Advancements in the understanding of adult spinal deformity have led to a greater awareness of the role of the pelvis in maintaining sagittal balance and alignment. Pelvic incidence has emerged as a key radiographic measure that should closely match lumbar lordosis. As proper measurement of the pelvic incidence requires accurate identification of the S-1 endplate, lumbosacral transitional anatomy may lead to errors. The purpose of this study is to demonstrate how lumbosacral transitional anatomy may lead to errors in the measurement of pelvic parameters. The current case highlights one of the potential complications that can be avoided with awareness.

The authors report the case of a 61-year-old man who had undergone prior lumbar surgeries and then presented with symptomatic lumbar stenosis and sagittal malalignment. Radiographs showed a lumbarized S-1. Prior numbering of the segments in previous surgical and radiology reports led to a pelvic incidence calculation of 61°. Corrected numbering of the segments using the lumbarized S-1 endplate led to a pelvic incidence calculation of 48°. Without recognition of the lumbosacral anatomy, overcorrection of the lumbar lordosis might have led to negative sagittal balance and the propensity to develop proximal junction failure. This case illustrates that improper identification of lumbosacral transitional anatomy may lead to errors that could affect clinical outcome. Awareness of this potential error may help improve patient outcomes.

Key Words sagittal alignment; pelvic parameters; lumbosacral radiographic measurements; anatomy; lumbar
diologist consistent with the prior operative reports. Preoperative standing radiographs were initially measured using the S-1 endplate that correlated with the medical records. This endplate also correlated with the first nonrectangular vertebral body. Using this endplate for “S-1,” the pelvic incidence was calculated to be 61°. Considering the thoracolumbar compensation, the “lumbar lordosis” was calculated as 27° to the endplate of T-12 (Fig. 2A). As the thoracolumbar junction in the “normal spine” is straight, surgeons may choose to focus on any of the endplates from T-10 to L-2 when formulating a preoperative plan for restoring “normal” sagittal alignment. The preoperative measurements suggested that surgical correction would require an increase in “lumbar lordosis” of 34°. Additional review of the imaging studies during surgical planning identified a transverse process (no rib) at what was labeled T-12 (Fig. 2B). The patient was then considered to have 6 lumbar vertebrae or a lumbarized (lumbar shaped) S-1.

Remeasurement of the pelvic incidence using the newly identified S-1 endplate showed a lower pelvic incidence

FIG. 1. Preoperative CT myelogram with radiologist’s numbering of lumbar segments. The patient had previously undergone laminectomy and fusion of what is labeled L3–S1. Significant central canal stenosis and vacuum discs can be seen at the levels that are labeled T12–L3.

FIG. 2. A: Preoperative standing lateral radiograph showing the lumbar lordosis (27°) and pelvic incidence (61°) measured from the previously labeled S-1 superior endplate. Based on these measurements, the lumbar lordosis should be corrected approximately 30° to match the pelvic incidence. B: Preoperative posteroanterior standing radiograph showing a transverse process and no rib at what was labeled T-12. C: Preoperative standing lateral radiograph showing lumbar lordosis (27°) and pelvic incidence (48°) measured from the “true” S-1 superior endplate. Based on these measurements, the lumbar lordosis should be corrected approximately 21° to match the pelvic incidence.

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of 48° (Fig. 2C). Based on the preoperative symptoms of standing and walking intolerance with claudication and positive sagittal balance and imaging findings suggesting that a decompression alone would be inadequate, the patient underwent a posterior laminectomy to decompress the spinal stenosis, a pedicle subtraction osteotomy of L-3 to add the needed 20° of lumbar lordosis, and an instrumented fusion T10–S1 to maintain spinal stability and alignment. The secondarily identified “S-1 endplate” was suggested to provide the true pelvic incidence by postoperative imaging (Figs. 3 and 4). Figure 3 shows the postoperative measurements with the initially identified S-1 endplate and a pelvic incidence to lumbar lordosis mismatch. The high pelvic tilt (30°) does not correlate with the normal sacral slope (30°) and normal sagittal vertical axis (C-7 plumb line). Figure 4 shows the postoperative measurements using “L-6” or the lumbarized S-1 endplate. The normal pelvic tilt (17°) correlates with the normal sacral slope (30°) and normal sagittal vertical axis (C-7 plumb line). Additionally in Fig. 4, the intercrestal line (the top of the iliac crest) appears to fall along the
“normal” L4–5 disc level, further supporting the measurements as shown.

Clinically, the patient was quite pleased with the outcome of surgery. He reported subjective improvement and demonstrated objective improvement in standing and walking tolerance. He had relief of his claudication symptoms and was able to stand erect with much less effort and energy expenditure. Radiographic follow-up demonstrated a stable reconstruction (Fig. 5).

Discussion

With an increased focus on the clinical importance of sagittal alignment and concurrent advancements in surgical techniques, the measurement of pelvic parameters (pelvic incidence and pelvic tilt) has become increasingly used to calculate the goals of surgical correction. Although overcorrection of sagittal alignment has been previously reported, no prior reports of errors due to lumbosacral transitional anatomy were identified in the literature or our personal experience. Overcorrection of lumbar lordosis has been implicated as a risk factor for the development of proximal junctional kyphosis or failure that may require revision surgery.

The radiographic characteristics of transitional lumbosacral anatomy have been widely reported. Previously reported clinical relevance includes increased rates of degeneration at supra-adjacent segments and the risk of improper level identification during decompression surgery. The current case illustrates another circumstance (i.e., the measurement of pelvic parameters in adult spinal deformity) where improper identification of lumbosacral transitional anatomy may lead to errors that could affect clinical outcome. Awareness of this potential error (pelvic incidence miscalculation due to lumbarization of S-1) may help surgeons avoid it during the complex process of planning surgery for sagittal malalignment.

References


Disclosures

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