Factors associated with improved quality of life outcomes in patients undergoing surgery for adult spinal deformity

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ACKNOWLEDGEMENT

The authors would like to thank Ms. Naomi Uchiyama, Ms. Nao Kuwahara, Ms. Tomoe Mabuchi, and Mr. Taku Nagao, and Mr. Tomokazu Suzuki, secretaries of department of Orthopedic Surgery, for their excellence in technical assistance during data collection.

Key points

- Patients with poor preoperative health-related quality of life were more likely to achieve improvement in SRS-22r parameters after extensive corrective fusion surgery for adult spinal deformity.
- Postoperative improvement to sagittal vertical axis increased the likelihood of MCID for the SRS-22r Subtotal domain.
- Revision surgery negatively affected the likelihood of meaningful functional improvements; therefore, minimizing the risk of revision surgery is important.

- **Mini abstract**

Patients with poor preoperative health-related quality of life were more likely to achieve functional improvement after extensive corrective fusion surgery for adult spinal deformity. Postoperative improvement to sagittal vertical axis increased the likelihood of MCID for the SRS-22r Subtotal domain.

Structured abstract

Study design: Retrospective longitudinal cohort study.

Objective: This study aimed to elucidate factors affecting the likelihood of achieving minimum clinically important difference (MCID) to patient-reported outcomes defined by the Scoliosis Research Society-22r (SRS-22r) among patients with adult spinal deformity (ASD) who underwent extensive corrective fusion surgery from the thoracic spine to the pelvis.

Summary of background data: Achieving MCID for SRS-22r parameters was a measure of surgical efficacy. Patient characteristics and surgical and radiographic factors that affect the likelihood of achieving MCID for SRS-22r parameters are unknown.

Methods**:** Data from patients with ASD who underwent extensive corrective fusion surgery from the thoracic spine to the pelvis during 2010-2016 were retrospectively reviewed. Data from a total of 167 patients with ≥2 years of follow-up were included. Multivariate analysis was used to investigate factors associated with the likelihood of achieving MCID for each of the SRS-22r domains (Function, Pain, Subtotal) 2 years after surgery. The following MCID values were used: 0.90 for Function, 0.85 for Pain, and 1.05 for the Subtotal.

Results: MCID achievement rate was 36.5% for Function, 46.1% for Pain, and 44.3% for the Subtotal domain. In multivariate analysis, preoperative SRS-22r Function (OR=0.204, 95% CI, 0.105-0.396) increased the likelihood of achieving MCID for SRS-22r Function. Preoperative SRS-22r Subtotal (OR=0.211, 95% CI, 0.107-0.413), preoperative pelvic tilt (OR=1.072, 95% CI, 1.012-1.136), preoperative pelvic incidence minus lumbar lordosis (OR=0.965, 95% CI, 0.934-0.997), and postoperative sagittal vertical axis (OR=0.985, 95% CI, 0.974-0.995) affected the likelihood of achieving MCID for the SRS-22r Subtotal.

Conclusions: Patients with poor preoperative health-related quality of life were more likely to achieve improvement in SRS-22r parameters after extensive corrective fusion surgery for ASD. Achieving postoperative sagittal alignment increased the likelihood of achieving MCID for the SRS-22r Subtotal domain.

KEYWORDS: adult spinal deformity, spino-pelvic parameters, extensive corrective fusion surgery, alignment, minimum clinically important difference, Scoliosis Research Society-22r

Level of evidence: 3

INTRODUCTION

Adult spinal deformity (ASD) encompasses various types of pathology such as remnant idiopathic scoliosis, *de novo* kyphosis, scoliosis associated with disc degeneration, kyphosis after vertebral body fracture, and iatrogenic kyphosis after spinal fusion.[1] Symptoms associated with ASD vary, including back pain, leg pain, visceral disorders, and psychological disorders.[2-4] Conservative treatment for moderate to severe adult spinal deformity is less effective compared to surgery, which is required to improve health-related quality of life (HRQOL)[5-7]. Surgical treatment for ASD often requires multi-level spinal fusion from the thoracic spine to the pelvis.[8] Efficacy of treatment for ASD is assessed based on patient-reported outcomes (PROM). The Scoliosis Research Society-22r (SRS-22r) Questionnaire is a PROM assessment tool for ASD, which has been previously reported as reliable, valid, and representative of treatment effects. [9-12] Minimal clinically important difference (MCID) represents improvement to baseline status that is clinically meaningful[13]; specific values for SRS-22r were previously calculated in studies from North America and Japan.[14,15] However, patient characteristics and surgical and radiographic factors that affect the likelihood of achieving MCID for the SRS-22r parameters are unknown. This study aimed to elucidate factors that affect the likelihood of achieving MCID for the SRS-

22r domains in patients with ASD undergoing extensive spinal corrective fusion from the thoracic spine to the pelvis.

MATERIALS AND METHODS

Patient population

This study was reviewed and approved by our Institutional Review Board (IRB No. 14-306, Hamamatsu University School of Medicine) and adhered to the principles of the Declaration of Helsinki. We obtained written informed consent from all participants to publish our findings. In this study, patients were diagnosed with ASD if they were 18 years old or older with confirmed presence of at least one of the following: coronal scoliosis with a Cobb angle ≥ 20°, a sagittal vertical axis (SVA) ≥ 5 cm, pelvic tilt (PT) ≥ 25°, or thoracic kyphosis ≥ 60°. The cohort included patients with ASD who underwent extensive corrective fixation surgeries between 2010 and 2016 at a single institution. To be included in our cohort, patients had to have received posterior instrumented fusion from the thoracic spine to the pelvis and have available full-length standing radiographs and HRQOL data collected before and 2 years after the operation. Posterior instrumented fusion from the thoracic spine to the pelvis was defined as extensive corrective fusion surgery. Cases of spinal deformities associated with infection, malignancy, and neuromuscular disease were excluded from the study. Patients with incomplete outcome data were excluded. Data on the following patient characteristics were extracted: age, sex, body mass index (BMI) (kg/m^2), Charlson Comorbidity Index (CCI),[16] and American Society of Anesthesiologists (ASA) classification. The pathology of the patient was investigated. We defined scoliosis that started during teen years and progressed to adulthood as adult scoliosis. We defined kyphoscoliosis or kyphosis that developed during adulthood and that caused by the degeneration of spinal structures as adult degenerative kyphoscoliosis or degenerative kyphosis scoliosis. HRQOL data were derived from the SRS 22r-Score domains (function/activity, pain, self-image/appearance, mental status, satisfaction, and subtotal score).[12,17]

Radiographic measurements

Full-length freestanding posteroanterior and lateral spine radiographs obtained before and 2 years after surgery were analyzed. Seven board-certified spine surgeons used standard techniques to measure spinopelvic parameters, including: thoracic kyphosis (TK; Cobb angle between the superior endplate of T-5 and inferior endplate of T-12), lumbar lordosis (LL; Cobb angle between the superior endplate of L-1 and superior endplate of S-1), PT (angle subtended by a vertical reference line originating from the center of the femoral head and the midpoint of the sacral endplate), mismatch between pelvic incidence (PI; angle between the line perpendicular to the sacral plate at its midpoint and the line connecting this point to the femoral head axis), and SVA (C-7 plumb line relative to S-1).[18,19] The inter-observer correlation coefficient for TK, LL, PT, PI, SS, and SVA was 0.751, 0.736, 0.882, 0.744, 0.730, and 0.837, respectively.[20]

Patient-reported outcome measures

The SRS-22r is a scoliosis specific HRQOL questionnaire with 22 items and 5 domains: Function, Pain, Self-image, Mental Health and Satisfaction.[12] Each domain score ranges from 1 to 5 points, with higher scores indicating better outcomes.[17,21,22] The scale has been reported as representative, reliable, and valid in populations with ASD.[9-11] We calculated the mean improvement rate as follows: 100 × [postoperative value – preoperative value]/preoperative value for SRS-22r each domain.

MCID threshold value

MCID for the SRS-22r for ASD has been previously reported based on data from a Japanese cohort; these values were: Function=0.90, Pain=0.85, Self-image=1.05, Mental Health=0.70, and Subtotal=1.05.[14,23] The rate of achievement of MCID for SRS-22r Function, Pain, Self-image, Mental health, and Subtotal domain 2 years after surgery was calculated.[24]

Statistical analyses

All values are expressed as mean ± standard deviation (SD). The Shapiro-Wilk test was used to verify the assumption regarding the normal distribution of the data. A paired sample t-test and Wilcoxon signed-rank test were used for within-group comparisons of continuous variables. For each SRS-22r domain, MCID achievement was used as an objective variable, and age, sex, BMI, CCI, pre-operative SRS-22r, pre- and post-operative spino-pelvic parameters, the number of fused segments, and presence or absence of revision surgery were used as explanatory variables. Logistic regression analysis was used to calculate odds ratios (OR) and corresponding (95%

confidence intervals (95% CI) for the MCID of each SRS-22r domain. Preoperative SRS-22r domain scores were dichotomized according to the best cut-off value established from a receiver-operating-characteristic (ROC) curve analysis. A ROC curve was constructed for each domain. The optimal cutoff value for ROC corresponds to the point of optimal trade-off between sensitivity and specificity. The ROC curve derived the cutoff value for the preoperative SRS-22r domain score with equal weight to both sensitivity and specificity to distinguish the "MCID achievement for each domain" from the "no MCID achievement" patients. The accuracy of the ROC curve was evaluated using the calculated area under the curve (AUC). A p-value < 0.05 was considered statistically significant. Statistical analyses were performed using the Statistical Package for Social Sciences (SPSS) software (version 26.0; SPSS, Chicago, IL, USA).

RESULTS

Participant characteristics

Of 356 patients who underwent corrective fusion surgery for ASD during the study period, 167 met the inclusion criteria (Figure 1). Patients' average age was 67.5 ± 9.9 years (23 males). The cohort's average BMI was 23.0 ± 3.8 kg/m^2. The mean CCI was 0.4 ± 0.8. The pathology of patients undergoing extensive corrective fusion surgery for ASD is described in Table 1.

Surgical details and outcomes

The upper instrumented vertebra was T4 in 10 patients, T5 in 8 patients, T6 in 3 patients, T7 in 6 patients, T8 in 15 patients, T9 in 34 patients, T10 in 84 patients, T11 in 6 patients, and T12 in 1 patient. Pelvic fixation was performed using S1 screws for 11 patients and iliac screws for 156 patients. The mean number of vertebral levels fused was 9.8 ± 1.2. The types of procedure performed were 38 (23%) cases of pedicle subtraction osteotomy, 19 (11%) of vertebral column resection, and 49 (29%) of lateral lumbar interbody fusion. Revision surgeries were performed a total of 35 times in a total of 33 ASD patients (19.8%). There were 17 cases of rod fracture, 8 of proximal junctional failure (PJF), 5 of implant-related disorders, 4 of hematomas, and 1 of infection.

Radiographic and PROM parameters

The mean postoperative LL, PT, PI minus LL, and SVA significantly improved from 11.3° to 42.6°, 35.1° to 25.5°, 40.3° to 11.1°, and 113.5 mm to 57.2 mm, respectively (all $p < 0.001$) (Table 2). Scores of all SRS-22r domains significantly improved 2 years after surgery (all p <

0.001) (Table 2).

Proportion of ASD patients achieving MCID for SRS-22r

The proportion of patients who achieved MCID for SRS-22r was 36.5% for Function, 46.1% for Pain, 61.1% for Self-image, 56.9% for Mental Health, and 44.3% for the Subtotal domain. In the multivariate analysis, preoperative SRS-22r Function (OR=0.204, 95% CI, 0.105-0.396) affected the likelihood of achieving MCID for SRS-22r Function (Table 3). The preoperative SRS-22r Pain (OR=0.205, 95% CI, 0.117-0.361) affected the likelihood of achieving MCID for SRS-22r Pain (Table 4). The preoperative SRS-22r Subtotal score (OR=0.211, 95% CI, 0.107-0.413), preoperative PT (OR=1.072, 95% CI, 1.012-1.136), preoperative PI minus LL (OR=0.965, 95% CI 0.934-0.997), and postoperative SVA (OR=0.985, 95% CI, 0.974-0.995) were significant predictors of achieving MCID for the SRS-22r Subtotal score (Table 5).

Cutoff value for the preoperative SRS-22r domain score for predicting achievement of MCID

The ROC curve analysis (Figure 2A) indicated that the best cut-off level of the preoperative SRS-22r Function for predicting the achievement of MCID for SRS-22r Function was 2.55, with sensitivity and specificity of 65.1% and 67.2%, respectively. The area under the ROC curve (AUC) was 0.734 ($P < 0.001$; 95% CI, 0.657–0.812). The ROC curve analysis (Figure 2B) indicated that the best cut-off level of the preoperative SRS-22r Pain for predicting the achievement of MCID for SRS-22r Pain was 2.90, with sensitivity and specificity of 72.2% and 70.1%, respectively. The area under the ROC curve (AUC) was 0.792 ($P < 0.001$; 95% confidence interval [CI], 0.725–0.859). The ROC curve analysis (Figure 2C) indicated that the best cut-off level of the preoperative SRS-22r Subtotal for predicting the achievement of MCID of the SRS-22r Subtotal score was 2.52, with sensitivity and specificity of 66.7% and 68.9%, respectively. The area under the ROC curve (AUC) was 0.998 ($P < 0.001$; 95% confidence interval [CI], 0.619–0.778).

DISCUSSION

This study examined factors that increase the likelihood of achieving post-surgical MCID for each SRS-22r domain in patients with ASD undergoing extensive spinal fusion. MCID represents a clinically significant change to PROM; achieving MCID after surgery is an important measure of treatment efficacy.[13] In this study, poor preoperative HRQOL score was a significant predictor of post-surgical achievement of MCID to all SRS-22r domains (Function, Pain, and Subtotal). This suggests that among patients with ASD, those with low baseline QOL were most likely to experience improvement as a result of surgery. Several previous studies have shown that conservative treatment is less effective than surgery in moderate and severe ASD cases[5-7]; in fact, surgical treatment has been shown as the only approach that can improve

HRQOL in this patient group. Evidence that patients with severe ASD are likely to achieve MCID for the SRS-22r domains is encouraging to patients and surgeons alike, as this can be considered when selecting the most suitable treatment approach. If baseline HRQOL is poor, achieving MCID for the SRS-22r domains might be more likely given the relatively low point of departure. In this study, the cutoff values for the preoperative SRS-22r domain score for predicting achievement of MCID were also calculated. In contrast, relatively satisfactory baseline HRQOL might make it more difficult to achieve MCID, as there might be a limit to the extent of improvement that can be recognized by the patient. These effects, referred to as the “floor” and “ceiling” effect, respectively, are a limitation inherent to the concept of MCID.

Meanwhile, low postoperative SVA was associated with achieving MCID to SRS-22r Subtotal. Previous reports have shown that global sagittal alignment is associated with health-related quality of life.[25,26] In the present study, post-operative global sagittal alignment emerged as an important factor after adjusting for patient demographics, comorbidities, and preoperative spinal pelvic parameters. Nevertheless, Park et al. reported that acquisition of optimal alignment did not affect achievement of MCID.[27] However, these authors did mention that clinical outcomes were associated with spino-pelvic parameters. In the present study, postoperative PI-LL was not a significant factor; in contrast, postoperative SVA was a significant predictor of QOL-related outcomes. Yilgor et al. have suggested that overcorrection might increase the risk of complications[28] and that it may not always be necessary to set PI-LL to the minimum value. Meanwhile, Lafage et al. and Protopsaltis et al. reported that the degree of correction should be selected based on a patient's age.[29,30]

Low postoperative SVA was associated with the likelihood of achieving MCID to SRS-22r Function; however, this association was not statistically significant. In many cases of ASD, spinal corrective fusion requires extensive fixation from the thoracic spine to pelvis, which reduces mobility around the waist.[4,31,32] However, despite these disadvantages, improvement of sagittal alignment tends to improve walking and ability to perform other activities of daily living.[20] Moreover, although not statistically significant, age affected the likelihood of achieving MCID for SRS-22r Function; in fact, the effect of treatment tends to be greater among younger than among older patients likely due to similar correction goals set for all age groups.[33] Yamato et al. reported that rigorous correction is necessary for extremely elderly patients.[34] The present study may have involved insufficient correction for the oldest included adults, leading to relatively low rates of MCID SRS-22r Function achievement in this group.

To achieve MCID for SRS-22r Pain, preoperative poor SRS-22r Pain was the only relevant factor; postoperative sagittal alignment did not affect this outcome. Pain in patients with ASD cannot always be accounted for by alignment; indeed, previous studies have associated pain in ASD with psychological factors.[3,35] Nevertheless, in the present study, 46.1% of patients achieved MCID for SRS-22r Pain, which was a higher proportion of patients who experienced improvement than that reported for Function or Subtotal domains; this finding suggests that extensive corrective fusion from the thoracic spine to the pelvis might be an effective approach to pain management in patients with ASD.

Revision surgery did not affect outcomes assessed with SRS-22r Function and Subtotal socre; however, it tended to decrease the likelihood of achieving MCID. The majority of patients who require revision surgery experience mechanical complications such as rod breakage and PJF; efforts to minimize the incidence of these complications are required.[36-38] In this study, the rate of revision surgery was 29.8% at 2 years after the index surgery, which is consistent with previous reports[39,40]; nevertheless, such a revision surgery rate is not sustainable from either a clinical or an economic standpoint.

This study has some limitations. First, it was a single-center study; therefore, the present findings might have limited generalizability. Second, different types of ASD were included in this study, creating a sample of patients with heterogeneous disease etiology. Third, the follow-up period was short, and cases of revision surgery might have occurred after 2 years. Therefore, a long-term prospective study is required to replicate the present findings.

CONCLUSION

Achieving MCID for SRS-22r domains 2 years after extensive fusion surgery for ASD was significantly associated with poor preoperative HRQOL scores in the present study. Achieving postoperative global sagittal alignment increased the likelihood of achieving MCID for the SRS-22r Subtotal domain. Revision surgery negatively affected the likelihood of achieving MCID for SRS-22r domains and therefore risks associated with need of revision surgery should be minimized.

Table 1 Demographic and clinical characteristics of patients undergoing extensive corrective fusion surgery for adult spinal deformity

Number	167
Age (years)	67.5 ± 9.9
Female N (%)	144 (86)
Body Mass Index (kg/m^2)	23.0 ± 3.8
Charlson Comorbidity Index	0.4 ± 0.8
ASA classification	1.9 ± 0.4
Pathology	
Degenerative kyphoscoliosis	79 (47%)
Degenerative kyphosis	39 (23%)
Kyphosis after vertebral fracture	20 (12%)
Adult scoliosis	15 (9%)
Iatrogenic kyphosis	11 (7%)
Other	3 (2%)

* Mean values are presented as mean ± SD. ASA, American Society of Anaesthesiologists. We defined scoliosis that started during teen years and progressed to adulthood as adult scoliosis. We defined kyphoscoliosis or kyphosis that developed during adulthood and that caused by the degeneration of spinal structures as adult degenerative kyphoscoliosis or degenerative kyphosis scoliosis.

Table 2. Radiographic findings and clinical outcomes 2 years after surgery among patients undergoing extensive corrective fusion surgery for adult spinal deformity

Parameter	Baseline	2 years post-surgery	Improvement (%)	The proportion of patients achieving MCID 2-years post-operatively (%)	P-value*†
Radiographic parameters					
Thoracic kyphosis (°)	25.3 ± 20.2	44.1 ± 17.2			<0.001
Lumbar lordosis (°)	11.3 ± 21.0	42.6 ± 12.5			<0.001
Pelvic tilt (°)	35.1 ± 11.6	25.5 ± 9.5			<0.001
Pelvic incidence minus lumbar lordosis (°)	40.3 ± 21.9	11.1 ± 14.5			<0.001
Sagittal vertical axis (mm)	113.5 ± 78.1	57.2 ± 55.7			<0.001
Clinical outcome parameters					
SRS-22r Function	2.61 ± 0.71	3.26 ± 0.77	31.8	36.5	<0.001
SRS-22r Pain	3.00 ± 0.90	3.83 ± 0.85	36.7	46.1	<0.001
SRS-22r Self-image	2.03 ± 0.72	3.39 ± 0.81	84.8	61.1	<0.001
SRS-22r Mental	2.54 ± 0.92	3.39 ± 0.88	49.8	56.9	<0.001
SRS-22r Satisfaction	NA	3.56 ± 0.85	NA	NA	
SRS-22r Subtotal	2.53 ± 0.61	3.47 ± 0.67	43.4	44.3	<0.001

Values are presented as mean ± SD. Bold type indicates statistical significance. †Comparison between parameters at baseline and 2 years after surgery. NA, not applicable; MCID, minimum clinically important difference; SRS, scoliosis research society. Improvement rate: 100 × [postoperative value – baseline value]/baseline value for SRS-22r each domain.

Table 3 Factors affecting functional outcomes in patients undergoing extensive corrective fusion surgery for adult spinal deformity 2-years post-operatively

Variable	Odds Ratio	P -value	95% confidence interval	
			Lower limit	Upper limit
Age	0.958	0.053	0.918	1.001
Sex	1.594	0.435	0.494	5.139
Body Mass Index	1.006	0.910	0.900	1.125
Charlson Comorbidity Index	0.712	0.185	0.431	1.176
Preoperative SRS-22r Function	**0.204**	**0.000**	**0.105**	**0.396**
Preoperative SVA	1.007	0.096	0.999	1.016
Preoperative PT	1.023	0.377	0.972	1.078
Preoperative PI -LL	0.974	0.118	0.942	1.007
Postoperative SVA	0.990	0.071	0.978	1.001
Postoperative PT	1.020	0.577	0.952	1.092
Postoperative PI -LL	1.016	0.581	0.962	1.072
No. of fused vertebrae	1.118	0.304	0.903	1.385
Revision Surgery	0.403	0.080	0.146	1.114

Bold type indicates statistical significance. SRS, scoliosis research society. A positive value for sex indicates that females were more likely to achieve MCID than were males.

Table 4 Factors affecting pain outcomes in patients undergoing extensive corrective fusion surgery for adult spinal deformity 2-years post-operatively

Variable	Odds Ratio	P -value	95% confidence interval	
			Lower limit	Upper limit
Age	0.985	0.443	0.946	1.024
Sex	0.933	0.901	0.310	2.808
Body Mass Index	1.022	0.703	0.916	1.140
Charlson Comorbidity Index	0.990	0.968	0.621	1.579
Preoperative SRS-22r Pain	**0.205**	**0.000**	**0.117**	**0.361**
Preoperative SVA	1.000	0.898	0.992	1.007
Preoperative PT	0.995	0.840	0.944	1.048
Preoperative PI -LL	1.004	0.802	0.973	1.036
Postoperative SVA	0.996	0.453	0.986	1.007
Postoperative PT	1.007	0.848	0.937	1.082
Postoperative PI -LL	1.001	0.975	0.948	1.056
No. of fused vertebrae	1.026	0.828	0.816	1.290
Revision Surgery	0.757	0.557	0.299	1.916

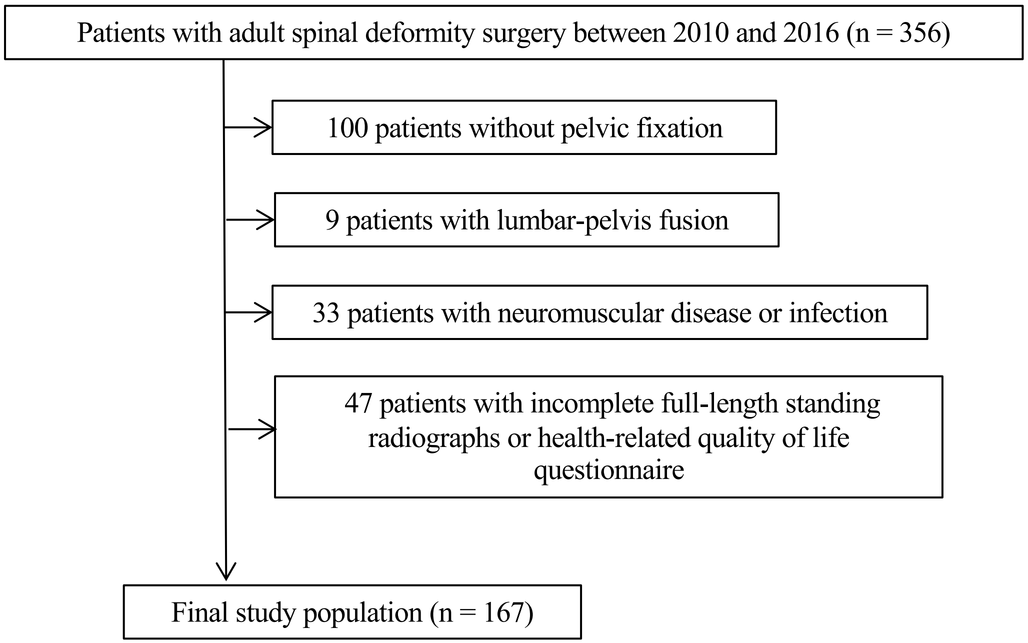
Bold type indicates statistical significance. SRS, scoliosis research society. A positive value for sex indicates that females were more likely to achieve MCID than were males.

Table 5 Factors affecting subtotal outcomes in patients undergoing extensive corrective fusion surgery for adult spinal deformity 2-years post-operatively

Variable	Odds Ratio	P -value	95% confidence interval	
			Lower limit	Upper limit
Age	0.985	0.471	0.947	1.026
Sex	1.768	0.318	0.577	5.413
Body Mass Index	1.055	0.341	0.945	1.178
Charlson Comorbidity Index	0.868	0.559	0.540	1.395
Preoperative SRS-22r Subtotal	**0.211**	**0.000**	**0.107**	**0.413**
Preoperative SVA	1.005	0.164	0.998	1.013
Preoperative PT	**1.072**	**0.018**	**1.012**	**1.136**
Preoperative PI -LL	**0.965**	**0.035**	**0.934**	**0.997**
Postoperative SVA	**0.985**	**0.005**	**0.974**	**0.995**
Postoperative PT	0.936	0.077	0.871	1.007
Postoperative PI -LL	1.053	0.060	0.998	1.111
No. of fused vertebrae	0.952	0.650	0.768	1.179
Revision Surgery	0.390	0.054	0.150	1.016

Bold type indicates statistical significance. SRS, scoliosis research society. A positive value for sex indicates that females were more likely to achieve MCID than were males.

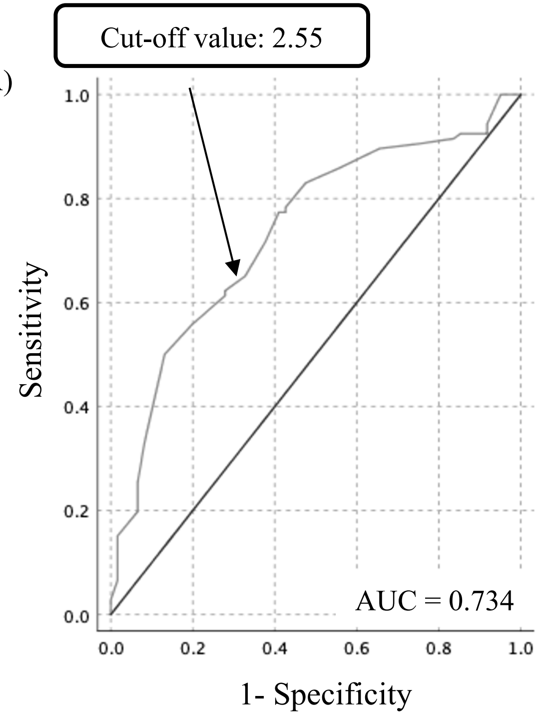
Figure 1



Patients with adult spinal deformity surgery between 2010 and 2016 (n = 356)
100 patients without pelvic fixation
9 patients with lumbar-pelvis fusion
33 patients with neuromuscular disease or infection
47 patients with incomplete full-length standing radiographs or health-related quality of life questionnaire
Final study population (n = 167)

Figure 2

(A)



Cut-off value: 2.55
1.0
0.8
0.6
0.4
0.2
0.0
Sensitivity
AUC = 0.734
0.0
0.2
0.4
0.6
0.8
1.0
1- Specificity

Figure 2

(B)

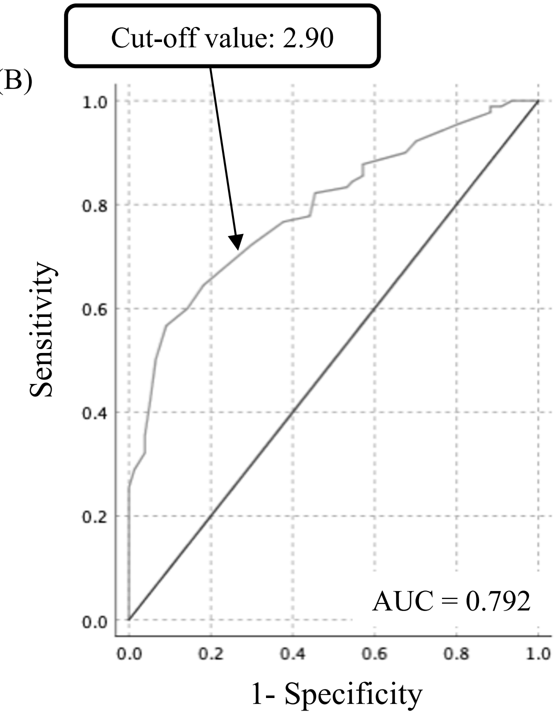
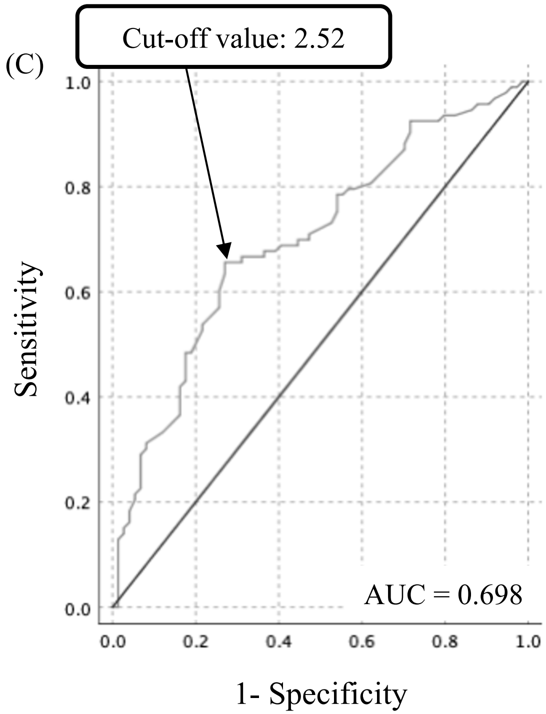

Cut-off value: 2.90
1.0
0.8
0.6
0.4
0.2
0.0
Sensitivity
0.0
0.2
0.4
0.6
0.8
1.0
1- Specificity
AUC = 0.792

Figure 2


Cut-off value: 2.52
(C)
Sensitivity
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0
AUC = 0.698
1- Specificity