CASE REPORT

Adjacent Segment Degeneration and Sagittal Imbalance Post Lumbar Interbody Fusion: Mathematic Based on Pelvic Incidence for Recreation of Lumbar Lordosis

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ABSTRACT

In reconstructive spinal surgery particularly in degenerative spinal diseases, measuring radiographic pelvic and spinal parameters for sagittal balance analysis has become more important. Sagittal balance should be addressed during posterior interbody fusion for degenerative spondylolisthesis to improve surgical outcome and maintain spinal balance. Clinical and radiological spinopelvic parameters of sagittal balance should be routinely measured in degenerative spinal disease as part of surgical intervention to prevent post operative functional impairment. The authors present a case of adjacent segment degeneration with sagittal imbalance post lumbar interbody fusion, which was successfully treated with revision surgery by carefully calculating the corrections needed based on the spinopelvic parameters. Restoration of sagittal balance base on calculation of spinopelvic parameters in our case has shown to have a good clinical outcome.

Keywords: Sagittal balance, Degenerative spine disease, Adjacent segment disease, Lumbar interbody fusion

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INTRODUCTION

Numerous surgical complications have been identified in spinal fusion surgeries. Adjacent segment disease (ASD) is one of the deleterious surgical complication post spinal fusion and is commonly noted in patients with rheumatoid arthritis (RA). It has been reported that patients with RA has 4.5 times higher risk of adjacent segment disease than patients without RA at 7 years after surgery (1). Adjacent segment disease causing loss of sagittal balance could lead to residual back pain and poor functional outcome. There was strong evidence of increase pain and decrease function in a sagittal imbalance spine (2). We present a case of a patient with RA who developed adjacent segment disease and a sagittally imbalanced spine after a short spinal fusion which revision surgery was done with analysis of the spinopelvic parameters.

CASE REPORT

A 60 years old lady with underlying RA and osteoporosis presented to our center with complains of lower back pain and radicular pain of her left lower limb for the past one year. She had been relying on wheelchair ambulation for the past 6 months. The back pain was worst when standing with Visual Analog Scale (VAS) of 8 and relieved by stooping forward. She had a previous history of L4/L5 and L5/S1 oblique lumbar interbody fusion (OLIF) done four years ago due to severe lower back pain and right radicular pain (Figure 1).

Clinical examination revealed weakness of bilateral knee extensors and numbness from knee downwards. Lumbosacral radiograph showed loss of lumbar lordosis and spinal imbalance with pedicle screw cut out at the level of L3 vertebra. We attributed the loss of sagittal balance and failure of instrumentation from previous surgery to the underlying RA and her present neurology due to nerve root compression at L3/4 level from the adjacent segment disease. A revision surgery was planned in order to restore sagittal balance and decompression of the neural elements. Decompression of L2-L4 and multiple levels posterior column osteotomy (PCO) was done (Figure 2). Patient had improvement of symptoms related to back pain and leg pain after surgery with VAS score reduced to 3. Patient was able to stand up for a duration of 5 minutes and supported ambulation with elbow-walker upon discharge. Table I shows the changes of parameters of sagittal balance prior and after each surgery.

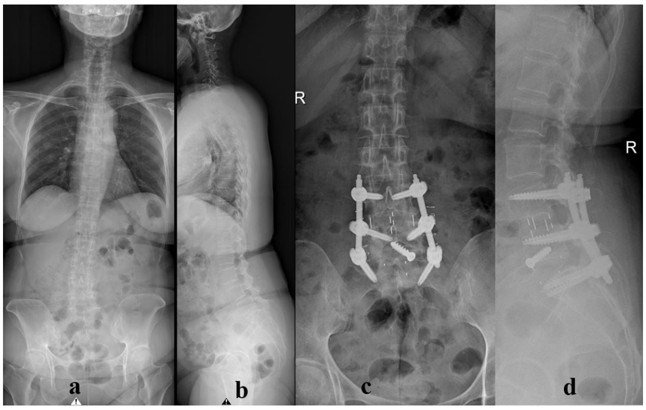

Figure 1 : a,b – Anteroposterior (AP) view and lateral view radiograph of the patient prior to oblique lumbar interbody fusion with gross sagittal imbalance; c,d – AP and lateral view lumbar radiograph after patient underwent oblique lumbar interbody fusion.

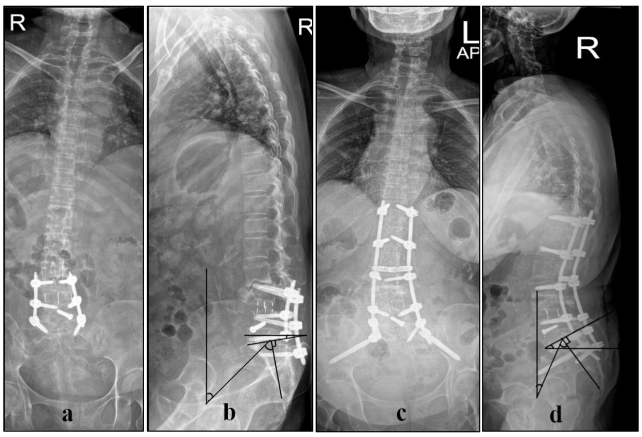

Figure 2 : a-b - Preoperative radiograph with measured Pelvic Incidence (PI) of 53°, lumbar lordosis angle (LLA) of 20.8°. Note here the marked loss of lumbar lordosis with high Pelvic Tilt angle of 42.2° (Normal Value: 12-18°). the right; c-d - Postoperative radiograph with measured LLA=43.9°, PI = 53°

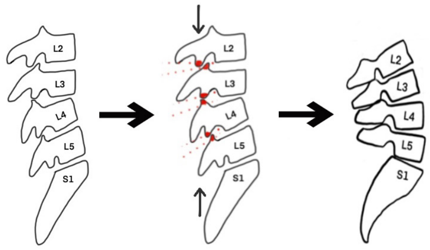

Figure 3 : Diagram dimostrate 3 levels posterior column osteotomy resulting in ideal lumbar lordosis.

SURGICAL TECHNIQUE

Patient was positioned in prone position for open surgery of the lower back. A spinal table was used to facilitate the surgery. The position of the patient is of utmost importance as this could ensure restoration of lordosis by gravity before and after osteotomy. The hip pads were carefully placed under the iliac bone and hips while the abdomen is not supported. Intraoperative neuromonitoring was used throughout this surgery. After incision of the skin and muscle layers extending from T11 to S2, the pre-existing implant was observed. The connecting rods and the L4 screws were removed. Pedicle screws were then inserted at T11, L1, and L3. Sacral-alar iliac screws were inserted to provide strong foundation for the construct. Subsequently, PCO was done at L2/3, L3/4 and L4/5 to allow creation of lordosis based on the PI. The ideal angle for correction is determined by comparing an average normal value of lumbar lordosis in normal population. Therefore, pelvic tilt (PT) and PI value must be known before the intervention in order to restore appropriate lumbar lordosis. As the PI was 53 degrees, the pre-op lordosis of 20.8 must be corrected to 53±10 degrees. To get the minimum 20 degrees of correction, 3 levels of PCO was done as each level of PCO will reliably provide ±7 degrees per level of osteotomy. Therefore, based on this calculation, we'll manage to get the minimum 43 degrees of lumbar lordosis as projected from calculating the pelvic incidence and its relationship with lumbar lordosis. Additionally, laminectomy was also performed from L2 to L4 to ensure no dural sac compression as the lordosis was created. Longer rods were bent according to the created lordotic angle supplemented with cross-link for added stability and correction of deformity was checked under image intensifier. Arthrodesis was completed with autograft and Tricalcium Phosphate bone graft substitute.

Table I : Changes of parameters of sagittal balance before and after index and revision surgeries

Parameters	Pre-OLIF (°)	Post-OLIF (°)	Prior to revision surgery (°)	After revision surgery (°)
Lumbar Lordotic Angle (LLA)	34.5	44.0	20.8	43.9
Sacral Slope (SS)	37.9	32.3	22.6	31.0
Pelvic Tilt (PT)	19.7	25.2	42.2	13
Pelvic Incidence (PI)	53	53	53	53
Sagittal Vertical Axis	9.34	-	10.22	5.43

DISCUSSION

ASD is one of the important complications of spinal fusion surgery as it affects long-term outcome. Besides abnormal sagittal balance, Park et al in 2018 has identified RA and age at the time of surgery as significant risk factors for development of ASD in short segment fusion surgery (1). The authors also found that the risk of ASD increases proportionally with the numbers of segments involved in the fusion surgery. Li et al in 2019 has also studied the biomechanical effects of osteoporosis in the development of ASD (3). In our case, ASD has occurred despite correction of spinopelvic parameters shows that the degenerative process with the underlying RA and increased stress on adjacent segments after fusion surgery are likely the causes leading to this phenomenon.

There is a close correlation between spinopelvic parameters changes and residual pain after fusion surgery. Lazennec et al in 2000 has noted that patients who experience pain after fusion surgery had abnormal spinopelvic parameters. They determined that the abnormally less sacral slope during follow up is the main prognostic factor for post fusion residual pain (4). The reduced sacral slope could clearly be seen in our patient four years after the indexed surgery with the presence of severe lower back pain.

PCO is one of the many osteotomy methods which could be used to correct the sagittal alignment of the spine. Dorward et al has determined that for each level of PCO done they could achieve a mean correction of 8.8 degrees (5). Relatively low complications rate were reported if the procedure is done correctly. Potential complications of the procedure include neurological deficit, durotomy, wound infections and deep vein thrombosis. The correction of sagittal alignment could be successfully achieved with the addition of instrumentation and posterior compression in a closed wedge fashion. The mathematical methods and deduction demonstrated in this case report will enable surgeons to pre-calculate the amount of levels of PCO needed in order to restore sagittal balance. By using this method, it also allows surgeon to predict the clinical outcome in complex spine surgery by pre-operative measurement of the spinopelvic parameters.

CONCLUSION

In our particular case, restoring sagittal balance through the calculation of spinopelvic parameters resulted in a positive clinical outcome. In conclusion, careful pre-operative planning which include clinical analysis of spinopelvic parameters such as pelvic tilt angle, lumbar lordosis angle, pelvic incidence, sacral slope and sagittal vertical axis distance will provide valuable biomechanical understanding for the surgeons to plan the amount of correction needed and the right choice of osteotomy to perform during complex revision surgery.

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