

Research Paper

Midterm Outcomes and Complications of Scoliosis Correction in Adolescent Idiopathic Scoliosis: A Tertiary Center Study



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ABSTRACT

Background: Spinal fusion surgery combined with instrumentation has emerged as the gold standard for managing severe cases of adolescent idiopathic scoliosis (AIS). Although several studies have reported the advantages of this surgical procedure, the prevalence of associated complications remains controversial.

Objectives: This study aims to assess the prevalence of various complications among patients who underwent the AIS corrective surgery at Shafayahyaian Hospital.

Methods: This retrospective cohort study included AIS patients who underwent corrective surgery before 2011 at Shafayahyaian Hospital. Patients were followed up for up to five years, and variables, including demographic data, surgical outcomes, and postoperative complications, were assessed during this period.

Results: A total of 95 patients with a mean age of 13.62 ± 2.69 years at the time of scoliosis diagnosis were evaluated. Among them, 13 patients (13.68%) were men, and 20 patients (21.05%) underwent corrective surgery for anterior-posterior scoliosis, while 75 patients (78.95%) underwent corrective surgery for posterior scoliosis. Postoperative complications included surgical site infection (6.3%), pain (2.1%), and implant-related complications (5.2%). Most patients (82.1%) reported no back pain during the 5-year postoperative period.

Conclusion: Scoliosis corrective surgery in AIS patients has beneficial outcomes. Although complications may occur, they are rare and do not outweigh the advantages of surgery.

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Introduction

Adolescent idiopathic scoliosis (AIS) is the primary cause of spinal deformities in the pediatric population. Extensive research has explored the natural progression of AIS and devising effective treatment methodologies [1-3]. Among these, spinal fusion surgery combined with instrumentation has emerged as the gold standard for managing severe cases of scoliosis [4]. However, this surgical procedure poses a physiological burden on healthy adolescents and requires a delicate balance between achieving correction and potential loss of mobility. While traditional evaluation methods have relied on radiographic parameters to assess the efficacy of spinal fusion, there is a growing emphasis on incorporating patient-reported quality-of-life assessments as primary indicators of treatment success [5, 6].

Advancements in AIS surgery introduced pedicle screw technology, offering improved three-dimensional orthopedic effects with fewer segments involved compared to complete hook techniques [7]. Pedicle screw instrumentation, particularly effective for patients with presurgical Cobb angles of less than 60 degrees, has shown safety and efficacy in correcting frontal and sagittal plane deformities [8]. Despite requiring one more integrated segment, posterior surgery with pedicle screws demonstrated comparable outcomes to anterior surgery, although with decreased surgical risks and shorter hospital stays [9]. This shift in favor of posterior surgery was attributed to reduced complications and surgical injury [10, 11].

Based on the above information and the importance of the patient's outcome and surgical technique in AIS, we conducted a retrospective cohort analysis of AIS cases treated at our hospital before 2011 to compare the advantages and disadvantages and evaluate the patients' postoperative complications and outcomes.

Methods

This retrospective cohort study employed a census sampling method, enrolling all patients diagnosed with AIS who underwent corrective surgery at [Shafayahaieyan Hospital](#) before 2011. The inclusion criteria included patients diagnosed with AIS by a spine subspecialist who underwent posterior spinal fusion (PSF) or anterior spinal fusion (ASF) surgery. The exclusion criteria included patients with congenital, neuromuscular, or infantile scoliosis, a history of previous spine surgeries, such as discectomy, and the presence of diseases, such as rheumatoid arthritis and diabetes, that may affect surgical outcomes.

Data collection involved reviewing patients' hospital and follow-up records. The collected data included demographic information at the time of surgery, including age, sex, occupation, educational level, sports activities, marital status, number of children, type of surgical procedure, presence or absence of back pain, Cobb angle before and after surgery, and during follow-up visits.

Patients were followed for up to five years, and postoperative complications following five years after corrective surgery were also collected, including history of reoperation due to involvement of upper or lower parts, proximal junctional kyphosis/distal junctional kyphosis, reoperation history due to device failure, history of infection, reoperation history due to pain or nonunion, history of prominence of subcutaneous device, history of device removal, and patient satisfaction.

Statistical analysis

Data were entered and analyzed using SPSS software, version 26. The results are presented as frequencies and percentages (%) for qualitative variables and as Mean±SD for quantitative variables. The normality of data distribution was assessed using the Kolmogorov-Smirnov test. The relationships between variables were assessed using chi-square and independent t-test for normally distributed data and nonparametric tests, such as Mann-Whitney and Wilcoxon ranked test for non-normally distributed data. Statistical significance was set at $P < 0.05$.

Results

A total of 95 patients were evaluated in our study. The mean age of patients at the time of scoliosis diagnosis ranged from 10 to 25 years (Mean±SD 13.62±2.69 years), and 13 patients (13.68%) were men. Among these, 20 patients (21.05%) underwent corrective surgery for anterior-posterior scoliosis, and 75 (78.95%) underwent corrective surgery for posterior scoliosis. Patients were followed up for an average of 6.63±3.2 years. [Table 1](#) presents the demographical and clinical features of the patients included in our study.

The mean Cobb angle before corrective surgery in patients was 49.99±13.61°, which decreased to 16.79±8.09° postoperatively. The average decrease was 33.20±10.71°. Based on the Wilcoxon signed rank test analysis, this decrease was statistically significant ($P < 0.001$). Furthermore, no relationship was observed between the amount of Cobb angle decrease with the surgery method ($P = 0.090$), patient age ($P = 0.768$), gender ($P = 0.101$), and BMI ($P = 0.068$).

Table 1. Background characteristics of AIS patients (n=95)

Variables		Mean±SD/No. (%)
Gender	Male	13(13.7)
	Female	82(86.3)
Age (y)	Time of diagnosis	13.6±2.7
	Time of surgery	17.1±4.8
Body mass index (kg/m ²)		19.7±3.9
Occupation	Student	84(88.4)
	Employee	1(1.1)
	Home keeper	10(10.5)
Surgery type	ASF	20(21.1)
	PSF	75(78.9)
Cobb angle (degree), median (Q1–Q3)	Pre-operation	47.6 (40.4 – 54.9)
	Post-operation	15.2 (11.0 – 22.3)
Postoperative back pain	No	75(81.5)
	Weekly	6(6.5)
	Monthly	10(10.9)
	Always	1(1.1)
Postoperative complication	No	82(86.3)
	Instrument related complication	5(5.3)
	Surgical site infection	6(6.3)
	Surgical site pain	2(2.1)
Postoperative exercise	No	74(77.9)
	Occasionally	18(19.0)
	Semi-professional	2(2.1)
	Professional	1(1.1)

Regarding the patients' postoperative complications, midterm complications (6.63±3.2 years postoperatively) in the study patients included surgical site infection (SSI) (6 cases, 6.3%), surgical site pain (2 cases, 2.1%), and instrument-related complications (5 cases, 5.2%) (Table 2).

After corrective surgery, one patient (1.05%) reported continuous and daily back pain, six patients (6.31%) reported weekly back pain, 10 patients (10.52%) reported monthly back pain, and the remaining patients (78 out

of 95, 82.1%) reported no back pain during the 5-year postoperative period. Furthermore, one patient (1.05%) engaged in professional sports, two patients (2.1%) engaged in semi-professional sports, 17 patients (17.89%) engaged in occasional and recreational sports, and the remaining patients (75 of 95, 78.94%) reported no physical activity (Table 2).

Table 2. Postoperative features and complications of AIS patients undergoing scoliosis corrective surgery (n=95)

Variables	No. (%)	
Back pain	No	75(81.5)
	Weekly	6(6.5)
	Monthly	10(10.9)
	Always	1(1.1)
Complication	No	82(86.3)
	Instrument related complication	5(5.3)
	Surgical site infection	6(6.3)
	Surgical site pain	2(2.1)
Exercise	No	74(77.9)
	Occasionally	18(19.0)
	Semi-professional	2(2.1)
	Professional	1(1.1)

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Discussion

This study investigated the frequency of complaints and complications experienced by patients during five years of corrective surgery for scoliosis and the associated factors, including the patient's age, sex, and type of surgical procedure. In summary, our study underscores the effectiveness of fusion-based surgery for correcting scoliosis in adolescents, as evidenced by reduced Cobb angle and alleviated postoperative issues. Nonetheless, undergoing surgery does not automatically result in heightened physical activity or increased engagement in exercise.

The primary quantitative measure used to assess scoliosis correction was the change in the Cobb angle. Regardless of the surgical technique employed, the postoperative Cobb angle was significantly reduced compared to the initial angle in all patients, indicating the success of surgical intervention in addressing this issue. Despite the higher prevalence of the posterior surgical approach than the anterior-posterior approach, no significant difference was observed in the postoperative Cobb angle correction. This result is consistent with previous studies and underscores the effectiveness of fusion-based surgical approaches in treating scoliosis.

Early SSI following AIS surgery is observed at a rate of 1.6% [12]. The federal directive aimed at eradicating SSIs and the potential withholding of reimbursements for their treatment could prompt shifts in clinical protocols. The results of a study by Marks et al. [12] offer benchmark SSI rates aggregated from various centers, facilitating future comparisons. Analyzing practice disparities among centers may reveal areas warranting enhancement to minimize SSIs in patients with AIS. Encouragingly, 92% of patients maintained their implants and remained pain-free at the last follow-up assessment [12]. In our study, complaints reported by patients postoperatively over five years were primarily related to infection and postoperative pain, albeit infrequently. Commonly reported complaints, such as those related to implant sensations, are rare. The incidence of postoperative complaints related to corrective surgery for scoliosis is low. Sensations associated with implanted devices, including feelings of foreign objects in the body, have occasionally been reported and may require further examination by researchers in future studies.

Back pain is a common complaint in AIS. Danielsson et al. reported that back pain is a prevalent issue affecting three-quarters of adolescents diagnosed with idiopathic scoliosis. However, PSF has also been shown to reduce pain. Factors, such as being overweight, older age, and larger proximal thoracic curve magnitudes are associat-

ed with greater preoperative pain. Additionally, patients who perceive themselves as more deformed experience higher levels of pain and may have less postoperative pain relief [13]. As expected, the prevalence of postoperative back pain was minimal, and most patients reported either no pain or occasional monthly discomfort. Given the high prevalence of back pain in the general population worldwide, factors other than surgical intervention may contribute to postoperative discomfort, including pre-existing back pain in patients. The primary therapeutic goal of scoliosis surgery is symptom relief and functional restoration, as evidenced by the study's results indicating successful surgical outcomes for patients at our center.

Bridwell et al. highlighted that the primary motivation for undergoing AIS surgery is often the anticipation of reducing future pain and disability in adulthood [14]. However, long-term follow-up studies from 5 to 20 years do not convincingly demonstrate these expectations. Furthermore, inconclusive evidence indicates that improved radiographic outcomes translate into enhanced function, self-image, or overall health [15, 16]. Despite adolescents with AIS potentially experiencing significant psychological distress, body image concerns, and other health-related quality-of-life issues, these issues diminish with transition into adulthood [17]. An analysis of postoperative physical activity levels revealed that most patients did not engage in any physical exercise. This result may be attributed to various reasons, including physician recommendations to avoid exercise, patients' fear of exacerbating symptoms, back pain, inability to perform exercises, and family and caregivers' recommendations.

Conclusion

In conclusion, this study demonstrates the success of fusion-based scoliosis corrective surgery in adolescents, reducing Cobb angle and mitigating postoperative complaints. However, surgical interventions do not necessarily increase physical activity or exercise engagement.

Our study had several limitations. First, the sample size was small, and the study was conducted at a single center. Additionally, our study's retrospective nature limits data collection and analysis. Further research is needed to overcome these limitations and obtain more robust results. Specifically, multicenter studies involving larger populations provide comprehensive insights. Moreover, randomized clinical trials offer a more rigorous evaluation of the effects of different treatment methods and variables on patient outcomes.

Ethical Considerations

Compliance with ethical guidelines

The Institutional Review Board of **Iran University of Medical Sciences** approved the study. The university administrators were asked for permission to conduct the study and access the patient's records. The study complied with the relevant guidelines and regulations and the Declaration of Helsinki and was approved by the Ethics Committee of **Iran University of Medical Sciences**, Tehran, Iran.

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Authors' contributions

All authors contributed equally to the conception and design of the study, data collection and analysis, interception of the results and drafting of the manuscript. Each author approved the final version of the manuscript for submission.

Conflict of interest

The authors declared no conflict of interest.

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