CASE REPORT 3

Sacral dome resection and single-stage posterior reduction in the treatment of high-grade spondylolisthesis in a young girl.

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ABSTRACT

Introduction:

The treatment of high-grade spondylolisthesis remains controversial in terms of in situ fusion versus reduction. The aim of operation in this patient is to restore the spino-pelvic alignment, sagittal profile of the spine and prevention of progression of slip with a minimal neurological risk.

Case presentation:

18 years old schooling girl referred with a history of backache and right lower limb numbness over lateral aspect of foot for four years duration. She also had intermittent lower back pain, produced by long distant walking and relived by rest. It was aggravated by standing for long duration. There was no radiation of pain, no red flag sign or no cauda equina symptoms. Apart from her right lower limb neurology which was her power MRC grade IV in L5 and S1 myotome, other examinations were normal. X-Ray revealed grade V spondyloptosis. MRI showed evidence of right exiting L5 nerve root entrapment with grade V spondyloptosis. She underwent single stage posterior instrumentation of L4 - S1vertebrae, sacral dome resection, reduction of L5 over S1, interbody fusion of L5 - S1 and posterolateral intertransverse fusion of L4 to S1 vertebrae. She was ambulated on post-operative day one without brace. There was no worsening of neurology.

Conclusion:

Lumbosacral spondylolisthesis grade V can be treated using posterior approach alone to obtain reduction, decompression, and solid fusion. The sacral dome resection is a shortening osteotomy of the lumbosacral spine which allows a single-stage reduction of L5 without lengthening of lumbosacral region in high-grade spondylolisthesis, which helps to avoid neurological complications.

Key words: High grade spondylolisthesis, Sacral dome resection, Posterior reduction, Spino-pelvic alignment

Introduction:

The treatment of high-grade spondylolisthesis remains controversial in terms of in situ fusion versus reduction. While satisfactory clinical outcome has been reported after in situ fusion, this procedure is associated with higher rates of pseudarthrosis and slip progression. Without reduction the lumbosacral alignment does not improve. The aim

of operation in this patient is to restore the spino-pelvic alignment, sagittal profile of the spine and prevention of progression of slip with a minimal neurological risk.

Reduction of the slipped L5 over S1 in high-grade spondylolisthesis places the L5 nerve root under tension which can lead to neurological complications. The reduction restores the segmental lordosis, improves lumbosacral alignment and therefore the overall sagittal profile of the spine. Pelvic morphology and spino-pelvic alignment are abnormal in high-grade spondylolisthesis. While pelvic incidence(PI) remains constant as a morphologic descriptor, surgical reduction of L5 over S1 can improve lumbosacral and spino-pelvic alignment as reflected by changes in pelvic tilt(PT) and sacral slop(SS).

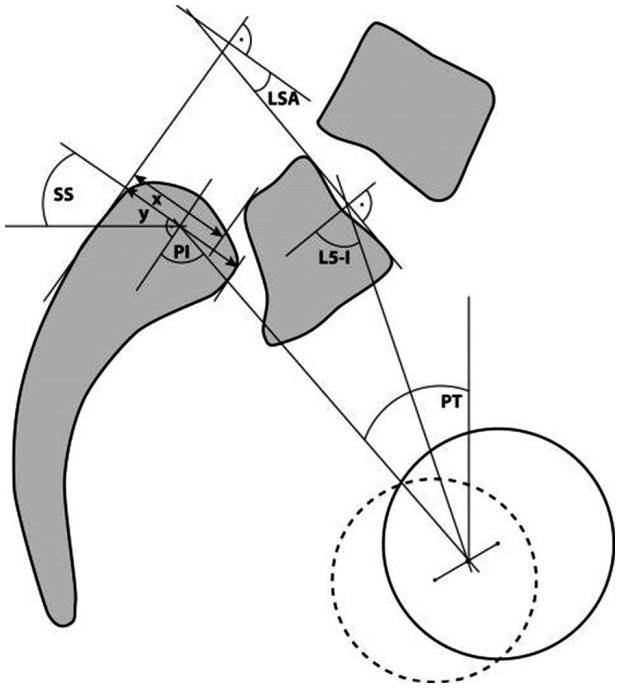

***Fig. 1** L5 Slip is x/y in percent, L5 incidence (L5-I), lumbosacral angle (LSA), pelvic incidence (PI), pelvic tilt (PT), sacral slope (SS)*

The severity of spondylolisthesis is measured as percentage of forward slip of L5 over S1. Lumbar lordosis (LL) is the Cobb angle from the superior endplates of L1–L5. L5 incidence (L5-I) is the angle between a perpendicular line to the L5 superior endplate and a line joining the center of the bicoxo-femoral axis and the center of the superior endplate of L5. The LSA or slip angle is the angle between the lines on the superior endplates of L5 and S1. Pelvic incidence is the angle between a line connecting the centre of the upper endplate of S1 to the bicoxo-femoral axis and a line perpendicular to the end plate of S1. Pelvic tilt is the angle between a vertical line and a line connecting the centre of the upper endplate of S1 to the bicoxo-femoral axis, and SS is the angle between a horizontal line and the endplate of S1.

Case description:

18 years old schooling girl referred to clinic with a history of backache and right lower limb numbness over lateral aspect of foot for last four years duration. It was a lower back intermittent pain, produced by long distant walking and relived by rest. Standing for long duration induced pain in her lower back. There was no radiation of pain to groin or legs. Gradually claudication distant reduced. She was able to walk as usual. She was able to climb stairs up and down without pain. There was no alteration in bladder bowel function. There was no neck or upper limb pain. She denied any history of trauma, recent weight loss, nocturnal fever, contact history of tuberculosis, history of cancer or steroid use.

She walked without pain. Her shoulder and pelvis stayed in symmetrical position. There were no

leg length discrepancies. Her bilateral straight leg raise test was negative. She had right lower limb power MRC grade IV in L5 and S1 myotome. But her left lower limb power was MRC grade V. There was no sensory alteration in both lower legs. Her perianal sensation and peripheral pulse were intact.

X-Radiograph showed grade V spondyloptosis (Fig 2.). Followed by she underwent an MRI scan to assess her cord and nerve root status. It shows there was right L5 exiting nerve root entrapment with grade V spondyloptosis (Fig 3.).

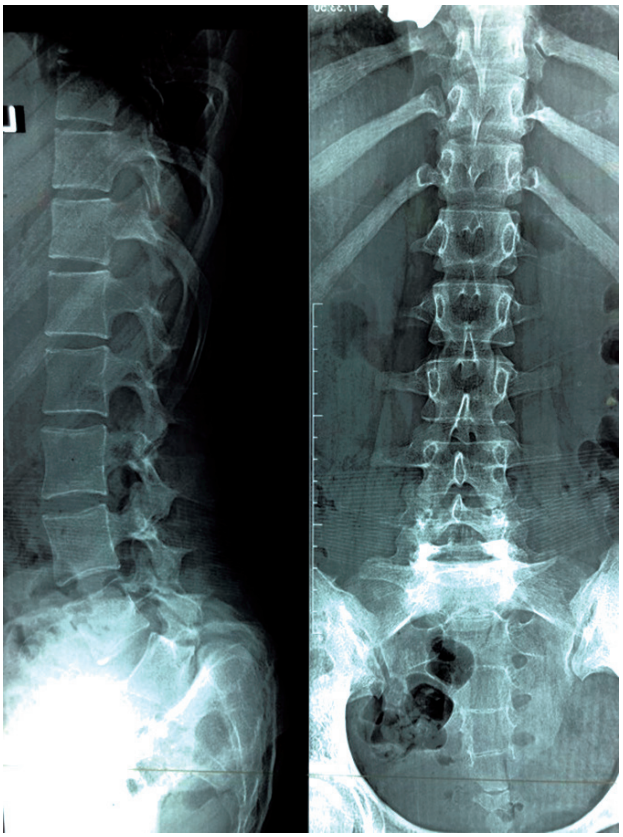

Fig 2. : *X-Ray lumbosacral lateral & AP view in standing position*

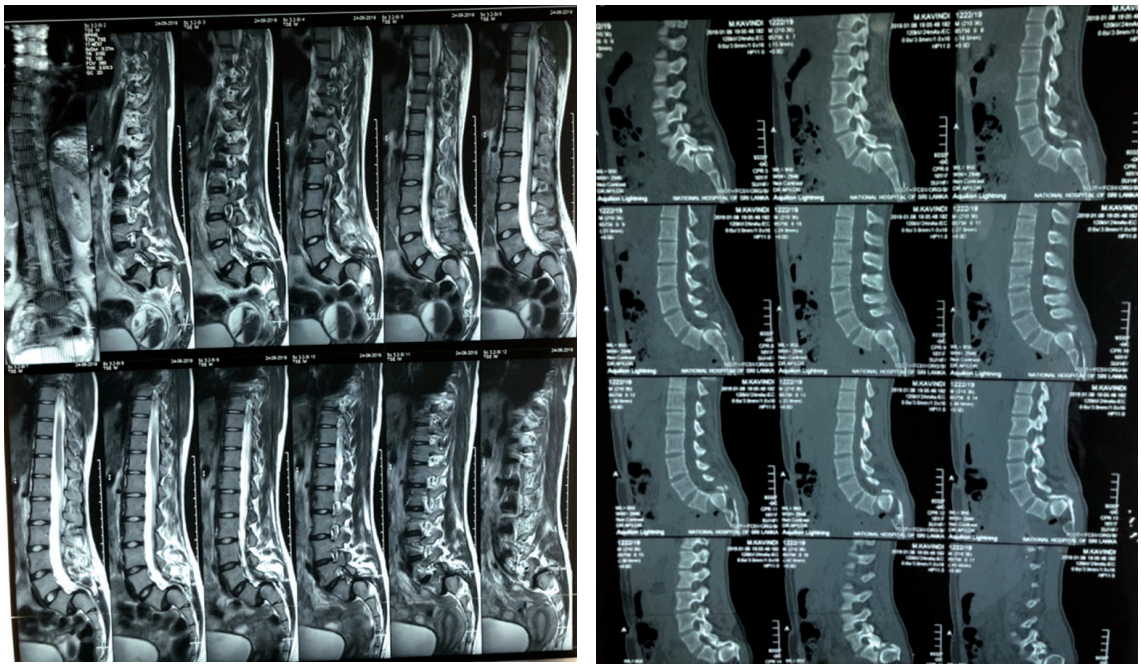

Fig. 3. : *MRI scan*

Surgical technique:

L4–S2 region was exposed from the posterior midline. Pedicle screws were inserted in L4, L5 and S1.(Fig4.) S1 pedicle screws were placed in a more caudal position to leave room for the sacral dome osteotomy and resection. Both S1 pedicle screws were placed to the anterior cortex for bicortical purchase after visualization of S1exsisting nerve root. A complete removal of lamina L5, flavectomy of L5/S1 were performed. L5 roots were thoroughly decompressed in the isthmus region by removing bony callus and granulation tissues of the spondylolysis. The L5 roots were exposed laterally until exiting from the foramen. The cranial part of the ala of sacrum was excised to release the L5 roots from tension completely. The annulus fibrosus in high-grade spondylolisthesis had a bulging part in the foramen below the existing L5 roots and the roots found to be under tension. Care was taken to remove this bulging part far laterally under the L5 roots. The L5/S1 disc was exposed bilaterally between the S1 and L5 roots and excised. Temporary connecting rods were used with minimal distraction. The osteotomy of the sacral dome was performed from both sides in an antero-medial direction using ordinary straight osteotomes, after which the upper part of the sacrum together with attached disc fragments were removed in piece meal. Anterior lip of the lower plate of the L5 vertebra body osteotomised and excised through the disc space to remodel the trapezoid shape of L5 body. Position of osteotome and osteotomy sites were confirmed with image intensifier. A lateral fluoroscopy or a lateral radiograph was helpful to make sure that the extent of the osteotomy was adequate. During this procedure, the segment L5/S1 gradually became mobile. The rods were contoured in lordosis and firmly fixed to the S1 screws first. The L4 and L5 screws were sequentially reduced to the fixed rods, reducing the slipped L5 on to the osteotomised surface of S1. L5 roots were continuously visualized to make sure that they were not stretched. When adequate amount of sacral dome was resected, the reduction was possible without lengthening of L5–S1 and without tension on the L5 roots. The amount of slip reduction was determined by the development of tension in the L5 roots. It was not necessary to aim for full reduction. Correction of the lumbosacral kyphosis and a good L5 nerve root decompression were more important than a full slip reduction. The sacral dome resection was a shortening osteotomy of the lumbosacral junction and any maneuver causing lengthening of the lumbosacral junction was avoided during the whole procedure. The disc space between the end plates of L5 and S1 was cleared fully, removing all cartilages. The space was supported by PEEK cage filled with autologous graft in order to achieve 3600 fusions. Prior to insertion of cage, autologous bone graft was placed to partly fill the anterior disc space. Subsequentially the position of the cage was checked by direct vision to prevent impingement of nerve root and dura. The cage position was further confirmed using image intensifier, by conforming the position of radio-opaque markers. Posterolateral intertransverse fusion of L4–S1 was done using bone graft to achieve bony fusion.

It took around two and half hours to complete whole procedure. There was around 500ml to 600ml of blood loss during the procedure. Within this 600 ml blood loss, approximately only 100ml to 200ml loss due to osteotomy. The procedure can also be performed with neuromonitoring if facilities permit.

Ambulation of the patients began on the second postoperative day. No braces were worn. Postoperative neurology was remained as preoperative without any worsening or much improvement. Up to now, there was no pseudarthrosis or implant failure.

Radiographic parameters:

The preoperative standing radiograph of lumbosacral spine showed slip percentage of 90%, L5 incidence 820, lumbosacral angle -370 indicating a kyphotic deformity, pelvic incidence 760, pelvic tilt 380 and sacral slop of 380. Post-operative standing radiograph of lumbosacral spine showed slip percentage 15%, L5 incidence 480, lumbosacral angle 60, indicating a reversal of kyphotic deformity to lordosis. The pelvic incidence was not changed and remained as 760. But pelvic tilt improved to 400 and sacral slop improved to 360.

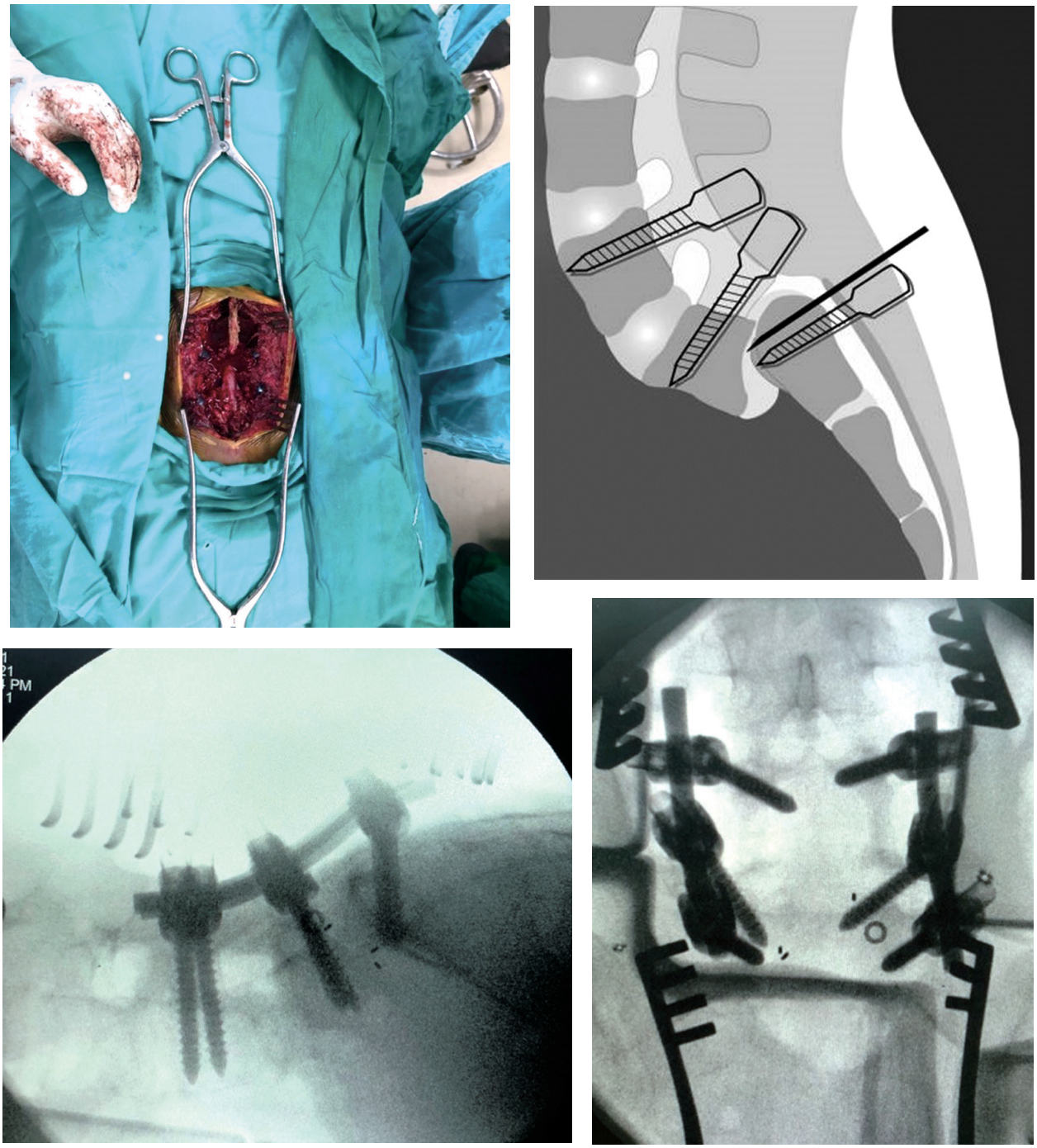

Fig 4 : *Intraoperative image after screw insertion before rod application (Upper left), performing osteotomy of sacral dome (Upper right), after reduction and rod application II view lateral (Lower left) and antero-posterior (Lower right).*

Discussion:

The best way to treat a high-grade spondylolisthesis is to correct the multidirectional deformity of lumbosacral junction with minimal neurological risks. Even though there are conflicting reports about the in situ fusion for high-grade spondylolisthesis, the instrumented fusion with reduction has a clear advantage like facilitation of full nerve decompression, promotion of bony union, restoration of body posture and mechanics, as well as improvement of appearance.

The reduction procedure is known to be associated with neurological complications. There are various descriptions of reduction from posterior alone or anterior posterior

combined procedures. The aim of the surgery is to decompress the spinal canal and nerve roots, as well as to improve the lumbosacral deformity. The reduction of a severely slipped L5 is usually associated with elongation of the lumbosacral junction. Bohlman and Cook first described the removal of the upper corner of the S1 vertebral body to decompress the nerve roots in a surgical procedure where the reduction was not undertaken. Gaines and Nichols described an extensive anteroposterior procedure for L5 vertebrectomy and reduction from L4 on to S1 in the treatment of spondyloptosis, which was a procedure of shortening of the lumbosacral junction.

The sacral dome is excised from posterior approach to produce shortening in this region. In addition to this, the sacral dome resection results in complete mobilization of the L5/S1 segment, facilitates complete L5 nerve root release laterally.

Instrumented fusion from L4 to S1 has advantages over monosegmental L5/S1 fusion. Firstly, screw purchase in severely dysplastic L5 pedicles may be weak and unreliable and secondly, the L4/5 facet joints are usually abnormal in severely dysplastic high-grade spondylolisthesis. We recommend an instrumented fusion from L4 to S1 to avoid loss of correction and sacral bending, as well as development of spondylolisthesis of L4.

Sacral dome excision and reduction produce ample bony surfaces between the bodies of L5 and S1 for anterior column fusion. In L5/S1 segment, the interbody fusion is important and able to achieve good anterior column fusion without an additional anterior procedure. Posterolateral fusion is done between the transverse processes of L4–S1vertebrae.

The posterior alone approach with shortening sacral dome resection, single-stage reduction and pedicle-screw fixation from L4 to S1 allowed the restoration of spino-pelvic alignment towards more physiological values, with minimal risks for neurological injury.

Conclusion:

We conclude that sacral dome resection from posterior approach in high-grade spondylolisthesis is a shortening osteotomy of the lumbosacral junction. It is very useful for single-stage posterior reduction of L5–S1 with the use of pedicle screws avoiding lengthening of lumbosacral junction and avoiding additional anterior surgery. This procedure followed by the instrumented fusion of L4–S1 produces a good multidimensional deformity correction with a minimal risk of neurological injury and a satisfactory clinical outcome. This is a safe surgical procedure to restore spino-pelvic alignment and the sagittal profile of the spine in the treatment of high-grade spondylolisthesis.

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