# Pedicle Subtraction Osteotomy in Treatment of Sagittal Imbalance

Systematic Review

*Submitted for Partial Fulfillment of Master Degree in Orthopedic Surgery*

By

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Asem Mahmoud Sayed Abdel Rasoul

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# List of Abbreviations

| Abb. | Full term |
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| ALL | Anterior longitudinal ligament |
| AS | Ankylosing spondylitis |
| CK | Congenital kyphosis |
| CSL | Central sacral line |
| FSI | Fixed sagittal imbalance |
| FSU | Functional Spinal Unit |
| LL | Lumbar lordosis |
| ODI | Oswestry disability index |
| PI | Pelvic incidence |
| PLK | Postlaminectomy kyphosis |
| PLL | Posterior longitudinal ligament |
| PSO | Pedicle subtraction osteotomy |
| SPO | Smith-Petersen osteotomy. |
| SVA | Sagittal vertical axis |
| VCR | Vertebral Column Resection. |

# Abstract

***Study design*** : a systematic review study.

***Objective*** **:** To evaluate the outcomes of pedicle subtraction osteotomy (PSO) for sagittal imbalance and to discuss the surgical strategies of this surgery.

***Methods:*** From 2000 to December 2017, nine Papers are chosen that discussing patients with sagittal imbalance Underwent PSOs. radiographic assessments which contain thoracic kyphosis (TK), lumbar lordosis (LL), global kyphosis (GK), and sagittal vertical axis were carefully recorded pre and postoperatively to evaluate the sagittal balance. Intra and postoperative complications were also registered. All patients were asked to fill out Oswestry Disability Index before surgery and at the last follow-up visit.



**Keywords :** fixed sagittal imbalance & Kyphosis & Pedicle subtraction osteotomy & Spine deformity

# INTRODUCTION

Since first being described by Thomasen in 1985, pedicle subtraction osteotomy has been used increasingly for the surgical correction of fixed sagittal plane deformity resulting from congenital, posttraumatic, metabolic, infectious, and neoplastic disorders. (1)

These disabling deformities may result in flattening of normal lumbar lordosis, in thoracic hyperkyphosis, and in forward translation (positive sagittal balance) of the head and cervical spine. Such postures are functionally and psychologically disabling. (2)

The pedicle subtraction osteotomy is useful for treating patients with ankylosing spondylitis and an imbalance in the sagittal plane of the spine. (3)

The pedicle subtraction osteotomy is historically performed at L2 or L3, and an ideal candidate for the procedure typically has a positive sagittal imbalance of >12 cm. The pedicle subtraction osteotomy is also indicated for patients who have had a circumferential fusion along multiple vertebrae. (4)

## Anatomy

The functional spinal unit is made up of an intervertebral disc, the adjacent superior and inferior vertebra, the interconnecting right and left facet joint, and the surrounding

ligamentous tissue. The two adjacent vertebrae are linked by three joints the intervertebral disc, the right and left facet joints (Fig. 1). This joint complex allows three-dimensional movements: flexion-extension, axial rotation, and lateral bending. (5)

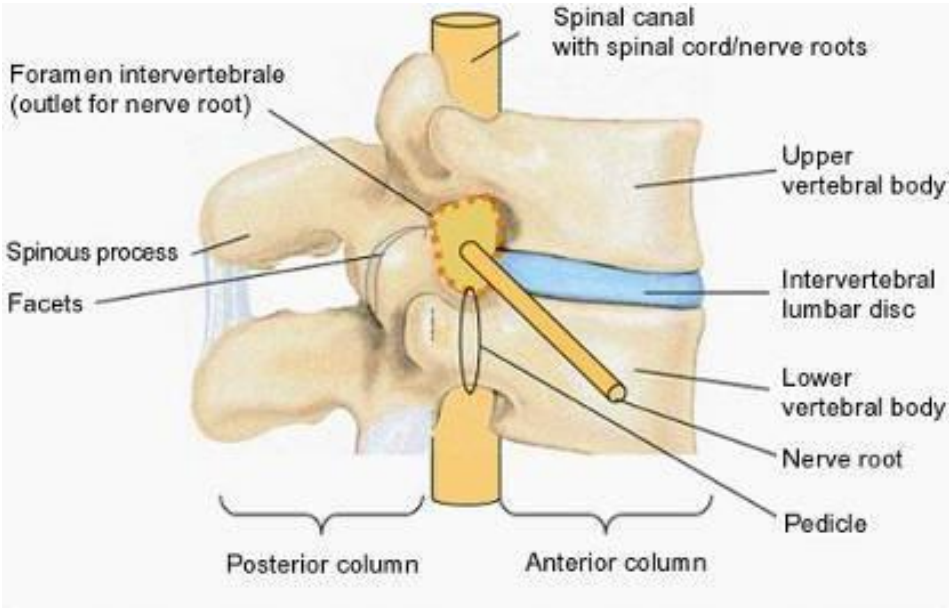


**Fig. (1):** Functional Spinal Unit (FSU). (5)

## Osseous support:

A typical vertebra has a ventral body, a dorsal vertebral (neural) arch, extended by lever-like processes, and a vertebral foramen, which is occupied in life by the spinal cord, meninges and their vessels. (6)

Pedicles are short, thick, rounded dorsal projections from the superior part of the body at the junction of its lateral and

dorsal surfaces: the concavity formed by the curved superior border of the pedicle is shallower than the inferior one. (6)

When vertebrae articulate by the intervertebral disc and facet joints, these adjacent vertebral notches contribute to an intervertebral foramen. The complete perimeter of an intervertebral foramen consists of the notches; the dorsolateral aspects of parts of adjacent vertebral bodies and the intervening disc, and the capsule of the synovial facet joint (Fig. 2). (7)

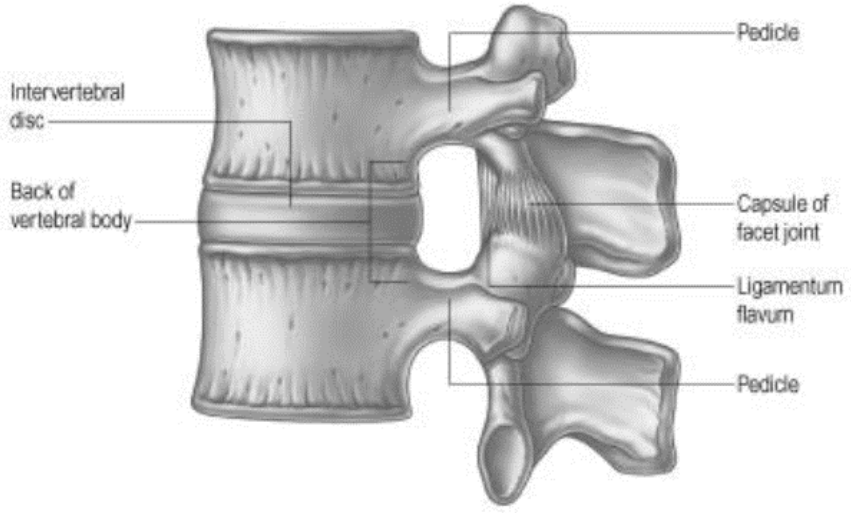


**Fig. (2):** Osseous anatomy of the vertebrae. (7)

## 2-Ligamentous and muscular support:

The soft tissue structures of the lumbar spine include the ligaments, the musculature and the fascia. (8)

The main supporting ligaments of the lumbar spine are the anterior longitudinal ligament (ALL), posterior longitudinal ligament (PLL), the outer part of the annulus fibrosus,

sacrotuberous ligament, iliolumbar ligament, ligamentum flavum and facet capsular ligament (fig.3). [9]

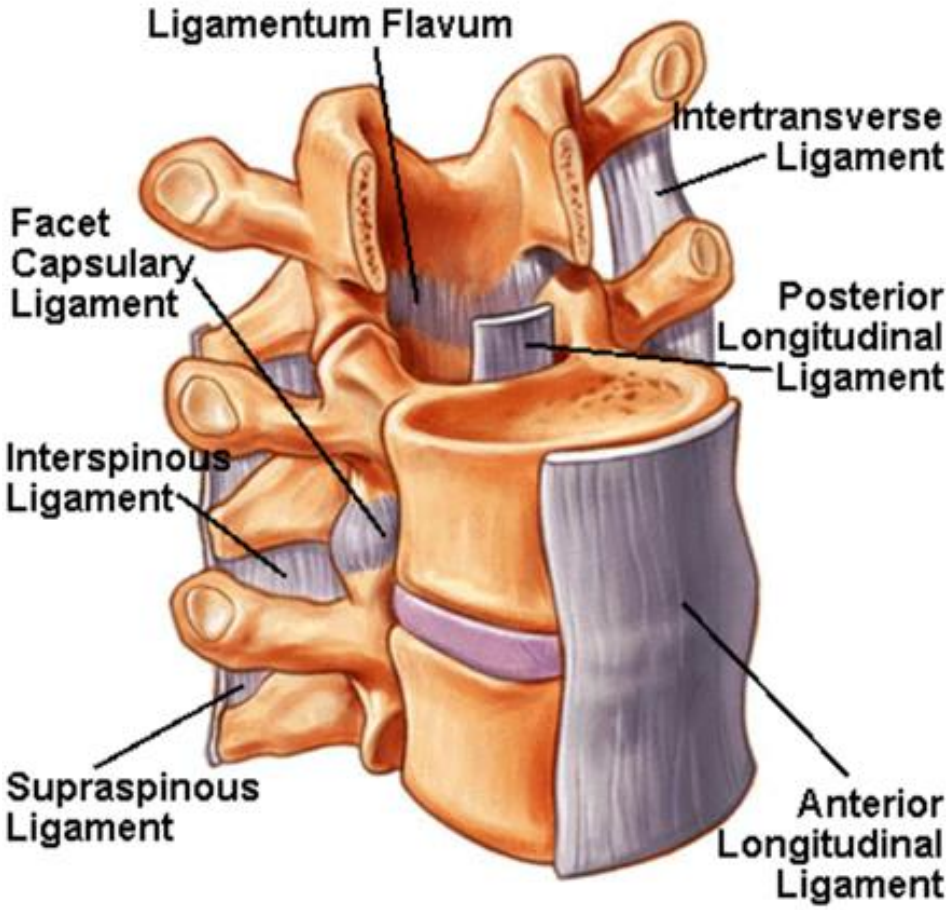


**Fig. (3):** Ligamentous support of the spine. [9]

The ligamentum flavum, otherwise known as the yellow ligament, is a short and thick ligament which connects the laminae of consecutive vertebrae. Its function is to prevent flexion, as well as prestress the disc for functional activities. [10]

It is known as the yellow ligament because it is comprised of 80% elastin and 20% collagen which gives it a yellowish hue and makes it more elastic than other ligaments in the body. This is important functionally so that during backward bending the ligament does not buckle and put pressure on the spinal cord. (10)

The anterior longitudinal ligament (ALL) lies on the front of the spine and attaches segmentally to the vertebral bodies. The function of this ligament is acting as restraint to prevent extension. (10)

The posterior longitudinal ligament (PLL) is a narrow band that attaches segmentally to the back of the vertebral bodies. It widens over the discs and is narrower over the vertebral bodies. The function of this ligament is to resist flexion. (10)

## Adult curvature of the vertebral column:

In the sagittal plane, the normal spine has four balanced curves: the cervical spine is lordotic; the thoracic spine is kyphotic (20 to 48 degrees), with the curve extending from T2 or T3 to T12; the lumbar region is lordotic (43 to 61 degrees); the sacral curve is kyphotic. On standing, the thoracic kyphosis and lumbar lordosis are balanced. Normal sagittal balance is defined as a plumb line dropped from C7 and intersecting the posterior superior corner of the S1 vertebra (Fig. 4) (11)

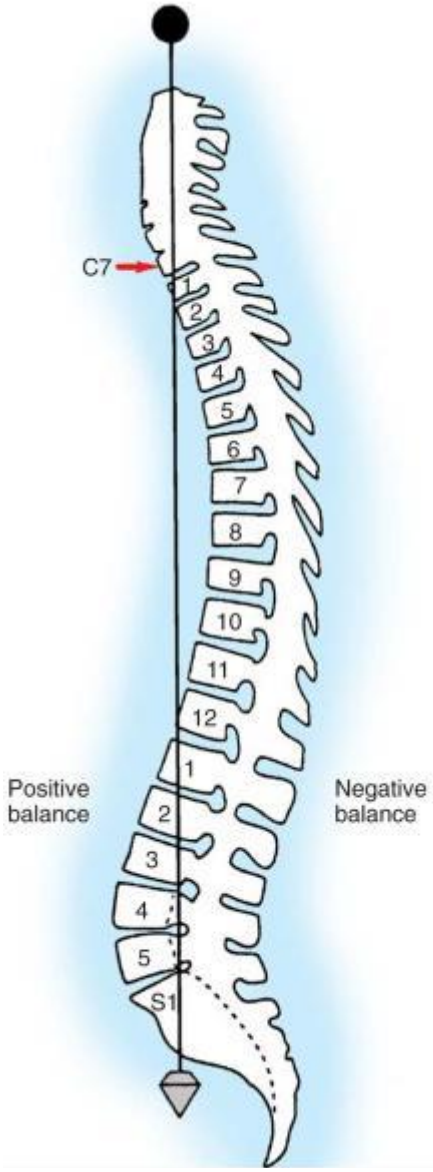


**Fig. (4):** Plumb line is dropped from middle of C7 vertebral body to posterior superior corner of S1 vertebral body. (11)

## Sagittal Imbalance:

There are two general types of spinal imbalance in the sagittal plane: type 1 and type 2. (12)