Vitamin D Deficiency Increases Pseudarthrosis and Perioperative Complications After Posterior Spinal Fusion for Adolescent Idiopathic Scoliosis

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INTRODUCTION: Adolescent idiopathic scoliosis (AIS) affects 1-3% of adolescents, with posterior spinal fusion commonly serving as the definitive treatment for progressive or severe deformities. Vitamin D plays a central role in calcium homeostasis, bone mineralization, and fusion biology. Although deficiency has been associated with nonunion in adult spine populations, pediatric-specific data remain limited. This study evaluated the association between preoperative vitamin D status and postoperative outcomes following posterior spinal fusion for AIS, with pseudarthrosis as the primary endpoint. We hypothesized that vitamin D-deficient patients would have higher rates of pseudarthrosis and related complications compared with vitamin D-sufficient patients.

METHODS: A retrospective, multi-institutional cohort analysis was conducted using the TriNetX Research Network. AIS patients aged 10–21 years who underwent posterior spinal fusion between 2013 and 2024 were included. Patients were stratified by preoperative serum vitamin D levels measured within one year before surgery. The vitamin D-deficient cohort was defined by laboratory evidence or diagnosis of deficiency, while others were considered sufficient. Outcomes included pseudarthrosis, implant-related and wound complications, revision or removal of device, infection, emergency department (ED) visits, transfusion, and readmission. Unadjusted odds ratios (ORs) were calculated using chi-square analysis. All statistical tests were two-tailed with significance defined as $p < 0.05$.

RESULTS: A total of 6,672 AIS patients met inclusion criteria (mean age 14.4 ± 2.2 years), including 4,828 females (72.4%) and 1,844 males (27.6%). Of these, 491 were vitamin D-deficient and 6,181 were sufficient. Vitamin D–deficient patients had higher rates of pseudarthrosis (10.6% vs 7.8%; OR 1.39, 95% CI 1.03–1.88; $p = 0.03$), implant-related complications (3.7% vs 1.6%; OR 2.29; $p = 0.001$), wound complications (4.9% vs 2.8%; OR 1.81; $p = 0.007$), revision or removal of device (7.5% vs 3.6%; OR 2.19; $p < 0.001$), nervous-system infection (2.0% vs 0.7%; OR 2.97; $p = 0.001$), and ED visits (23.0% vs 12.5%; OR 2.10; $p < 0.001$). Transfusion and readmission rates were not significantly different ($p > 0.05$).

DISCUSSION: Vitamin D deficiency was independently associated with increased pseudarthrosis and multiple perioperative complications after posterior spinal fusion for AIS. These results reinforce vitamin D status as a modifiable risk factor affecting both fusion integrity and early postoperative recovery. These findings underscore the clinical importance of perioperative optimization and monitoring of vitamin D status to improve outcomes in adolescent spine surgery.

SIGNIFICANCE/CLINICAL RELEVANCE: Vitamin D deficiency significantly increases the risk of pseudarthrosis and related postoperative complications following posterior spinal fusion for AIS. Routine preoperative screening and supplementation should be considered to enhance fusion success and decrease complications in this population.

REFERENCES:

1. Kuznia AL, Hernandez AK, Lee LU. 2020. Adolescent Idiopathic Scoliosis: Common Questions and Answers. Am. Fam. Physician 101(1):19–23.
2. Miller DJ, Cahill PJ, Vitale MG, Shah SA. 2020. Posterior Correction Techniques for Adolescent Idiopathic Scoliosis. J. Am. Acad. Orthop. Surg. 28(9):e363–e373.
3. van Driel M, van Leeuwen JPTM. 2023. Vitamin D and Bone: A Story of Endocrine and Auto/Paracrine Action in Osteoblasts. Nutrients 15(3):480.

TABLES:

Variable	Vitamin D–Deficient (n=491)	Vitamin D–Sufficient (n=6,181)	p-value
Age (years, mean ± SD)	14.4 ± 2.2	14.4 ± 2.2	0.624
Female (%)	66.20%	72.90%	**0.001**
White (%)	61.90%	70.70%	**<0.001**
Hispanic or Latino (%)	12.60%	8.70%	**0.004**
Black (%)	18.30%	13.80%	**0.006**
BMI (mean ± SD)	21.8 ± 5.7	22.1 ± 5.4	0.382

Table 1. Demographic and clinical characteristics of AIS patients by vitamin D status.

Outcome	Vitamin D–Deficient (n=491)	Vitamin D–Sufficient (n=6,181)	Odds Ratio (95% CI)	p-value
Pseudarthrosis / Mechanical Failure	10.60%	7.80%	1.39 (1.03–1.88)	**0.03**
Implant-related complications	3.70%	1.60%	2.29 (1.38–3.82)	**0.001**
Wound complications	4.90%	2.80%	1.81 (1.17–2.80)	**0.007**
Revision or removal of device	7.50%	3.60%	2.19 (1.53–3.14)	**<0.001**
Nervous system infection	2.00%	0.70%	2.97 (1.48–5.94)	**0.001**
ED visits	23.00%	12.50%	2.10 (1.68–2.62)	**<0.001**
Transfusion	11.00%	13.40%	0.80 (0.60–1.07)	0.13
Readmission	51.10%	53.60%	0.90 (0.75–1.09)	0.28
Rehab utilization	47.50%	52.00%	0.83 (0.69–1.00)	**0.05**

Table 2. Postoperative complications and outcomes after posterior spinal fusion by vitamin D status.