Current surgical management of isthmic spondylolisthesis of the lumbar spine

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Abstract

The objective of this study is to discuss the different strategies and modalities of surgical treatment of isthmic spondylolisthesis. The study was done on 15 patients. The patients were evaluated and followed-up both clinically and radiologically. Decompression and posterolateral fusion was done in 86.7% of cases, and all cases were fixed using transpedicular screws. Solid fusion was encountered in 91.7% of the followed up cases and 86.6% of the cases showed a satisfactory outcome.

Key Words: spondylolisthesis- isthmic spondylolisthesis- spinal surgery

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Contents

List of figures

List of tables

Introduction

The earliest description of spondylolisthesis is credited to Herbinaux (1782), a Belgian obstetrician who drew attention to a bony prominence in the front of the sacrum that could occasionally obstruct childbirth. **(Mcphee, 1990)**

The term spondylolisthesis is derived from the Greek word spondylos (vertebra) and olisthy (to slip or slide) and it is defined as the forward displacement of the body of one lumbar vertebra of the vertebra below it or on the sacrum. **(Haid and Morone, 1997)**

The most widely recognized classification of spondylolisthesis is that subdivides spondylolisthesis into: dysplastic, isthmic, degenerative, traumatic, pathologic, and iatrogenic types **(Wiltse, et al., 1976).** A spondylolisthetic defect in the pars interarticularis may lead to a vertebral body subluxation; this is known as isthmic spondylolisthesis **(Wiltse and winter, 1983).**

Isthmic spondylolisthesis has a multifactorial origin; mechanical, hereditary, and hormonal. Several theories have been proposed, the most attractive of which is that spondylolysis represents a stress fracture through an area of bone predisposed to fracture. **(Ganju A., 2002)**

Most cases are completely asymptomatic. In symptomatic patients, the most common symptom is pain. Other clinical symptoms include deformity in the form of palpable step, kyphosis, or scoliosis; tight hamstring syndrome; cauda equina syndrome; and neurogenic claudication. **(Haid and Morone, 1997)**

Plain radiographs (anteroposterior, lateral, dynamic, and oblique views) of lumbosacral spine are excellent initial step in the evaluation of displacements. CT is the most accurate investigation in diagnosis of spondylolysis. **(Bennett GJ, 2004)**

The treatment of isthmic spondylolisthesis depends on factors including the degree of spondylolisthesis, the age of the patient, the severity of pain, and the presence of neurological deficit. Conservative management should be tried first before surgical intervention. Conservative treatment includes bed rest, symptomatic medications, traction, epidural injections, facet joint infiltrations, patient education, exercise programs, and bracing. **(Sinaki, et al., 1989)**

General indications for surgical treatment of isthmic spondylolisthesis include severe pain, a patient with neurological deficits, progressive olisthesis, and children younger than 10 years. Surgical options include

decompression, spinal fusion (posterior, posterolateral, ALIF, PLIF, TLIF, instrument assisted fusion, and direct pars repair). (**Haid and Morone, 1997)**

Aim of work

1. Review of literature and recent publications regarding presentation, diagnosis, investigations and management of isthmic spondylolithesis of the lumbar spine.
2. Discussing the different strategies and modalities (surgical and conservative) of treatment of isthmic spondylolisthesis and the outcome of each.
3. Evaluation of the best line of surgical management and the results of different modalities of surgery through a study done on 15 patients of both sexes and different ages. The patients will be evaluated by X-ray, CT scan and MRI of the spine. Follow up (immediate and 3 months postoperative) will include x ray and clinical evaluation of the patients.

ANATOMY OF THE LUMBAR SPINE AND LUMBOSACRAL REGION

Skeletal framework

The human spinal column is an articulated segmental structure that serves the dual purposes of protection and motion, formed of thirty three vertebrae segmentally connected with one another, forming a protective housing for the spinal cord and nerves **(Bell G.R., 1996)**. There are 5 lumbar vertebrae, 5 sacral vertebrae and variable number, usually four, of coccygeal vertebrae. The five sacral vertebrae are fused into one single bone called the sacrum, which articulates on each side with a pelvic bone and is a component of the pelvic wall. Coccygeal vertebrae fuse as well into a single small triangular bone called the coccyx **(Drake R.L., et al., 2005).**

The lumbosacral space is S-shaped, with an anterior lumbar convexity "lordosis", and anterior sacral concavity. In the lumbar region, the intervertebral spaces are narrower posteriorly. The lumbosacral angulation varies from subject to subject (118 degrees in women and 126 degrees in men) according to wedging of its components which involves the body of L5, the L5/S1 disc, and the inclination of the sacral plate. The lumbosacral canal is triangular in cross-section with an anterior base. It widens from L1 to L5/S1 space, then narrows again down to the sacral hiatus. **(Louis, 1983)**

Typical vertebra

A typical vertebra consists of a vertebral body and a posterior vertebral arch. The vertebral body is the weightbearing part of the vertebra and is linked to adjacent vertebral bodies by intervertebral discs and ligaments. The vertebral bodies are often wedge shaped, wider anteriorly than posteriorly. The discs between the lumbar vertebrae are wedge shaped, and these are primarily responsible for the normal lordosis that is characteristic of the lumbar spine. **(Bell G.R., 1996)**

The vertebral arch forms the lateral and posterior parts of the vertebral foramen. The vertebral foramina of all the vertebrae together form the vertebral canal which contains the spinal cord and its protective membranes, together with blood vessels, connective tissue, fat, and proximal parts of spinal nerves. **(Drake R.L., et al., 2005)**

The vertebral arch of each vertebra consists of pedicles and laminae. The two pedicles are bony pillars that attach the vertebral arch to the vertebral body. The two laminae are flat sheets of bone that extend from

each pedicle to meet in the midline and form the vertebral arch. The interlaminar spaces are occupied by thick ligamentum flavum, these spaces are 8-15 millimeters on flexion and much smaller on extension. The L5/S1 interlaminar space is the largest **(Louis, 1983).**

Extending from the vertebral arch are a number of processes for muscle attachment and articulation with adjacent bone:

- A spinous process projects posteriorly and inferiorly from the junction of the two laminae.
- A transverse process extends posterolaterally from the junction of the pedicle and lamina on each side.
- Also projecting from the region where the pedicles join the laminae are superior and inferior articular processes, which articulate with the inferior and superior articular processes, respectively of adjacent vertebrae **(Drake R.L., et al., 2005)**. The articular facets are 10-12 mm high in the craniocaudal direction and 10-15 mm wide transversly **(Louis, 1983).**

Between the vertebral body and the origin of the articular processes, each pedicle is notched on its superior and inferior surfaces. These superior and inferior vertebral notches participate in forming intervertebral foramina. The vertebral arches of the vertebrae are aligned to form the lateral and posterior walls of the vertebral canal.

Lumbar vertebrae

The five lumbar vertebrae **(Fig. 1)**are distinguished from vertebrae in other regions by their large size; they increase in size from L1 to L5. Also, they lack facets for articulation with ribs. The transverse processes are generally thin and long, with the exception of those on L5 vertebra, which are massive and somewhat cone-shaped for the attachment of iliolumbar ligaments to connect the transverse processes to the pelvic bones. **(Drake R.L., et al., 2005)**

The transverse processes from the upper four vertebrae are more posteriorly located than those of the L5 vertebra, sitting well back on the pedicle. The fourth transverse process is usually the longest and frequently angles slightly superiorly. The fifth lumbar transverse processes are shorter, and thicker, and are more anteriorly situated, projecting from the anterior aspect of the pedicle and the lateral aspect of the vertebral body.

Embryologically, the transverse process is formed from the costal process. The true transverse element of the lumbar vertebra, corresponding to the rudimentary transverse process of a thoracic vertebra, consists of the mamillary process and the accessory tubercle. The mamillary process is a small elevation that projects posteriorly from the superior articular process behind the articular facet. The accessory tubercle lies below the mamillary process at the base of the transverse

process. These two projections serve as muscle attachments for the erector spinae muscle of the spine. **(Bell G.R., 1996)**

The angled lateral borders of the spinal canal are called the lateral recesses and constitute the bony canal of the spinal nerve root. Posterior to the upper portion of the body are the pedicles which are short and have slight medial inclination. In general, the pedicle width increases gradually from L1 to L5, but the pedicle height varies between individuals. The pedicle lengths measured between the dorsal and ventral cortex of the vertebra average 40 to 50 mm. The medial inclination of the lumbar pedicle increases consistently from L1 to L5.The projection point of the pedicle axis is located above the midline of the transverse process at the levels above L4 **(Fig. 2)**. At L4, the projection point is close to midline of the transverse process. **(Ebraheim, et al., 1996)**

The lamina is thicker and oriented in a more vertical direction in the sagittal plane in comparison to the cervical and thoracic spines. The lamina may be divided into two portions: cephalad and caudal. The cephalad portion is arched and has a smooth inner surface, whereas the caudal portion has a rough inner surface, which is the site of attachment of the ligamentum flavum. **(Van-schaick, et al., 1985)**

The portion of the lamina between the superior and inferior articular processes and just below the level of the pedicle is the isthmus or pars interarticularis. The superior articular surface is concave and faces posteromedially, and the inferior articular process is convex and faces anterolaterally. The facet angles relative to the sagittal plane range form 120 to 150 degrees with a decreasing trend form L1 to L5 **(panjabi MM. et al., 1993).** In a small percentage of patients, abnormal segmentation results in either sacralization of the fifth lumbar vertebrae or in lumbarlization of the first sacral segments **(Rauschning, 1986).**

Sacrum

The sacrum **(Fig. 3)** is a single bone that represents the five fused sacral vertebrae. It is triangular in shape with the apex pointed inferiorly, and is curved so that it has a concave anterior surface and a correspondingly convex posterior surface. It articulates above with L5 vertebra and below with the coccyx. It has two large L-shaped facets, anteriorly on each lateral surface, for articulation with the pelvic bones. **(Drake R.L., et al., 2005)**

The posterior surface of the sacrum has four pairs of posterior sacral foramina and the anterior surface has four pairs of anterior sacral foramina for the passage of the posterior and anterior rami, respectively, of S1 to S4 spinal nerves. The posterior wall of the vertebral canal may be incomplete near the inferior end of the sacrum. The sacrum is distinguished from the lumbar column by the absence of interlaminar

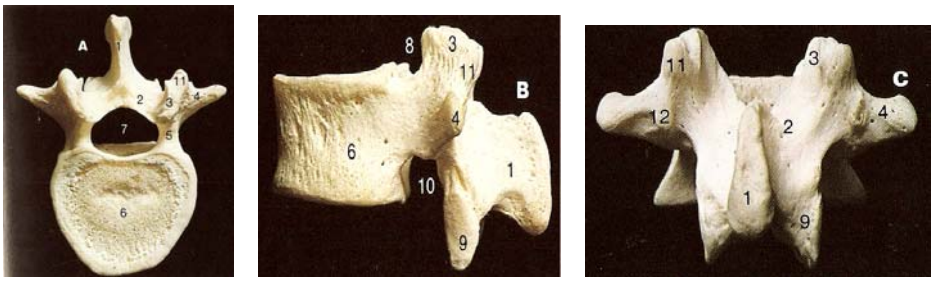

Fig. 1. Lumbar vetebra, **(A)** from above, **(B)** from the left, **(C)** from behind
1. spinous process 2. lamina 3. superior articular process 4. transverse process 5. pedicle
5. pedicle 6. body 7. vertebral column 8. superior vertebral notch 9. inferior articular process
10. inferior vertebral notch 11. mamillary process 12. accessory process

(Mcminn, et al., 1993)

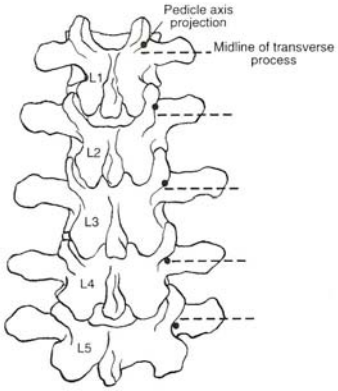

Fig. 2. the location of the pedicle axis on the posterior aspect of the lumbar spine. The dotted lines represent midline of the transverse process. **(Rongming Xu, 1999)**

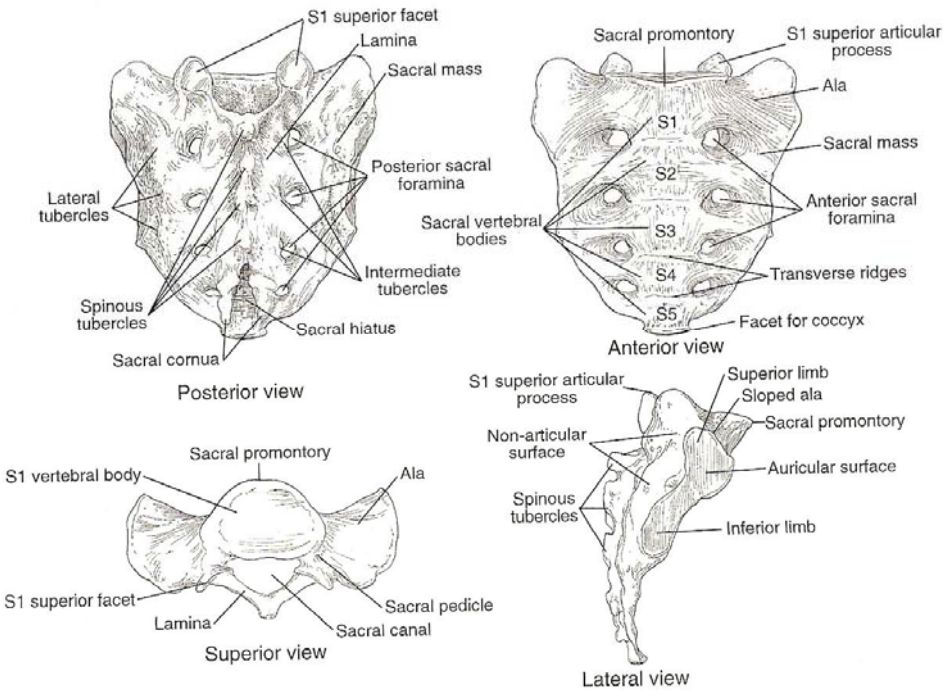

Fig. 3. the sacrum in posterior, anterior, superior, and lateral views. **(Rongming Xu, 1999)**