Surgical and general complications in 2,961 Japanese patients with cervical spondylotic myelopathy: Comparison of different age groups

Yasuaki Imajo[1)], Toshihiko Taguchi[1)], Masashi Neo[2)], Koji Otani[3)], Tadanori Ogata[4)], Hiroshi Ozawa[5)], Naohisa Miyakoshi[6)], Hideki Murakami[7)] and Tetsuhiro Iguchi[8)]

1) Department of Orthopedic Surgery, Yamaguchi University Graduate School of Medicine, Japan
2) Department of Orthopedic Surgery, Osaka Medical College, Japan
3) Department of Orthopaedic Surgery, Faculty of Medicine, Fukushima Medical University, School of Medicine, Japan
4) Spine Center, Ehime University Hospital, Japan
5) Department of Orthopaedic Surgery, Tohoku University School of Medicine, Japan
6) Department of Orthopedic Surgery, Akita University Graduate School of Medicine, Japan
7) Department of Orthopaedic Surgery, Graduate School of Medical Science Kanazawa University, Japan
8) Department of Orthopaedic Surgery, Hyogo Rehabilitation Center Hospital, Japan

Abstract:

Introduction: Details of surgical and general complications for patients with cervical spondylotic myelopathy (CSM) are still uncertain. The purpose of this study was to describe surgeries and their complications among Japanese patients with CSM. **Methods:** The Japanese Society for Spine Surgery and Related Research performed a nationwide survey on spine surgery and complications in 2011. Data of patients with 2,961 CSM >40 years old were included. The clinicopathological variables were basic demographic and clinical information, surgical information, and surgical and general complications. To examine the influence of age, variables were compared among three age groups: patients 40-64 (n=1,123), 65-74 (n=966), and ≥75 (n=872) years of age. **Results:** The study included 1,970 males and 991 females and the mean age was 64.3 years old. There were 168 anterior (5.7%) and 2,770 posterior (94.2%) approach surgeries. The vast majority of patients with CSM were treated using the posterior approach, 89.4% of whom had decompression surgery only. Anterior surgeries were more common in the younger age group, but posterior surgeries were equally distributed. The incidence of total complications including surgical/general complications was similar for the anterior (16/168; 9.5%) and posterior (295/2,770; 10.6%) approaches. No patient died on the operating table, but four patients (0.1%) died within one month after surgery. No association was detected between complications and age, comorbidity, and other surgical factors. The incidence of complications was similar for the different age groups. However general complications were predominantly observed in the older group and those who had instrumented surgery. **Conclusions:** The results indicate that the indication and surgical performance for patients with CSM is favorable in Japan, despite the super-aging population. Few serious complications were reported in this study. However, more detailed informed consent about surgical and, in particular, general complications is necessary for the older patients with CSM.

Keywords:

cervical spondylotic myelopathy, surgery, surgical complications, general complications, elderly

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Introduction

The Japanese Society for Spine Surgery and Related Research (JSSR) includes more than 1,300 board certified spine surgeons, and most members are orthopedists and researchers. The JSSR performed nationwide surveys relating to spinal surgery and the associated complications in 1994, 2001, and 2011[1-3)].

Corresponding author: Yasuaki Imajo, i-yasuak@yamaguchi-u.ac.jp
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Japan is a super-aging country. In 2011, the life expectancy and healthy life expectancy were 79.4 years and 72.3 years for males, respectively, and 85.9 years and 73.6 years for females, respectively. The elderly population index (100 × population >65 years/productive population [15-64 years]) was 36.6% indicating the oldest country in 2011, followed by Germany (31.2%), and Italy (30.9%)[4].

Cervical spondylotic myelopathy (CSM) and lumbar spinal stenosis are common degenerative spinal diseases among the elderly. Multilevel spinal stenosis and local kyphosis due to progressive disc degeneration are frequently seen in the elderly, exacerbating the condition[5,6]. Patients with advanced CSM tend to fall easily, resulting in them being bedridden or in a wheelchair because of the spinal cord disorder[7]. Surgical treatment is necessary before severe cord deterioration to prevent advanced myelopathy from decreasing their life expectancy and to improve clinical symptoms.

Because an advanced age itself is a major risk factor for surgery and the elderly have more comorbidities than younger patients, surgeons must be cautious of various risks and prepare for sudden accidents with adequate informed consent. Trends in surgical procedures for spine surgery may be influenced by different government policies and medical insurance systems in many countries. However, analysis of the risk factors for surgical and general complications relating to the surgery of interest is important and applicable in different countries. This study described surgeries and complications for a large sample of Japanese patients with CSM. The main purpose was to investigate the effect of age on surgeries and complications. The secondary purpose was to describe the surgical trends in a rapidly aging society.

Materials and Methods

Data collection

The primary data were obtained from a survey conducted by the JSSR in 2011[3]. Briefly, a research team prepared a computerized questionnaire to capture both clinicopathological and surgical information. A recordable optical disc was sent to 1,105 board-certified spine surgeons who were members of the JSSR in January 2012. The data was returned by the end of May 2012. The surgeons were distributed among 750 institutions in all 47 prefectures. Responses were received from 209 institutions (response rate: 28%). Data about 2,961 patients with CSM >40 years old were examined. This study was approved by the institutional review board of Yamaguchi University Hospital.

Investigation

The clinicopathological variables investigated included basic patient characteristics (age, sex, body weight, and height) and comorbidities and medication use (diabetes mellitus (DM), dialysis, corticosteroid use, disease-modifying antirheumatic drug (DMARD) use involving biologic therapy, and Parkinson's disease). Information about the American Society of Anesthesiologists Physical Status (ASA-PS) classification for the patients was also obtained[8]. The surgical information included operation time (OT), intraoperative blood loss (IOBL), surgical approach, surgical procedure (decompression and fusion methods), instrumentation, and surgical techniques (conventional surgery [CS], microscopic surgery [MS], and microendoscopic surgery [MES]). CS was defined as open surgery without the use of a microscope and/or microendoscope.

The surgical complications included in this analysis were nerve root damage (NRD), spinal cord damage (SCD), vascular injury (VI), dural tear (DT), implant failure (IF), implant dislodgement (ID), wrong level (WL), epidural hematoma (EH), deep wound infection (DWI), spinal fluid leakage (SFL), and pulmonary embolism/thromboembolism (PE/TE). The general complications were mental disorder (MD), urinary disease (UD), digestive disease/liver disease (DD/LD), respiratory disease (RD), cerebral disease, circulatory disease, anesthesiological complication, and death. Surgical and general complications that occurred within one month after surgery were included.

Patients

Data were collected on 1,970 males and 991 females. The mean age was 64.3 years. The sample included patients in their 40s (n=201: 6.8%), 50s (n=453: 15.3%), 60s (n=899: 30.4%), 70s (n=985: 33.3%), 80s (n= 410: 13.8%), and 90s (n=13: 0.4%). To examine the influence of the age, all variables, except spinal instrumentation, were compared for three age groups: 40-64 (n=1,123), 65-74 (n=966), and ≥75 (n=872). DM was a more common comorbidity among 65-74 and ≥75 year olds compared with 40-64 year olds. However, there were no significant differences with regard to the other comorbidities, and use of medications, including dialysis, corticosteroid use, DMARD therapy, and Parkinson's disease. There was no patient classified into ASA-PS category five, and the severity of the ASA-PS, except for category four was strongly associated with older age.

Statistical analysis

Univariate statistical analyses were performed using Statcel, version 2, software (Saitama, Japan. URL: http://www.oms-publ.co.jp). Cross-tabulations were performed for categorical variables, and chi-square tests were used to compare distributions. Because of the large sample size of this study and the need for multiple comparisons, p values <0.01 were considered statistically significant for all analyses. To evaluate factors associated with major surgical complications, multiple logistic regression analyses were performed. In this study, age, sex, comorbidities, OT, IOBL, instrumented surgery, surgical techniques, and ASA-PS classification were used as explanatory variables. Multivariate regression models were conducted using StatFlex version 6.0 (Artech Co., Ltd., Osaka, Japan. URL: http://www.statflex.net/).

We focused on the surgical complications occurring in more than 10 cases (NRD, DT, DWI, and EH). The associa-

Table 1. Surgical Procedures in Different Age Groups.

Surgical procedure	age			p-value
	40-64	65-74	≥75	
Anterior approach				
Decompression plus fusion with instrumentation (n=135)	81 (60.0)	39 (28.9)	15 (11.1)	N.S.
Decompression plus fusion without instrumentation (n=30)	20 (66.7)	5 (16.7)	5 (16.7)	N.S.
Others (n=3)	0 (0.0)	1 (33.3)	2 (66.6)	#1
Anterior Total (n=168)	101 (60.1%)	45 (26.8%)	22 (13.1%)	-
Posterior approach				
Decompression alone (n=2,476)	899 (36.3)	829 (33.5)	748 (30.2)	N.S.
Fusion alone (n=1)	0 (0.0)	1 (100)	0 (0.0)	N.S.
Decompression plus fusion with instrumentation (n=212)	74 (34.9)	62 (29.2)	76 (35.8)	N.S.
Decompression plus fusion without instrumentation (n=81)	34 (42.0)	23 (28.4)	24 (29.6)	N.S.
Posterior Total (n=2,770)	1,007 (36.4%)	915 (33.0%)	848 (30.6%)	-

N.S: not significant, #1: significant difference ($p<0.01$) between 40-64 and ≥75 range

tions between surgical complications and sex, age, ASA-PS classification, presence of major comorbidities (binary variables), such as DM, dialysis, corticosteroid use, DMARD therapy involving biologic therapy, and Parkinson's disease, the use of instrumentation, surgical techniques, surgical approaches, surgical procedures, OT, and IOBL were assessed. A stepwise variable selection method was used to identify variables associated with surgical complications.

Results

Surgical information

Information on surgical techniques and surgical procedures was available for 2,938 (99.2%) patients. The posterior approach (n=2,770; 94.2%) was much more common than the anterior approach (n=168; 5.7%) (Table 1). Anterior surgeries were predominantly performed in the younger age group, and posterior surgeries were almost equally distributed among the age groups. The majority of surgeries using an anterior approach were performed by decompression and fusion with/without instrumentation (98.2%). When the posterior approach was used, the numbers of CS, MS, and MES were 2,182 (78.4%), 550 (19.8%), and 50 (1.8%), respectively. Decompression alone was performed on 2,476 (89.4%) patients. The majority of surgeons preferred laminoplasty. One patient (0.04%) had fusion alone, 81 (2.9%) had decompression and fusion without instrumentation, and 212 (7.6%) had decompression and fusion with instrumentation.

Most (82%) posterior surgeries and 49% of anterior surgeries lasted <3 hours. More anterior approach surgeries lasted ≥6 hours compared with posterior surgeries (3.4% and 0.7%, respectively). The IOBL was similar for the anterior and posterior approach groups (78 and 79%, respectively lost ≤200 ml and 4 and 3%, respectively, lost ≥500 ml). However, more patients who had instrumented surgery lost ≥500 ml of blood compared with non-instrumented surgery ($p<0.01$, data not shown).

Complications

The incidence of total complications, including both surgical and general complications, was similar for the anterior (16/168; 9.5%) and posterior (295/2,770; 10.6%) approaches. No patient died on the operating table, but four patients (0.1%) died in the hospital within one month after surgery. The causes of death were associated with aspiration pneumonitis (n=1), septicemia (n=1), and unknown (n=2). The mortality rate was 0.1% with no difference among the age groups (40-64: 0.1%, 65-74: 0.2%, and ≥75: 0.1%). No relationships between the comorbidities and surgical/general complications were detected.

There were 14 (8.3%) surgical complications, including three ID and three NRD, and 2 (1.2%) general complications, when the anterior approach was used (Table 2). There were no associations between complications and age, comorbidity, and other surgical factors such as OT and IOBL, when the anterior approach was used.

The posterior approach involved 212 (7.6%) surgical and 83 (3.0%) general complications. The most common surgical complications were NRD (n=53; 1.9%), DWI (n=31; 1.1%), and DT (n=24; 0.9%). No patients had IF. The most common general complications, among patients who had the posterior approach, were MD (n=21; 0.8%) and UD (n=12; 0.4%), both of which were significantly more common in the older age group (Table 2). There was no relationship between the surgical complications and age groups.

Association between complications and ASA-PS classification

General complications but not surgical complications were significantly associated with the severity of ASA-PS among the three age groups (Table 3). The incidence of general complications among patients with ASA-PS 1 or 3 was not significantly different among the age groups. However, among patients with ASA-PS 2, the 40-64 year-olds were less likely to have had general complications compared with

Table 2. Incidence of Principal Variables in Complications[§].

	Variable	Patients (%[†])	age			p-value
			40-64	65-74	≥75	
Anterior approach						
Surgical	ID	3 (2.2)*	2	1	0	N.S
	NRD	3 (1.8)	1	1	1	N.S
	Others	8 (4.2)	7	1	0	N.S
	Total	14 (7.8)	10	3	1	N.S
General	CD	1 (0.6)	0	0	1	N.S
	AN	1 (0.6)	1	0	0	N.S
	Others	0	0	0	0	N.S
	Total	2 (1.2)	1	0	1	N.S
Posterior approach						
Surgical	NRD	53 (1.9)	22	20	11	N.S
	DWI	31 (1.1)	15	8	8	N.S
	DT	24 (0.9)	8	10	6	N.S
	EH	23 (0.8)	9	9	5	N.S
	Others	81 (4.8)	26	24	24	N.S
	Total	212 (7.6)	87	70	55	N.S
General	MD	21 (0.8)	0	9	12	#1, #2
	UD	12 (0.4)	2	1	9	#2, #3
	DD/LD	9 (0.3)	1	6	2	N.S
	CD	8 (0.3)	3	1	4	N.S
	Others	19 (1.2)	3	10	6	N.S
	Total	83 (3.0)	12	33	38	#1, #2

NRD: nerve root damage, ID: implant dislodgement, DWI: deep wound infection, DT: dural tear, EH: epidural hematoma, AN: anesthesiological, MD: mental disorder, UD: urinary disease, DD/LD: digestive disease/liver disease, CD: Circulatory disease, [§]: Overlapping cases were included. [†]: Percentage indicates incidence rate in total patients. *: 3 cases/135 instrumented cases

#1: significant difference ($p<0.01$) between 40-64 and 65-74 range, #2: significant difference ($p<0.01$) between 40-64 and ≥75 range, #3: significant difference ($p<0.01$) between 65-74 and ≥75 range. N.S: not significant

Table 3. Association between Complications and ASA-PS Classification in Different Age Groups.

Complication	ASA-PS	Age*			p-value
		40-64	65-74	≥75	
Surgical	1 (n=1,026)	33 (55.9)	21 (35.6)	5 (8.5)	N.S
	2 (n=1,395)	47 (36.7)	45 (35.2)	36 (28.1)	N.S
	3 (n=244)	6 (25.0)	4 (16.7)	14 (58.3)	N.S
	4 (n=4)	1 (100)	0 (0.0)	0 (0.0)	-
General	1 (n=1,026)	3 (21.4)	9 (64.3)	2 (14.3)	N.S
	2 (n=1,395)	7 (15.2)	14 (30.4)	25 (54.3)	#1
	3 (n=244)	1 (4.5)	10 (45.5)	11 (50.0)	N.S
	4 (n=4)	1 (100)	0 (0.0)	0 (0.0)	-

ASA-PS: American Society of Anesthesiologists Physical Status classification, N.S: not significant, *: patient number (%), #1: significant difference ($p<0.01$) between 40-64 and ≥75 range

the ≥75 year-olds ($p<0.01$).

In the logistic regression analyses, there were no variables associated with NRD, DT, or EH. Patients with an ASA-PS classification were more likely to have had DWI (odds ratio (OR)=2.5, 95% confidence interval (CI)=1.4-4.4, $p<0.002$).

Associations between complications and surgery with/without instrumentation

Because of the small number of ≥75 year-old patients with instrumentation, two age groups (40-64 and ≥65) were

Table 4. General Complications With/without Instrumented Surgery in over 65 Age Group[§].

Variables	Patient (%*)	Instrumented Surgery (138)	Non-instrumented Surgery (1,627)	p-value
Mental Disorder	21 (1.2)	1 (0.7)	20 (1.2)	N.S
Urinary Disease	10 (0.6)	3 (2.2)	7 (0.4)	p<0.01
DD/LD	8 (0.5)	0 (0.0)	8 (0.5)	N.S
Respiratory Disease	6 (0.3)	3 (2.2)	3 (0.2)	p<0.01
Cerebral disease	6 (0.3)	1 (0.7)	5 (0.3)	N.S
Circulatory disease	5 (0.3)	1 (0.7)	4 (0.2)	N.S
Death	3 (0.2)	2 (1.4)	1 (0.1)	p<0.01
Anesthesiological	2 (0.1)	0 (0.0)	2 (0.1)	N.S
Others	16 (0.9)	2 (1.4)	14 (0.9)	N.S
Total	71 (4.0)	8 (5.8)	63 (3.9)	N.S

[§]: Overlapping cases were included. DD/LD: digestive disease/liver disease, N.S: not significant,

*: Percentage indicates incidence rate in total patients.

used to investigate complications between instrumented and non-instrumented surgeries. The incidence of complications after instrumented and non-instrumented surgeries was 13.5 and 7.8%, respectively, in the younger age group and 9.4 and 6.9%, respectively, in the older age group (p>0.01). Furthermore, in the younger age group, there were no significant differences between any of the surgical or general complications and the use of instrumentation. Although no significant differences in surgical complications were observed between instrumented and non-instrumented surgeries in the older age group, UD, RD, and death were significantly more common after instrumented surgery (p<0.01, Table 4). These results indicated that the incidence of surgical complications did not differ by age group. However, the general complications listed above were frequent in the elder and instrumented groups.

Discussion

This study described surgical and general complications for nearly 3,000 patients with CSM >40 years old. The fact that 2,770 (94.2%) patients with CSM were treated by posterior surgery and 2,476 (89.4%) patients by decompression surgery alone is outstanding. CSM is the most frequent cervical lesion in the world, especially among the elderly, and this study indicates that the vast majority of cervical surgery performed recently in Japan used the posterior approach. The use of the posterior and anterior approaches varied in the literature. Fehlings et al. presented the results of 278 patients in the AO Spine North America prospective multicenter study and showed that anterior surgery was predominant in patients with mild (76.5%), moderate (61.8%), and severe (43.5%) conditions, ; however, it became inferior to posterior surgery (45.8%) in patients with severe CSM[9]. A Chinese study found posterior (76) and combined (58) surgeries were more common than anterior (19) surgery for 153 consecutive patients with multilevel CSM[10].

The reason why Japanese surgeons preferred posterior surgery for patients with CSM is uncertain, but there are several possible explanations. First, posterior surgery is a suitable option for patients with multilevel spinal stenosis and developmental cervical stenosis is frequently seen in Asian patients[11]. Second, it is important to prevent reoperation due to adjacent segmental disease after spinal fusion in the elderly[12]. Third, the surgeons may prefer the lower risk surgery achieved by using the posterior approach. Luo et al. compared anterior and posterior approaches for patients with multilevel CSM by systemic review and meta-analysis[13] and they found the anterior approach was associated with better neural function recovery but with higher rates of complications and reoperations, resulting in no definitive conclusion regarding the preferred approach[13]. Another meta-analysis also pointed out that anterior decompression and fusion is recommended for patients with CSM with <3 segmental involvements, and it was associated with significantly longer OT and larger IOBL[14]. Similar complication rates (10.9% and 10.6% for anterior and posterior, respectively) for both approaches and shorter OT and less IOBL following the posterior surgeries were demonstrated in this study. These reasons may contribute to the preference for posterior surgery in Japan.

It is not clear from this study if posterior decompression surgery alone was preferable. Anterior surgery was more common in the younger age group, but the rates of surgery involving decompression alone or decompression with fusion were not different among the three age groups. Better results of the laminoplasty in follow-up studies may contribute to the preference for posterior decompression surgery[15,16]. Because of progressive kyphosis, segmental instability, and postoperative neurological deterioration after laminectomy, laminoplasty surgery became a main posterior decompressive surgery. However, neurological deterioration after laminoplasty for patients with CSM and special conditions, such as ≥10 degrees local kyphosis, has been apparent in longer follow-up studies, so posterior reconstructive surgery with instrumentation or anterior/posterior combined surgeries have recently been recommended[17,18].

The rates of surgical complications for anterior surgery

and posterior surgery vary in the literature. Kristof et al. reported that 40.5% of 42 anterior patients and 36.1% of 61 posterior patients with CSM had complications[19]. Complications included hardware failure (n=7), radiculopathy (n=5), and hoarseness and dysphagia (n=3) for anterior surgeries and radiculopathy (n=12), wound infection (n=4), and hardware failure (n=4) for posterior surgeries (complications were not mutually exclusive)[19]. Graft complications, including dislodgement and fracture, nonunion, radiculopathy, dysphagia and/or dysphonia, infection, and esophageal fistula were the main complications in anterior surgeries. Radiculopathy including C5 palsy, wound infection, hardware failure, and hematoma occurred following posterior surgeries[10,20-22]. There were few reports that described general complications in CSM surgeries[9,19,23], and there has not been a report that described the associations between general complications and surgical variables and preoperative conditions, including comorbidities.

Few previous reports have compared complications between younger and older patients. Nagashima et al. compared 37 patients with CSM >80 years old and 124 patients <80 years old in a multicenter retrospective study and found that lower Japanese orthopaedic association scores before and after surgeries were observed in the elder group, but age was not significantly associated with recovery rate or surgical and general complications[24]. A study of patients with CSM who underwent decompressive surgery in a single institution compared 36 patients ≥75 years old with 34 patients <65 years old and described the surgical outcomes and complications[25]. There were no significant difference in the recovery rates but the incidence of the complications was higher in the older group compared with the younger group (38 and 6%, respectively; p=0.002). Major complications in the older group were delirium (n=4) and dysphagia (n=2), and one each had epidural hematoma and hyponatremia in the younger group. Variation inclusion criteria, age ranges and types of surgery might have contributed to the different results in the two reports. In our study, surgical complications did not differ by group, but some of the general complications were more common in the older groups. To obtain definitive results, a rigorous and detailed investigation of medical records may be an important future study.

Limitations

There was a low response rate, so even with the inclusion of many institutions throughout Japan, selection bias might have influenced the results. Details about the patient's background and the surgical/general complications were not available. Therefore, the authors could not examine associations between these variables or study how to prevent surgical and general complications in this study. Finally, every surgery might have been affected by social influences, such as an insurance company or governmental medical policy. However, these would have less influence on the incidence of complications. Despite these limitations, this study adds valuable information about surgery and complications for patients with CSM in a super-aging country.

Conclusion

This study found the vast majority (94.2%) of recent CSM surgeries were performed using the posterior approach and 89.4% of the patients were treated by decompression surgery only. Similar complication rates were observed in anterior (9.5%) and posterior (10.6%) surgeries. The surgical complications did not show any association with age, but some general complications were more common in the older age group. These results indicate that the indication and surgical performance of patients with CSM around the index surgery is favorable in Japan, despite the age of the population. However, the authors emphasize that more detailed informed consent about surgical and general complications, especially the latter, is necessary for the older patients with CSM.

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Conflict of Interest: The authors declare that they have no conflict of interest.

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