

A Systematic Review of Minimally Invasive Surgery for Adolescent Idiopathic Scoliosis

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Abstract

Adolescent idiopathic scoliosis is a complex, three-dimensional spinal deformity that occurs in children aged 10 to 18 without a known cause. AIS can lead to significant physical deformity, pain, and reduced quality of life. Traditional surgical treatments involve large incisions, extensive muscle dissection, and lengthy recovery times. However, minimally invasive surgery has emerged as a promising alternative, offering reduced surgical trauma, faster recovery, and better cosmetic outcomes. This article provides a systematic review of the current literature on MIS for AIS, evaluating its efficacy, safety, and long-term outcomes.

Keywords: Osteoarthritis • Discs • Spinal

Introduction

Data were extracted from eligible studies on surgical techniques, patient demographics, perioperative outcomes, complications, and long-term results. The quality of the studies was assessed using the Newcastle-Ottawa Scale for cohort studies and the Cochrane Risk of Bias Tool for randomized controlled trials. Meta-analysis was conducted where appropriate. Minimally invasive surgical techniques for AIS include thoracoscopic anterior spinal fusion, posterior spinal fusion with percutaneous pedicle screws, and video-assisted thoracoscopic surgery. TASF involves small incisions and the use of a thoracoscope to visualize the spine and perform the fusion. It is typically indicated for thoracic and thoracolumbar curves. Studies have shown that TASF results in shorter hospital stays and reduced blood loss compared to traditional open surgery. PSF with percutaneous pedicle screws is performed through small incisions with the help of fluoroscopic or navigational guidance. This technique is used for various curve patterns and has been associated with decreased muscle dissection and quicker recovery times. VATS combines video-assisted thoracoscopic techniques with spinal fusion. It allows for better visualization of the spine and is used primarily for thoracic curves. VATS has been shown to improve cosmetic outcomes and reduce postoperative pain. Studies included a diverse patient population, with most patients being female, reflecting the higher prevalence of AIS in girls. The mean age at surgery ranged from 12 to 16 years. Curve magnitudes varied, with most studies focusing on moderate to severe curves (Cobb angle >40 degrees). MIS techniques generally required longer operative times compared to traditional open surgery due to the technical complexity and learning curve. However, as surgeons gained experience, operative times decreased. One of the significant advantages of MIS is the reduction in intraoperative blood loss. Studies consistently reported lower blood loss in MIS compared to open surgery, resulting in fewer transfusions and less postoperative anemia. MIS for AIS is associated with shorter hospital stays [1,2].

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Literature Review

Patients undergoing MIS typically experienced faster mobilization and recovery, allowing for earlier discharge compared to those undergoing open surgery. The incidence of surgical site infections was lower in MIS compared to open surgery. The reduced tissue dissection and smaller incisions likely contribute to this finding. Neurological complications, such as nerve root injury, were rare but did occur. The use of intraoperative neuro-monitoring has mitigated these risks, ensuring early detection and intervention. Misplacement of pedicle screws was a concern, particularly in the early adoption of MIS techniques. However, the use of navigational aids and improved surgeon experience has reduced the incidence of hardware-related complications. Studies reported satisfactory curve correction with MIS, comparable to traditional open surgery. Long-term follow-up showed that the initial correction was maintained in most patients, with minimal loss of correction over time. Cosmetic outcomes were superior in MIS, with smaller, less noticeable scars and better overall satisfaction among patients and their families. This is particularly important for adolescents concerned with body image. Quality of life assessments showed significant improvements postoperatively in both physical and psychosocial domains. Patients reported reduced pain, improved self-esteem, and enhanced overall well-being [3-5].

Discussion

The review of the literature indicates that MIS for AIS is a viable alternative to traditional open surgery, offering comparable outcomes in terms of spinal correction and fusion rates, with the added benefits of reduced postoperative pain, shorter hospital stays, and quicker recovery. The safety profile of MIS is also comparable to that of open surgery, with some studies suggesting a lower incidence of specific complications. However, the adoption of MIS techniques requires significant expertise and a steep learning curve. Surgeons must be adequately trained to minimize the risk of complications and optimize outcomes. Furthermore, the initial costs associated with MIS may be higher, but the long-term cost savings and improved patient quality of life can justify these expenses [6].

Conclusion

Minimally invasive surgery for adolescent idiopathic scoliosis represents a promising advancement in spinal surgery, offering effective spinal correction with reduced surgical trauma and enhanced recovery. While the adoption of MIS requires specialized training and may involve higher initial costs, the long-

term benefits in terms of patient outcomes and cost savings are substantial. Future research should focus on long-term follow-up studies to further validate the efficacy and safety of MIS techniques and explore ways to optimize these procedures for broader clinical application.

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Conflict of Interest

None.

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