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Clinical Study

Paraspinal muscle, facet joint, and disc problems: risk factors for adjacent segment degeneration after lumbar fusion

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Abstract

BACKGROUND CONTEXT: Adjacent segment degeneration (ASD) is one of the major complications after lumbar fusion. Several studies have evaluated the risk factors of ASD. Although the paraspinal muscles play an important role in spine stability, no study has assessed the relationship between paraspinal muscle atrophy and the incidence of ASD after lumbar fusion.

PURPOSE: In the present study, we aimed to verify the known risk factors of ASD, such as body mass index (BMI), preoperative adjacent facet joint degeneration, and disc degeneration, and to assess the relationship between paraspinal muscle atrophy and ASD.

STUDY DESIGN: This is a retrospective 1:1 pair analysis matched by age, sex, fusion level, and follow-up period.

PATIENT SAMPLE: To calculate the appropriate sample size for the study, we performed a pre-study analysis of the paraspinal muscle cross-sectional area (CSA), and estimated that at least 35 cases would be needed for each group. Among the 510 patients who underwent posterior lumbar fusion for degenerative lumbar disease between January 2009 and October 2009, a total of 50 patients with ASD after surgery were selected. Another group of 50 matched patients with degenerative lumbar disease without ASD after spinal fusion were selected as the control group. Each patient in the ASD group was matched with a control patient according to age, sex, fusion level, and follow-up period.

OUTCOME MEASURES: Radiographic measurements and demographic data were reviewed.

METHODS: The risk factors considered were higher BMI, preoperative adjacent segment disc and facet degeneration, and preoperative paraspinal muscle atrophy and fatty degeneration. The radiographic data were compared between the ASD and control groups to determine the predictive factors of ASD after posterior lumbar fusion by using logistic regression analysis. The study was not externally funded. The authors have no conflict of interest to declare.

RESULTS: Multivariate logistic regression analysis indicated that higher BMI (odds ratio [OR]: 1.353, p=.008), preoperative facet degeneration on computed tomography examination (OR: 3.075, p=.011), disc degeneration on magnetic resonance imaging (MRI) (OR: 2.783, p=.003), fatty degeneration (OR: 1.080, p=.044), and a smaller relative CSA of the paraspinal muscle preoperatively (OR: 0.083, p=.003) were significant factors for predicting the development of ASD.

FDA device/drug status: Not applicable.

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CONCLUSIONS: The occurrence of radiological ASD is most likely multifactorial, and is associated with a higher BMI, preexisting facet and disc degeneration on preoperative examination, and a smaller preoperative relative CSA of the paraspinal muscle on MRI.

Keywords: Adjacent segment degeneration; Lumbar spinal fusion; Paraspinal muscle atrophy; Posterior lumbar interbody fusion; Risk factors; Spine surgery

Introduction

Spinal fusion is currently the standard surgical treatment for various lumbar spinal diseases, ranging from degenerative disorders to deformities. Although posterior lumbar fusion with pedicle screw fixation has yielded satisfactory clinical results, solid fusion can accelerate degeneration of the adjacent unfused segment [1–6]. A long-term follow-up study after fusion surgery indicated the presence of degenerative changes, such as segmental instability, spinal stenosis, intervertebral disc lesion, spondylolisthesis, and fracture at the adjacent segments [7–9]. Moreover, abnormal loading and increased mobility in the adjacent segments may explain the development of adjacent segment degeneration (ASD) [5,10–13].

Based on radiographic evidence, the prevalence of ASD is reported to be more than 40%, and the incidence of symptomatic ASD that requires revision surgery reportedly ranges from 5.2% to 18.5% [5,14]. Several risk factors for the development of ASD have been proposed, including age, female sex, body weight, body mass index (BMI), postmenopausal state, osteoporosis, lumbar stenosis, preexisting degenerated disc at the adjacent level, fusion length, rigid pedicle screw instrumentation, injury to the facet joint of the adjacent segment, and sagittal malalignment [5,15–19].

The spine consists of vertebral bodies, intervertebral discs, facet joints, spinal ligaments, and muscles. Similar to the other spine components, paraspinal muscles play an important role in spine stability [20–22]. A recent study reported that a decrease in the cross-sectional area (CSA) of the multifidus muscle is related to lumbar disc herniation [23]. Moreover, Onesti [24] reported that paraspinal muscle atrophy, which occurs after spinal fusion surgery, causes failed back surgery syndrome. In addition, extensive degeneration and weakness of the lumbar extensor muscles are believed to be risk factors of ASD [25]. However, to our knowledge, no studies have analyzed the relationship between preoperative paraspinal muscle atrophy and ASD.

In the present study, we aimed to verify the known risk factors of ASD, such as BMI, preoperative adjacent facet joint degeneration, and disc degeneration [17–19], and to assess the relationship between paraspinal muscle atrophy and ASD.

Materials and methods

Subjects

To calculate an appropriate sample size for the study, we performed a pre-study analysis of the CSA of the paraspinal muscles, which demonstrated differences between the ASD and non-ASD groups with an effect size of 0.60. With this effect size, to achieve a power of at least 80% using independent-samples *t* test with a significance level of .05, at least 35 cases are needed for each group.

We retrospectively evaluated the results of 510 instrumental posterior lumbar or lumbosacral fusions performed with conventional midline open posterior lumbar interbody fusion combined with open pedicle screw fixation at our institution for the treatment of degenerative conditions between January 2009 and October 2009. We excluded patients treated with anterior or lateral lumbar fusion surgery and minimally invasive lumbar fusion surgery. The mean follow-up duration was 20.5 months. We excluded patients treated for nondegenerative conditions, such as trauma, tumor, infection, or inflammation, and those who had undergone previous fusion surgery. We also excluded patients who had a pathologic condition at a site other than the lumbar spine, as confirmed by whole spine sagittal magnetic resonance imaging (MRI). The initial diagnosis included spinal stenosis, isthmic and degenerative spondylolisthesis, degenerative disc disease, and disc herniation.

All patients underwent a trial of nonoperative and conservative treatment, including medication, physical therapy, and pain relief for at least 3 months before surgery. The patients were recommended for a surgical procedure after failing to respond to non-operative treatment. All continued to experience significant back and leg pain, with a significant restriction of daily activities due to radicular or neurogenic claudication. In each patient, the index fusion had been performed for those segments that corresponded to clinical and radiological findings of neural compressive degenerative lesions. In some cases, to determine the fusion level, we performed an electromyography study or diagnostic selective nerve root block preoperatively.

Among these 510 patients, we selected 50 patients with radiological evidence of ASD (Fig. 1). Radiological ASD was diagnosed based on the presence of olisthesis of >4 mm, angular changes of >10° on flexion and extension lateral radiography, loss of disc height by >10%, or deterioration of 2 or more grades on the University of California at Los Angeles (UCLA) disc degeneration scale (Table 1) [6,14,26,27]. Radiological ASD was also diagnosed based on MRI findings, in cases where the modified Pfirrmann classification [28] (Table 2) indicated a grade of IV and V, or where spinal stenosis or disc herniation was detected at an adjacent level. We measured disc height on