Semin Spine Surg 26 (2014) 219–224

Available online at www.sciencedirect.com

ScienceDirect

www.elsevier.com/locate/semss

# The radiographic parameters for the prediction of spondylolysis and spondylolisthesis

*Satyajit V. Marawar, MD*[a,b,c,*]

[a]Syracuse VA Medical Center, Syracuse, NY
[b]Department of Orthopedic Surgery, Upstate Medical University, Syracuse, NY
[c]Department of Neurosurgery, SUNY Upstate Medical University, Syracuse, NY

ARTICLE INFO

ABSTRACT

The grading of severity of spondylolisthesis and measurement of percentage slip are well-known radiological parameters that affect progression of the slip. The role of pelvic morphology and spino-pelvic balance in the prediction of spondylolisthesis has been recently scrutinized. Pelvic incidence, sacral slope, and pelvic tilt define the pelvic morphology and position. Pelvic incidence is most important as it determines the spino-pelvic balance, affects the biomechanical stresses at the lumbosacral junction, and predicts the progression of spondylolisthesis. A new classification by the Spinal Deformity Study Group incorporates pelvic morphological parameters and global sagittal balance and seeks to guide surgical management of spondylolisthesis.

Published by Elsevier Inc.

## 1. Introduction

Spondylolysis is defined as a defect in the pars interarticularis of the posterior arch. Spondylolisthesis is an anterior or posterior translation of one vertebra on the other, which may or may not be associated with spondylolysis. The most common site of spondylolisthesis is at L5–S1 due to spondylolysis at L5.[1] Spondylolisthesis has been studied extensively since the first description of this condition by the Belgian obstetrician Herbinaux in 1782. Multiple radiologic classification systems have been proposed to explain the causation and to predict progression of the condition. The most commonly used classification system was by Wiltse and Winter[1] and Wiltse et al.[2] who described five main groups based on pathogenesis. This included congenital or dysplastic spondylolisthesis, lytic or isthmic spondylolisthesis, degenerative spondylolisthesis, post-traumatic spondylolisthesis, and pathologic spondylolisthesis. Although this classification system was based on the pathogenesis of this condition, it does not have a prognostic value in terms of progression. Marchetti and Bartolozzi[3] further simplified this classification by dividing spondylolisthesis into two categories: developmental and acquired. The developmental category was further subdivided into high dysplastic and low dysplastic. The acquired category included traumatic, pathologic, postsurgical, and degenerative types.

## 2. Radiographic grading of spondylolisthesis

The most commonly used radiographic grading system for spondylolisthesis was proposed by Meyerding.[4] This system describes the severity of anterolisthesis by dividing it into five grades. The degree of anterolisthesis is measured as the percentage of distance the vertebral body has moved anteriorly over the superior endplate of the inferior vertebral

*Corresponding author at: Syracuse VA Medical Center, 800 Irving Avenue, Syracuse, NY 13210.
E-mail address: satyajitm77@gmail.com

http://dx.doi.org/10.1053/j.semss.2014.09.003
1040-7383/Published by Elsevier Inc.

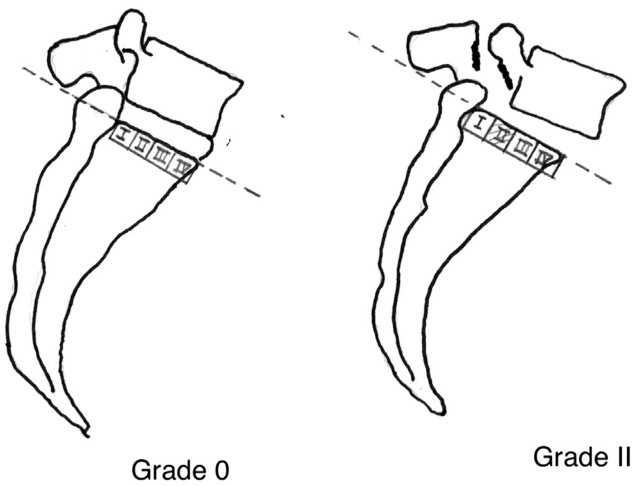


**Fig. 1 – Meyerding classification showing an example of grade II slip.**

body. At L5–S1, this is done by first drawing a line along the posterior sacral border. Then, a perpendicular is drawn to this line at the posterior superior edge of the sacrum. The anterior translation of the inferior endplate of L5 is expressed as a proportion of width of the sacrum along the previously drawn line. Spondylolisthesis is graded as increasing from Grade I to Grade IV, with spondyloptosis being Grade V (Fig. 1). Wiltse and Winter recommended that the forward displacement of the L5 vertebra in relationship to the sacrum should be measured as an actual slip percentage as previously described by Laurent and Osterman.[5] Studies have shown that slip percentage and slip grade is predictive of progression.[6,7] While these studies predict that high-grade spondylolisthesis is at risk of progression, they do not aid in the prediction of the risk of progression in low-grade spondylolisthesis, which is a much more common type.

In addition to anterior translation in spondylolisthesis, there is also sagittal rotation at the affected level. The Meyerding classification does not take sagittal rotation into account. This rotation is simply measured as the slip angle. The slip angle, which is measured on a standing lateral radiograph, is the angle between a line drawn perpendicular to the posterior cortex of the sacrum and a line parallel to the inferior endplate of L5. Alternatively, the slip angle can as well be measured between a line extending off the anterior cortex of L5 vertebral body and a line along the posterior border of the first sacral vertebra. Wiltse and Winter[1] termed this as sagittal rotation and believed the endplates of L5 and S1 could be unreliable osseous landmarks to measure sagittal rotation. The slip angle or sagittal rotation essentially expresses lumbosacral kyphosis. Boxall et al.[8] reported that a slip angle more than 55° is associated with a high probability and rate of progression.

The pathogenesis of spondylolisthesis and its predictive factors still elude the scientific community. None of the radiologic parameters described above has been shown to reliably predict progression, especially in low-grade slips. Biomechanical studies have proposed the stresses at the lumbosacral junction predict progression of spondylolisthesis and these stresses correlate with spino-pelvic parameters.[7,9] Recently there has been a focus on pelvic morphology to evaluate its influence on spino-pelvic balance, and pathogenesis as well as progression of spondylolisthesis.

## 3. Pelvic radiological parameters

### 3.1. *Pelvic incidence*

Adoption of upright position by the human species has led to a more vertical pelvis and appearance of spinal curves. Sagittal pelvic position and the sagittal spinal curves provide a stable and ergonomic position to the human spine. Dubousset et al.[10] term the pelvis as a vertebra that forms the link between the spine and the lower limbs. The geometric relationship of the sagittal pelvic position with the sagittal spinal alignment is complex and has been postulated to play a role in the pathogenesis of spondylolysis and spondylolisthesis.

Multiple radiological parameters have been described in an effort to represent pelvic morphology and sagittal pelvic position. The interrelationship between these pelvic factors and their influence on the sagittal spinal alignment may help further define anatomical factors and mechanical stresses that may play a role in causation of spondylolysis and progression of spondylolisthesis.

During et al.[11] first described the pelvisacral angle as a morphological parameter that is unaffected by pelvic position. This angle is formed between a tangent to the sacral endplate and a line connecting the center of the sacral endplate to the center of the hip joints. Duval-Beaupere et al.[12,13] then defined the pelvic incidence (PI), which is a complement angle to the pelvisacral angle. Thus, the pelvic incidence is the angle between a line that is perpendicular to the sacral endplate and a line connecting the midpoint of the sacral endplate to the center of the femoral heads. Pelvic incidence is a constant anatomic parameter that is specific for each individual and does not change with the position of the pelvis. During childhood, pelvic incidence remains relatively unchanged. In adolescence it increases and reaches its maximum at the end of growth; thereafter, it remains constant.[14,15] This increase in the pelvic incidence is caused by the more horizontal position of the sacrum with growth and plays a significant role in increasing lumbar lordosis and maintenance of upright posture. The mean value of pelvic incidence is $55^\circ \pm 10^\circ$.

While pelvic incidence remains unaffected by pelvic position, assuming there is no significant motion at the SI joint, sacral slope and pelvic tilt are two other factors closely related to the pelvic incidence but are dependent on pelvic position. Sacral slope is defined as the angle between the tangent to the sacral endplate and the horizontal. Pelvic tilt is the angle between the vertical and a line joining the center of the sacral endplate to the center of the femoral heads. These two parameters describe the position of the pelvis in the sagittal plane with reference to the horizontal and the vertical axes. A simple geometric calculation shows that pelvic incidence is an arithmetic sum of sacral slope and pelvic tilt. As pelvic incidence remains constant, and sacral slope and pelvic tilt change with position of the pelvis, there has to be an inverse correlation between the sacral slope and

Download English Version:

https://daneshyari.com/en/article/4094632

Download Persian Version:

https://daneshyari.com/article/4094632

Daneshyari.com