 (1-240)
Smoking status (n, %)	1 (1.5%)
Drug use (n, %)	
Anticoagulants	18 (27.3%)
Osteoporosis medication	12 (18.2%)
History of cancer	12 (18.2%)
Comorbidity (n, %)	
Hypertension	28 (42.4%)
Cardiac disorders	15 (22.7%)
Diabetes	10 (15.2%)
Gastrointestinal disorders	9 (13.6%)
Cerebrovascular disorders	7 (10.6%)
Renal disorders	6 (9.1%)
Respiratory disorders	4 (6.1%)
Dementia	2 (3.0%)
Diagnosis (n, %)	
CSM	57 (86.4%)
OPLL	6 (9.1%)
AAD	2 (2.0%)
CDH	1 (1.5%)
Surgical method	
Posterior	64 (97.0%)
Anterior	2 (3.0%)
Decompression only	53 (80.3%)
Decompression with fusion	13 (19.7%)
Mean surgical segments	
Decompression	3.8 (1-7)
Fusion	2.5 (1-8)
Estimated blood loss (ml)	166.2 (5-1160)
Surgical time (min)	152.2 (46-418)

CSM: Cervical spondylotic myelopathy, OPLL: Ossification of posterior longitudinal ligament of the cervical spine, AAD: atlanto-axial dislocation, CDH: Cervical disc herniation, yr: years old, n: number

Results

Patient demographics are shown in Table 1; average age was 83.4 years (range: 80-91 years). Males comprised 31 cases and females 35. Average disease duration was 24.1 months (range: 12-96). Diagnoses were CSM in 57 cases, OPLL in six cases, AAD in two cases, and cervical disc herniation in one case.

The number of complications

Overall complication rate was 31.8% (21 cases). Major complications comprised 10.6% (7 cases) and minor 21.4% (14 cases). The details of each complication are listed in Table 2. Delirium occurred in 9.1% (six cases), C5 nerve root palsy and urinary tract infection in 4.5% (three cases) and

temporal neurological deterioration and dural tear in 3.0% (one case). As for the major complications, 3.0% (two cases) developed epidural hemorrhage, and 1.5% (one case) developed cerebral infarction, systemic edema, arrhythmia, acute respiratory disorder, and epileptic seizure. In our data set, each complication occurred in a patient; i.e., no patient experienced more than one complication.

Table 2. Details of Complications.

	Number (%)
Overall complication	21 (31.8)
Major complication	7 (10.6)
Epidural hemorrhage	2 (3.0)
Cerebral infarction	1 (1.5)
Systemic edema	1 (1.5)
Arrhythmia	1 (1.5)
Acute respiratory disorder	1 (1.5)
Epileptic seizure	1 (1.5)
Minor complication	14 (21.2)
Delirium	6 (9.1)
C5 nerve root palsy	3 (4.5)
Urinary tract infection	3 (4.5)
Temporal neurological deterioration	1 (1.5)
Dural tear	1 (1.5)

Univariate and multivariate analysis

Univariate logistic regression analysis showed that cerebral disorders (OR, 5.694; p=0.045) and renal disorders (OR, 1.211; p=0.012) were significant risk factors for overall complications; cancer history (OR, 8.500; p=0.017) was a significant risk factor for major complications. The presence of DM, age, diagnosis, and surgical method were not predictive factors for complications in this study. Multivariate logistic regression analysis revealed two significant risk factors: cerebrovascular disorders (OR, 6.337; p=0.043) for overall complications and cancer history (OR, 8.168; p= 0.021) for major complications (Table 3, 4).

Discussion

This study verified novel candidates as risk factors for complications that were not reported before: cerebrovascular disorders and cancer history. Boaky et al.[8] reported that age (ref=18-44, 65-84 years: OR=2.28, ≥85 years: OR=5.07) and number of comorbidities (ref=less than two, ≥ three: OR= 1.98) were risk factors for complications of cervical surgery. Furthermore, Fehlings et al.[9] reported that risk factors for cervical surgery were age (OR=1.029) and operative duration (OR=1.005) for overall complications, and age (OR= 1.054) and combined anterior-posterior procedures (OR= 5.297) for major complications. Although these were well-

Table 3. Risk Factors of Overall Complications.

Risk factor	(Reference)	Univariate			Multivariate		
		OR	95%CI	p value	OR	95%CI	p value
Age ≥85 yr	(<85yo)	0.996	0.344-2.882	0.606			
Gender male	(female)	0.726	0.263-2.004	0.359			
Disease duration ≥12mo	(<12mo)	1.661	0.570-4.842	0.254			
Smoking status	(w/o)	0.977	0.933-1.023	0.652			
Drug use							
Anticoagulants	(w/o)	1.273	0.415-3.907	0.442			
Osteoporosis medication	(w/o)	0.921	0.245-3.461	0.592			
History of cancer	(w/o)	2.176	0.612-7.742	0.188			
Comorbidity							
Hypertension	(w/o)	0.540	0.177-1.644	0.207			
Cardiac	(w/o)	1.914	0.592-6.193	0.215			
Diabetes	(w/o)	0.314	0.063-1.1578	0.129			
Gastrointestinal	(w/o)	0.925	0.209-4.100	0.617			
Cerebrovascular	(w/o)	5.694	1.009-32.150	0.045	6.337	1.056-38.525	0.043
Renal	(w/o)	1.211	1.004-1.460	0.012	2.395	0.731-16.441	0.106
Respiratory	(w/o)	6.300	0.616-64.426	0.118			
Dementia	(w/o)	1.909	0.144-32.009	0.579			
Diagnosis							
OPLL	(CSM)	5.125	0.853-30.788	0.075			
AAD	(CSM)	0.281	0.185-0.425	0.089			
Surgical method							
Posterior	(Anterior)	0.524	0.031-8.783	0.579			
With Fusion	(w/o)	2.682	0.718-10.015	0.171			

CSM: Cervical spondylotic myelopathy, OPLL: Ossification of posterior longitudinal ligament of the cervical spine, AAD: atlanto-axial dislocation, CDH: Cervical disc herniation, dis: disorder, yr: years old, mo: month, w/o: without

Table 4. Risk Factors of Major Complications.

Risk factor	(Reference)	Univariate			Multivariate		
		OR	95%CI	p value	OR	95%CI	p value
Age ≥85 yr	(>85)	1.436	0.298-7.179	0.466			
Gender male	(female)	0.315	0.057-1.757	0.166			
Disease duration ≥12mo	(12mo)	3.294	0.665-16.307	0.138			
Smoking status	(w/o)	0.983	0.951-1.017	0.894			
Drug use							
Anticoagulants	(w/o)	1.075	0.189-6.109	0.622			
Osteoporosis agents	(w/o)	0.797	0.700-0.906	0.277			
History of cancer	(w/o)	8.500	1.597-45.254	0.017	8.168	1.377-48.454	0.021
Comorbidity							
Hypertension	(w/o)	0.724	0.129-4.059	0.534			
Cardiac	(w/o)	1.415	0.246-8.158	0.504			
Diabetes	(w/o)	0.797	0.700-0.906	0.227			
Gastrointestinal	(w/o)	1.063	0.113-10.024	0.661			
Cerebrovascular	(w/o)	4.320	0.660-28.266	0.157			
Renal	(w/o)	5.500	0.799-37.837	0.118			
Respiratory	(w/o)	0.932	0.870-0.999	0.631			
Dementia	(w/o)	0.966	0.921-1.013	0.798			
Diagnosis							
OPLL	(CSM)	0.895	0.819-1.978	0.534			
AAD	(CSM)	8.500	0.469-154.174	0.225			
Surgical method							
Posterior	(Anterior)	1.123	0.879-1.433	0.798			
With Fusion	(w/o)	4.784	0.898-25.456	0.084			

CSM: Cervical spondylotic myelopathy, OPLL: Ossification of posterior longitudinal ligament of the cervical spine, AAD: atlanto-axial dislocation, CDH: Cervical disc herniation, DM: diabetes mellitus, yr: years old, mo: month, w/o: without

designed retrospective or prospective studies with adequate sample size, the average age in these reports was 55 and 57 years, respectively. However, we focused in our survey on elderly patients with an average age of 83.4 years to enable us to identify the novel factors.

In our study, 18.2% of patients were cancer survivors and 10.6% had cerebrovascular disorders as a comorbidity, which were much higher than previous studies[14]. On the other hand, the number of patients with DM was similar[12] and that of smokers was extremely low[14]. These characteristics could reflect two types of selection. First is the surgeon's selection; surgeons tend to avoid performing operations for patients with risk factors, such as DM or smoking, especially in elderly patients. Second is the natural selection; patients with risk factors tend to have shorter life expectancy.

Our study did not include patients who underwent surgery for cancer-related myelopathy or instability; therefore, cancer itself had little impact on the outcomes. Nevertheless, cancer history may be a candidate risk factor. This may relate to the potential damage secondary to cancer therapy. For example, many types of chemotherapy were reported to have chronic cardiotoxic effects[15]. It is reported that the incidence of congestive heart failure (CHF) was 29.4% in patients who received trastuzumab, which is a major chemotherapy for breast cancer[16]. Moreover, anthracyclines[17], fluoropyrimidines[18], tyrosine kinase inhibitors[19], and bevacizumab[20], which are known vascular endothelial growth factor (VEGF) inhibitors, were also associated with CHF. Additionally, radiotherapy may lead to fibrosis in lung, liver, vascular, or other major organs[21]. These potential systemic after-effects, which cannot be detected by the general preoperative examinations, such as blood test, radiography, electrocardiography or echocardiography, may be related to our result that cancer history is a risk factor for major complications, even with no cancer recurrence. Regarding history of cerebrovascular disorders as a risk factor for overall complications, it is well reported that cerebrovascular disease is significantly associated with the incidence of delirium[22,23]. These may relate to our results because postoperative delirium was the most popular complication in our cohort.

In contrast, our results dismissed some well-known risk factors for postoperative complications. Cook et al suggested that DM is a risk factor for cardiac complications (OR= 1.57), hematomas (OR=5.13), and postoperative infection (OR=7.46)[12]. Hasegawa et al.[24] reported that OPLL (OR= 19.0) is also related to complications. However, these two factors were not significantly related to complications in our study. Although these may be due to the surgeon's selection to consider the surgical indication, novel surgical indication for such elderly patients would be an area for debate, including characteristics for aged populations, such as cancer history, muscle volume[25], dementia, and vascular age.

Although our results can provide beneficial information

for surgeons and patients, this study had some limitations. First, the sample size was small. However, the rate of cervical surgery for patients over 80 years is relatively low compared to overall surgery[26] and we only reviewed fully recorded preoperative comorbidities and postoperative complications with a follow-up of more than one year from 35 facilities. Our inclusion criteria were strict enough to keep the results reliable. Second is the retrospective design based on data review, which did not allow evaluation of the severity of the comorbidities and complications. Finally, cancers have different types and staging systems, and cancer therapy has many classes. Although sub-analyses considering these variations are needed, the current study did not allow for them. Therefore, large-scale, prospective studies with more details on comorbidities and complications are critical to overcome these limitations.

In conclusion, preoperative cerebrovascular disorders and cancer history were risk factors for overall complications and major complication after cervical surgery, especially in patients aged over 80 years. Because there is a trend of population aging and prolongation of the healthy life expectancy, the chance of the elderly undergoing cervical surgery is expected to increase. Surgeons should pay attention to these specific factors in elderly patients to improve the safety of cervical operations.

Conflicts of Interest: The authors declare that there are no conflicts of interest.

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