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Clinical Study

Patients with proximal junctional kyphosis after stopping at thoracolumbar junction have lower muscularity, fatty degeneration at the thoracolumbar area

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Abstract

BACKGROUND CONTEXT: There are several reports regarding pathogeneses and risk factors for proximal junctional kyphosis (PJK) in adult spinal deformity surgery. However, the relationship between thoracolumbar muscle condition and PJK has not been investigated yet.

PURPOSE: We aimed to elucidate the thoracolumbar muscle conditions on the incidence of PJK in adult patients with spinal deformity treated by long instrumented spinal fusion surgery stopping at thoracolumbar junction with a minimum 2-year follow-up (F/U).

STUDY DESIGN: This is a retrospective review of prospective database.

PATIENT SAMPLE: A total of 44 cases of patients having multilevel spinal instrumented fusion stopping at thoracolumbar junction for adult spinal deformity in two academic institutions from 2004 to 2012 were enrolled in this study.

OUTCOME MEASURES: For clinical outcomes, the Scoliosis Research Society questionnaire-22r (SRS-22r) was used preoperatively and at ultimate F/U.

METHODS: Inclusion criteria were age >20 and minimum five vertebrae fused from T9 upper instrumented vertebra (UIV) to any lower instrumented vertebra. Radiographic assessment included pelvic parameters, Cobb measurements in the coronal-sagittal plane, and measurements of the thoracolumbar muscularity (cross-sectional area of muscle-vertebral body ratio×100) and fatty degeneration (signal intensity of muscle-subcutaneous fat ratio×100).

RESULTS: The prevalence of PJK was 38.6%. Age at surgery, gender, fusions extending to the sacrum, levels fused, combined anterior-posterior surgery, and a UIV level were not significantly different between PJK and non-PJK groups. Lower bone mineral density (BMD; T-score: −2.5 vs. −1.3, p=.003) and lower muscularity and higher fatty degeneration at the level of T10 to L2 (131.8 vs. 159.0, p<.01; 59.0 vs. 44.0, p<.001, respectively) were identified risk factors for PJK. Radiographic parameters demonstrated a higher postoperative lumbar lordosis (LL) change (43.8 vs. 29.3, p<.001) and a larger sagittal vertical axis (SVA) change with surgery (8.4 cm vs. 4.8 cm, p=.01) in those with PJK. Although SRS postop pain scores were inferior in PJK group (3.3 vs. 4.1, p<.05), there were no significant differences in the average scores between the groups (3.5 vs. 3.3, p<.05).

CONCLUSIONS: Patients with PJK had lower thoracolumbar muscularity and higher fatty degeneration than patients without PJK before surgery. Our data suggest that osteoporosis, large corrections in LL and SVA with surgery, and lower muscularity and higher fatty degeneration at the thoracolumbar area can lead to PJK.

Keywords: Adult spinal deformity; Fatty degeneration; Lumbar lordosis; Paraspinal muscle; Proximal junctional kyphosis; Sagittal balance

FDA device/drug status: Not applicable.

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Introduction

Proximal junctional kyphosis (PJK) is a radiographic finding and defined as kyphosis between upper instrumented vertebra (UIV) and two levels above the UIV greater than 10 degrees, which can lead to progressive kyphosis. Proximal junctional kyphosis is recognized as a common and problematic complication after multilevel instrumented spinal fusion surgery [1–4]. The incidence of PJK in adults has been reported with a range of rates from 17% to 61% [1,4–10], depending on the study population and the duration of follow-up (F/U). It is obvious that PJK has a multifactorial etiology. Recently, several studies reported proximal junctional failure after long instrumented spine fusion with mechanisms including fracture or subluxation at or above the UIV [6,7,11]. However, the relationship between thoracolumbar muscle condition, including the quality as well as quantity, and PJK has not been investigated yet. Also, over- or under-correction as a risk factor for PJK remains incompletely defined [9,12,13]. Our hypothesis was that patients with PJK after stopping at thoracolumbar junction have lower muscularity, higher fatty degeneration, and larger sagittal balance corrections. Thus, the purpose of our study was to elucidate the radiographic consequences of sagittal balance parameters such as lumbar lordosis (LL), C7 sagittal vertical axis (SVA), and thoracolumbar muscle conditions on the incidence of PJK in adult patients with spinal deformity treated by long instrumented spinal fusion surgery with stopping at thoracolumbar junction with a minimum 2-year F/U.

Materials and methods

A total of consecutive 44 cases of patients having multilevel spinal instrumented fusion stopping at thoracolumbar junction (from T9 to L2) for adult spinal deformity in two academic institutions from 2004 to 2012 were retrospectively enrolled in this study. Inclusion criteria were age >20 and minimum five vertebrae fused from the UIV at T9 to any lower instrumented vertebra for adult spinal deformity. Specific diagnosis was presented in Table 1. Patients were divided into two groups according to the occurrence of PJK. Radiographic assessment included pelvic and sagittal parameters, and Cobb measurements in the coronal-sagittal plane. For clinical outcomes, the Scoliosis Research Society questionnaire-22r (SRS-22r) was used preoperatively and at ultimate F/U.

Table 1
Preoperative diagnosis

	PJK group (n=17)	Non-PJK group (n=27)	p-value
Degenerative lumbar flatback/kyphosis	10	10	.169
Degenerative scoliosis	2	7	.236
Kyphoscoliosis	1	1	.161
Postoperative kyphotic decompensation syndrome	4	9	.490

PJK, proximal junctional kyphosis.

EVIDENCE & METHODS

Context
The authors maintain that the extent to which muscular conditioning and osteoporosis influence proximal junctional kyphosis (PJK) following surgical intervention for deformity has not previously been evaluated.

Contribution
This was a retrospective review of 44 patients treated for spinal deformity with fusion-based procedures stopped at the thoracolumbar junction (2004–2012). Seventeen (38.6%) subsequently went on to develop PJK. The authors maintain that osteoporosis, large surgical corrections and lower muscularity with higher fatty degeneration at the thoracolumbar region may predispose to the development of PJK.

Implications
However the data may have been collected, this study presents Level IV evidence as a retrospective review of cases with a small sample population and less than 20 individuals developing the outcome of interest (PJK). The extent to which these findings can be extrapolated to others and serve as definitive risk factors for the development of PJK remains to be determined. The results of this investigation should be considered as "hypothesis generating" as opposed to "definitive" in outlook.

—The Editors

Paraspinal muscle evaluation

All enrolled patients had undergone magnetic resonance imaging (MRI) of thoracolumbar area before surgery. Magnetic resonance imaging was performed using 1.5T Magnetom Vision (Siemens, Erlangen, Germany), 1.5T Gyroscan (Philips, Eindhoven, Netherlands), and 1.5T Sigma (General Electric, Milwaukee, WI, USA) scanners. Axial MRI images were aligned parallel to the inferior endplate of the vertebral body (VB). The T1-weighted images (repetition time/echo time=550–750 ms/12–30 ms) and the T2-weighted axial images (repetition time/echo time=3,500–3,600/112–120 ms) were analyzed at the inferior endplate of T10, T11, T12, L1, and L2 levels. After scanning, the images were saved in Digital Imaging and Communications in Medicine (DICOM) format for Picture Archiving and Communication System.

The cross-sectional area (CSA) of individual paraspinal muscles (erector spinae [ES] and multifidus [MF]) were measured at axial T2-weighted image by constructing polygon points around the outer margins of the muscles. The number of points selected for each image varied according to the shape and size of the muscle, and created a polygon that replicated the shape of the underlying muscle. The AutoCAD package (AutoCAD 2008, Autodesk Inc, San Rafael, CA, USA) was used to calculate the area contained within the polygon. To decrease bias caused by the relative body