

# Radiological Assessment of Spondylolisthesis

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## ABSTRACT

Spondylolisthesis is a condition, in which one vertebral body slips with respect to an adjacent vertebral body. Radiographs are the standard diagnostic modality for its diagnosis. Loss of alignment of one vertebral body to the next is the diagnostic hallmark. Radiographs have a larger role to play apart from diagnosis, as the classification and grading of spondylolisthesis are based on radiographs. We demonstrate the complete radiological analysis of spondylolisthesis including the description of method of drawing the several parameters, and their significance. We provide a pictorial representation of the assessment of Meyerding's grading by measurement of slip, slip angle/kyphotic angle, sacral slope, pelvic tilt, and pelvic incidence on digital radiographs.

**Key words:** Measurement, Meyerding, pelvic incidence, pelvic tilt, radiological assessment, sacral slope, slip angle, spondylolisthesis

## INTRODUCTION

Spondylolisthesis is a condition, in which one vertebral body slips with respect to an adjacent vertebral body. Radiographs are the standard diagnostic modality for its diagnosis. Loss of alignment of one vertebral body to the next is the diagnostic hallmark. One must also look for breaks in the pars interarticularis. Radiographs have a larger role to play apart from diagnosis, as the classification and grading of spondylolisthesis is based on radiographs.<sup>[1]</sup>

## CLINICAL FEATURES

A 51-year-old lady presented with complaints of pain in her lower back for 5 years. Pain was insidious in onset, sharp pricking type, radiating to the left lower limb for the past 5 years, radiating to bilateral lower limbs for the past 6 months, gradually progressive over the past 5 years, aggravated with activity, and decreased with rest. She had no history of urinary/bowel complaints. There was no history of


trauma, fever, and loss of weight/loss of appetite. She was a known case of diabetes mellitus and hypothyroidism.

## RADIOLOGICAL FEATURES

Anteroposterior and lateral radiographs of the lumbosacral spine were done [Figure 1]. Radiographs showed spondylolisthesis of L4–L5 and spondylolysis of L4 [Figure 2]. The percentage slip was measured to be 28.34%, classifying it as Meyerding grade II slip [Figure 3]. The slip angle was measured to be 9.5° [Figure 4], sacral slope 40.9° [Figure 5], and pelvic tilt 11.9° [Figure 6]. She underwent posterior spinal decompression and instrumented fusion of L4–S1, along with transforaminal lumbar inter-body fusion of L4–L5 [Figure 7]. Postoperatively, the residual percentage of slip was found to be reduced to 19% [Figure 8] and slip angle reduced to 4.5° [Figure 9].

## DISCUSSION

Meyerding's grading is based on the percentage of anterior translation relative to the adjacent level. The slip is measured

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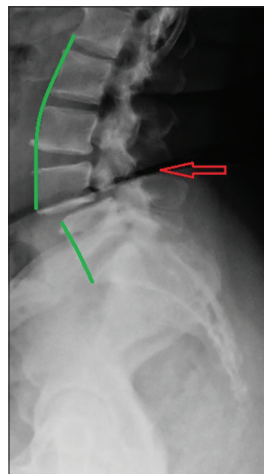
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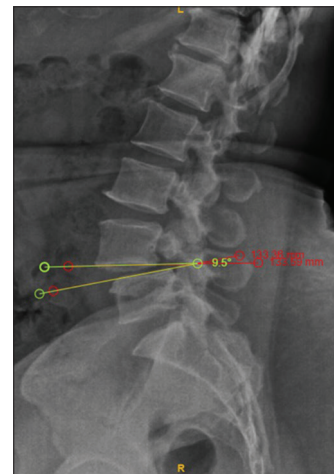
**Figure 1:** (a) Anteroposterior and (b) lateral radiographs of the lumbosacral spine. In the lateral view, the head of femur should be included



**Figure 3:** Measurement of the anterior translation of L4 over L5 and length of L5 vertebral body on lateral radiograph, for determining the Meyerding grade of slip



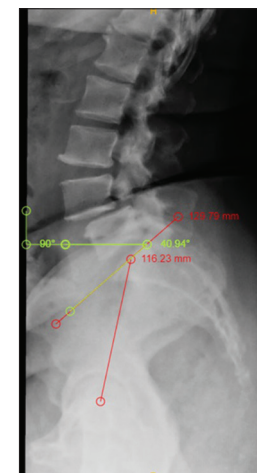
**Figure 2:** Lateral radiographs of lumbosacral spine showing anterior translation of L4 over L5 vertebrae as demonstrated by the discontinuity in the anterior vertebral line (green), with co-existing break in the pars interarticularis of L4 vertebra (red arrow)



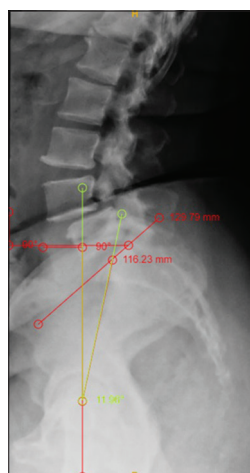
**Figure 4:** Measurement of slip angle on the lateral radiograph. Measure the angle between the lines drawn along the inferior end plate of L4 and the superior endplate of the L5 vertebra

by dividing the amount of displacement of the cephalad vertebra by the diameter of the caudal vertebral body.<sup>[2]</sup> It is then graded as Grade I: 0–25% slip, Grade II: 26–50% slip, Grade III: 51–75% slip, Grade IV: 76–99% slip, Grade V: 100%, or more slip. Grade I and II slips can be managed nonoperatively, while Grade III and IV slips would require surgical management.

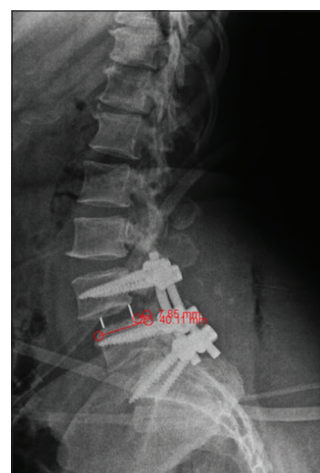
Slip angle or Kyphotic angle is the angle between the superior endplate of the caudal vertebra and the inferior end plate of the cephalad vertebra.<sup>[3]</sup> A slip angle of more than 40° is a risk factor for further slip. A progression of slip angle more than 30° is an indication for surgical management. Correction of the kyphotic deformity as measured by the slip angle is the most important goal of surgical reduction.<sup>[3]</sup>



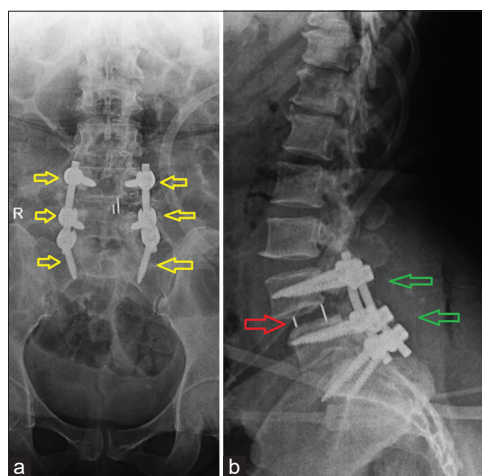
**Figure 5:** Measurement of sacral slope on lateral radiograph. Measure the angle between a horizontal line parallel to the floor and a line along the sacral plateau



**Figure 6:** Measurement of sacral tilt on lateral radiograph. Measure the angle between a vertical line drawn through the center of the femoral head, and the line joining the center of the femoral head to midpoint of the sacral plateau

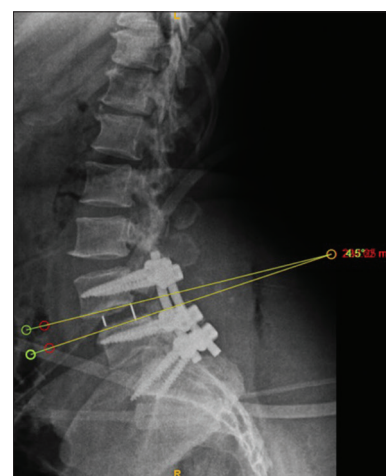


**Figure 8:** Post-operative lateral radiograph showing measurement of residual translation of L4 over L5, length of L5 vertebral body



**Figure 7:** Post-operative radiographs after posterior spinal decompression and instrumented fusion of L4–S1, along with transforaminal lumbar inter-body fusion of L4–L5. (a) Anteroposterior radiograph showing placement of pedicle screws (yellow arrows) in L4, L5 and S1 vertebral bodies. (b) Lateral radiograph showing the absence of posterior elements of the L4, L5 vertebra (green arrows). Inter-body fusion of L4–L5 vertebra indicated by radiopaque markers of the cage used (red arrow)

Abnormal sagittal sacropelvic orientation, as measured by sacral slope, pelvic tilt, and pelvic incidence, has an association with spondylolisthesis. Abnormal sacral slope and pelvic incidence are risk factors for further slip,<sup>[4]</sup> which, hence, require to be measured on radiographs. Sacral slope is the angle between a horizontal line and the orientation of the sacral plateau. Pelvic tilt is the angle between a vertical line drawn through the center of the femoral head, and the line joining the center of the femoral head to midpoint of the sacral plateau. Pelvic incidence is algorithmic sum of the sacral slope and pelvic tilt.<sup>[5]</sup>



**Figure 9:** Post-operative lateral radiograph showing the measurement of residual slip angle

## CONCLUSION

The radiological assessment of spondylolisthesis should include assessment of Meyerding's grading by measurement of slip, slip angle/kyphotic angle, sacral slope, pelvic tilt, and pelvic incidence on digital radiographs. Orthopedic surgeons should be aware of the methods to perform such an assessment, which is vital to guide treatment and prognosis.

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