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Results of the Scoliosis Research Society Morbidity and Mortality Database 2009–2012: A Report From the Morbidity and Mortality Committee

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Abstract

Introduction: Members of the Scoliosis Research Society are required to annually submit complication data regarding deaths, visual acuity loss, neurological deficit and infection (2012-1st year for this measure) for all deformity operations performed. The purpose of this study is to report the 2012 results and the differences in these complications from the years 2009-2012.

Methods: The SRS M&M database is a self-reported complications registry of deformity operations performed by the members. The data from 2009-2012, inclusive, was tabulated and analyzed. Differences in frequency distribution between years were analyzed with Fisher's exact test. Significance was set at $\alpha = 0.05$.

Results: The total number of cases reported increased from 34,332 in 2009 to 47,755 in 2012. Overall mortality ranged from 0.07% in 2011 to 0.12% in 2009. The neuromuscular scoliosis group had the highest mortality rate (0.44%) in 2010. The combined groups' neurological deficit rate increased from 0.44% in 2009 to 0.79% in 2012. Neurological deficits were significantly lower in 2009 compared to 2012 for idiopathic scoliosis >18 years, other scoliosis, degenerative and isthmic spondylolisthesis and other groups. The groups with the highest neurological deficit rates were dysplastic spondylolisthesis and congenital kyphosis. There were no differences in vision loss rates between years. The overall 2012 infection rate was 1.14% with neuromuscular scoliosis having the highest group rate at 2.97%.

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Conclusion: Neuromuscular scoliosis has the highest complication rates of mortality and infection. The neurological deficit rates of all groups combined have slightly increased from 2009 to 2012 with the highest rates consistently being in the dysplastic spondylolisthesis and congenital kyphosis groups. This could be due to a number of factors, including more rigorous reporting.

Keywords: Complications; Neurologic deficit; Spinal Deformity

Introduction

The Scoliosis Research Society (SRS) was organized in 1966 as the first subspecialty-specific society within the orthopedic field. Its founders sought to provide educational and research opportunities for their peers that care for spinal deformity patients. Since the third SRS meeting in 1968, members have been required to submit an annual complications report, known as the Morbidity and Mortality (M&M) report [1].

Initially, submission was performed with punch cards mailed to the SRS headquarters and remained that way into the 1990s. In the early to mid-1990s, computerized entry was introduced and more detailed surgical and complication data were requested. Complication reporting rates and compliance among the membership declined following this change. In 2009, the online system was modified to only request detailed information for patients with the following complications: death, blindness, and neurologic deficit. In 2012, acute infection was added to this list. The purpose of this study was to analyze the SRS M&M database and trends of complications among the membership in the treatment of patients with spinal deformity between 2009–2012.

Materials and Methods

SRS members self-report complications related to spinal deformity operations they perform. Complication reporting is required annually or members may opt out by paying a $300 fee. Information collected includes the total number of surgeries performed within each diagnostic group and more detailed information on any patients who sustained one of the four specified types of complications. Information is due by April 1 of the following year. Members may input data throughout the year or enter all information at the deadline.

Deformity groups defined in the SRS M&M database include idiopathic scoliosis (IS) <10 years, IS 10–18 years, IS $>$ 18 years, congenital scoliosis, neuromuscular scoliosis, other scoliosis, isthmic spondylolisthesis, degenerative spondylolisthesis, dysplastic spondylolisthesis, congenital kyphosis, Scheuermann kyphosis, other. Primary complications recorded include death, vision change, neurologic deficit, and infection (starting in 2012). Vision change included any deficit in vision, ranging from bilateral blindness to partial visual field loss. Neurologic deficit was reported in the database as root or cord level. If the injury was cord level, it was noted to be complete or incomplete. Only acute (within 90 days of surgery) infections were included in the infection category.

Total tabulated case numbers and category complication rates were calculated. Differences in frequency distribution of complications between years within deformity groups were analyzed with the Fisher exact test. Differences between deformity groups were not calculated due to data being in aggregate form only. Data were analyzed with SPSS Statistics v21.0 (IBM Corp, Armonk, NY). Significance was set at $\alpha = 0.05$.

Table 1
Year 2009 data.

	Total	Deaths		Vision loss		Neurologic deficit		Cord level	Complete
		n	%	n	%	n	%		
IS < 10	1,108	2	0.18	0	0.00	2	0.18	2	0
IS 10–18	6,946	2	0.03	2	0.03	16	0.23	9	0
IS > 18	3,511	7	0.20	0	0.00	23	0.66	21	0
Congenital scoliosis	1,806	2	0.11	0	0.00	14	0.78	9	4
NM scoliosis	2,687	7	0.26	0	0.00	13	0.48	5	3
Other scoliosis	3,782	7	0.19	1	0.03	10	0.26	6	2
Isthmic spondylolisthesis	2,841	0	0.00	0	0.00	8	0.28	n/a	n/a
Degenerative spondylolisthesis	7,875	3	0.04	0	0.00	19	0.24	n/a	n/a
Dysplastic spondylolisthesis	308	1	0.32	0	0.00	6	1.95	n/a	n/a
Congenital kyphosis	386	1	0.26	0	0.00	9	2.33	6	0
Scheuermann kyphosis	588	0	0.00	0	0.00	3	0.51	2	0
Other	2,494	8	0.32	1	0.04	28	1.12	16	4
Total	34,332	40	0.12	4	0.01	151	0.44	76	13

IS, idiopathic scoliosis; n/a, not applicable; NM, neuromuscular.

Table 2
Year 2010 data.

	Total	Deaths		Vision loss		Neurologic deficit		Cord level	Complete
		n	%	n	%	n	%		
IS < 10	1,381	0	0.00	1	0.01	2	0.14	2	1
IS 10–18	8,127	1	0.01	0	0.00	19	0.23	17	6
IS > 18	4,234	3	0.07	2	0.09	31	0.73	4	3
Congenital scoliosis	2,185	4	0.18	0	0.00	17	0.78	10	5
NM scoliosis	3,157	14	0.44	0	0.00	5	0.16	3	1
Other scoliosis	4,780	13	0.27	0	0.00	16	0.33	5	1
Isthmic spondylolisthesis	3,226	0	0.00	1	0.01	17	0.53	n/a	n/a
Degenerative spondylolisthesis	9,047	2	0.02	2	0.43	26	0.29	n/a	n/a
Dysplastic spondylolisthesis	469	0	0.00	0	0.00	5	1.07	n/a	n/a
Congenital kyphosis	539	1	0.19	1	0.15	7	1.30	5	1
Scheuermann kyphosis	683	1	0.15	0	0.00	5	0.73	3	0
Other	2,645	9	0.34	2	0.00	29	1.10	14	4
Total	40,473	48	0.14	9	0.06	179	0.62	63	22

IS, idiopathic scoliosis; n/a, not applicable; NM, neuromuscular.

Table 3
Year 2011 data.

	Total	Deaths		Vision loss		Neurologic deficit		Cord level	Complete
		n	%	n	%	n	%		
IS < 10	1,586	0	0.00	0	0.00	4	0.25	3	0
IS 10–18	8,969	0	0.00	1	0.01	33	0.37	17	5
IS > 18	4,279	8	0.19	1	0.02	64	1.50	6	0
Congenital scoliosis	2,391	2	0.08	0	0.00	22	0.92	13	1
NM scoliosis	3,739	3	0.08	0	0.00	18	0.48	10	3
Other scoliosis	4,597	10	0.22	0	0.00	14	0.30	7	6
Isthmic spondylolisthesis	3,849	0	0.00	0	0.00	18	0.47	n/a	n/a
Degenerative spondylolisthesis	11,157	6	0.05	0	0.00	55	0.49	n/a	n/a
Dysplastic spondylolisthesis	469	0	0.00	0	0.00	4	0.85	n/a	n/a
Congenital kyphosis	526	0	0.00	0	0.00	14	2.66	10	2
Scheuermann kyphosis	896	1	0.11	1	0.11	4	0.45	1	1
Other	2,954	2	0.07	2	0.07	39	1.32	26	8
Total	45,412	32	0.07	5	0.02	289	0.84	93	26

IS, idiopathic scoliosis; n/a, not applicable; NM, neuromuscular.

Table 4
Year 2012 data.

	Total	Deaths		Vision loss		Neurologic deficit		Cord level	Complete	Superficial infections		Deep infections		Total infection	
		n	%	n	%	n	%			n	%	n	%	n	%
IS < 10	1,784	1	0.06	0	0.00	3	0.17	3	0	2	0.11	4	0.22	6	0.34
IS 10–18	9,582	2	0.02	1	0.01	30	0.31	21	3	18	0.19	35	0.37	53	0.55
IS > 18	4,344	2	0.05	0	0.00	76	1.75	11	2	20	0.46	56	1.29	76	1.75
Congenital scoliosis	2,570	4	0.16	0	0.00	28	1.09	16	3	3	0.12	15	0.58	18	0.70
NM scoliosis	3,571	9	0.25	0	0.00	16	0.45	14	4	21	0.59	85	2.38	106	2.97
Other scoliosis	5,520	12	0.22	1	0.02	14	0.25	7	2	8	0.14	19	0.34	27	0.49
Isthmic spondylolisthesis	3,873	1	0.03	0	0.00	44	1.14	n/a	n/a	4	0.10	15	0.39	19	0.49
Degenerative spondylolisthesis	11,287	5	0.04	0	0.00	65	0.58	n/a	n/a	53	0.47	90	0.80	143	1.27
Dysplastic spondylolisthesis	500	0	0.00	0	0.00	11	2.20	n/a	n/a	2	0.40	0	0.00	2	0.40
Congenital kyphosis	579	0	0.00	0	0.00	21	3.63	14	0	1	0.17	7	1.21	8	1.38
Scheuermann kyphosis	897	1	0.11	0	0.00	3	0.33	3	0	7	0.78	9	1.00	16	1.78
Other	3,248	13	0.40	0	0.00	66	2.03	25	3	15	0.46	54	1.66	69	2.12
Total	47,755	50	0.10	2	0.00	377	0.79	114	17	154	0.32	389	0.81	543	1.14

IS, idiopathic scoliosis; n/a, not applicable; NM, neuromuscular.

Table 5
Trends in neurologic deficit by diagnosis.

IS > 18			NM Scoliosis			Isthmic spondylolisthesis		
Year 1	Year 2	Fisher exact (p value)	Year 1	Year 2	Fisher exact (p value)	Year 1	Year 2	Fisher exact (p value)
2009	2010	.784	2009	2010	.032	2009	2010	.162
2009	2011	.000	2009	2011	1.000	2009	2011	.241
2009	2012	.000	2009	2012	.853	2009	2012	.000
2010	2011	.001	2010	2011	.021	2010	2011	.737
2010	2012	.000	2010	2012	.047	2010	2012	.006
2011	2012	.394	2011	2012	.865	2011	2012	.001
Degenerative spondylolisthesis			Congenital kyphosis			Other		
Year 1	Year 2	Fisher exact (p value)	Year 1	Year 2	Fisher exact (p value)	Year 1	Year 2	Fisher exact (p value)
2009	2010	.653	2009	2010	.307	2009	2010	1.000
2009	2011	.007	2009	2011	.833	2009	2011	.539
2009	2012	.001	2009	2012	.344	2009	2012	.008
2010	2011	.026	2010	2011	.126	2010	2011	.466
2010	2012	.002	2010	2012	.013	2010	2012	.005
2011	2012	.411	2011	2012	.394	2011	2012	.030

IS, idiopathic scoliosis; NM, neuromuscular.
Significance was set at $p < .05$.

Results

The total number of cases reported increased from 34,332 in 2009 to 47,755 in 2012. In 2012, 92% of the SRS members completed their M&M requirement. Overall mortality ranged from 0.07% in 2011 to 0.12% in 2009. The neuromuscular scoliosis group had the highest group mortality rate (0.44%) in 2010. The only significant difference in mortality between years was from 2010 to 2011 in the neuromuscular scoliosis group (0.44% vs 0.08%; $p = .0028$) (Tables 1–4).

The overall neurologic deficit rate increased yearly from 0.44% in 2009 to 0.79% in 2012. Neurologic deficits increased over the course of the years studied in idiopathic scoliosis >18 years, neuromuscular scoliosis, isthmic and degenerative spondylolisthesis, and Other groups (Table 5). The groups with the highest neurologic deficit rates were dysplastic spondylolisthesis and congenital kyphosis (Tables 1–4).

Vision loss rates were less than 1% for all groups. The highest vision loss rate was 0.19% in the congenital kyphosis group during 2010. There were no differences in vision loss rates among years in any deformity group. The overall 2012 infection rate was 1.14%. Neuromuscular scoliosis had the highest infection rate of 2.97% (Tables 1–4).

Discussion

This paper reports the first four years of data from the SRS M&M database since changing to more specific reporting of the four complication categories in 2009. Overall, complication rates were consistent throughout the four years with the exception of neurologic deficit, which increased over the reporting period. The reason for this is unknown, but could be due to a number of reasons, including more accurate reporting.

Congenital kyphosis and dysplastic spondylolisthesis consistently had the highest neurologic complication rate. This is consistent with previously published reports. Yaszay et al. reported on 76 patients with congenital kyphosis treated surgically with a 7.8% neurologic complication rate [2,3]. These ranged from a postoperative seizure to profound lower extremity weakness. All of these patients had a full recovery. Likewise, Min et al. reported on 15 patients with dysplastic spondylolisthesis treated with a sacral dome osteotomy and noted 4 (27%) with a neurologic complication [4]. All of their patients' symptoms resolved eventually.

The rate of complications among the cohort of patients with Scheuermann kyphosis remained consistent throughout the study period. There was no report of visual field deficits, the neurologic deficit rate ranged from 0.33% to 0.73% and mortality ranged from 0% to 0.15%. A previous study of patients from the SRS M&M database from 2001 to 2004 reported on 683 patients with this diagnosis treated surgically and the neurologic deficit rate was 1.9% with a 0.6% mortality rate [5]. The current study, while reporting a lower complication rate, included more than 3600 patients, nearly six times the size of the previous report. Other authors have reported low mortality and neurologic deficit rates as well for Scheuermann kyphosis [6,7].

Among the adolescent idiopathic scoliosis (AIS) patients, complication rates remained consistent across the studied years. The total number of patients with this diagnosis treated over the four-year period was 33,624. The neurologic deficit rate ranged from 0.23% to 0.37% and the mortality ranged from 0% to 0.03%. Hwang et al. reported on 99 patients with AIS treated with pedicle screws, and there were no deaths in their series [8]. They reported seven

patients with postoperative radicular symptoms that did not require surgical treatment. Larger studies of this patient population have reported low complication rates as well. A 2011 study of the SRS database reported on 11,000 patients with idiopathic scoliosis, combining infantile, juvenile, and adolescent patients treated from 2004 to 2007. They reported a neurologic deficit rate of 0.8% and a mortality of 0.02% [9]. A previous study of this same database from 2001 to 2003 studying only AIS reported a mortality rate of 0.03% and neurologic complication rate of 0.49% [10]. These numbers are consistent with our current rates with a patient population that was three times larger.

The 13,154 patients with neuromuscular scoliosis had the highest mortality (mean 0.26%) and the highest infection (2.97%) rates among the diagnostic groups studied. This is similar to a previous study of the SRS M&M database in 2011 reporting a mortality rate of 0.3% and a combined deep and superficial infection rate of 5.5% among 4,657 patients [9]. Likewise, Sharma et al. performed a meta-analysis of the last 15 years' literature and found a pooled neurologic complication rate of 3% (range 0%–61%) and a pooled infection rate of 10.9% (range 0%–46%) [10].

The primary concern of any study such as this is the accuracy and completeness of the data submitted. The information contained in this study was voluntarily submitted and no quality assurance was then made of the de-identified (patient and physician) data. Martin et al. recently reviewed National Surgical Quality Improvement Program (NSQIP) results from 50 pediatric hospitals in the United States for the incidence of wound complications in spinal arthrodesis in children and found good concordance between SRS M&M data and NSQIP data with respect to this complication [11]. Webb et al. studied the rates of postoperative infection reported in the SRS M&M database and compared to NSQIP for the years 2012 and 2013. The SRS rate was 1.21%, and the NSQIP rate, 1.85%. This difference was significant, but small, and differences existed only for the categories of Scheuermann kyphosis (5.49%), AIS ages 10–18 (1.10%), and adult scoliosis (1.28%). Differences were attributed to differences in data collection methods, and the conclusion was that SRS M&M data were reliable [12].

The Scoli-Risk study [13] is a prospective study evaluating patients undergoing complex adult spinal deformity surgery. They used a prospective collection protocol with trained American Spinal Injury Association (ASIA) –certified examiners evaluating each patient and reported a neurologic complication rate higher (17%) than that found in retrospective studies [13]. There are several explanations for the vast difference in rates between the Scoli-Risk study and the SRS Database. The most obvious is underreporting in our cohort. The Scoli-Risk study enrolled patients undergoing much higher-risk surgeries than any one particular diagnostic group in our database, and this could also account for some of the difference. However, the neurologic deficit rates in this study, although consistent with previous retrospective reports in the literature, almost certainly underestimate the true incidence of complications in these patients.

This study reports the results of the first four years of data from the SRS M&M database since moving to a simplified reporting system. This represents information that is different from an administrative database, as the treating physicians have identified the diagnostic categories in which each patient belongs. However, the treating surgeon is responsible for reporting the complications, which is also different from an administrative database. Its primary weakness is the voluntary reporting format and lack of a quality assurance analysis, which limits the impact of the data. Other weaknesses include a lack of clear definitions of specific complications, possible recall bias for surgeons who submit all cases at year-end rather than on a continual basis, an inability to analyze cofactors or comorbidities that could explain differences among the cohort, an inability to analyze complication impact on cost and health-related quality of life, and a lack of long-term follow-up. The main strength is the sheer size of this cohort, with 168,907 cases reported over 4 years. In addition, the SRS membership size is increasing annually and there was a respective increase in cases reported and improvement in reporting rates over the same period. This database still provides important global complication data across a massive cohort of spinal deformity patients.

Conclusions

The Scoliosis Research Society Morbidity and Mortality database had 168,907 cases reported between 2009 and 2012 by 716 of its 782 members (92%). Membership, reporting rates, and total number of cases all increased each year over the study period. Neuromuscular scoliosis cases had the highest mortality and infection rates. Neurologic deficit rates showed an increasing trend over the four-year study period and occurred most frequently in congenital kyphosis and dysplastic spondylolisthesis cases. The principal benefit of the SRS M&M database is that it is a large cohort registry, which aids in quantifying global complication rates among spinal deformity patients.

Key Points

- The neuromuscular scoliosis group had the highest mortality rate.
- The highest rate of neurologic deficit occurred in the dysplastic spondylolisthesis and congenital scoliosis groups.
- The neuromuscular scoliosis group had the highest infection rate.

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