

Adjacent segment spondylolysis and the biomechanics of “relative spondylolisthesis”: An insight

Sir,

A 44-year-old female presented with history of low backache for 18 months duration which was insidious in onset, gradually progressive in severity, and localized in distribution without any radiation to lower limbs. There were no sphincteric disturbances. Not surprisingly, her occupational history was significant as she used to work in a coal mine lifting significant weights daily. Clinical examination only showed tenderness at the region of L4 and L5 paracentrally. Rest of the examination was normal. Plain radiograph [Figure 1a] of the lumbosacral region showed defects at the adjacent pars interarticularis of both L4 and L5 vertebrae, along with spondylolisthesis at L4/5 and L5/S1 levels. However, the listhesis at the upper level was more than that of lower one. This *relative spondylolisthesis* revealed the biomechanics of two-level sagittal translation involving two adjacent motion segments. Magnetic resonance imaging (MRI) revealed mild lumbar canal stenosis at the affected levels [Figure 1b], while computed tomography (CT) of the lumbosacral spine confirmed the adjacent pars defects and also showed vacuum phenomenon at L5-S1 disc space [Figure 1c]. Although the osteoporotic workup could not be done for this patient, the X-ray did not reveal any suggestive findings. However, a thorough osteoporotic workup is scheduled in the next follow-up. Surgery will be planned thereafter and L4-L5-S1 pedicle screw fixation along with interbody fusion will be performed. In the mean time, patient was advised back protection measures and admission at a later date.

Ravichandran has reported that 1.48% patients with back pain have multi-level spondylolysis. According to the author, trauma was the common factor in all of his six patients of multi-level spondylolysis.^[1] Hersh *et al.* have reported multi-level spondylolysis in one of their patients and have done an extensive literature review on the same.^[2] Fracture at the pars is a consequence of microtrauma induced by fatigue due to rotational and extension forces in young adults who are involved in sports and excessive physical activities.^[3] The etiology of stress-induced microfractures in the region of pars seems to be directly related to the relatively fixed zygapophyseal joints leading to transfer of load-bearing vector through the pars and consequent fracture of the same. Pre-existent osteoporosis predisposes patients to sustain these types of injuries, and therefore,



Figure 1: (a) Flexion and extension X-rays of lumbar spine showing pars interarticularis defects of L4 and L5 vertebrae. There is no significant instability at other levels. (b) MRI lumbosacral spine reveals listhesis with focal canal stenosis, along with spondylolisthesis at L4-L5 and L5-S1 levels. The relative and higher degree of listhesis is seen at the higher L4-L5 level (arrow) than at the lower L5-S1 level. (c) CT lumbosacral spine showing the same along with vacuum phenomenon at the L5-S1 interspace. Also note the higher relative degree of listhesis at the higher level (L4-L5)

these types of multi-level spondylolysis are seen most commonly in postmenopausal women. We noticed an interesting biomechanics in this patient with adjacent pars defects leading to two-level listhesis. Actually the sagittal balance of the lumbar spine is such that the center of gravity always tends to create a force vector anterior to S1 vertebra. In two-level listhesis, the translation at the upper-level listhesis (L4-5) is relatively more (hence, the sagittal slip is more) as compared to the lower-level listhesis (L5-S1). This occurs because the center of gravity is creating a stronger force vector at L4 body which moves along with the whole of spine in comparison to the sagittal force vector acting on L5 which is completely free from any bony attachment due to pars defects both above and below [Figure 2]. Hence, the spondylolisthesis will always be *relative and more* at the higher level than at the lower level. Also, it should be emphasized that conservative management



Figure 2: CT showing the L4 body in continuation with the upper spine (white arrow) while L5 body is almost completely free (white oval) by virtue of upper and lower pars defects. Note that the center of gravity pushes the upper spine anteriorly over L5 (black arrow). No such force exists on S1, as L5 is almost free except for the cartilaginous–ligamentous attachments

forms the mainstay of single-level pars defect while multi-segmental defects are best treated by surgical measures.^[4,5] Even conservative management for years has ultimately resulted in surgery for many patients and the overall quality of life has improved in those undergoing early surgery.

Therefore, our case highlights the biomechanics of adjacent segment spondylolysis or pars defects associated with spondylolisthesis which is more at the higher listhetic level. The rarity of such an occurrence

makes one wonder about the feasibility of a clinical study. Also, a cadaveric study is required to actually test and validate the above-said hypothesis in a more convincing manner.

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