The Japanese Scoliosis Society Morbidity and Mortality Survey in 2014: The Complication Trends of Spinal Deformity Surgery from 2012 to 2014

Ryo Sugawara[1)], Katsushi Takeshita[1)], Yasushi Inomata[1)], Yasuhisa Arai[2)], Masashi Takaso[2)], Jun Takahashi[2)], Hideo Hosoe[2)] and Manabu Itou[2)]

1) Department of Orthopedic Surgery, Jichi Medical University, Tochigi, Japan
2) Morbidity, Mortality and Outcome Committee of Japanese Scoliosis Society, Chiba, Japan

Abstract:

Introduction: The Japanese Scoliosis Society (JSS) created a longitudinal complication survey of spinal deformity surgery and established the Morbidity and Mortality (M&M) Committee in 2012. The purpose of this study was to analyze the results of the complication survey in 2014 and to report the differences in the complication rates between the years 2012 and 2014.

Methods: A request to participate in this survey was mailed to all JSS members. The questionnaires were sent through e-mail to the members who took part in this survey, and the responses were returned through the same. Diagnosis was grouped into idiopathic scoliosis, congenital scoliosis, neuromuscular scoliosis, spondylolisthesis, pediatric kyphosis and adult spinal deformity. Complication was grouped into death, blindness, neurological deficit (motor or sensory deficit), infection, massive bleeding, hematoma, pneumonia, cardiac failure, DVT/PE, gastrointestinal perforation and instrumentation failure.

Results: A total of 2,012 patients were reported from 71 institutes. Overall, complications were observed in 326 patients, and the complication rate increased from 10.4% in 2012 to 15.3% in 2014. The complication rate decreased from 8.8% to 3.7% in idiopathic scoliosis, 21.9% to 15.8% in neuromuscular scoliosis and 26.8% to 0% in kyphosis. The complication rate increased from 6.6% to 14.4% in congenital scoliosis, 9.3% to 12.0% in other types of scoliosis, 3.5% to 14.3% in spondylolisthesis and 21.6% to 26.0% in adult spinal deformity. The rate of neurological deficit, especially in motor deficit, increased from 3.2% to 7.7% in older patients with adult spinal deformity. Instrumentation failure was also more common in patients with adult spinal deformity (5.2% to 5.8%), especially in patients aged 40-65 years (4.4% to 9.1%).

Conclusions: The major complication trends were an increasing rate of neurological deficit and instrumentation failure, especially in adult spinal deformity.

Keywords:

Complication trends, Spinal deformity, Surgery, Mortality and Morbidity

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Introduction

Owing to the advances in surgical techniques and devices, the number of spine procedures performed, including fusions and scoliosis corrections, has greatly increased over the past quarter-century[1,2)]. In Japan, the number of spine surgeries performed in older patients has been also increasing over the last decade[3,4)], which means that the number of older patients who experience complications secondary to spinal deformity surgery is increasing. With the rise in the number of operations, the number and type of surgical complications have also changed. It is important for surgeons to understand the complication trends and to clarify their risk factors in order to take preventive measures and minimize adverse patient outcomes.

The worldwide members of the Scoliosis Research Society (SRS) have been required to submit annual complication reports known as Morbidity and Mortality (M&M) Re-

Corresponding author: Ryo Sugawara, sugaryo@jichi.ac.jp
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search, and there was a recent study that focused on the trends of complications from 2009 to 2012[5]. Prior to this, the Japanese Orthopaedic Association and the Japanese Society for Spine Surgery and Related Research performed a few nationwide surveys on complications related to spine surgery[4,6], but there has been no continuous survey on spinal deformity surgery alone. Based on this, the Japanese Scoliosis Society (JSS) created a longitudinal complication survey of spinal deformity surgery and established the M&M Committee in 2012. We analyzed the surgical complications of spinal deformity survey in 2012 and reported that the complication rate for spinal deformity surgery was 10.4%[7]. The purpose of the current study was to analyze the results of the complication survey in 2014 and to report the differences in the complication rates between the years 2012 and 2014.

Materials and Methods

The subjects included patients who underwent spinal deformity surgery between January and December of 2014 at institutions with which the JSS members were affiliated. A questionnaire was created based on the basic survey items of the M&M Research by the SRS in 2012, with the addition of complications and a modification for practical use in Japan. As a result, the definition of a few diagnostic groups and complications altered from 2012 to 2014. The survey items included the total number of patients who underwent spinal deformity surgery and surgical complications within each diagnostic group and did not include data allowing the identification of individual patients. In addition, the details for each complication were omitted to simplify the questionnaire and increase the response rate.

The diagnostic groups in the 2014 survey included the following: idiopathic scoliosis (classification according to the patient's age < 10 years, 10-19 years), congenital scoliosis, neuromuscular scoliosis, other types of scoliosis, spondylolisthesis (Meyerding grades 3 or 4, which was modified from the 2012 survey, which included all grades), pediatric kyphosis (congenital, Scheuermann's kyphosis, and others), and adult spinal deformity including kyphosis (classification according to the patient's age 20-40 years, 40-65 years, ≥65 years).

The surgical complications assessed included the following: death, blindness, neurological deficit (divided into motor and sensory, which was modified from the 2012 survey), early infection (within 3 months after the operation, which was modified from 1 month), late infection (more than 3 months after the operation), massive bleeding (≥ 3,000 mL), postoperative hematoma (symptomatic hematomas requiring surgical intervention), postoperative pneumonia, postoperative cardiac failure, postoperative deep vein thrombosis (DVT) or pulmonary embolism (PE), gastrointestinal perforation, and instrumentation failure.

A request to participate in this survey was mailed to all JSS members. The questionnaires were sent through e-mail to the members who agreed to take part in this survey, and these data were returned through the same. The M&M research team tabulated total case numbers and calculated the complication rate. For statistical analysis, SPSS software (ver. 22; IBM Corp., Armonk, NY, USA) was used. The differences in complication rates between the years were analyzed with the Fisher exact test, and the accepted level of significance was a *P*-value of <0.05.

Results

There were 355 institutions with which the JSS members were affiliated, and responses were obtained from 71 institutions (20% response rate). The total number of cases decreased from 2,906 in 2012 to 2,129 in 2014.

The total number in each diagnostic group in 2014 is as follows: 699 patients with idiopathic scoliosis, 181 with congenital scoliosis, 114 with neuromuscular scoliosis, 217 with other types of scoliosis, 35 with spondylolisthesis, 26 with pediatric kyphosis, and 857 with adult spinal deformity. The number of spondylolisthesis cases decreased dramatically because of the modification from 2012 with the restriction of grades (Table 1). Overall, complications were observed in 326 patients, and the complication rate increased yearly from 10.4% in 2012 to 15.3% in 2014 (Table 2). The number of complications likely increased because neurological deficit, which some patients experienced, was divided into motor and sensory loss categories. There were no differences between 2012 and 2014 in the rates of death, blindness, infections, massive bleeding, postoperative pneumonia, cardiac failure, DVT/PE, gastrointestinal perforation, and instrumentation failure. The complication rate in the total number for each diagnosis is shown in Table 3. In 2014, the complication rate of the idiopathic scoliosis significantly decreased from 8.8% to 3.7%. The rate of the congenital scoliosis increased from 6.6% to 14.4%. The rate of the neuromuscular scoliosis decreased from 21.9% to 15.8%. The rate of the other types of scoliosis increased from 9.3% to 12.0%. The rate of the spondylolisthesis significantly increased from 3.5% to 14.3%. The rate of the kyphosis significantly decreased from 26.8% to 0%. The rate of the adult spinal deformity significantly increased from 21.6% to 26.0%. The detailed complication rate for each diagnosis is shown in Table 4, 5. There were no complications in 2014 in patients with pediatric kyphosis, which had higher rates of neurological deficit (4.9%), massive bleeding (7.3%), and instrumentation failure (4.9%) in 2012. The rate of neurological deficit, especially in motor deficit, decreased from 2.5% to 0% in patients with idiopathic scoliosis and increased from 3.2% to 7.7% in older patients with adult spinal deformity in 2014. Massive bleeding remained more common (12.2% to 8.8%) in patients with neuromuscular scoliosis and adult spinal deformity (8.0% to 4.8%). Instrumentation failure was also more common in patients with adult spinal deformity (5.2% to 5.8%), especially in patients aged 40-65 years (4.4% to 9.1%).

Table 1. Diagnosis of Spinal Deformity.

Diagnosis		2012		2014	
		Total number	%	Total number	%
Idiopathic scoliosis	<10 yo*	30	1.0	58	2.7
	10-18 (19 in 2014) yo	458	15.8	641	30.1
Congenital scoliosis		91	3.1	181	8.5
Neuromuscular scoliosis		82	2.8	114	5.3
Other types of scoliosis		214	7.4	217	10.2
Spondylolisthesis†	Isthmic	167	5.8	11	0.5
	Degenerative	1,067	36.7	13	0.6
	Dysplastic	7	0.2	11	0.5
Kyphosis (excluding adults)	Congenital	7	0.2	18	0.9
	Scheuerman's kyphosis	0	0.0	1	0.1
	Others	34	1.2	7	0.3
Adult spinal deformity	19 (20 in 2014) -40 yo	80	2.8	143	6.7
	40-65 yo	205	7.0	208	9.8
	≥ 65 yo	464	16.0	506	23.8
Total		2,906	100	2,129	100

*: Years old

†: Restricted in Meyerding grades 3 or 4 from 2014

Table 2. The Detailed Complication Rates in All Patients.

Complication	2012		2014		*P* value
	Total number	%	Total number	%	
Death	3	0.1	1	0.1	0.64
Blindness	0	0.0	0	0.0	1.00
Neurological deficit†	49	1.7			
Motor loss			58	2.7	<0.01**
Sensory loss			58	2.7	
Early infection	37	1.2	25	1.2	0.75
Late infection‡	14	0.5	11	0.5	0.86
Massive bleeding§	91	3.1	73	3.4	0.56
Postoperative hematoma	18	0.6	4	0.2	0.02*
Postoperative pneumonia	6	0.2	9	0.4	0.16
Postoperative cardiac failure	1	0.1	5	0.2	0.09
Postoperative DVT/PE	9	0.3	10	0.4	0.36
Gastrointestinal perforation	2	0.1	3	0.1	0.66
Instrumentation failure	73	2.5	69	3.2	0.12
Total	303	10.4	326	15.3	

P values *: <0.05 **: <0.01

†: Divided into motor and sensory loss from 2014

‡: Within 1 month in 2012 and 3 months in 2014

§: ≥ 3,000 mL

Discussion

The SRS Morbidity and Mortality committee reported the complication trends of spinal deformity surgery from 2009 to 2012[5]. In their reliable report, the total number of spinal deformity surgeries increased annually worldwide, and overall complication rates were consistent with the exception of neurological deficit, which increased over the reporting period. The groups with the highest neurological deficit rates were dysplastic spondylolisthesis and congenital kyphosis. Similar trends may occur in Japan, but few reports have focused on spinal deformity surgery in Japan.

In this survey, the total number of spinal deformity surgeries in Japan decreased from 2012 to 2014. Although the true trend of spinal deformity surgery is unclear, the complication rate of spinal deformity surgery in Japan increased from 10.4% to 15.3%. In detail, the complication rate of spondylolisthesis and adult spinal deformity significantly increased. The reason for these changes was likely the altered definitions of the diagnoses and complications. For example,

Table 3. The Complication Rates in Total Number for Each Diagnosis.

Diagnosis		2012		2014		*P* value
		Patient number	Complication number	Patient number	Complication number	
Idiopathic scoliosis	<10 yo	30	6 (20)	58	2 (3.4)	0.02*
	10-18 (19 in 2014) yo	458	37 (8.1)	641	25 (3.9)	<0.01**
	total	488	43 (8.8)	699	27 (3.7)	<0.01**
Congenital scoliosis		91	6 (6.6)	181	26 (14.4)	0.07
Neuromuscular scoliosis		82	18 (21.9)	114	18 (15.8)	0.35
Other types of scoliosis		214	20 (9.3)	217	26 (12.0)	0.44
Spondylolisthesis†	Isthmic	167	6 (3.6)	11	2 (18.2)	0.08
	Degenerative	1,067	36 (3.4)	13	0	1.00
	Dysplastic	7	1 (14.3)	11	3 (27.8)	0.62
	Total	1,241	43 (3.5)	35	5 (14.3)	<0.01**
Kyphosis (excluding adults)	Congenital	7	4 (57.1)	18	0	<0.01**
	Scheuerman's kyphosis	0	0	1	0	1.00
	Others	34	7 (20.6)	7	0	0.32
	Total	41	11 (26.8)	26	0	<0.01**
Adult spinal deformity	19 (20 in 2014) -40 yo	80	7 (8.8)	143	15 (10.5)	0.82
	40-65 yo	205	40 (19.5)	208	55 (26.4)	0.10
	≥ 65 yo	464	115 (24.8)	506	153 (30.2)	0.06
	Total	749	162 (21.6)	857	223 (26.0)	0.04*

The incidence in parenthesis

P values *: <0.05 **: <0.01

†: Restricted in Meyerding grades 3 or 4 from 2014

the severe restriction in spondylolisthesis criteria substantially decreased the number of patients, and the division of neurological deficit into motor and sensory loss increased the total number of neurological deficits, which included some of the same patients. Considering that the number of spondylolisthesis patients decreased substantially from 1,241 in 2012 to 35 in 2014, the true total number of spinal deformity surgeries likely increased in 2014. Moreover, even if the number of neurological deficits in 2014 was limited to motor loss, neurological deficit rates increased in 2014. However, most complication rates, excluding instrumentation failure, were comparable to or lower than those previously reported: 0.05-0.19% for death[4,8-11], 0.3-2.8%[4,6,9,10] for neurological deficit, 1.1-2.8% for infection[9,10,12], and 1.0-1.6% for instrumentation failure[6,10,13,14].

Our previous study reported higher complication rates for pediatric kyphosis and adult spinal deformity in 2012. Fortunately, there were no complications in patients with pediatric kyphosis in 2014. In this survey, the spinal deformity surgeries for congenital scoliosis, neuromuscular scoliosis, severe spondylolisthesis and adult spinal deformity would be risky in the point of higher complication rate. In detail, the neurological deficit rate was higher than in 2012 patients with neuromuscular scoliosis, spondylolisthesis and adult spinal deformity. Massive bleeding remained more common in patients with neuromuscular scoliosis and adult spinal deformity. Instrumentation failure was also higher in patients with adult spinal deformity. Although the details of each surgery were unknown because of the simplicity of the questionnaire, the surgical difficulty associated with these disorders requiring osteotomy or longer spinal fusion may cause these high complication rates. Further efforts must be made to improve surgical outcomes through a greater understanding of the complication trends.

In summary, there were two major complication trends of spinal deformity surgery in Japan: increasing neurological deficit and instrumentation failure, which had higher rates than in the previous reports, particularly in case of adult spinal deformity.

Regarding neurological deficit, the exclusion of mild spondylolisthesis in 2014 likely affected the increased rate of neurological deficit. However, there were trends of decrease in idiopathic scoliosis and increase in adult spinal deformity. The availability of safety tools such as intraoperative CT scans and neurological monitoring may decrease the neurological complication rate, especially in idiopathic scoliosis. These inconsistencies may be explained by the fact that Japan became an aging society at an unprecedented rate. There were some reports that focused on higher complication rates of adult spinal deformity, ranging from 8.4% to 41.2%[15,16]. Smith et al.[17] reported that older patients experienced significantly more complications with adult scoliosis surgery, with the oldest age group (65-85 years) having nearly 4 times the number of minor complications and nearly 5 times the number of major complications compared with the youngest age group (25-44 years). Shaw et al.[18] reported that there was a significant trend toward increasing complication rates with each decade of life in adult scoliosis

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Table 4. The Complication Rate for Each Diagnosis (Death-Infection).

Diagnosis		Total number		Death		Blindness		Neuro-logical deficit	Motor loss	Sensory loss	Early infection‡		Late infection‡	
		2012	2014	2012	2014	2012	2014	2012	2014		2012	2014	2012	2014
Idiopathic scoliosis	<10 yo	30	58	0	0	0	0	0	0	0	1 (3.3)	0	0	0
	10-18 (19 in 2014) yo	458	641	0	0	0	0	12 (2.6)	0	5 (0.8)	6 (1.3)	6 (0.9)	5 (1.1)	3 (0.5)
	total	488	699	0	0	0	0	12 (2.5)	0	5 (0.7)	7 (1.4)	6 (0.9)	5 (1.1)	3 (0.4)
Congenital scoliosis		91	181	0	0	0	0	1 (1.1)	5 (2.8)	7 (3.9)	2 (2.2)	1 (0.6)	0	0
Neuromuscular scoliosis		82	114	0	0	0	0	1 (1.2)	4 (3.5)	0	2 (2.4)	0	0	0
Other types of scoliosis		214	217	1 (0.5)	0	0	0	2 (0.9)	1 (0.5)	3 (1.4)	3 (1.4)	2 (0.9)	0	1 (0.5)
Spondylolisthesis†	Isthmic	167	11	0	0	0	0	2 (1.2)	1 (9.1)	1 (9.1)	1 (0.6)	0	0	0
	Degenerative	1,067	13	1 (0.1)	0	0	0	6 (0.6)	0	0	6 (0.6)	0	2 (0.2)	0
	Dysplastic	7	11	0	0	0	0	0	0	3 (27.3)	1 (14.3)	0	0	0
	Total	1,241	35	1 (0.1)	0	0	0	8 (0.6)	1 (2.9)	4 (11.4)	8 (0.6)	0	2 (0.2)	0
Kyphosis (excluding adults)	Congenital	7	18	0	0	0	0	0	0	0	1 (14.3)	0	1 (14.3)	0
	Scheuerman's kyphosis	0	1	0	0	0	0	0	0	0	0	0	0	0
	Others	34	7	0	0	0	0	2 (5.9)	0	0	1 (2.9)	0	0	0
	Total	41	26	0	0	0	0	2 (4.9)	0	0	2 (4.9)	0	1 (2.4)	0
Adult spinal deformity	19 (20 in 2014) -40 yo	80	143	1 (1.2)	0	0	0	0	0	1 (0.7)	2 (2.5)	0	0	2 (1.4)
	40-65 yo	205	208	0	0	0	0	8 (3.9)	8 (3.8)	8 (3.8)	3 (1.5)	3 (1.4)	2 (1.0)	3 (1.4)
	≥ 65 yo	464	506	0	1 (0.2)	0	0	15 (3.2)	39 (7.7)	30 (5.9)	8 (1.7)	13 (2.6)	4 (0.9)	2 (0.4)
	Total	749	857	1 (0.1)	1 (0.1)	0	0	23 (3.1)	47 (6.6)	39 (4.6)	13 (1.7)	16 (1.9)	6 (0.8)	7 (0.8)

The incidence in parenthesis

†: Restricted in Meyerding grades 3 or 4 from 2014

‡: Within 1 month in 2012 and 3 months in 2014

Table 5. The Complication Rate for Each Diagnosis (Massive Bleeding-Instrumentation Failure).

Diagnosis		Massive bleeding‡		Postoperative hematoma		Postoperative pneumonia		Postoperative cardiac failure		Postoperative DVT/PE		Gastrointestinal perforation		Instrumentation failure	
		2012	2014	2012	2014	2012	2014	2012	2014	2012	2014	2012	2014	2012	2014
Idiopathic scoliosis	<10 yo	0	0	0	0	0	0	0	0	0	0	0	0	5 (16.7)	2 (3.4)
	10-18 (19 in 2014) yo	11 (2.4)	6 (0.9)	0	0	1 (0.2)	2 (0.3)	0	1 (0.2)	1 (0.2)	0	0	0	1 (0.2)	2 (0.3)
	Total	11 (2.2)	6 (0.9)	0	0	1 (0.2)	2 (0.3)	0	1 (0.1)	1 (0.2)	0	0	0	6 (1.2)	4 (0.6)
Congenital scoliosis		1 (1.1)	8 (4.4)	0	0	0	1 (0.6)	0	0	0	0	0	0	2 (2.2)	4 (2.2)
Neuromuscular scoliosis		10 (12.2)	10 (8.8)	0	0	3 (3.7)	3 (2.6)	0	0	0	0	1 (1.2)	0	1 (1.2)	1 (0.9)
Other types of scoliosis		5 (2.3)	8 (3.7)	1 (0.5)	0	0	1 (0.5)	0	0	0	0	0	0	8 (3.7)	10 (4.6)
Spondylolisthesis†	Isthmic	0	0	1 (0.6)	0	0	0	0	0	0	0	0	0	2 (1.2)	0
	Degenerative	1 (0.1)	0	5 (0.5)	0	0	0	0	0	1 (0.1)	0	1 (0.1)	0	13 (1.2)	0
	Dysplastic	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	1 (0.1)	0	6 (0.5)	0	0	0	0	0	1 (0.1)	0	1 (0.1)	0	15 (1.2)	0
Kyphosis (excluding adults)	Congenital	1 (14.3)	0	0	0	0	0	0	0	0	0	0	0	1 (14.3)	0
	Scheuerman's kyphosis	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Others	2 (5.9)	0	1 (2.9)	0	0	0	0	0	0	0	0	0	1 (2.9)	0
	Total	3 (7.3)	0	1 (2.9)	0	0	0	0	0	0	0	0	0	2 (4.9)	0
Adult spinal deformity	19 (20 in 2014) -40 yo	2 (2.5)	5 (3.5)	0	0	0	0	0	0	1 (1.3)	2 (1.4)	0	0	1 (1.3)	5 (3.5)
	40-65 yo	14 (6.8)	10 (4.8)	2 (1.0)	1 (0.5)	1 (0.5)	0	1 (0.5)	0	0	3 (1.4)	0	0	9 (4.4)	19 (9.1)
	≥ 65 yo	44 (9.5)	26 (5.1)	8 (1.7)	3 (0.6)	1 (0.2)	2 (0.4)	0	3 (0.6)	6 (1.3)	5 (1.0)	0	3 (0.6)	29 (6.3)	26 (5.1)
	Total	60 (8.0)	41 (4.8)	10 (1.3)	4 (0.5)	2 (0.3)	2 (0.2)	1 (0.1)	3 (0.4)	7 (0.9)	10 (1.2)	0	3 (0.4)	39 (5.2)	50 (5.8)

The incidence in parenthesis

†: Restricted in Meyerding grades 3 or 4 from 2014

‡: ≥ 3,000 mL

surgery, and implant-related complications were the most common in patients less than 50 years old.

In addition, deformity surgery using spinal instrumentation has been increasing annually with the development of instrumentation and operative techniques. In this survey, the complication rate of adult spinal deformity increased from 21.6% to 26.0%. Patients aged 40-65 years had the highest complication rates of instrumentation failure (9.1%), and patients aged ≥ 65 years had higher complication rates in motor loss (7.7%), early infection (2.6%), and massive bleeding (5.1%). As the aging population has increased, so has the number of high-risk patients with comorbidities and more severe canal stenosis, thus leading to increased complication rates in 2014, particularly for adult spinal deformity. Moreover, surgeons may have the tendency to perform longer fusions in middle-aged patients and shorter fusions in older or high-risk patients, which may have resulted in the lower instrumentation failure rates in patients aged ≥ 65 than 40-65 years. Although elderly patients with adult spinal deformity have the greatest risk of complications, they have a greater degree of improvement in disability and pain compared with younger patients[17]. It is important to understand the trends of complications in each diagnostic group and age to be able to perform the safe surgeries and improve surgical outcomes.

The problematic issue in this survey was the accuracy and completeness of the data. As the data were submitted voluntarily, the questionnaire response rate was low, as it was with the 2012 survey, and complications may have been underreported from the institutes with lower patient numbers. Although these data were less accurate than the SRS database, in which response rate was more than 90%[5], we believe these data were adequately correct to understand the complication trends in Japan because most of the institutes participating in this survey had a greater number of patients and responded to both the 2012 and 2014 survey. For continuous surgical complication surveys, the survey items should be standardized, and annual changes in the same items should be evaluated to create more accurate surveys and evaluations. We intend to perform a complication survey in 2017 with the same questionnaire in 2014 to determine the serial change in complication trends of spinal deformity surgery and consider a new reporting system that will increase the questionnaire response rate.

Conclusion

We surveyed the complication rates associated with spinal deformity surgery performed in Japan in 2014. The complication rate of idiopathic scoliosis and kyphosis significantly decreased, but spondylolisthesis and adult spinal deformity significantly increased. The rate of neurological deficit was higher than in 2012 in patients with neuromuscular scoliosis, spondylolisthesis, and adult spinal deformity. Massive bleeding remained more common in patients with neuromuscular scoliosis and adult spinal deformity. Instrumentation failure was also more frequent in patients with adult spinal deformity. The major complication trends were an increasing rate of neurological deficit and instrumentation failure, especially in adult spinal deformity.

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