



Risk Factors of Proximal Junctional Kyphosis in Adolescent Idiopathic Scoliosis—The Pelvis and Other Considerations

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Abstract

Study Design: Prospective multicenter database study.

Objectives: To assess the incidence of proximal junctional kyphosis (PJK) in operative adolescent idiopathic scoliosis (AIS) using contemporary surgical techniques and to identify risk factors for PJK.

Summary of Background Data: The incidence of PJK has been reported as high as 46% in AIS. Factors associated with PJK have been incompletely explored.

Methods: Prospectively enrolled 851 AIS patients (2000–2011, 78.5% female, average 14.4 years) were evaluated 2 years postoperatively. Radiographic and sagittal spinopelvic parameters and rod contour angle (RCA), a new measure that reflects the proximal contouring of the rod, were independently evaluated for association with PJK based on Lenke type. Multivariate logistic regression with backward elimination was performed to identify risk factors for PJK.

Results: Overall PJK incidence was 7.05% and varies based on Lenke type (Lenke 1, 6.35%; Lenke 2 and 4, 4.39%; Lenke 3 and 6, 11.64%; and Lenke 5, 8.49%; $p = .06$). Among patients with Lenke 1 curves, risk factors for PJK were loss of kyphosis after surgery, and stopping caudal to the upper end vertebra (UEV). The risk of developing PJK increases by 7.1% with each lost degree of kyphosis compared with preoperation that occurs after the instrumentation is placed. For Lenke 2 and 4 curves, loss of kyphosis and more lordotic (negative) RCA were risk factors for PJK. For Lenke 3 and 6 curves, larger preoperative T5–T12 kyphosis was the only significant risk factor for PJK. Upper instrumented vertebra (UIV) at or cephalad to the UEV was associated with increased risk of PJK in Lenke 5 curves, which was contrary to the finding for Lenke 1 curves. No significant correlation was found between sagittal pelvic parameters and developing PJK.

Conclusion: The incidence of PJK in patients after surgery for AIS is 7.05% and varies based on Lenke type. Loss of kyphosis, larger preoperative kyphosis, UIV caudal to the proximal UEV (Lenke 1), UIV at or cephalad to the UEV (Lenke 5), and decreased RCA were the major risk factors for PJK in AIS.

Level of Evidence: Level II.

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Introduction

Proximal junctional kyphosis (PJK) is a common and potentially clinically significant sequela after corrective spinal deformity surgery. The incidence of PJK in adolescent idiopathic scoliosis (AIS) patients following posterior instrumented arthrodesis has been reported to range from 27% to 46% [1-3].

Several risk factors have been identified to be associated with developing PJK. Previous studies [1,3] showed that PJK was more commonly associated with posterior instrumentation compared with anterior instrumentation. Larger pre-operative thoracic kyphosis, greater decrease in thoracic kyphosis, thoracoplasty, and male sex were significantly correlated with PJK [2]. Risk factors for different curve types have not been previously assessed; rather patients have been considered as one large category of AIS. There have been no studies in which multivariate analysis has been performed to evaluate the overall effect of multiple risk factors simultaneously. Furthermore, there is a lack of information on the association of sagittal spinopelvic parameters with the risk of developing PJK or of the impact of rod contouring on the development of PJK.

The purpose of this study was to assess the incidence of PJK in a large cohort of operative AIS patients at 2-year follow-up and to evaluate the impact of sagittal spinopelvic variables and ratios and other potential risk factors on this phenomenon. In addition, stratification of risk factors for PJK by curve type was also performed.

Materials and Methods

Query of a multicenter database AIS registry study of surgically treated patients who were prospectively enrolled was conducted. This registry was established in 1995 and is the largest prospective AIS patient database in existence. There are 15 participating sites (12 in the United States, 2 in Canada, and 1 in the United Kingdom) and more than 4,000 operative patients enrolled in the database. Inclusion criteria were AIS diagnosis, surgery via a posterior approach

between the years 2000 and 2011, and minimum 2-year follow-up. Institutional review board approval was obtained for this study from the Mount Sinai Medical Center.

Clinical and radiographic data collected included age at surgery, gender, height, weight, levels instrumented, anchor type, level of upper (UIV) and lower (LIV) instrumented vertebrae, major Cobb angle, T5–T12 kyphosis, lumbar lordosis, PJK, pelvic incidence (PI), and rod contour angle (RCA). RCA (Fig. 1) is a new measure that reflects the



Fig. 1. Illustration of the measurement of proximal junctional kyphosis (PJK) and rod contouring angles.

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