Operative Techniques in
Orthopaedics

# Vertebral Derotation in Adolescent Idiopathic Scoliosis

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**The treatment of adolescent idiopathic scoliosis has evolved substantially over the years. Early designs, such as the Harrington rod, corrected coronal deformity but failed to account for normal sagittal alignment. Cotrel-Dubousset instrumentation allowed for better control of sagittal contours such as thoracic kyphosis and lumbar lordosis while maintaining coronal deformity correction. However, rotational control of scoliosis remained poor. Modern instrumentation systems with pedicle screws allow for the first time the possibility of true rotational correction, but this requires more than simple rod derotation maneuvers. Instead, a method of directly applying rotational force to a screw that has 3-column purchase is required in order to effect a derotation of individual vertebra. This is accomplished through the advent of direct vertebral rotation devices. We describe the technique to use these devices to perform rotational correction of scoliotic deformities later in the text.**

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**KEYWORDS** idiopathic scoliosis, pedicle screws, derotation, rib prominence

The revolutionary design and capabilities of the Cotrel-Dubousset (CD) Spinal Instrumentation System transformed the treatment of spinal deformities with its introduction in the early 1980s. For nearly 20 years, hooks were the primary implant used for fixation to the thoracic and lumbar vertebrae. Although the novel 90° rod rotation maneuver espoused by Cotrel and Dubousset was excellent for coronal and sagittal realignment of scoliosis deformities, axial plane rotation malalignment was more problematic. Because conventional rod derotation maneuvers are essentially a translational corrective maneuver in the axial plane, minimal true derotation of the apical vertebrae and rib cage occurs, with studies demonstrating only 9% rotational correction at the apex.[1,2] This is of significant clinical interest, as the rotational component of a scoliosis is often a major source of patient complaint, particularly in the thoracic spine where it can cause an unsightly rib prominence. Conventionally, this has been addressed by many surgeons with a thoracoplasty. However, thoracoplasty has been shown to result in a substantial decrease in pulmonary function, with patients averaging 23% lower pulmonary function test scores at 2 years after surgery.[3] A direct method of derotating the apical vertebrae and subjacent rib cage would therefore represent a more elegant solution to this problem.

Beginning in the 1990s, surgeons used lumbar and thoracolumbar pedicle screws at the lower end of spinal deformity constructs with deformity correction superior to hook constructs. These early successes led to increasing number of scoliosis surgeons around the world using pedicle screws in the thoracic spine with similarly promising outcomes.[4] Advantages offered by screw fixation include a secure 3-column fixation, superior control of the upper and lower instrumented vertebrae, and the ability to manage larger scoliosis deformities with a posterior-only approach.[5,6] These advantages provide the possibility of true apical derotation for the first time in modern deformity surgery.

As with any new principle, there are many techniques available to accomplish this periapical derotation. Using fixed-angle pedicle screws at the apex provides significantly more vertebral derotation than multiaxial screws because the torque through the screw is not partially dissipated by a multiaxial joint.[7] Active derotation maneuvers can consist of either manipulating concave apical screws by pushing in a lateral direction or pushing convex periapical screws in a medial direction. From a biomechanical perspective, pushing and derotating a convex periapical pedicle screw provides a more effective and safer derotation than manipulating a concave periapical screw.[8] The anatomic rationale stems from

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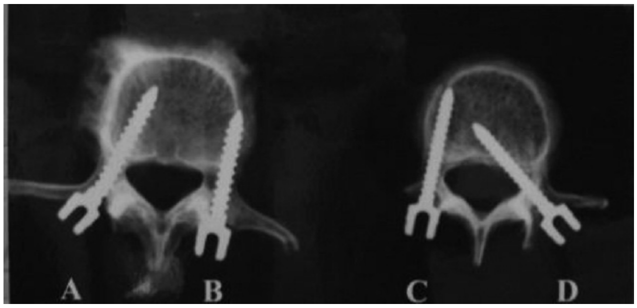


**Figure 1** The dangers of overzealous torque on single pedicle screws are illustrated. Screw B demonstrates lateral body wall cut out from attempted derotation of a concave screw. Screw D shows the type of failure that can occur from the convex side.

the knowledge that the medial pedicle border has stronger bone and can therefore accommodate greater forces applied to the convex screw during derotation maneuvers as opposed to the weaker lateral vertebral body bone that resists derotation maneuvers for the concave screw. From a safety perspective, derotation through either the convex or the concave side carries important considerations. Although the medial pedicle wall is strong, it can be breached by an overzealous derotational force applied through the convex periapical screw. This results in the possibility of the screw cutting out into the spinal canal with possibly disastrous neurologic consequences. The position of the aorta on the left side of the thoracic vertebrae also mandates careful consideration of concave periapical screw derotation for the fear of displacing

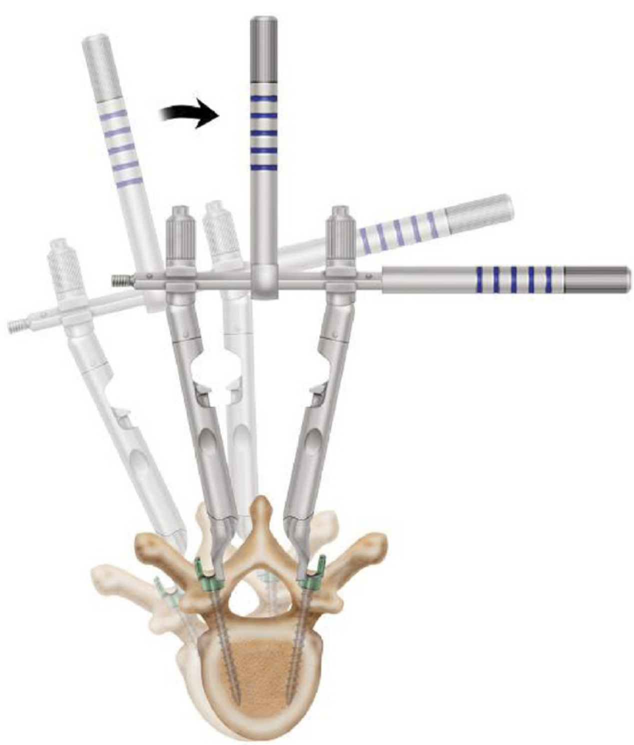

**Figure 2** By connecting and then triangulating the concave and convex screws with a rod, the forces used to derotate the vertebra are shared between both screws. This allows a greater load to failure.

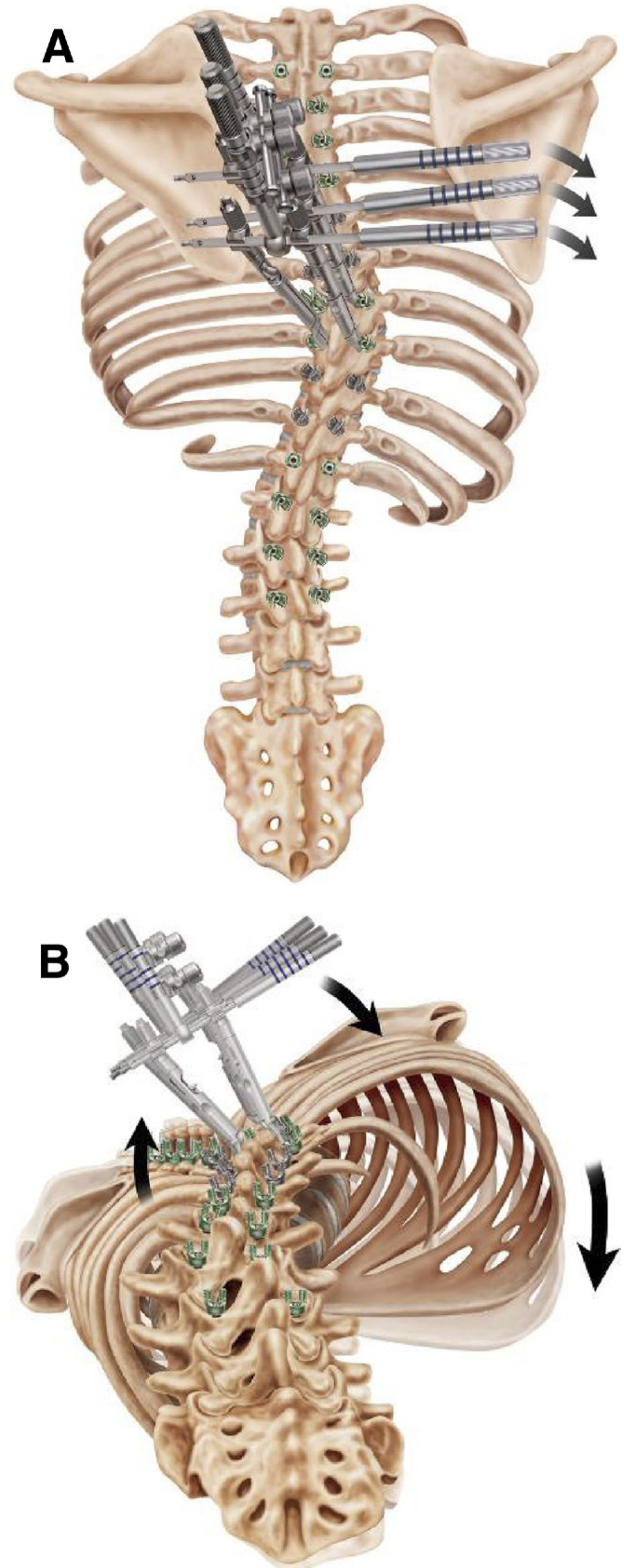


**Figure 3** Coronal (A) and axial (B) view of the derotation maneuver using a direct vertebra rotation (DVR) device. This allows the derotational forces to be distributed among numerous periapical screws, which lessen the risk of screw cut out. The particular device in this illustration is the vertebral column manipulator (VCM; Medtronic, Minneapolis, MN).