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Risk Factors For the Development of a Mobile Degenerative Spondylolisthesis at L4–L5

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Abstract

Objective: The purpose of this study was to identify factors that may be important in determining whether a degenerative spondylolisthesis at L4–L5 is mobile.

Summary of background data: Degenerative scoliosis is a common condition among middle-aged and elderly adults. Sacropelvic morphology and orientation modulate the geometry of the lumbar spine and, consequently, the mechanical stresses at the lumbo-sacral junction. To date, no in vivo data exist to describe the relationship between these pelvic parameters and their association with a mobile spondylolisthesis.

Method: Sixty consecutive patients with a degenerative spondylolisthesis (DS) at L4–L5 with adequate imaging were identified. Patient groups were defined on the basis of whether the DS was mobile (Group A) or nonmobile (Group B) when comparing the upright plain lumbar radiograph to the supine magnetic resonance imaging (MRI). We assessed the grade of slip, lumbar lordosis, pelvic parameters, and facet characteristics (angles, tropism, presents of effusion, degenerative score—cartilage and sclerosis values) as well as disc degenerative score (Pfirrmann) at L4–L5.

Results: There were 40 patients in Group A and 20 in Group B. No significant differences were found between groups for pelvic incidence ($p = .409$), pelvic tilt ($p = .476$), sacral slope ($p = .785$), lumbar lordosis ($p = .695$), degree of facet tropism ($p = .38$), and magnitude of the facet effusions ($p = .01$). Facet angle differences between groups approached significance ($p = .058$). Significant differences between groups were found in cartilage degenerative score ($p = .01$), facet sclerosis grade ($p = .01$), and disc degenerative score ($p < .0001$). In Group A, 10 of 40 (25%) reduced fully and were not apparent on the supine MRI.

Conclusions: Sagittal pelvic parameters do not play a significant role in differentiating between mobile and nonmobile DS at L4–L5. However, DS does appear to be associated with more sagittally orientated facets, higher Pfirrmann grade, and higher facet cartilage and sclerosis degenerative scores.

Keywords: Degenerative spondylolisthesis; Risk factors; Pelvic parameters

Introduction

Degenerative spondylolisthesis (DS) is defined as an acquired anterior displacement of one vertebra over the subjacent vertebra, associated with degenerative changes, without an associated disruption or defect in the vertebral ring [1]. DS is common among middle-aged and elderly adults with prevalence estimates in US cohorts ranging from 14% to 30% [2-5]. In the United States, more than 300,000 lumbar spine fusion surgeries are performed annually, and one-third of these are for degenerative spondylolisthesis, spinal stenosis or a combination of the two [6,7].

Multiple possible treatment modalities exist for the management of DS ranging from nonoperative management through to simple decompression, decompression with uninstrumented fusion, posterolateral fusion with pedicle screw fixation, posterior lumbar interbody fusion and transforaminal interbody fusion. The Spine Patient Outcomes Research Trial (SPORT) reported improved outcomes with surgical treatment compared with conservative management in patients with DS but did not report

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on the superiority of one form of surgical treatment over another [8]. Posterior lumbar and transforaminal interbody fusion procedures have been shown to have higher fusion rates than instrumented posterolateral fusion, which in turn has higher rates of fusion than noninstrumented fusion [9-14]. However, surgical outcomes have not been shown conclusively to be improved with the more complicated surgical techniques (eg, posterior lumbar and transforaminal interbody fusion) [1,8,12,15].

Sagittal sacropelvic morphology and orientation modulate the geometry of the lumbar spine and consequently, the mechanical stresses at the lumbosacral junction. Roussouly et al. [16] in their classification of the normal variation in the sagittal alignment of the human lumbar spine and pelvis in the standing position identified a number of clear patterns of spinopelvic alignment. Type 4 in this classification is associated with a relatively high pelvic incidence and sacral slope together with a large lumbar lordosis. With this spinopelvic configuration, the sagittal S1 end plate orientation is relatively vertical, possibly representing a predisposing factor for anterior slippage of a lumbar vertebra. An anterior displacement of the center of gravity is usually compensated by a posterior tilt of the pelvis [17]. This compensatory mechanism leads to a translation of load posteriorly, potentially increasing the shear stress on the facet joint complex and thus predisposing to the development of facet joint osteoarthritis. Numerous other studies have found that DS appears to be associated with the pattern of spinopelvic alignment described above [18,19]. What has not been established is as to whether there is a specific pattern of spinopelvic alignment that is associated with a mobile versus a nonmobile DS.

Previous studies have reported numerous other factors predisposing to the development of a DS. Degenerative change and sagittal orientation of the lumbar facet joints at L4–L5 together with raised body mass index were reported by Schuller et al. [19]. Imada et al. [20] reported oophorectomy as an independent risk factor for the development of DS whereas Sanderson [21] and Matsunaga [22] reported that pregnancy and joint laxity were independent risk factors for the development of DS. Lattig et al. [23] reported that the degree of facet joint effusion is associated with mobility of the DS.

In our practice we recognized 2 distinct groups of patients with DS. Patients that had a stiff nonmobile slip and patients in whom the slip appeared unstable and increased in magnitude with the patient standing compared with lying. It was our intention from this study to determine why some patients develop a very mobile DS and to define risk factors that may predispose a patient in time to develop a DS that is mobile. The mobility or potential mobility of a DS has clear implications in choice of treatment selected, as simple decompression in a DS that is mobile or likely to become mobile could potentially lead to an unfavorable surgical outcome. In particular, our study sets out to understand the role played by the local anatomic and geometric factors that would potentially influence the mobility of a DS at the L4–L5 motion segment. These include pelvic and sagittal alignment parameters, local facet anatomy and degeneration, which we evaluate in this study.

Materials and Methods

Cohort demographics

We identified the patients on our database that had been referred with symptoms of spinal stenosis and back pain with a diagnosis of L4–L5 spondylolisthesis between 2009 and 2012. Only patients with degenerative spondylolisthesis were included, with exclusion criteria including previous surgery and incomplete imaging. All included patients had undergone plain erect radiographs (anteroposterior [AP] and lateral) of the lumbar spine together with a supine static magnetic resonance imaging (MRI). All patients were noted to have a low-grade degenerative listhesis at L4–L5 (Fig.1).

Parameters assessed

Pelvic sagittal parameters including incidence, sacral slope, and pelvic tilt were measured and have been clearly defined previously [24]. Lumbar lordosis was measured between the superior end plate of L1 and the superior end plate of S1. We realize that using L1 is an arbitrary endpoint as an inflexion point may be variable, but we used this as standard to simplify analysis [25]. The lumbar

Fig. 1. Standing lateral lumbar radiograph of the same patient in demonstrating a mobile degenerative spondylolisthesis.