ORIGINAL RESEARCH

A Comparative Study of Surgical vs. Conservative Treatment for Adolescent Idiopathic Scoliosis

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Received: 22 January, 2021

Accepted: 27 February, 2021

ABSTRACT

Aim: This study aimed to compare the outcomes of surgical versus conservative treatment for adolescent idiopathic scoliosis (AIS) in terms of curve correction, pain management, functional recovery, and patient satisfaction. Material and Methods: Eighty patients aged 10 to 18 years diagnosed with AIS were included and divided into two groups: the surgical treatment group (n=40) and the conservative treatment group (n=40). The surgical group underwent posterior spinal fusion, while the conservative group received bracing and physical therapy. The inclusion criteria required patients with curves of at least 20° and curve progression. Follow-up assessments were conducted at 6 months, 1 year, and 2 years, where spinal curvature, pain levels, mobility, and quality of life were evaluated. Statistical analyses were performed with a significance threshold of $p < 10^{-10}$ 0.05. Results: The surgical group exhibited significantly better outcomes compared to the conservative group. By 2 years, the surgical group showed a mean curve of 8.1° , while the conservative group had 27.2° (p < 0.01). Pain scores in the surgical group decreased from 7.2 to 1.1, compared to the conservative group, which dropped from 7.3 to 4.1 (p < 0.01). Functional recovery, measured through mobility and quality of life, was notably superior in the surgical group, with mean scores of 7.8 and 8.6, respectively, compared to 5.4 and 6.8 in the conservative group (p < 0.01). Additionally, patient satisfaction was significantly higher in the surgical group across all measures, including curve improvement (95% vs. 55%), pain relief (92.5% vs. 60%), functional recovery (90% vs. 57.5%), and overall satisfaction (85% vs. 60%). Conclusion: Surgical treatment for AIS resulted in superior outcomes in terms of curve correction, pain relief, functional recovery, and patient satisfaction compared to conservative management. While bracing can be effective in preventing curve progression in mild cases, surgery provides more substantial and sustained improvements, especially in moderate to severe cases. These findings highlight the importance of personalized treatment strategies and early intervention for optimal patient care in AIS management.

Keywords: Adolescent idiopathic scoliosis, surgical treatment, conservative treatment, curve correction, patient satisfaction This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-Non Commercial-Share Alike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

INTRODUCTION

Adolescent Idiopathic Scoliosis (AIS) is a spinal deformity that affects adolescents during their growth spurt, usually between the ages of 10 and 18 years. It is characterized by an abnormal lateral curvature of the spine, often accompanied by vertebral rotation. The exact cause of AIS remains largely unknown, although genetic, hormonal, and environmental factors are believed to contribute to its development. The condition is more common in females than males, and the severity of the deformity varies greatly, ranging from mild curves that do not progress to severe curves that cause significant physical deformity and, in some cases, complications such as respiratory or cardiovascular problems. If left

untreated, severe scoliosis can lead to reduced quality of life and increased disability due to pain, deformity, and functional limitations.¹

The management of AIS can be broadly categorized into conservative and surgical treatment options, both of which aim to halt or reduce the progression of the spinal curvature. Conservative treatments, such as bracing and physical therapy, are typically recommended for patients with mild to moderate curves (usually between 20° and 40°), while surgical intervention is generally reserved for patients with more severe curves or those in whom conservative treatment fails to prevent progression. The decision regarding which treatment modality to pursue is influenced by multiple factors, including the severity

Online ISSN: 2250-3137 Print ISSN: 2977-0122

of the curve, the patient's age, the risk of progression, and their overall health status.²

Bracing is the most commonly used conservative treatment for AIS. The primary goal of bracing is to prevent curve progression, particularly during the rapid growth phase of adolescence. A variety of braces are available, with the most common being the thoracolumbosacral orthosis (TLSO), which is designed to apply corrective forces to the spine and prevent further deformity. Although bracing has been shown to be effective in preventing curve progression in some cases, it does not correct the curve, and its long-term success depends on patient compliance, the timing of the intervention, and the degree of curve at the time of treatment initiation. Physical therapy may also be prescribed to help manage symptoms and improve posture, flexibility, and strength. While these interventions are less invasive, they are not always sufficient for more severe cases or in patients whose curves continue to progress despite treatment.³

On the other hand, surgical treatment for AIS typically involves spinal fusion, a procedure where two or more vertebrae are joined together using bone grafts or other materials to prevent further curvature. In some cases, instrumentation, such as rods, screws, and hooks, is used to provide additional support and alignment during the fusion process. Surgery is generally recommended for patients with curves greater than 40° to 50° or for those with curves that continue to progress despite conservative treatment. The main goals of surgery are to correct the spinal deformity, prevent further progression, and improve the patient's overall quality of life by alleviating pain, improving appearance, and enhancing functional capacity. While surgical outcomes have generally been favorable, the procedure carries risks, including infection, nerve damage, hardware complications, and the potential need for additional surgeries in the future. Furthermore, surgery requires a longer recovery time and significant post-operative rehabilitation.4

The choice between conservative and surgical treatment is often a difficult one, requiring careful consideration of the potential benefits and risks associated with each approach. Factors such as the patient's age, skeletal maturity, curve severity, and personal preferences must all be taken into account. In general, conservative treatment is preferred for patients with mild to moderate scoliosis, as it is non-invasive and carries fewer risks. However, for patients with severe curves or those who do not respond to conservative treatments, surgery may be the only viable option to prevent further progression and improve quality of life.⁵

Although both conservative and surgical treatments have been studied extensively, there remains a need for more comprehensive and long-term comparative studies to determine the relative effectiveness of these approaches. While many studies have demonstrated the efficacy of surgical intervention in correcting spinal deformities and improving outcomes such as pain relief, mobility, and quality of life, the role of conservative treatments, particularly bracing, remains controversial. Some studies suggest that bracing is effective in preventing curve progression in certain patients, particularly those who are still growing, while other research has shown that the benefits of bracing are limited and that many patients experience curve progression despite consistent use of the brace. Similarly, while spinal fusion surgery has proven to be effective in reducing curvature and improving function, it also comes with significant risks and a lengthy recovery period, which can affect a patient's overall well-being and ability to return to normal activities.^{6,7}

Given these considerations, it is essential to better understand how surgical and conservative treatments compare in terms of long-term outcomes. This includes not only the effectiveness of each treatment in terms of curve correction, pain relief, and functional recovery but also the impact on patient satisfaction, psychological well-being, and overall quality of life. By systematically comparing the outcomes of these two approaches, clinicians will be better equipped to make informed decisions about treatment options, providing patients with the best possible care tailored to their individual needs.^{8,9}

MATERIAL AND METHODS

In this comparative study, a total of 80 patients diagnosed with Adolescent Idiopathic Scoliosis (AIS) were enrolled, with the aim of evaluating the outcomes of surgical versus conservative treatment approaches. The study included patients aged 10 to 18 years, with confirmed AIS based on clinical evaluation and radiographic imaging. The cohort was divided into two groups: the surgical treatment group (n = 40) and the conservative treatment group (n = 40). The surgical treatment group consisted of patients who underwent spinal fusion surgery, and the conservative group included patients who received non-surgical management, such as bracing and physiotherapy, as per standard clinical guidelines for AIS management.

The inclusion criteria for both groups required that the patients had a curve of at least 20° and a progression of the curve over time. Additionally, only patients without any significant comorbidities or previous spinal interventions were selected. For the surgical group, the procedure involved posterior spinal fusion, with or without instrumentation, depending on the severity of the curve. Post-surgery, patients followed a standardized rehabilitation protocol that included pain management, mobility exercises, and gradual return to physical activity. The conservative treatment group underwent a combination of a custom-molded brace worn for a specified duration daily and a structured physical therapy program aimed at improving posture and spinal alignment.

Follow-up assessments were conducted at 6 months, 1 year, and 2 years post-treatment, during which radiographs were taken to monitor changes in spinal curvature, and clinical evaluations were performed to assess pain levels, mobility, and quality of life. Outcomes from both groups were compared in terms of scoliosis progression, pain management, functional recovery, and patient satisfaction. Statistical analysis was conducted to determine the significance of differences between the two treatment modalities, using a p-value of <0.05 as the threshold for statistical significance. This study adhered to ethical guidelines, and informed consent was obtained from all patients or their guardians prior to participation.

RESULTS

Table 1: Demographic Characteristics of Patients

Table 1 presents the demographic data of the 80 patients who participated in the study, split into two treatment groups: surgical (n=40) and conservative (n=40). The average age of patients in the surgical group was 14.8 years, and 15 were male while 25 were female. In the conservative group, the mean age was slightly higher at 15.1 years, with 16 males and 24 females. The difference in age and gender distribution between the two groups was not statistically significant, with p-values of 0.62 and 0.80, respectively. The initial curve degree was nearly identical between the two groups (38.2° for the surgical group and 37.9° for the conservative group), and the p-value of 0.90 further confirms that there was no significant difference in the severity of the scoliosis at the time of treatment. All patients in both groups were followed up for a duration of 24 months, which was consistent across both groups (p-value = 1.00), ensuring comparable long-term outcomes.

Table 2: Spinal Curve Changes Over Time

Table 2 tracks the changes in spinal curvature over a period of 2 years. Both groups showed significant improvement in spinal curve correction, but the surgical group experienced a more substantial reduction in curve degree. At baseline, the surgical group had a mean curve of 38.2°, while the conservative group had a mean of 37.9°, and no significant difference was observed between the groups (p-value = 0.90). At the 6-month follow-up, surgical group demonstrated a marked the improvement, with a mean curve reduction to 12.4°, whereas the conservative group had only a modest improvement to 32.1° (p-value < 0.01). This trend continued at 1 year, where the surgical group had an average curve of 10.3° , compared to 28.6° in the conservative group (p-value < 0.01). By 2 years, the surgical group showed an even further reduction in the curve, with a mean of 8.1°, whereas the conservative group had a curve of 27.2° (p-value < 0.01). These results clearly indicate that surgical treatment resulted in more effective and sustained curve correction compared to conservative management.

Table 3: Pain Management Outcomes

Table 3 evaluates pain management in both groups over time. At baseline, the surgical group reported an average pain score of 7.2, while the conservative group had a slightly higher score of 7.3, which was not statistically significant (p-value = 0.85). After 6 months, the surgical group reported a significant reduction in pain, with a mean pain score of 3.5, while the conservative group showed a smaller reduction, with a score of 5.9 (p-value < 0.01). Similarly, at 1 year, the surgical group's pain score dropped further to 2.2, while the conservative group's pain score was 4.7 (p-value < 0.01). By 2 years, the surgical group reported minimal pain, with an average score of 1.1, whereas the conservative group still had a pain score of 4.1 (p-value < 0.01). These results highlight that the surgical treatment led to significantly better pain relief compared to conservative management over the 2-year period.

Table 4: Functional Recovery (Mobility and
Quality of Life)

Table 4 assesses the functional recovery of patients in both groups, focusing on mobility and quality of life scores. At baseline, there was no significant difference in the mobility scores between the groups, with the surgical group at 3.2 and the conservative group at 3.3 (p-value = 0.88). However, at the 2-year follow-up, the surgical group showed significantly better mobility, with a mean score of 7.8, compared to the conservative group's score of 5.4 (p-value < 0.01). Regarding quality of life, the surgical group had a baseline score of 5.1, and the conservative group had a score of 5.2, with no significant difference (p-value = 0.75). After 2 years, the surgical group showed a considerable improvement in quality of life, with a score of 8.6, whereas the conservative group had a lower improvement at 6.8 (p-value < 0.01). These findings suggest that surgical treatment contributed significantly more to functional recovery, both in terms of mobility and overall quality of life, compared to conservative treatment.

Table 5: Patient Satisfaction and Outcomes

Table 5 presents the outcomes from a satisfaction perspective, with both the number and percentage of patients reporting improvements. In the surgical group, 95% of patients (38 out of 40) experienced improvement in their curve, compared to only 55% of patients (22 out of 40) in the conservative group (p-value < 0.01). Regarding pain relief, 92.5% of the surgical group (37 out of 40) reported relief, while only 60% of the conservative group (24 out of 40) did (p-value < 0.01). Functional recovery was also superior in the surgical group, with 90% (36 out of 40) of patients reporting functional improvement, compared to 57.5% (23 out of 40) in the conservative

group (p-value < 0.01). Finally, overall patient satisfaction was higher in the surgical group, with 85% (34 out of 40) of patients satisfied, compared to 60% (24 out of 40) in the conservative group (p-value

< 0.01). These results indicate a clear preference for surgical intervention, as it resulted in significantly higher levels of patient satisfaction across all assessed outcomes.

Table 1: Demographic Characteristics of Patients

Characteristic	Surgical Group (n=40)	Conservative Group (n=40)	p-value
Age (mean ± SD)	14.8 ± 2.4	15.1 ± 2.1	0.62
Gender (M/F)	15/25	16/24	0.80
Initial Curve Degree (mean ± SD)	38.2 ± 6.7	37.9 ± 7.4	0.90
Duration of Follow-up (months)	24	24	1.00

Table 2: Spinal Curve Changes Over Time

Timepoint	Surgical Group (mean	Conservative Group (mean	p-value
	curve degree ± SD)	curve degree ± SD)	
Pre-treatment	38.2 ± 6.7	37.9 ± 7.4	0.90
6 Months	12.4 ± 4.2	32.1 ± 5.5	< 0.01
1 Year	10.3 ± 3.9	28.6 ± 5.1	< 0.01
2 Years	8.1 ± 3.2	27.2 ± 5.6	< 0.01

Table 3: Pain Management Outcomes

Timepoint	Surgical Group (mean pain score ± SD)	Conservative Group (mean pain score ± SD)	p-value
Pre-treatment	7.2 ± 1.5	7.3 ± 1.4	0.85
6 Months	3.5 ± 1.1	5.9 ± 1.8	< 0.01
1 Year	2.2 ± 0.9	4.7 ± 1.6	< 0.01
2 Years	1.1 ± 0.6	4.1 ± 1.7	< 0.01

Table 4: Functional Recovery (Mobility and Quality of Life)

Measure	Surgical Group	Conservative Group	p-value
	(mean score ± SD)	(mean score ± SD)	
Mobility Score (Pre)	3.2 ± 1.0	3.3 ± 1.1	0.88
Mobility Score (2 Years)	7.8 ± 1.1	5.4 ± 1.3	< 0.01
Quality of Life (Pre)	5.1 ± 1.3	5.2 ± 1.4	0.75
Quality of Life (2 Years)	8.6 ± 0.9	6.8 ± 1.2	< 0.01

Table 5: Patient Satisfaction and Outcomes

Outcome	Surgical	Surgical	Conservative	Conservative	p-value
	Group (n=40)	Group (%)	Group (n=40)	Group (%)	
Improvement in Curve	38	95.00%	22	55.00%	< 0.01
Pain Relief	37	92.50%	24	60.00%	< 0.01
Functional Recovery	36	90.00%	23	57.50%	< 0.01
Overall Satisfaction	34	85.00%	24	60.00%	< 0.01

DISCUSSION

The findings of this study provide a comprehensive comparison between surgical and conservative treatment approaches for adolescent idiopathic scoliosis (AIS), contributing valuable data regarding curve correction, pain management, functional recovery, and patient satisfaction.

The mean age of patients in this study was comparable between the surgical (14.8 years) and conservative (15.1 years) groups, with no statistically significant differences in gender distribution or initial curve degree. This is consistent with findings by **Yeldan et al. (2012)**, who reported that age and gender were similar across surgical and conservative groups, ensuring comparability at baseline. Moreover, the lack of significant differences in curve severity between groups further supports the robustness of the initial cohort selection, as both groups were at similar stages of scoliosis.¹⁰

The most notable finding in this study is the superior curve correction achieved through surgical intervention. A clear and significant difference in curve reduction between the surgical and conservative groups at each timepoint. By 2 years, the surgical group exhibited a mean curve of 8.1° , a substantial improvement compared to the conservative group's mean of 27.2° . These results are consistent with **Smith et al. (2011)**, who also reported greater spinal correction in surgical patients, with a similar 2-year follow-up showing a mean curve reduction of 28.6° for surgery compared to a modest 16° in the conservative group . Such findings underline the efficacy of surgery in preventing curve progression and achieving long-term spinal alignment in AIS patients.¹¹

At 2 years, the surgical group reported a mean pain score of 1.1, a marked contrast to the 4.1 score in the conservative group. These findings are in line with **Williams et al. (2010)**, who noted that surgical treatment for AIS often results in long-term reductions in pain, with a similar reduction in pain scores over 24 months. Conservative treatments, including bracing, often fail to provide the same level of sustained pain relief, which may explain the persistently higher pain scores observed in the conservative group. These differences emphasize the advantages of surgery, particularly for patients who experience significant pain due to scoliosis.¹²

In terms of functional recovery, the results in Table 4 indicate that the surgical group showed significant improvements in both mobility and quality of life after 2 years, with mean scores of 7.8 for mobility and 8.6 for quality of life, compared to 5.4 and 6.8, respectively, in the conservative group. These findings are supported by Liu et al. (2013), who found that surgical intervention for AIS not only improves spinal alignment but also significantly enhances functional outcomes, including mobility and quality of life. In contrast, conservative treatments such as bracing, while effective in curve stabilization, fail to provide the same degree of functional improvement. This difference underscores the importance of considering long-term functional recovery in the management of AIS.¹³

Patient satisfaction data, with the surgical group showing significantly higher rates of satisfaction across all measures-curve improvement (95% vs. 55%), pain relief (92.5% vs. 60%), functional recovery (90% vs. 57.5%), and overall satisfaction (85% vs. 60%). These findings align with Johnson et al. (2012), who reported similar results, where 87% of surgical patients expressed overall satisfaction, compared to only 56% in the conservative group. This high level of satisfaction among surgical patients can be attributed to the overall effectiveness of the treatment in achieving clinical goals such as curve correction, pain relief, and improved functional outcomes. In contrast, conservative treatments may not meet patient expectations for improvement, contributing to lower satisfaction levels.14

CONCLUSION

In conclusion, this study demonstrates that surgical treatment for adolescent idiopathic scoliosis (AIS) leads to significantly better outcomes compared to conservative management in terms of curve correction, pain relief, functional recovery, and patient

satisfaction. While conservative treatments such as bracing can be effective in preventing curve progression in mild cases, surgery provides more substantial and sustained improvements, particularly for patients with moderate to severe scoliosis. These findings underscore the importance of early intervention and personalized treatment strategies, guiding clinicians in making informed decisions for optimal patient care in AIS management.

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