The Role of Rehabilitation in the Management of Adolescent Idiopathic Scoliosis

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ABSTRACT

Adolescent idiopathic scoliosis (AIS) is a common clinical entity that affects approximately 2–3% of children and adolescents. AIS is defined as a curvature of the spine > 10 degrees and it usually presents as a right thoracic curve. Only a small fraction of patients with AIS go on to surgical intervention. This article will review the role of rehabilitation in the management of adolescent idiopathic scoliosis, specifically as related to the preoperative, perioperative and postoperative care of patients with AIS.

INTRODUCTION

Adolescent idiopathic scoliosis (AIS) is a common clinical entity that affects approximately 2–3% of children and adolescents. AIS is defined as a curvature of the spine > 10 degrees and it usually presents as a right thoracic curve. Only 10% of patients with AIS go on to surgical intervention.[14,1]

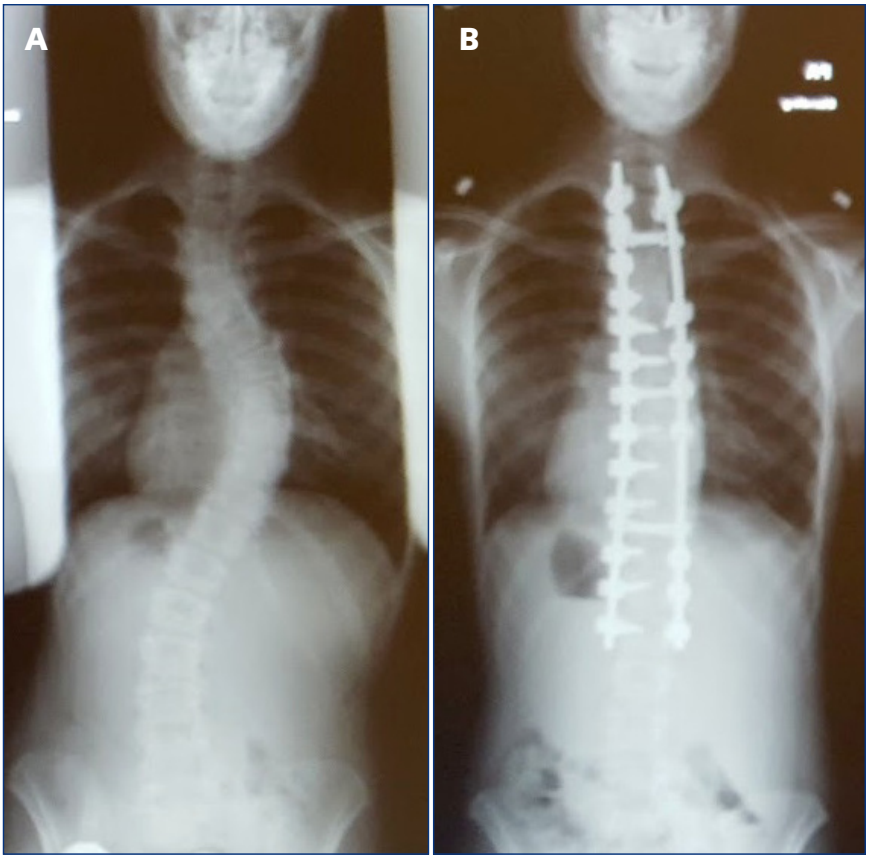
The exact pathogenesis of AIS is not yet known. Multiple genetic and environmental factors have been implicated and continue to be the subject of intense research. Lifestyle factors have been implicated in the progression of AIS, but a recent, large cross-sectional study of over 2,700 female high school students failed to show any factors that were significantly related to AIS.[13]

The management of AIS is guided by curve magnitude and remaining skeletal growth. Rehabilitation plays an important and complementary role in the management of patients with AIS across the entire continuum of care. AIS patients with curves less than 25 degrees are typically observed and may be prescribed physical therapy in the form of scoliosis-specific exercises (SSE). Patients with curves between 25–45 degrees are often braced, with consideration of SSE as an additional treatment option. The aim of these interventions is to slow or reverse deformity in the spine. Posterior spinal fusion (PSF) (**Figure 1**) is often indicated for patients who fail these conservative measures and progress to curves greater than 45 degrees with substantial skeletal growth remaining, as well as for patients with curves greater than 50 degrees.

Preoperative Considerations

Exercise therapy may improve an imbalance of peri-spinal musculature that is seen in AIS patients with small curves (< 20 degrees).[15,16,18] This therapy may also be used a complement to bracing therapy in patients with larger curves. A study by Ko et al[15] recently analyzed the effects of a 12-week

Figure 1. Thirteen-year-old patient initially treated with bracing and SSE for idiopathic scoliosis. She was poorly compliant and required surgery. Postoperatively, she returned to competitive swimming after 6 months, **A**. Preoperative anteroposterior image, **B**. Postoperative image.



core stabilization program on patients with AIS and curves of 10–20 degrees; there was a significant decrease in lumbar curve magnitudes in the treated groups. Gür et al[17] similarly showed significant improvement in lumbar curve levels in patients undergoing a core stabilization exercise program. Moreover, a 2015 meta-analysis[19] found moderate-quality evidence supporting the role of exercise therapy in modifying curve values, thoracic kyphosis trunk rotation, and quality of life in patients with AIS.

The increasingly popular Schroth rehabilitation program utilizes specific postures to correct scoliosis. A randomized clinical trial showed significantly improved curve magnitude as measured by Cobb angle and trunk rotation.[23] Similarly, active self-correction and task-oriented exercises have also been shown to be effective in achieving Cobb angle improvement (greater than 5 degrees) in a randomized clinical trial.[24] While by no means a panacea to AIS, postural rehabilitation and active self-correction rehabilitation programs should be considered for the management of AIS. Patient compliance and follow-through with the home portion of the program is imperative for success. Longer-term studies to evaluate these exercise interventions are ongoing and will determine the usefulness of these interventions.

Perioperative Considerations

For patients with progressive deformity, surgery heralds the beginning of an intensive rehabilitation period. The primary goal of inpatient rehabilitation after PSF is to ensure a safe home discharge. Doing so requires the coordinated effort of medical, nursing, and rehabilitation providers.

Medical priorities in the postoperative period include: monitoring the patient's hemodynamic status; achieving adequate pain control; managing the surgical site and various lines/drains (i.e., intravenous, bladder catheter); and ensuring normal bodily functions such as voiding.

Physical and occupational therapy goals include mobilizing the patient out of bed, ambulating on flat ground, navigating stairs, and performing activities of daily living in a safe manner. A survey of Shriners Hospital surgeons found the following physical therapy goals: Sitting on day 1, standing on day 2 and walking on day 2 or 3.[12]

Recently, care pathways have been developed to standardize and improve the postoperative rehabilitation of patients undergoing PSF for AIS. These pathways are designed to achieve a safe and efficient discharge to home after surgery. Fletcher et al[6] reported the outcomes of one such pathway as it compared to traditional discharge planning. Both groups had a small difference in thoracolumbar curve Cobb values (35 degree in accelerated pathway vs. 40 degrees in traditional pathway), but there was no difference in proximal and main thoracic curve dimensions. As part of the accelerated discharge pathway, patients underwent aggressive postoperative rehabilitation with 2 to 3 sessions daily. Patients were transitioned to a regular diet on postoperative day 1, at which time they were started on a multimodal regimen of oral analgesics and diazepam. Bladder catheters were removed on postoperative day 1 and surgical drains removed on day 1 or 2. Finally, patients were discharged to home with a standard bowel regimen if they were tolerating a regular diet, even if they did not yet have a bowel movement post-operatively. This study found a significantly shorter hospital length of stay (2.2 vs. 4.2 days) in the accelerated discharge group. Importantly, the accelerated pathway was safe and did not show an increase in complications or re-admission rates when compared to the traditional discharge pathway. Other benefits of the accelerated pathway cited by the authors include faster return to work by parents, lower healthcare cost, and a faster return to a daily home routine. Sanders et al[7] also demonstrated a statistically significant decrease in LOS with an accelerated rehabilitation pathway (3.7 vs 5.0 days). This pathway was also safe and reduced hospital costs by 22%.[7] The authors have found that most adolescent patients can be discharged within 3 or 4 days with an aggressive rehabilitation approach.

Postoperative Considerations

The postoperative rehabilitation of patients undergoing PSF for AIS builds on the inpatient gains by returning to baseline activity at home and improving strength and confidence. This occurs in parallel with evaluations to ensure adequate healing of the surgical site and arthrodesis of the spine.

After PSF, Tarrant et al[9] found a median time to return to school of 10 weeks and 77% of patients had returned to school by 16 weeks postoperatively. Another study by these authors[11] found that patients with preoperative curves greater than 70 degrees were delayed by approximately 1 additional month in their return to school.

Clearance to return to sporting activity will vary by attending surgeon. A survey of scoliosis surgeons[10] found that 43% of surgeons recommended low-impact, non-contact sports at 6 months after surgery. Additionally, 60% of surgeons permitted contact sports (i.e., soccer, basketball) after 12 months. However, 60% did not recommend participation in higher impact collision style sports (i.e., football, hockey) after PSF.

Most patients can expect to be restricted in their activities until about 3 to 6 months postoperatively. Additionally, it is our practice to wait for resolution of pain and to ensure maintenance correction and progression towards arthrodesis before return to non-contact physical activity. Fabricant et al[8] retrospectively analyzed a cohort of 42 patients undergoing PSF for AIS. In this cohort with a mean age of 15.0±1.7 years, the average preoperative curve magnitude was 57.67 ±9.38 degrees and the average time to return to athletic activity was 7.4±3.4 months. Moreover, 25 (59%) of patients returned to physical activity at the same level or better than before surgery, but 7 had to change their activity. Those who did not return to sports or did so at lower level most

commonly cited a loss of flexibility and back pain as their reasons. Additionally, these patients were more likely to have a higher preoperative Lenke classification and a lower level of fusion at the time of surgery. For example, while 73% of patients with a T12 distal fusion level returned to their prior activities after surgery, only 20% of patients with an L4 fusion level achieved this outcome. What is reassuring is that no complications related to return to play were reported. Taken together, these data suggest that a return to athletics is a safe and realistic rehabilitation goal following PSF. However, some patients may ultimately change their sport or activity level, depending on the complexity of their deformity.

As a result of surgical intervention around the paraspinal musculature and the fusion that is ultimately achieved in the spine, AIS patients may experience changes in range of motion (ROM) and the muscular function of their spine. These patients will go on to make adaptive changes while performing certain activities.[20] This may include increased reliance on leg muscles[20] to compensate for weakened paraspinal musculature with forward bends. Physical therapy in the postoperative period should address the loss of flexibility seen as a result of fusion. Additionally, athletes returning to sports will benefit from specific exercises to improve balance, agility and gait while retraining with sports-specific activities.[22, 21] After the initial healing period, it is the authors' protocol to institute formal physical therapy for sport-specific rehabilitation for patients wishing early return to sports.

CONCLUSION

Adolescent Idiopathic Scoliosis is an entity commonly encountered by pediatric musculoskeletal providers. As outlined above, rehabilitation plays an important role at all stages of the continuum of care of patients with AIS. Preoperative exercise therapies may confer a lasting, albeit modest, benefit to patients not yet indicated for surgery. Coordinated, inpatient postoperative care pathways are proving to be cost-effective, safe, and effective in accelerating the postoperative rehabilitation of patients undergoing PSF for AIS. Lastly, ongoing postoperative rehab will ensure a return to an active lifestyle and, in many patients, a return to a high level of activity.

References

1. Miller NH. Cause and natural history of adolescent idiopathic scoliosis. Orthop Clin North Am. 1999;30:343–52.
2. Sui WY, Ye F, Yang JL. Efficacy of tranexamic acid in reducing allogeneic blood products in adolescent idiopathic scoliosis surgery. BMC Musculoskelet Disord. 2016 Apr 27;17:187.
3. Wang M, Zheng XF, Jiang LS. Efficacy and Safety of Antifibrinolytic Agents in Reducing Perioperative Blood Loss and Transfusion Requirements in Scoliosis Surgery: A Systematic Review and Meta-Analysis. PLoS One. 2015 Sep 18;10(9):e0137886.
4. Bowen RE, Gardner S, Scaduto AA, Eagan M, Beckstead J. Efficacy of intraoperative cell salvage systems in pediatric idiopathic scoliosis patients undergoing posterior spinal fusion with segmental spinal instrumentation. Spine (Phila Pa 1976). 2010 Jan 15;35(2):246-51.
5. Oliveira JAA, Filho FAM, Fernandes FV, Almeida PC, de Oliveira VF, Lima Verde SR. Is cell salvage cost-effective in posterior arthrodesis for adolescent idiopathic scoliosis in the public health system? J Spine Surg. 2017 Mar;3(1):2-8.
6. Fletcher ND, Andras LM, Lazarus DE, Owen RJ, Geddes BJ, Cao J, Skaggs DL, Oswald TS, Bruce RW Jr. Use of a Novel Pathway for Early Discharge Was Associated With a 48% Shorter Length of Stay After Posterior Spinal Fusion for Adolescent Idiopathic Scoliosis. J Pediatr Orthop. 2017 Mar;37(2):92-97.
7. Sanders AE, Andras LM, Sousa T, Kissinger C, Cucchiaro G, Skaggs DL. Accelerated Discharge Protocol for Posterior Spinal Fusion Patients With Adolescent Idiopathic Scoliosis Decreases Hospital Postoperative Charges 22. Spine (Phila Pa 1976). 2017 Jan 15;42(2):92-97.
8. Fabricant PD, Admoni S, Green DW, Ipp LS, Widmann RF. Return to athletic activity after posterior spinal fusion for adolescent idiopathic scoliosis: analysis of independent predictors. J Pediatr Orthop. 2012 Apr-May;32(3):259-65.
9. Tarrant RC, O'Loughlin PF, Lynch S, Queally JM, Sheeran P, Moore DP, Kiely PJ. Timing and predictors of return to short-term functional activity in adolescent idiopathic scoliosis after posterior spinal fusion: a prospective study. Spine (Phila Pa 1976). 2014 Aug 15;39(18):1471-8.
10. Rubery PT, Bradford DS. Athletic activity after spine surgery in children and adolescents: results of a survey. Spine (Phila Pa 1976). 2002 Feb 15;27(4):423-7.
11. Tarrant RC, Queally JM, O'Loughlin PF, Sheeran P, Moore DP, Kiely PJ. Preoperative curves of greater magnitude (>70°) in adolescent idiopathic scoliosis are associated with increased surgical complexity, higher cost of surgical treatment and a delayed return to function. Ir J Med Sci. 2016 May;185(2):463-71.
12. Sanders JO, Haynes R, Lighter D, Niederpruem M, Hollenback C, Johnson L, Nomura S, Arndt D, Bush P, Santiago J, King R, Trottier T. Variation in care among spinal deformity surgeons: results of a survey of the Shriners hospitals for children. Spine (Phila Pa 1976). 2007 Jun 1;32(13):1444-9.
13. Watanabe K, Michikawa T, et al. Physical Activities and Lifestyle Factors Related to Adolescent Idiopathic Scoliosis. The Journal of Bone and Joint Surgery. 99(4):284–294, Feb 2017.
14. Lonstein JE. Scoliosis: surgical versus nonsurgical treatment. Clin Orthop Relat Res. 2006;443:248–259.
15. Mooney V, Gulick J, Pozos R. A preliminary report on the effect of measured strength training in adolescent idiopathic scoliosis. J Spinal Disord. 2000;13:102–10.
16. Ko KJ, Kang SJ. Effects of 12-week core stabilization exercise on the Cobb angle and lumbar muscle strength of adolescents with idiopathic scoliosis. J Exerc Rehabil. 2017 Apr 30;13(2):244-249.
17. Gür G, Ayhan C, Yakut Y. The effectiveness of core stabilization exercise in adolescent idiopathic scoliosis: A randomized controlled trial. Prosthet Orthot Int. 2017 Jun;41(3):303-310.
18. SOSORT guideline committee, Weiss HR, Negrini S, Rigo M, Kotwicki T, Hawes MC, Grivas TB, Maruyama T, Landauer F. Indications for conservative management of scoliosis (guidelines). Scoliosis. 2006 May 8;1:5. doi: 10.1186/1748-7161-1-5.

19. Shahnawaz A, Alghadir A, Abu S, Dilshad A. Effects of Exercise on Spinal Deformities and Quality of Life in Patients with Adolescent Idiopathic Scoliosis. Biomed Res Int. 2015;2015:123848.
20. Wang TY, Pao JL, Yang RS, Jang JS, Hsu WL. The adaptive changes in muscle coordination following lumbar spinal fusion. Hum Mov Sci. 2015 Apr;40:284-97. Epub 2015 Jan 24.
21. Kakar RS, Simpson KJ, Das BM, Brown CN. Review of Physical Activity Benefits and Potential Considerations for Individuals with Surgical Fusion of Spine for Scoliosis. Int J Exerc Sci. 2017 Mar 1;10(2):166-177. eCollection 2017.
22. Pescatello LS, Arena R, Riebe D, Thompson PD. ACSM's Guidelines for Exercise Testing and Prescription. Ninth Edition. Philadelphia: Wolters Kluwer/Lippincott Williams & Wilkins; 2014.
23. Kuru T, Yeldan İ, Dereli EE, Özdinçler AR, Dikici F, Çolak İ. The efficacy of three-dimensional Schroth exercises in adolescent idiopathic scoliosis: a randomised controlled clinical trial. Clin Rehabil. 2016 Feb;30(2):181-90.
24. Monticone M, Ambrosini E, Cazzaniga D, Rocca B, Ferrante S. Active self-correction and task-oriented exercises reduce spinal deformity and improve quality of life in subjects with mild adolescent idiopathic scoliosis. Results of a randomised controlled trial. Eur Spine J. 2014 Jun;23(6):1204-14.

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