"A PROSPECTIVE STUDY OF FUNCTIONAL OUTCOME OF LUMBAR DISEASES TREATED WITH SINGLE LEVEL INSTRUMENTED POSTERIOR LUMBAR INTERBODY FUSION"

By

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Dissertation submitted to BLDE (Deemed to be University), Vijayapura.

In partial fulfilment of the requirements for the award of the degree of

DOCTOR OF MEDICINE

IN

ORTHOPAEDICS

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2019

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M. S

IN

ORTHOPAEDICS

ABBREVIATIONS

LBP- Low back pain

PLIF-Posterior lumbar interbody fusion

ALIF-Anterior lumbar interbody fusion

TLIF- Trans foraminal lumbar interbody fusion

IPLF- Instrumented posterior lumbar fusion

ODI- Oswestry disability index

VAS- Visual analogue scale

NRS- Numeric rating scale

BMI- Body mass index

LL- Lumbar lordosis

JOA- Japanese orthopaedic association

MRI- Magnetic resonance imaging

CT- Computed tomography

SPECT- Single photon emission computed tomography

LS- Lumbo-sacral

PEEK- Polyetheretherketone

ABSTRACT

Introduction: Low back pain is one of the most commonly reported problems in the world. The most common causes are injury or overuse, pressure on neural tissue from different pathologies (disc herniation, stenosis, degenerative disc disease, listhesis etc.).

Spinal fusion is essentially a " welding " process. The basic idea is to fuse together the painful vertebrae so that they heal into a single, solid bone. The theory being that if the painful vertebrae do not move, they should not hurt.

Posterior lumbar interbody fusion (PLIF) is done to obtain interbody vertebral fusion through a posterior approach. The advantage of PLIF over anterior lumbar interbody fusion(ALIF) is the avoidance of vascular and reproductive system complications that can occur with anterior lumbar surgery.

Aims and objective: To study the Functional outcome of lumbar diseases treated with single level instrumented posterior lumbar interbody fusion.

Material and Method: It is a prospective observational study. Patients who meet the inclusion criteria were admitted to BLDEU'S Shri B.M.Patil's Medical College, Hospital and Research Centre, Vijayapura's Department of Orthopedics. The patients were informed about study in all respects and informed written consent was obtained. Period of study was between November 2019 to May 2021. Follow up period was for 6 months.

Results: We studied 30 cases in our series with 21 male and 9 female patients. The radiological union rate was found to be 73.3 percent. From surgical incision to wound closure, the average operating time was 3.5 hours. The average blood loss was 237 millilitres.

The improvement in the post-operative VAS score at the six-month mark was drastic and significant, as proven by a "p value" of < 0.0001.

Improvement in quality of life, as assessment, based on the Wilcoxon signed rank test comparing preoperative and postoperative Oswestry Disability score (ODS) and Oswestry Disability index (ODI), was statistically significant, showing reduction in Oswestry Disability index and score postoperatively, indicating significant improvement in the quality of life.

Conclusion: A degenerated disc with disc space narrowing, spinal canal stenosis or a case of spondylolisthesis that hasn't responded to conservative treatment, are indications for PLIF.

In light of the results and minimal complication rate, we would recommend the PLIF technique combined with bone grafting as an appropriate technique for spondylolisthesis and degenerative disc disease.

Keywords: Posterior lumbar interbody fusion, degenerative disc disease, Spondylolisthesis, Oswestry Disability score.

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INTRODUCTION

Low back pain (LBP) is one of the most commonly reported problems in the world. The most common causes of LBP are injury or overuse, pressure on neural tissue from different pathologies (disc herniation, stenosis, generative disc disease, etc.)

Spinal fusion is a surgical procedure used to correct problems with the small bones in the spine (vertebrae). It is essentially a "welding" process. The basic idea is to fuse together the painful vertebrae so that they heal into a single, solid bone.

Spinal fusion is a treatment option when motion is the source of the pain—the theory being that if the painful vertebrae do not move, they should not hurt.

Posterior lumbar interbody fusion (PLIF) is done to obtain interbody vertebral fusion through a posterior approach. The advantage of PLIF over anterior lumbar interbody fusion(ALIF) is the avoidance of vascular and reproductive system complications that can occur with anterior lumbar surgery. PLIF is used to manage a variety of spinal pathologies , including degenerative disc disease, severe instability, spondylolisthesis, deformity and trauma.

Many different modalities have been advocated by different authors from time to time. In many cases, the condition can be treated conservatively. However when the symptoms persist, surgery needs to be performed. The principle underlying surgery includes stabilization of the slipping vertebrae. Various operative methods encompassing posterior interbody vertebra, posterior stabilization, facet joint fusion, excision of loose segment, anterior inter-body fusion etc.

Inter-body fusion techniques have been developed to provide solid fixation of spinal segments while maintaining load bearing capacity and proper disc height. The developmental evolution of posterior spinal segment instrumentation is derived from the pathologies of deformity correction and fracture fixation.

Posterior rather than anterior fusions are preferred by most because its technique is more flexible; it permits exploration of defects, nerve root and intervertebral defects.

The main aim is to have rigid fixation to bony elements in the area of attempted fusions and hopefully to improve fusion rates and eventual outcome[1]

OBJECTIVE OF THE STUDY

The purpose of this study is to evaluate functional outcome of lumbar diseases treated with single level instrumented interbody fusion.

REVIEW OF LITERATURE

1.**Michael Horeb, Ahmad Rizan Hendrawan, Angga Anggriawan, Karya Triko Biakto, Wilhelmus Supriyadi**. At Wahidin Sudirohusodo Hospital in Makassar, functional outcome following posterior lumbar interbody fusion with cage in a patient with lumbar spinal stenosis was studied. The investigation was conducted utilising a retrospective longitudinal study design with 16 patients who underwent PLIF with cage between December 2015 and September 2017, with a 6–12 month postoperative follow-up. The Oswestry Disability Index and the pain scale were used to assess all of the patients (ODI).

Patients' pain scales and functional outcomes improved following the initial procedure. The 6-month postoperative ODI was 43.7 percent, which was significantly lower than the pre-operative index. The 12-month postoperative ODI rate was also much lower, with an 85.6 percent decrease. With a fall of 74.5 percent, the 12-onth postoperative ODI was significantly lower than the 6-month postoperative ODI..[(2)]

2.**Sanganagouda S Patil, Saurabh Rawall, Premik Nagad, Bhavin Shial, Uday Pawar, and Abhay M Nene.** In 2011, a single level instrumented posterior lumbar interbody fusion was performed using corticocancellous laminectomy bone chips. There were 24 men and 11 females among the 35 patients, with an average age of 41 years. There were 16 patients with definitive fusion, 15 with probable fusion, four with possible pseudoarthrosis, and none with definitive pseudoarthrosis. Fusion took an average of 18 months to occur. Over a two-year period, the average loss of disc height in eight patients was only 3 mm. At the fusion level, three individuals developed a localised kyphosis of more than 3°. The average blood loss was 356 ml, with a 150-minute operating time.[(3)]

3. **Ming-Kai Hsieh, Lih-Huei Chen, Chi-Chien Niu, Tsai-Sheng Fu, Po-Liang Lai and Wen-Jer Chen** A total of 110 patients with degenerative spinal deformity with curves greater than 30 degrees were studied between November 2002 and November 2011. At the facility, 56 patients underwent surgery using a mixed anterior and posterior technique, while 54 patients underwent surgery using a posterior method. (1) rigid or frank lumbar kyphosis, (2) anterior or lateral bridged traction osteophytes, (3) gross coronal and sagittal deformity or imbalance, and (4) severe disc space narrowing that is not identifiable when performing posterior or transforaminal lumbar interbody fusion were all indications for anterior lumbar interbody fusion. The Oswestry disability index and the visual analogue scale were used to assess the clinical outcomes. The radiography data were used to determine the fusion status. Clinical and radiological follow-up was provided to all patients for a minimum of 24 months, with an average follow-up of 53 months (range, 26–96 months). The mean ODI score in the AP group improved from 28.8 to 6.4, and the mean back/leg VAS improved from 8.2/5.5 to 2.1/0.9, whereas the mean ODI score in the P group improved from 29.1 to 6.2, and the mean back/leg VAS improved from 9.0/6.5 to 2.3/0.5 at the final follow-up..(4)

4. **Bin Lin, Hui Yu, Zhida Chen, Zhuanzhi Huang and Wenbin Zhang**

In 2016, a study compared the PEEK cage to an autologous cage built from the lumbar spinous process and laminae in posterior lumbar interbody fusion. Sixty-nine patients with lumbar degenerative disc degeneration were randomly assigned to one of two groups: group A (34 patients) or group B (35 patients). All of the patients underwent monosegmental PLIF. The researchers compared the mean lumbar lordosis, mean disc height, visual analogue scale (VAS) scores, functional outcomes, fusion rates, and complication rates. The patients were followed for at least two years after surgery. All of the patients had successful radiographic fusion. During the follow-up period, no flexion–extension hypermobility or pedicle screw loosening or breakage occurred. When comparing the mean lumbar lordosis, mean disc height, visual analogue scale (VAS) scores, functional outcomes, fusion rates, and complication rates, there was no significant difference between the two groups. In both groups, satisfactory outcomes were obtained.(5)

5 **Monica Lara-Almunia, Juan A. Gomez-Moreta and Javier Hernandez-Vicente**

Description and relationship of clinico-surgical factors with prognosis in a series of 36 instances of posterior lumbar interbody fusion with instrumented posterolateral fusion in adult spondylolisthesis. There were a total of 36 cases operated on. There were 14 males and 22 women in the study, with an average age of 57.1727.32 years. The procedure consists of PLIF+IPLF with local bone fusion. The Visual Analogical Scale (VAS) and the Kirkaldy-Willis criteria were used to assess the clinical outcomes. The Bratingan (PLIF) and Lenke (IPLF) methodologies were used for the radiological evaluation. SPSS18 was used to statistically analyse a total of 42 variables. The Paired Student's T-test, logistic regression, and Pearson's Chi-square-test were employed in this study. Results In 15 cases, the spondylolisthesis was isthmic, while in 21 cases, it was degenerative. 94.5 percent (n=34) of postoperative evaluations were excellent or good, with a statistically significant improvement in back pain and sciatica (p -0.2). The logistical regression in our series revealed that the patient's clinical features, the lesion's radiological characteristics, and our surgical method were not linked to increased postoperative problems.[6]

6 **Hui Wang, Tao Wang, Qian Wang, Wenyuan Ding**. Persistent low back pain after posterior decompression and instrumented fusion for lumbar disc herniation: incidence and risk factors. 221 patients were retrospectively assessed after retrieving medical information from January 2013 to December 2016. At all postoperative follow-up time periods, patients were defined as having PLBP if their numeric rating scale (NRS) ratings were >50. (3 months, 6 months, and 12 months). Patients were separated into two groups based on the presence of PLBP: PLBP group and non (N)-PLBP group. The following three classified factors were statistically evaluated to investigate risk values for PLBP. Patient characteristics include age, gender, BMI, preoperative low back pain, comorbidities, smoking, and alcohol consumption. Surgical factors include surgical strategy, surgical segment, number of fusion levels, operation time, blood loss, and incision size. Preoperative lumbar lordosis (LL), immediate postoperative LL correction, Modic alterations, and preoperative paraspinal muscle degeneration are all radiographic markers. The presence of PLBP was found in 16 patients, who were assigned to the PLBP group. Age, gender, BMI, comorbidities, smoking, and drinking did not differ between the two groups. The PLBP group's preoperative low back discomfort was more severe than the N-PLBP group's. Surgery time, blood loss, surgical approach, number of fusion levels, and incision size were all the same. The PLBP group had a higher rate of surgery segment at L5–S1 than the N-PLBP group, although there was

no difference in preoperative LL, correction of LL, preoperative lumbar mobility, or Modic alterations. [(7)]

7. **Huan Liu, MDa , Ying Xu, MDb , Si-Dong Yang, MDa , Tao Wang, MDa , Hui Wang, MDa , Feng-Yu Liu, MDa , Wen-Yuan Ding, PhDa,**

For lumbar degenerative disorders, unilateral versus bilateral pedicle screw fixation with posterior lumbar interbody fusion

From January 2007 to January 2017, a comprehensive search of the literature on unilateral versus bilateral pedicle screw fixation with PLIF fusion for LDD was conducted in the Pubmed/MEDLINE, Embase, CNKI, and WANFANG databases, with language restrictions of Chinese or English. Blood loss, operation time, length of hospital stay, Japanese Orthopedic Association (JOA) scores, visual analogue scale (VAS) and Oswestry disability index (ODI) scores, fusion rate, total complications, infection, dural injury, and nerve injury were all extracted as variables. RevMan 5.3 and STATA 12.0 were used to analyse the data. Our study includes a total of 11 trials with a total of 844 patients. In terms of blood loss, unilateral pedicle screw fixation with PLIF outperformed bilateral pedicle screw fixation (P.05). [(8)]

8**Alexandros G. Brotis, MD,* Kostantinos N. Paterakis, MD, PhD,**

Paraskevi M. Tsiamalou, RN, MSc,w Kostas N. Fountas, MD, PhD. PLIF was performed on 46 patients for degenerative lumbar spine problems over a two-year period in 2010. In all cases, the surgical technique included posterior decompression of the afflicted segment(s) and stabilisation with pedicle screws and rods, with interbody implants in some cases. The Greek versions of (a) the Visual Analogue Scale (VAS) for pain assessment, (b) the Oswestry Impairment Index (ODI) for back-related disability, (c) the Prolo Scale for functional and economic status, and (d) the Zung Depression Scale for depression screening were used as outcome measures. Measurements were taken one week before surgery and three years later. The paired-samples t test was used to compare the preoperative and postoperative findings.

Our study included 39 individuals (25 females and 14 males) with an average age of 59 years. The agricultural sector employed half of them. Solid lumbar fusions formed in all of them. Instrumented posterior lumbar fusion reduced somatic pain as measured by the VAS (P0.001), increased function as measured by the ODI (P0.001), and permitted patients to return to work (P0.001). Nonetheless, the Zung Depression Scale found that depression was more common after surgery (P<0.001).[9]

9**. Haid RW Jr, Branch CL Jr, Alexander JT, Burkus JK.**

In 2004, posterior lumbar interbody fusion with cylindrical interbody cages was performed utilising recombinant human bone morphogenetic protein type 2. Recombinant human bone morphogenetic protein type 2 (rhBMP-2) on an absorbable collagen sponge carrier has been shown to reduce operative time and blood loss, promote osteoinduction and fusion, and be a safe and effective substitute for iliac crestharvesting in a large series of human patients undergoing open anterior lumbar interbody fusion with a tapered titanium fusion cage. Overall, the results demonstrate that rhBMP-2 can obviate the requirement for iliac crest graft harvesting and may be a viable alternative to autograft in successful posterior lumbar interbody fusions. There is a need for more research on the use of rhBMP-2 in posterior lumbar interbody fusion cage surgeries..[10]

10. **Park Y, Ha JW**. A one-level posterior lumbar interbody fusion using a minimally invasive method vs a typical open approach was compared. From October 2003 to October 2004, they looked at a group of 61 patients who had a one-level PLIF operation performed by one surgeon at one hospital (32 cases with a minimally invasive method and 29 cases with a typical open approach). Clinical and radiological findings, surgery time, estimated blood loss, transfusion needs, visual analogue scale postoperative back pain, time needed before ambulation, length of hospital stay, and complications were compared between the two groups with a 1-year minimum follow-up.[11]

SURGICAL ANATOMY

The vertebral column comprises 33 vertebrae divided into five sections (fig 1)

- 7 cervical,
- 12 thoracic,
- 5 lumbar,
- 5 sacral, and
- 4 coccygeal

The sacral and coccygeal vertebrae are fused, which typically allows for 24 mobile segments.

Figure 1

ANATOMY OF VERTEBRAE

The vertebral column

Males have a spinal column that measures 72 cm on average, whereas females have a spinal column that is 7 to 10 cm shorter. An anterior body and a posterior arch, which enclose the vertebral canal, are the parts of a typical vertebra (Fig.2,3).

The neural arch is made up of two pedicles on lateral side and two laminae on posterior aspect, which come together to produce the spinous process. (12)

On both sides of the arch of the body of the vertebra, a transverse process and articular processes (superior and inferior) are present. The synovial joints are the result of articulation of the superior and inferior articular processes of the adjacent vertebrae. Orientation of the articular processes, account for the range of movements possible in each segment of the vertebral column.

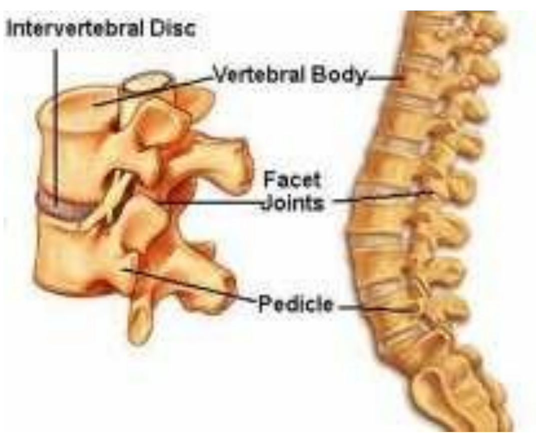


Figure 2

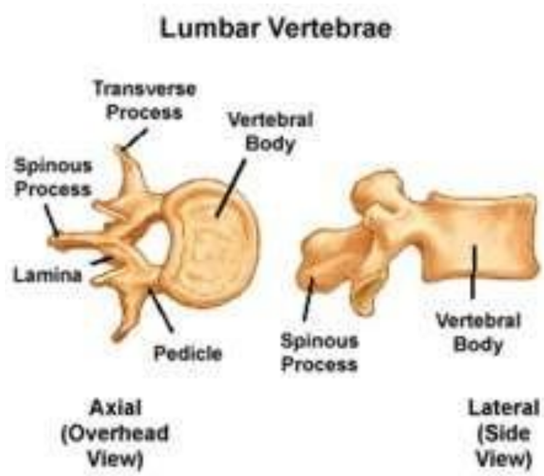


Figure 3

The facet joints

The zygapophyseal joints, also known as facet joints, are synovial joints produced between the superior articular process of one vertebra and the inferior articular processes directly below it. An articular cartilage lining, a synovial membrane covering, and a joint capsule encapsulate the joint surfaces. Branches of the posterior principal rami innervate these joints.

Intervertebral disc:

These are considered the largest avascular structures in the human body and nutrition is derived from a network of blood vessels of the end plate in the form of diffusion. These are present between two vertebral bodies. These are found throughout the entire vertebral column except between the first and second cervical vertebrae. This consists of superior and inferior vertebral end plates with a sandwich formed by the nucleus pulposus in the middle and an annulus fibrosus peripherally (fig.4,5).

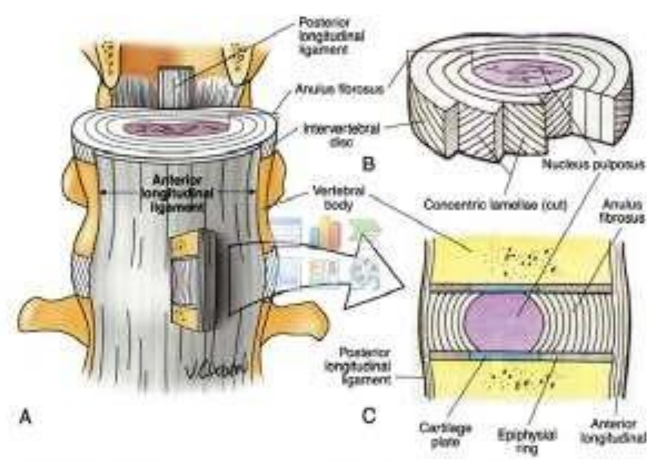


Figure 4 A- spine as seen from anterior aspect of anterior longitudinal ligament.

B- Transverse section through disc C- Sagittal section of spinal column

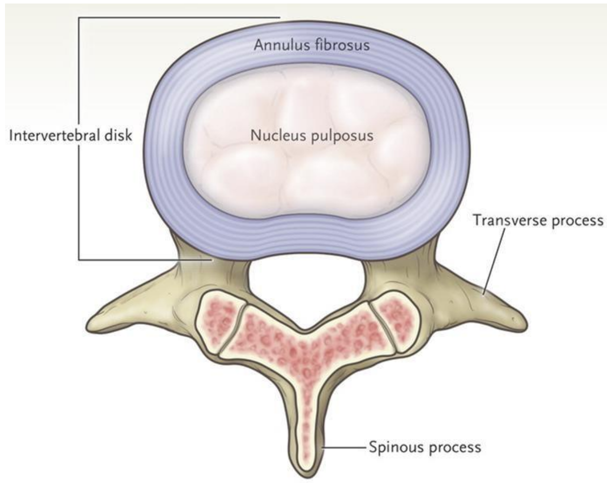


Figure 5: An image is depicting the intervertebral disc structure.

Each vertebral end plate, formed by fibrocartilage and hyaline cartilage, measures 1.03±0.24 mm for cranial (to disc) endplates and 0.78±0.16 mm for caudal endplates.[13] The percentage of fibrocartilage compared to hyaline cartilage increase with advancing age.

The Spinal Cord and Nerves

In adults, the spinal cord ends as a bulbous section called the conus medullaris at the level of the L1 vertebra. The fibrous band that connects the conus to the dorsum of the first coccygeal segment is known as the filum terminale. The spinal cord is surrounded by three protective coverings. From the outside in, these are the dura, arachnoid, and pia mater. The cerebrospinal fluid is contained in the subarachnoid space, which divides the pia and arachnoid membranes.

At each vertebral level, the anterior and posterior spinal nerve roots exit via the intervertebral foramen and combine at the foramen's outer border to produce the spinal nerve. There is a ganglion created at the outside region of the foramen before the dorsal root joins its ventral counterpart, known as the dorsal root ganglion, which can cause a dysesthetic pain response if manipulated.

C2-7 spinal nerves pass above their respective pedicles. The C8 roots travel via the foramen that connects the C7 and T1 pedicles. The nerve roots caudal to C8 pass through a foramen beneath their respective pedicles. The spinal cord is shorter than the vertebral column. As a result, the spinal nerves become more vertical as they move caudally.

The Lumbar Pedicles

When employing the pedicle as a screw purchase site, a detailed understanding of pedicle size and angles is essential. Pedicle dimensions have been examined by Zindrick et al., Saillant, and others. (14) These studies have revealed information concerning the anatomical properties of the pedicle as well as the depth to which screws can be safely put into the thoracolumbar spine.

The analysis of pedicles from T1 to L5 revealed that L5 had the broadest pedicle in the horizontal plane, while T5 had the narrowest. T11 had the widest pedicles in the sagittal plane, while T1 had the narrowest. Because of the oval form of the pedicle, the width in the sagittal plane was greater than in the horizontal plane. At L5, the horizontal plane has the greatest pedicle angle. In the sagittal plane, the pedicle angle at L5 is caudad, whereas it is cephalad at L3-T1. The depth to the anterior cortex along the pedicle's axis was greater than any line parallel to the midline of the vertebra's body. The exception was discovered at T12 and L1.

DEGENERATIVE DISC DISEASE

It is usually a disease of aging. It causes severe chronic pain if not well treated.

Stability of spine

Stabilizers, both dynamic and static, offer it. Muscles, ligaments, and posture are examples of dynamic stabilisers. Bony articulations and IV discs are examples of static. The motion segment, which consists of two neighbouring vertebrae and the intervertebral disc, is the spine's basic functional unit.

Mechanism of pain generation in degenerative disc disease

The outer 1/3rd of the annulus fibrosus is innervated by free nerve- endings, which transmit the pain.[(15,16)] A tear in the annulus fibrosis is one of the most common causes of low-back axial discomfort. The production of neuropeptides is linked to the development of pain. The innervation of severely deteriorated lumbar discs is more extensive than that of normal discs. There will be a rip in the annulus fibrosus during disc degeneration, which may stimulate various pain pathways. Cartilage end-plates are thought to get additional sensory nerves and neuropeptides in patients with degenerative disc degeneration.

Inflammatory chemicals irritate the duramater, causing severe back discomfort. Sciatica is caused by irritation of the nerve roots in the lower limb. Lower motor neuron lesion can develop when the nerve root is compressed, resulting in weakness, sensory abnormalities, and reduced reflexes in the lower limb.

Typical symptomatology were reproduced by stimulation of annulus fibrosus of the posterior disc, in about 66% of patients with intractable lower back.[17] In 61 percent of patients, vertebral end plate stimulation caused pain. The application of stretch or pressure to the nerve root caused pain in the lower limbs. The buttocks were painful when the annulus fibrosus and nerve root were stimulated at the same time. Even when no additional indications of aberrant motion or spondylolisthesis can be observed, the discomfort is often defined as "lumbar segmental instability" [18,19]when it is caused by degenerative disc disease,[20] or facet joint syndrome [21,22] even when no other features of abnormal motion or spondylolisthesis can be identified. There are numerous studies that suggest that full disc excision with intervertebral body arthrodesis can reduce persistent pain following successful discectomy.

KIRKALDY-WILLIS STAGES OF DISC DEGENERATION [23]

It is divided into 3 stages

- Dysfunction
- Instability
- Stabilization

If an instability or deformity is corrected, if neural compression is relieved, or if a combination of these case scenarios is positive, surgical therapy may be advantageous..

Stage of dysfunction

It mainly affects people between the ages of 15 and 45. End plate destruction is caused by repeated micro stress to the disc, which generates circumferential annular rips. Coalescence of annular tears results in radial tears. The nucleus pulposus will migrate to the annulus' periphery during time, although it will be contained by the posterior longitudinal ligament. The annulus eventually fails, resulting in disc herniation.

Stage of instability

This stage is characterised by increased facet joint motion, which leads to lower resistance to joint pressures, and it occurs in people aged 35 to 70. Internal disc disruption and resorption will occur, as well as facet joint degeneration and capsular laxity, resulting in subluxation and joint erosion. The neural foramen narrows as the disc height decreases. Nerve ischemia is caused by exposed disc material in the epidural space, which induces an inflammatory reaction.

Stage of stabilization

The final stage demonstrates its occurrence in people beyond the age of 60. The growth of hypertrophic bone around the disc and zygapophyseal joints will occur over time, resulting in segmental stiffness and ankylosis. In response to anterior column degeneration, the facet joint bears additional weight, resulting in a permanent deformity. Hypertrophic bone development affects the spinal nerve, resulting in stenosis of the spinal canal in degenerative arthritis.

Pathology

The disc's function can be impaired in two ways: by changing the water content or by wear and tear in the annulus. This results in a reduction in disc space, annulus bulging, collagen growth, calcification, and the production of osteophytes.

Pathological staging of disc herniation

(Eismont & Currier -1989) (fig-6a)

1) Bulge – due to disc dehydration / desiccation and degeneration
2) Protrusion of disc within the annulus
3) Extruded disc through the annulus – but not through the posterior longitudinal ligament
4) Sequestrated disc – through both annulus fibrosus & posterior longitudinal ligament – lies free in the spinal canal

Types and sites of Protrusion (fig 6b)

Central

Paramedian

Lateral

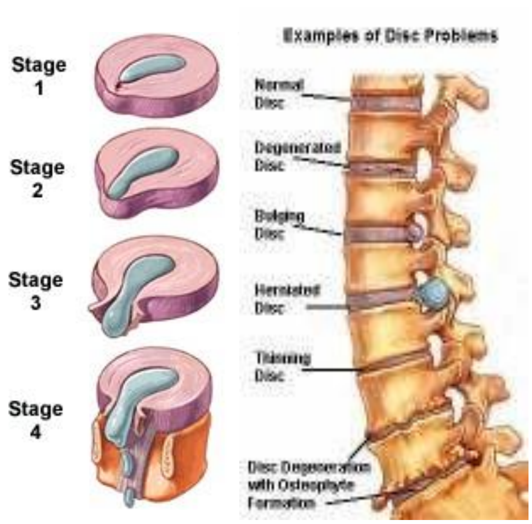


Figure 6a

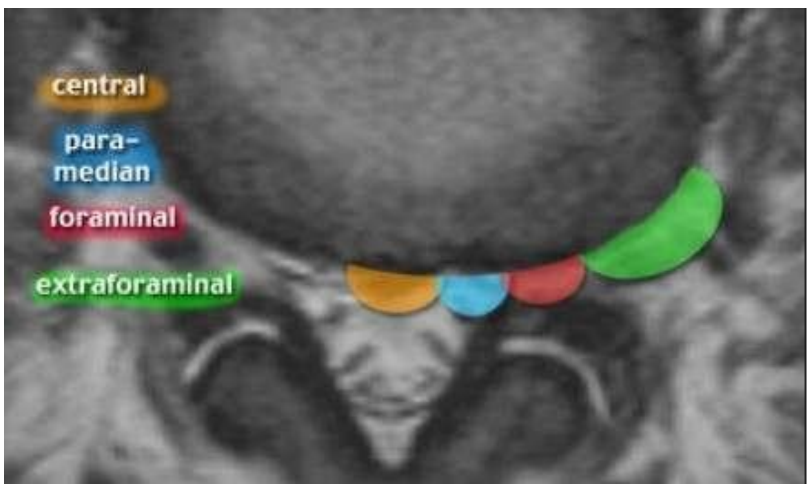


Figure 6b

INVESTIGATIONS

X-ray

X-rays of the affected spinal region must be taken from the front, back, and sides. The absence of normal lumbar lordosis due to paraspinal muscle spasm will be apparent in the early stages. The disc space will narrow and osteophytes will form as the stage proceeds.

Myelography

It reveals any variations in the spine and defines intraspinal lesions. It isn't necessary if a clinically sound diagnosis has been made and an MRI or CT scan identifies the condition. Its value can be increased by evaluating spinal stenosis using postmyelography CT.

Magnetic Resonance Imaging

It is now the standard for sophisticated spinal imaging because it provides more information about the disc and neuronal components. It can reveal the nerve root's features in the intervertebral foramen.

Bone scans

Positive findings are not confirmatory for intervertebral disc problems, but can confirm traumatic, arthritic, and neoplastic problems in the spine.[24]

Computed Tomography

The image has been reconstructed to offer a three-dimensional picture of the spine. The ability to see inside the dural sac and sleeves of the root is the most significant benefit. A bone origin or a disc condition can be identified as the cause of foraminal stenosis.

TREATMENT

CONSERVATIVE TREATMENT

It is recommended initially.

Patient is advised rest, NSAIDS with muscle relaxant, exercises and epidural steroids.

Chemonucleolysis

OPERATIVE TREATMENT

Indications include paralysis / cauda equina syndrome, severe deficit of neurology, failure of conservative treatment, severe penetrating pain. [25]

Operations done

- Open discectomy after fenestration / laminectomy / hemilaminectomy
- Microlumbar discectomy
- Endoscopic discectomy
- Percutaneous nucleotomy
- Laser discectomy
- Interbody fusion

Interbody cages are only used by those who have postlaminectomy syndrome or disc collapse with narrowing of the neuralforamen. 21 Continuing to load after a discectomy does not guarantee long-term success. Discectomy, followed by interbody fusion, is the key to success..[26]

SPONDYLOLISTHESIS

Spondylolisthesis is a descriptive term derived from the Greek **spondylo** (spine) and **olisthesis** (slip). Anterior translation of the cephalad vertebra relative to the adjacent caudal segment. The biomechanical force causing this translation is the anteriorly directed vector created by the contractionof the posteriorly located erector spinae muscles, coupled with the force of gravity acting on the upper body mass through the lordotic lumbar spine and lumbosacral junction.

Symptoms of spondylolisthesis include

- axial pain,
- neurogenic claudication,
- radiculopathy,
- cauda equina syndrome.

In addition, the deformity associated with spondylolisthesis can range from not clinically apparent to severe with significant sagittal imbalance and associated truncal shortening.

WILTSE CLASSIFICATION

Type I, dysplastic—Congenital abnormalities of the upper sacral facets or inferior facets of the fifth lumbar vertebra that allow slipping of L5 to S1.
No pars interarticularis defect is present in this type. (Figure7)

Type II, isthmic—Defect in pars interarticularis allows forward slipping of L5 on S1.
Three types of isthmic spondylolistheses are recognized:
■ Stress fracture of pars interarticularis (lytic) (Figure8)
■ Elongated but intact pars interarticularis (Figure9)
■ Acute fracture of pars interarticularis (Figure10)

Type III, degenerative—Intersegmental instability of long duration with subsequent remodeling of the articular processes at the level of involvement

Type IV, traumatic—Fractures in the area of the bony hook other than the pars interarticularis, such as the pedicle,
lamina, or facet

Type V, pathologic—Generalized or localized bone disease and structural weakness of the bone, such as osteogenesis imperfecta

Figure7

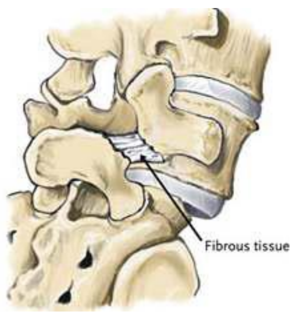


Figure8

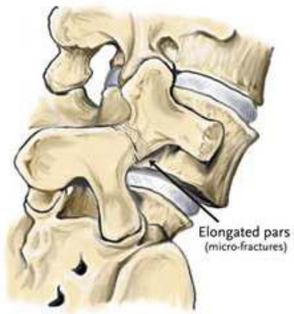


Figure9

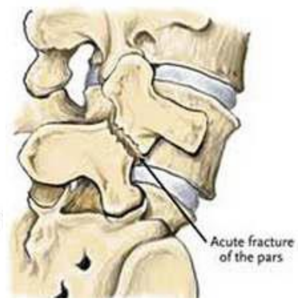


Figure10

Meyerding Classification of Spondylolisthesis (Figure 11)

GRADE	DISPLACEMENT
I	0-25%
II	26-50%
III	51-75%
IV	76-100%
V	> 100%

NORMAL

GRADE I

GRADE II

Classification of Spondylolisthesis (Marchetti and Bartolozzi)

Developmental

High dysplastic

With lysis

With elongation

Low dysplastic

With lysis

With elongation

Acquired

Traumatic

Acute fracture

Stress fracture

Post surgery

Direct surgery

Indirect surgery

Pathologic

Local pathology

Systemic pathology

Degenerative

Primary

Secondary

Developmental

The birth of the child will be with a dysplastic bony hook. Hence, there will be increase stress on Pars, which is stretched or is fractured. Due to the increased stress, disc will go in for early failure and progression results. It is seen in 14-21 % and is genetically predisposed. The presentation of symptoms is usually during adolescent growth spurts.

Three sub-types are present- A, B and C.

Sub-type A
Here, the articular processes are dysplastic, and are in transverse orientation. Spina-bifida may be present. The presentation is early and severe. It may present with severe hamstring spasm. Fusion is usually required.

Sub-type B
Here, there is sagittal mal-orientation of the dysplastic facet. The most common presenting symptoms are back pain & hamstring spasm.

Sub-type C
Here, there is congenital abnormality of the lumbosacral joint. There may be
(1) Congenital Kyphosis- due to failure of vertebral body formation,
(2) Angulatory deformities of sacrum.

Isthmic

This is the most common type presenting in adults. In 50% of the patients, lysis will be present. Male: Female ratio is 2:1

Causes

- Combination of dysplasia of pars, and stress of lower lumbar spine.
- Mal orientation of facets.
- Spina bifida occulta.
- Genetic factors (in 28-69 % cases)

- Mechanical stresses.

Repetitive cyclic flexion - extension loading or a long term repetitive position in lumbar lordosis in a young athlete (gymnast), accompanied by rotation, causes a stress fracture.

It occurs in adolescent and young adults.

Isthmic- subtypes

Sub type- A

It is fatigue or stress fracture of pars and is seen in an early age. Here callus formation is rarely seen. The defect, usually persists, due to constant motion of fracture ends and poor mechanical environment for healing to occur.

Sub-type B

Here, elongation of pars occurs without separation as fracture fragments. It occurs due to repeated micro fracture.

Sub-type C

Here acute pars fracture occurs due to severe trauma; but slippage is rarely seen. This subtype heals better on immobilization compared to type A.

Degenerative

It occurs 5-6 times more in Females above 40 yrs, and is seen 3 times more in blacks than whites. The L4 L5 level is 6-10 times more involved. Sacralization of L5 occurs 4 times more frequently. It is the result of long standing inter segmental instability.

Pathological

Generalized/ localized bone diseases.

Structural weakness of bones; Osteogenesis imperfecta.

Sub-type A- Generalized

eg: Osteoporosis, arthrogryposis.

Sub-type B- Localized

eg: Tumours, infections.

Etiology

Its origin is proposed to be multifactorial - mechanical, hereditary, and hormonal factors . [27]

Mechanical: On an upright spine, both gravitational and postural forces, act, causing stress on the pars, and hence priming it to injury.

Hereditary: Genetic basis is not fully known; high incidence of listhesis is seen in near relatives. In the general population, incidence of isthmic type is 4 to 8%, whereas it is approximately 25 to 30% in near relatives. [28]

Hormonal: It is unclear if hormones play a role in the progression of vertebral slippage that occurs during adolescence.

Clinical findings

- In children, the illness is usually asymptomatic, but it might manifest as a postural deformity or a gait anomaly. The most prevalent symptom is pain. It's a dull aching discomfort that starts during adolescent growth spurts, gets worsened by high activity or competitive sports, and is reduced by limiting activities and relaxation.
- Instability of the segment affected is the reason for back pain, whereas the reason for leg pain is nerve root irritation.
- Leg pain, may be sciatic, referred, or claudicating. Sciatica causes a dermatomal pattern of pain, paraesthesia, or numbness.
- Higher grade listhesis has a palpable prominence at the lumbosacral junction, where the 5th lumbar vertebra translates, then rotates anteroinferiorly over the 1st sacral vertebra, causing kyphosis. This leads to the development of compensatory lumbar hyperlordosis, which manifests as trunk shortening.
- The sacrum may become more vertical. Because of the sacral prominence, buttocks appear heart shaped. The trunk may be seen shortened. In more severe slips, the trunk becomes shortened and the waist-line is completely absent.
- Inchildren, pelvic waddle (Newmann) or spastic gait may be seen.
- In adults, objective signs of compression of nerve root include:

Motor/sensory weakness, change in reflex

Cauda equina symptoms (in higher-grade subluxations).

Causes of nerve roots compression

1. Hypertrophied fibrocartilage that occupies the pars defect.
2. Osteophytes adjacent to the defect.
3. Degenerative hypertrophic facets caudal to the defect.
4. Rarely, the intervertebral foramen can be compromised by a degenerated, herniated disc or by subluxation.

Scoliosis

Younger patients present with scoliosis in spondylolisthesis compared to elder population. Three types of scoliosis can occur:[29]

(1) Sciatic – Here the lumbar curve is due to muscle spasm, and resolves with recumbency or on symptom relief.

(2) Olisthetic – Here, the lumbar curve is torsional, with blending of rotation with the defect of spondylolisthesis. The causative factor is asymmetric slipping of vertebra. Usually, this curve resolves after treatment. Severe curves have chance of progression to structural type, and the treatment becomes complicated.

(3) Idiopathic- Physical manifestation of spondylolisthesis is in correlation with-

(a) the degree of slip, and (b) the lumbo-sacral kyphosis.

Associated conditions

1.Spina bifida occulta [30,31] - Common in isthmic 24-70%.
2. Reactive sclerosis/ fracture pedicle.
3. Disc degeneration.
4. Lumbaralization & sacralization 5-7%.
5. Scoliosis 5-7 %.

INVESTIGATIONS

X RAYS

AP, lateral, oblique & standing lateral.

Unilateral defect in pars is difficult to diagnose in a true lateral view.

Lateral oblique views - nearly 19% of the pars defects (Scottie dog collar sign) were able to be identified in this view .(32)

Ferguson view - 45° oblique and 20° cranial tilt.

Flexion and extension views for identification of translational mobility

Change in both percentage and angle of slip with change in posture (Boxall et al) is noted

AP VIEW

Reverse Nepolian Hat Sign- In severe spondylolisthesis or Grade 5 Spondyloloptosis, slipped L5 viewed end-on through sacrum in AP X ray (fig-12).

Spondylosis- unilateral wedging of vertebral body, sclerosis of pars and lamina.

LATERAL VIEW

Meyerdings grading [33]

Dewald modification of Newman [34]

This defines the amount of anterior roll of L5 over S1 in a better way. Both the sacral dome (superior aspect) and its anterior surface are divided into ten equal portions. The 1st number denotes the position of posteroinferior corner of the L5 vertebral body with respect to sacral dome. The 2nd number denotes the position of anteroinferior corner of L5 body with respect to anterior surface of S1.(fig-13 a)

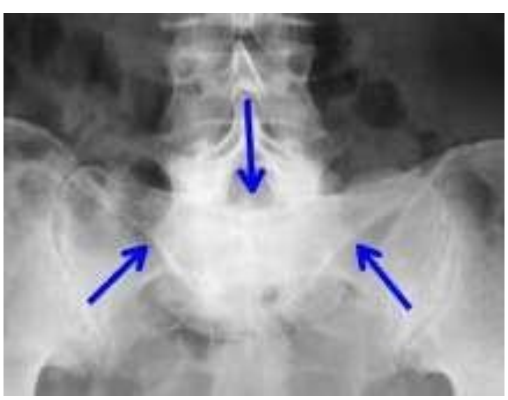


Figure 12 Show Reverse Nepolian Hat Sign

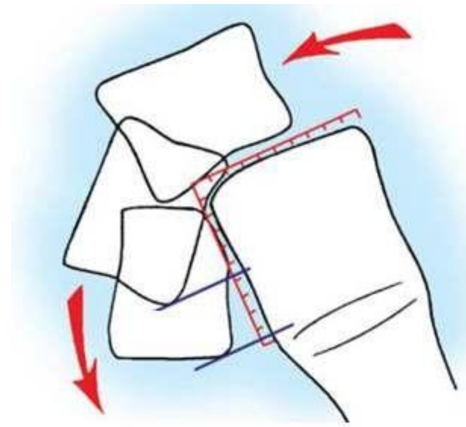


Figure 13 a

Slip angle

It's the angle formed by a line drawn parallel to the inferior aspect of the L5 vertebra intersecting with a line drawn perpendicular to the posterior side of the S1 vertebra's body (fig-13 b).

In most cases, the angle created is zero. It is the most accurate indicator of possible instability and also aids in slide progression prognosis. Deformity advancement will occur even after arthrodesis of the segment if the slip angle is more than 55 degrees.

Sacral inclination/ tilt

It refers to the location of the sacrum in relation to the vertical plane. It's determined as the angle formed by a line drawn along S1's posterior boundary intersecting with a true vertical line (perpendicular to the floor) (fig-13 c). Normally, the angle is greater than 30 degrees, although it decreases as the sacrum gets more vertical with higher slips.

Sagittal rotation / roll

It refers to the angle between the sacrum and the L5 vertebra. The angle formed by a line drawn along the anterior border of the L5 vertebral body and a line drawn along the post border of the S1 vertebra is used to calculate it. (fig-13 d).

Figure 13 b Slip angle

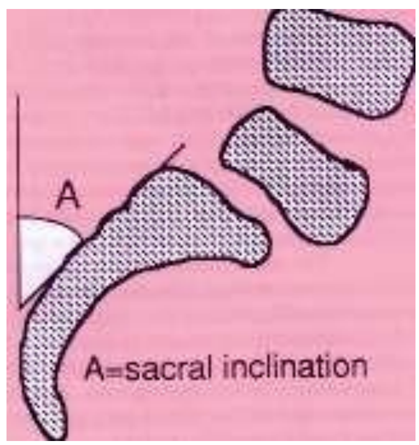


Figure 13 c sacral inclination

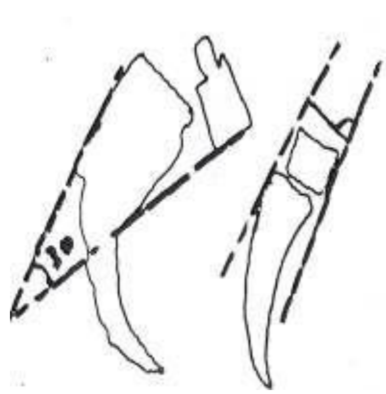


Figure 13 d sacral rotation

Instability at lumbar level is indicated on dynamic x rays

-4 to 5 mm of translation or more than 10 to 15 rotation

Radiological risk factors:

Dysplastic listhesis

Dome shaped, vertical sacrum

Trapezoid shape L5 body

>50% slip, i.e Grade 111 & 1V

Increase in slip angle

Instability on flexion/extension X-ray

MAGNETIC RESONANCE IMAGING

It detects compression of neural elements, identifies disc desiccation and guides invasive diagnostic procedures such as discogram and myelogram

CT MYELOGRAPHY

When MRI findings are within normal limits, or when MRI is contraindicated, it is effective for correlating preoperatively with Magnetic Resonance Imaging in those with symptoms of radicular affection and MRI showing multiple foci of disease or persistent radiculopathy

TECH-PYROPHOSPHATE BONE SCAN

It distinguishes between lysis and an acute pars fracture. A bone scan will be positive and an X-ray will be negative in an acute injury. The scan can be used to determine whether or not to immobilise the patient. Recent injury is indicated by a positive scan and a negative X-ray. An previous injury is indicated by a negative scan and a positive X-ray.Patients who have had symptoms for more than a year or who are asymptomatic should not undergo a scan.

SPECT BONE SCAN

It is extremely sensitive, and it can detect the presence of a stress reaction stage even before a fracture occurs. A CT scan can be used to distinguish between thicker cortices indicative of a stress reaction and an acute stress fracture if the scan demonstrates higher uptake in the pars.

Treatment of Acquired Spondylolysis [35,36]

It is based on the nature of lysis - acute or chronic.

If a SPECT scan reveals metabolic activity and a CT scan reveals pars thickening, avoid aggravating activities and core strengthening exercises.

When a SPECT scan reveals metabolic activity and a CT scan reveals an acute stress fracture, a three-month orthotic trial is recommended.

Long duration spondylolysis

Non Operative is the usual treatment.

Restriction of vigorous activity and back, abdominal, and core strengthening exercises are recommended.

If the symptoms are severe, a brief period of bed rest or immobilisation with a brace may be recommended.

Annual standing spot lateral radiographs of the LS region are used to keep a watchful eye on the progression of spondylolisthesis.

Asymptomatic patients do not need to limit their activities or avoid contact sports.

When conservative methods fail and other causes of back pain have been ruled out, surgical treatment may be required.

Surgical management

Various modalities include:

1. Repair of the defect of spondylolysis.
2. Root decompression for radiculopathy.
3. In situ fusion.

Pars Defect Repair

The principle of pseudo arthosis repair is debridement of fracture ends and bone grafting with compression of fracture.

Techniques include – Buck, Bradford, Van Dam Modified Scott Technique

If the MRI shows significant disc degeneration, fusion is done. Repair of the defect is not routinely done in adults with isthmic spondylolisthesis as symptomatic degenerative disc disease usually coexists.

Buck technique [37]

Here screws are inserted across pars defect.

Disadvantages - Difficult procedure as neurological & mechanical problems due to screws across defect.

Healing of pars is assessed by CT.

Bradford technique [38]

Repair of the pars defect is done with segmental wire fixation along with bone grafting. Direct repair of listhesis gives good result in 80 % cases.

Van Dam, Modified Scott Technique [39]

A 6.5 mm cancellous screw is inserted nearly 2/3rd into ipsilateral pedicle. A hole is made at the base of spinous process. The head of the screw will be looped with an 18-gauge wire, which is passed into the hole. The wire tips are then passed through a metal button and twisted tightly against it.
(fig-14).

Figure 14

After treatment

After the surgery lumbosacral orthosis must be used by the patient for 3 months to 6 months. Follow-up CT scan helps in evaluating the healing of the pars.

Root Decompression (Gill L5 Laminectomy) [40]

This procedure includes removal of L5 lamina and pars fibro cartilage to decompress L5 and other roots. In case of adolescent listhesis it is contraindicated as it leads to:

1. Increased instability
2. Progression of slip
3. Increased lumbosacral kyphosis.

Decompression alone is not recommended without fusion in patients less than 40yrs. It is rarely needed in children and adolescents.

Treatment of Spondylolisthesis

In the vast majority of cases, non-operative treatment is sufficient. Surgery isn't always necessary. If limited symptoms and mild slippage are present, activity limitation, rehabilitation of the muscles of the spine, abdomen, and trunk), and intermittent use of a hard back brace, anti-inflammatory drugs, and in some people, epidural steroid dosages may be sufficient.

If minor degrees of listhesis are present, activity restrictions are not required. Wiltse et al. advised avoiding contact sports and activities that can cause back injury if the slip is greater than 25% but less than 50%. Standing spot lateral X-rays of the LS region should be done every 6 to 12 months until growth is complete.

Bracing [41]

Few people support utilising an externally applied brace to evaluate the potential effectiveness of spinal arthrodesis if it is planned in the future. However, its predictability is debatable.

Moller and Hedlund found that insitu posterolateral fusion improved the outcome of therapy of isthmic spondylolisthesis in an adult with symptoms who was not responding to conservative treatment (exercise regimen). [42].

OPERATIVE

Indications

Persistence of symptoms for 9 months to 1 year.

Persistently Tight hamstrings/ abnormal gait/ pelvic-trunk deformity. Sciatic scoliosis.

Development of neurological deficits. Progressive slip even in asymptomatic.

Slip of more than 50% even in asymptomatic. High slip angle 40-50 degree in growing child.

Goals

Reduction of leg and back pain. Prevention of further slip.

Stabilization of unstable segment. Reversal of neurological deficits.

Restoration of normal spine mechanics, gait and improved appearance.

Surgical options [43]

- Posterior in situ fusion
- Addition of instrumentation to posterior in situ fusion
- Posterior decompression, partial or complete reduction, instrumentation and fusion
- Posterior fusion with postoperative cast reduction
- Posterior instrumentation, fusion with PLIF
- Anterior release
- In spondyloptosis, L5 spondylectomy with fusion of L4 to sacrum.

FUSION

In the presence of listhesis, insitu or reduction and fusion can be performed.

Techniques include:

1. Anterior Lumbar Interbody Fusion (ALIF)

2. Posterior Lumbar Interbody Fusion (PLIF)
3. Trans Foraminal Lumbar Interbody Fusion (TLIF)
4. Posterior fusion
5. Posterolateral Fusion
6. Anterior fusion and release with posterior fusion (360° fusion)

Posterior fusion:

It is one of the oldest surgical procedures for the treatment of spinal disorders. The overlaying of several small osseous flaps from lamina, spinous processes, and articular facets causes neural arches to fuse. 60-100 percent of individuals experience symptom relief. Solid fusion occurs in only 40-85% of cases.

Posterolateral fusion:

Decortication of the posterolateral spinal elements (transverse processes, lateral region of superior articular facet, and sacral ala) is performed, followed by the placement of an autologous bone transplant. When conservative treatment fails in children and adolescents with listhesis grade 2 or below, this procedure is used. The use of pedicle screws in these individuals eliminates the necessity for postoperative immobilisation.

It has a higher success rate than posterior fusion. According to Watkins, small chip grafts are used to fuse the facets, pars interarticularis, and bases of the transverse processes, while a larger bone graft is retained posteriorly on the transverse processes. Symptoms are reduced in 70-100 percent of cases. Solid fusion occurs in 50-100 percent of cases. Following fusion, listhesis does not progress.

Post op immobilization-Controversial:

If the mid-line structures are preserved – No immobilization is needed.

If high degree slips- custom moulded LS body jacket with thigh extension 2-3 months.

Posterolateral fusion rates adults- 66-89%

Reasons for low union rate for adults:

1. Smoking
2. Greater force which works against fusion mass
3. Generalised reduced healing rates.

After Treatment

Ambulation begins right after surgery, once the spine has been stabilised with a single pantaloon brace and the fixation has been confirmed. Once the fusion is strong enough, the brace will be removed (normally 3 to 4 months postoperatively).

Anterior Lumbar Interbody Fusion (ALIF)

This technique can be performed alone or with the help of posterior instrumentation. The spine is addressed from the front using a retroperitoneal approach in this procedure. From L1 through the sacrum, all of the lumbar vertebrae can be accessed.

Advantages

- Gives more wide access to the disc space and hence can accomplish complete discectomy, placement of optimal-sized devices is possible [44], which provide better stability, leading to a higher fusion rate.
- Can perform complete ligamentous release
- Avoids iatrogenic injury associated with stripping of paraspinal muscles and partial denervation
- Epidural scarring can be minimized

- Gives a better structural support to the anterior column of spine

Disadvantages

- Rigid fixation may be lacking if used alone
- High chance of graft failure or migration
- Chance of injury to iliac veins and autonomic plexus is high, hence the risk of bleeding and retrograde ejaculation. [45,46,47]

According to a study by Kim et al, an anterior interbody fusion corrects the incorrect posture of the lumbar spine, restores disc height, and relieves nerve compression caused by canal stenosis and foraminal narrowing. [48].

Lumbar Interbody Fusion from posterior aspect

This method avoids the potential difficulties associated with the anterior approach. The compression forces in the lumbar spine pass anteriorly through the disc space, which is a biomechanical advantage of LIF. Originally developed to treat tuberculosis, lumbar interbody arthrodesis through a posterior route was described by Jaslow in 1946 and popularised by Cloward in 1945 to cure axial lumbar discomfort.

Its popularity was previously hampered by a high risk of pseudoarthrosis and graft dislodgement. The advancement in lumbar interbody fusion apparatus and technique has resulted in widespread adoption of the procedure and interbody fusion cages.

A posterior approach is used in posterior lumbar interbody fusion (PLIF) and transforaminal lumbar interbody fusion (TLIF). The disc is removed and replaced with a spacer in the interbody fusion method (bone graft or mechanical spacer).

By restoring the height of the intervertebral disc gap and thereby reversing the vertical drop of vertebra above that narrows the neural foramen, indirect nerve root decompression can be achieved. [49,50]

Advantages

1. Single posterior approach is necessary.
2. Correction of slip angle can be achieved.
3. Preservation of disc height by use of cages.
4. High rate of union is achieved.
5. Second surgery for anterior column support is unnecessary.
6. Hypogastric plexus injury and the risk of retrograde ejaculation are avoided.

Disadvantages

1. Technically demanding
2. Risk of neural injury if graft displacement occur
3. Increased risk of nerve root injury, dural tears, epidural fibrosis from excessive handling
4. Disc space clearance is less compared to anterior approach

Posterior Lumbar Interbody Fusion (PLIF)

After carefully retracting the nerve root and neurologic structures, two bone graft spacers are implanted on each side of the interbody space in the classic PLIF procedure. [51] The facet joints are either left alone or clipped. Recently, a single spacer has been employed as well. The use of a unilateral interbody cage rather than the conventional two cages has no effect on fusion or clinical success.[52]

Transforaminal Lumbar Interbody Fusion (TLIF)

Harms was the one who described it. The facet joint on one side is removed, and a single bone graft spacer is kept in the middle of the interbody gap without retraction of the spinal nerves.[52]

TLIF can be performed at higher lumbar levels because no neural retraction is required. The chances of major blood loss, hospital stay, and operation time are nearly identical between PLIF and TLIF, however TLIF has fewer problems than PLIF. [53]

Circumferential Fusion

To reach the spine, separate anterior and posterior incisions are made. Technically, it is a difficult operation with a high risk of complications. As a result, it is recommended for individuals who have severe spinal instability or considerable anterior bone loss. Only patients with severe disability and a history of repeated failed back procedures should undergo this procedure if they have degenerative disease.

Other indications include

1. Patients who are highly prone for pseudoarthrosis
2. Multi segment involvement and marked segmental instability (as in infection and trauma)
3. For anterior column support (eg. in patients with significant osteoporosis)

The combined interbody and posterolateral fusion was proven to be highly effective in achieving fusion and also in preventing progression in cases of high grade listhesis . [54]

Shortcomings of Insitu Fusion

(1) High chance of pseudo arthrosis.

(2) Loss of motion segment.

(3) Progression of slip.

(4) Appearance or progression of neurological deficits.

(5) Persistence of deformities.

Reduction And Fixation

It is the most current reduction technique. It uses segmental pedicular screw fixation.

Advantages

1. Stop deformity progression.
2. Reduces post operative pain
3. Permits full decompression of the nerve.
4. Permits reduction of the slip angle, leading to improvement of sagittal lumbosacral orientation, increases the surface area available for interbody fusion and places it under more compression and thus may improve the success rate for bony fusion.
5. Less fusion length.
6. Restores the body posture mechanism.
7. Improves appearance and self image.

Problems arising due to complete reduction:

1. The operation becomes more extensive
2. An additional anterior procedure often is required
3. It is more prone for neurological damage (muscle relaxation occuring after the induction of general anesthesia and the procedure itself may cause further slippage, leading to increased stretching of sacral roots).

Criteria for an attempted reduction as listed by Bradford :

(1) vertebral slippage >60%,

(2) slip angle >50°,

(3) age between 12 and 30 years, and

(4) symptoms not controlled by nonsurgical ways.

Reduction & Fixation-Methods

Traction

Posterior Distraction Instrumentation. Anteroposterior Resection-reduction. Vertebrectomy.

Pedicle Fixation.

Posterior Levered Reduction.

Traction Cast Reduction Techniques

Jenkins was the first to describe a reduction method. The cast was applied few days following the procedure. On the Risser table, the patient was placed in cervical pelvic traction. Hyperextension of the lower extremities was paired with anterior sacral translation, which was usually accomplished by a posteriorly placed anteriorly directed force.

Vertebrectomy

Gaines & Nicholas described this treatment for the first time, and it is used to treat spondyloptosis surgically. The L5 vertebra was resected, resulting in a spine shortening. The anterior resection of the L5 vertebral body was followed by the removal of posterior parts of the L5 from the posterior aspect with Harringtons instrumentation to reduce slide. The L4 was fused to the sacrum. The portion was immobilised using a Spica cast for 5 months.

But this procedure was not accepted widely due to:

1. Occurrence of neurological deficits in nearly one third of the cases
2. Reduction which was not predictable
3. Compatibility of the procedure being low

Posterior Distraction Instrumentation

This was used for the first time by Harrington in 1967. Results were unsatisfactory.

A-P Resection Reduction

It is a combined procedure described by Danecke. L5 body anteriorly & Sacral dome posteriorly were resected. Listhesis was reduced and stabilised with Steinmann pin.Done in grade 3&4. High rate of complications occur.

Results

Achieves full correction of spine alignment and slip angle
Moderate correction of a slip occurs from a spondyloptosis to a grade 1 or 2 listhesis

Pedicle Screw Fixation

It is only when combination with combined interbody and posterolateral fusion that it is possible to achieve long-term reduction and stabilisation of high-grade listhesis. Pedicle-screw instrumentation resulted in better fusion in patients than those who did not.[55]

Posterior Levered Reduction

Introduced by Steffe and is a single stage operation. Has five steps

1. Removal of L5 arch & dome with sacroplasty
2. Elevation of L5
3. Posterior translation by tightening screw bolt
4. PLIF- anterior support combined with posterolateral fusion
5. Pedicle screw fixation

Gradual Instrumented Reduction

Edward was the one who brought it up. It achieves complete deformity correction with less surgery and morbidity. It is based on four ideas.:

Simultaneous application of three corrective forces Two point sacral fixation

Stress relaxation Anatomical alignment

Indications for Reduction Fixation Cauda equina syndrome Progressive slip more than 40-50%

Major deformity causing decompensation or distress Major pain or deficits with two or more risk factors

Risk Factors

Slip angle > 25 deg Trapezoidal L5

Rounded sacral end plate Hyperlordosis >50deg –L2 S1

L5 radiculopathy – decompression

Female adolescent – young patients with grade 2 or more Excess lumbosacral mobility

Signs of sacral root stretch – positive Lasegue sign,decreased ankle jerk,bowel and bladder dysfunctions

Current Recommendations:

For patients in whom fusion is indicated – posterior instrumentation

For older adults with fixed or high grade spondyloptosis – anterior resection with posterior pedicle fixation.

Pedicle Screw Fixation

For the first time in history, Roy-Camille described the use of posterior plates with screws positioned sagittally through the pedicles and articular processes in 1970, directed by Judet. Harrington and Tullos disclosed transpedicular screw fixation for the first time in the United States in 1967.

During preoperative planning, high-quality antero-posterior and lateral radiographs of the lumbar spine, as well as axial CT scans, are used to analyse individual spinal architecture. The anatomy of the pedicle can be assessed using coaxial fluoroscopy pictures.

The three techniques for pedicle localization are as follows : [56,57]

(1) The intersection technique

It is the most widely used technique. At a point over the pedicle, a line is dropped from the lateral aspect of the facet joint that intersects a line that bisects the transverse process. (fig-15)

(2) The pars interarticularis technique

The pars interarticularis is the region of the bone where the pedicle meets the lamina. The entry point in the lumbar spine is 2 mm lateral to the pars interarticularis and at the midway of the transverse process.[58]

(3) The mammillary process technique

The mammillary process is a small prominence at the base of the transverse process and is used as the entry point. (fig.16)

The pars interarticularis starting point is more medial than that for intersection technique which is more medial than mammillary process.

The direction of drilling is determined by preoperative CT scanning of the pedicle and intraoperative x-rays.

The areas for screw insertion were identified and described by Roy-Camille, Saillant, Mazel, and Louis. The midpoint of the transverse process and the respective facet joint space are the most critical reference points. An opening in the pedicle is produced with a hand-held curet or drill. The self-tapping screw is inserted into the vertebral body through the pedicle. The dural sac is located medial to the pedicle's medial wall. The nerve root is located underneath the pedicle's medial wall.

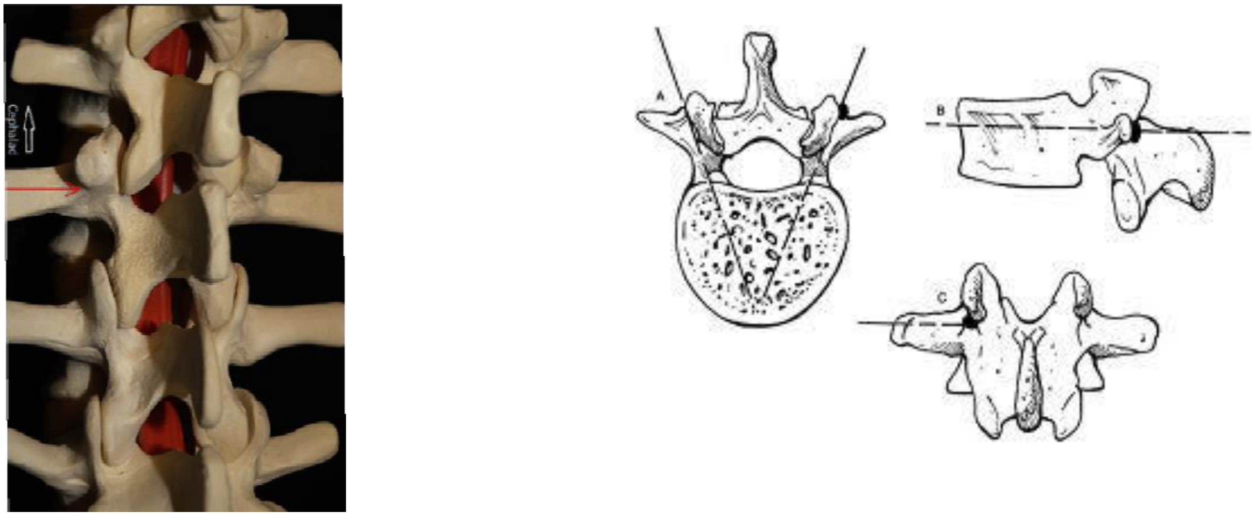


Figure 15 shows pedicle entry site by the intersection technique

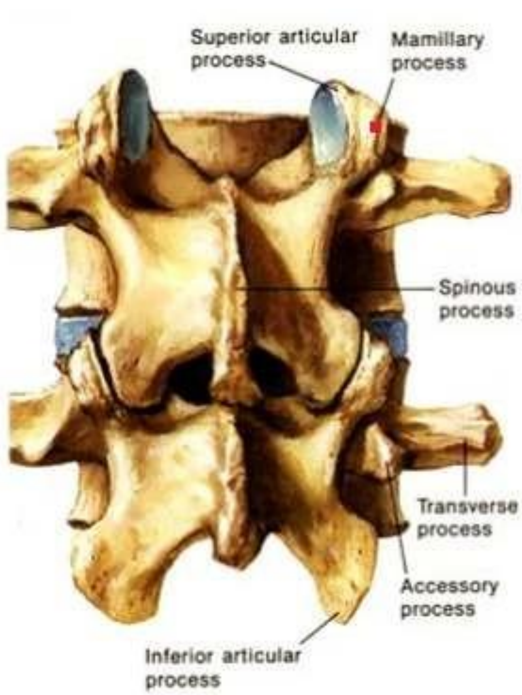


Figure 16 shows pedicle entry site through mamillary process

MATERIALS AND METHODS

1. SOURCE OF DATA**:**

- Patients admitted in Department of Orthopaedics in B.L.D.E. (DEEMED TO BE UNIVERSITY) Shri B.M.Patil's Medical College, Hospital and Research Centre, Vijayapura with lumbar diseases.
- The patients will be informed about study in all respects and informed written consent will be obtained.
- Period of study will be from 1st November 2019- 31st March 2021.
- Follow up period will be 1 month , 3 months and 6 months.

2. METHOD OF COLLECTION OF DATA**:**

- Patients admitted in Department of Orthopaedics in B.L.D.E. (DEEMED TO BE UNIVERSITY) Shri B.M.Patil's Medical College, Hospital and Research Centre, Vijayapura with lumbar diseases.
- By clinical examination.
- By interview.
- By follow up at 1 month, 3 months and 6 months.

INCLUSION CRITERIA

1. Patients of age less than 70 years
2. Pain in lower back 6 or more months with or without localized radiating pain to lower limbs.
3. Neurological claudication
4. Neurological deficit
5. Symptomatic Degenerative disc diseases
6. Symptomatic spondylolisthesis not relieved by conservative management/ isthmic or degenerative spondylolisthesis
7. Instability
8. Patients giving consent for surgery

EXCLUSION CRITERIA

1.Patients below 20 years

2.Patients with associated scoliosis

3.Patients with failed previous lumbar surgery

4.Acute traumatic spondylolisthesis

5.Neurovascular injury

6. Patients medically unfit for surgery.

SAMPLING

A prospective study

With 95% confidence level and margin of error of ±15%, a sample size of 30 subjects will allow the study to determine the “Outcome of single level instrumented posterior lumbar interbody fusion” with finite population correction (N=100).

By using the formula

$$n = \frac{z^2 p(1-p)}{d^2}$$

where

Z= z statistic at 5% level of significance

d is margin of error

p is anticipated prevalence rate (50%)

STATISTICAL ANALYSIS

All characteristics was summarized descriptively. For continuous variables, the summary statistics of N, mean, standard deviation (SD) was used. For categorical data, the number and percentage was used in the data summaries and data was analyzed by Wilcoxon signed rank test and diagrammatic presentation.

Procedure

To determine the neurological impairments, a comprehensive primary survey was conducted. X-rays and MRI scans were used to confirm the extent of the pathology. Additional tests, such as a full hemogram and blood sugar, were performed.

The patients were explained about the need for surgery, and its importance, and complications in detail. The proforma was filled and the pre operative planning was done.

- The pre operative planning included past medical history, Preoperative anteroposterior, lateral, dynamic x-rays and MRI were obtained. Intervertebral disc heights and slip grade (Meyerding grade.), Pre operative Visual Analogue scale & Oswestry Disability Index and Scores measured.
- The post op clinical and radiological evaluation was done at 1 month ,3 months and 6 months using postoperative Visual Analogue scale & Oswestry Disability Index and Scores and X rays.

DESCRIPTION OF POSTERIOR LUMBAR INTERBODY FUSION SURGERY

Anaesthesia:

Under general anesthesia the surgery is performed. The patient is intubated and connected to a ventilator. Preoperative intravenous antibiotics are administered.

Position:

Patient is catheterized and changed to prone position, placed on an operating radiolucent table in hyperextension to create lumbar lordosis. The abdomen hanging free. Pressure points are well padded. (fig.17)

Incision and procedure:

The surgical area is scrubbed, painted and drapped. (fig.18) A 8-14cm long midline incision is made on the back, over the affected site. (fig.19) The deep fascia is divided in the midline, On both sides, paraspinal muscles are stripped off the lamina at required levels and self retaining retractors are placed for proper visualization of the posterior vertebral arches.(fig.20) Then, image intensifier confirms the spinal level for surgery.(fig.21)

Pedicle screw insertion:

Pedicle entry was made under fluoroscopic guidance. All walls were probed for integrity. Pedicle screws (Titanium poly axial) were inserted in the upper and lower vertebral bodies. (fig.22,23,24)

Decompression:

Laminectomy is done. (fig.25), After visualizing the nerve roots (fig.26),the facet joints, overlying the roots, can then trimmed, which gives more space for the nerve roots. The bone spurs are visualized and removed after protecting and carefully retracting the nerve roots and neurologic structures. The arthritic, hypertrophic bone spurs and ligamentum flavum are removed using pituitary rongeur, kerrison rongeur and curettes. The morselized posterior elements were preserved as a graft source for interbody fusion. Then the nerve roots are retracted to one side and the disc space is cleaned of the disc material. (fig.27)

Cage placement:

The disc space is distracted for restoration of the normal disc height(fig.28), and also for determination of the appropriate size spacer to be placed. The cage is packed with morcellised compacted bone (local autograft). The next step is insertion of locally taken bone graft in the anterior aspect of intervertebral space, followed by an interbody cage with bone graft inside, into the disc space. (In the traditional PLIF procedure two small bone graft spacers are placed, after gently retracting the spinal nerves and neurologic structures. In our study, a single PLIF cage was placed) .[59] Two small metal rods are put, connecting the ipsilateral screws. The two vertebral bodies are compressed for good contact of cage with bone. Two small metal rods are put, connecting the ipsilateral screws. The correct placement of the spacer is confirmed using x-rays. (fig.29,30,31,32)

Closure:

The wound area is thoroughly washed with saline. 14 Number drain inserted. Ab gel is used if excess bleeding present. The deep fascial layer and subcutaneous layers are closed with absorbable sutures. Non absorbable stitches are used for skin closure. (fig 33) A sterile dressing is applied .The surgery requires around 3 to 4 hours.

Surgical procedure illustration:

Figure 17- Position of the patient

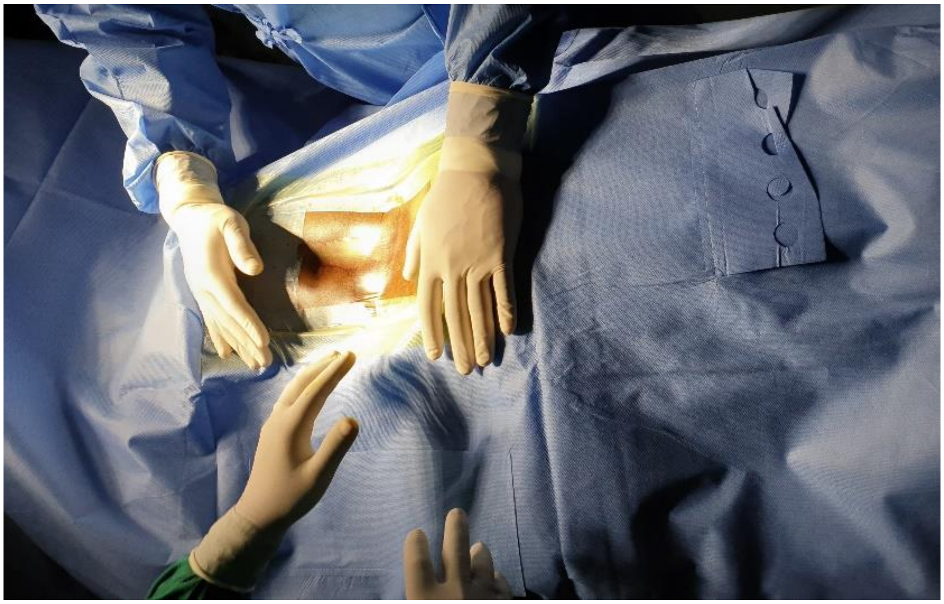


Figure 18- After draping of patient

Figure 19- Incision

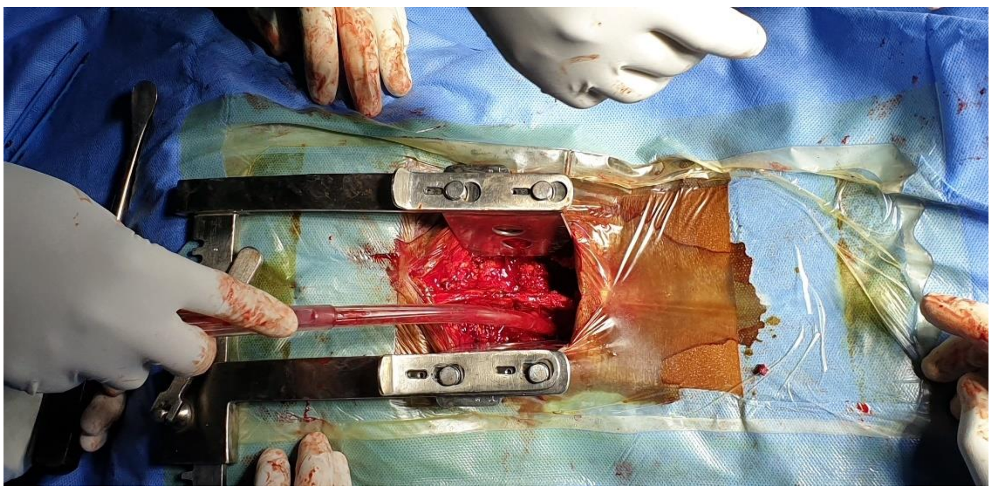


Figure 20- Exposure

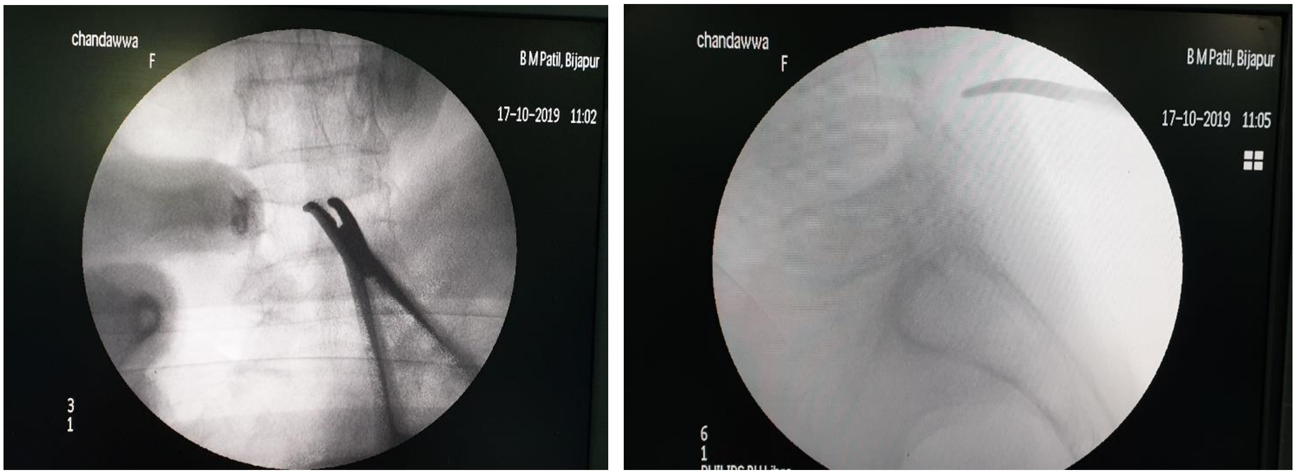


Figure 21- Identification of level using c arm

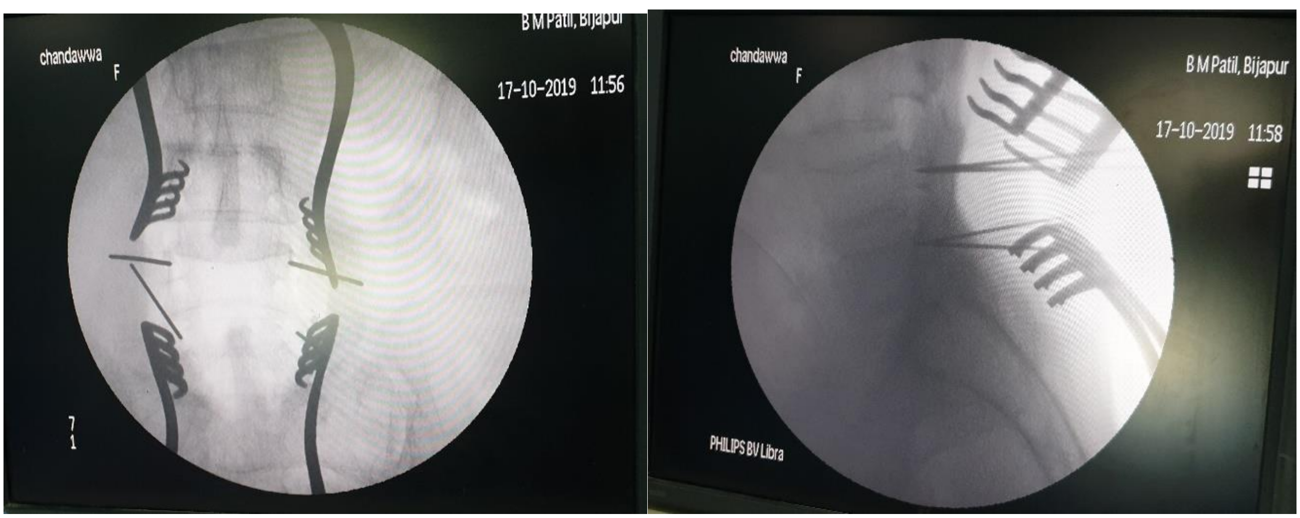


Figure 22- Pedicle entry was made under fluoroscopic guidance in ap and lateral view

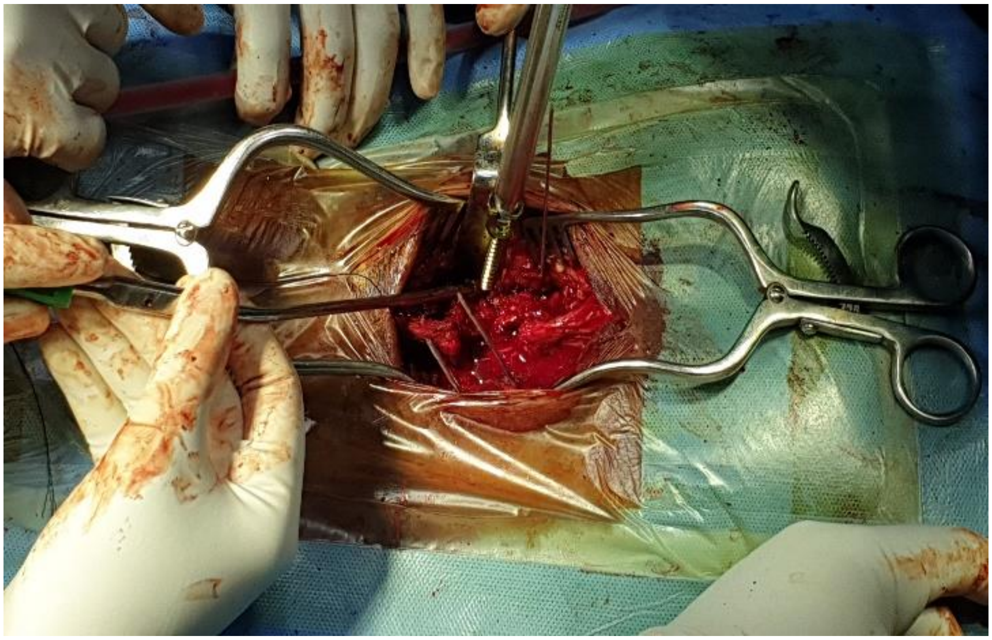


Figure 23- Pedicle entry was made

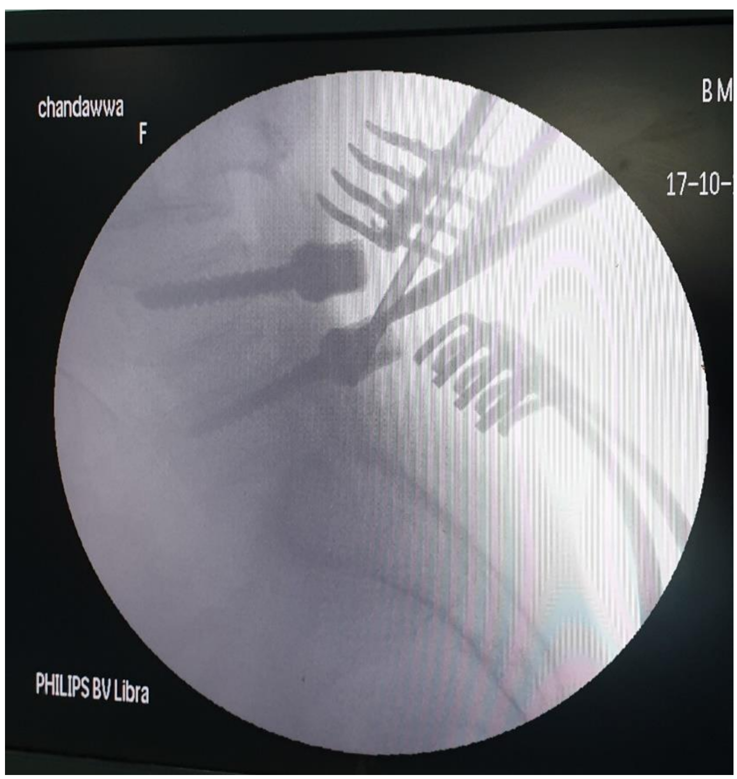


Figure 24 – Polyaxial screw position under c arm

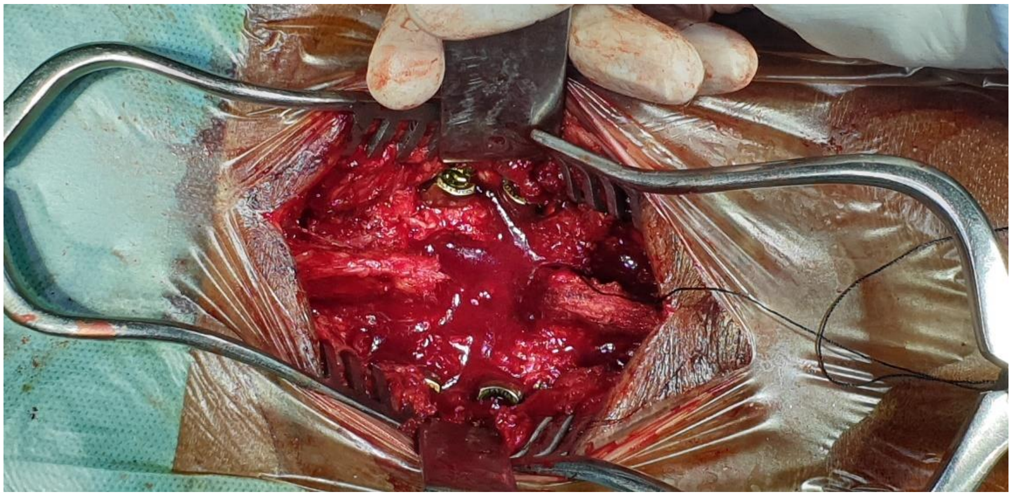


Figure 25-Laminectomy done

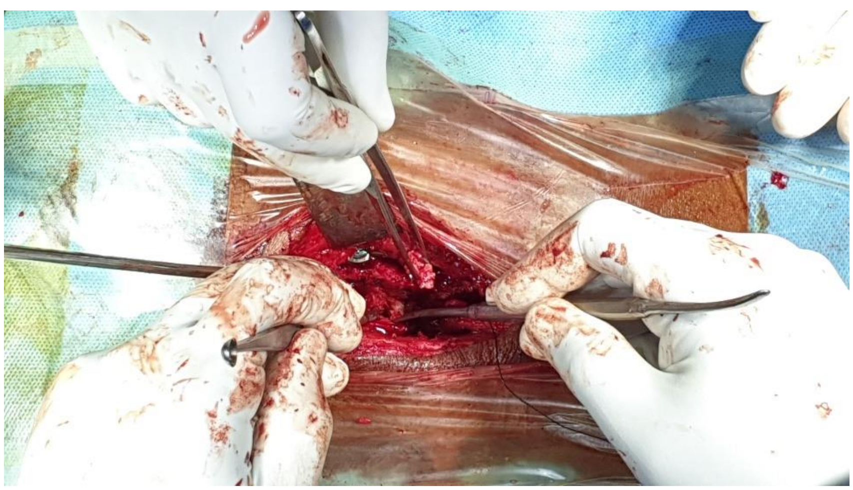


Figure 26- After laminectomy, nerve root is identified

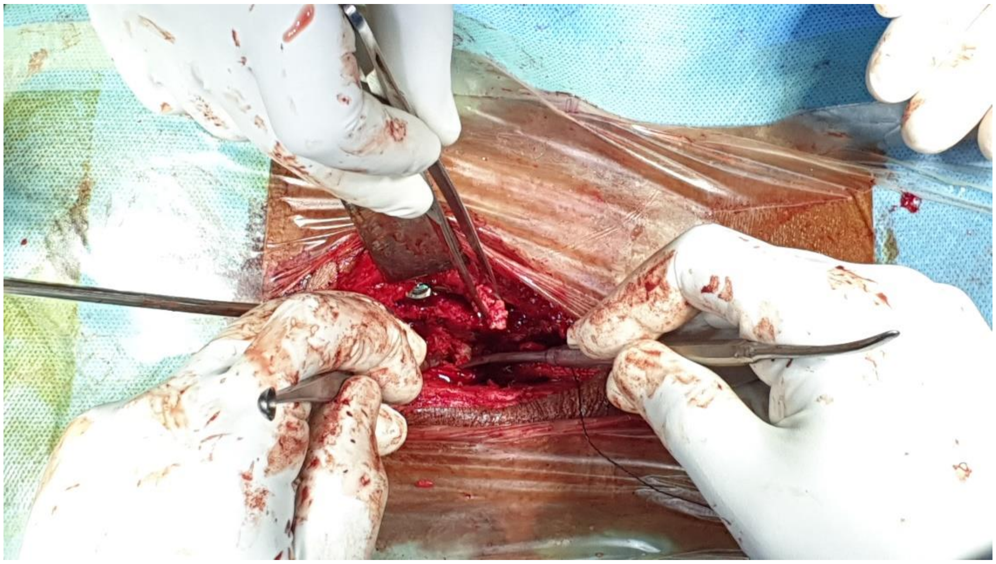


Figure 27- Disc space is cleaned of the disc material

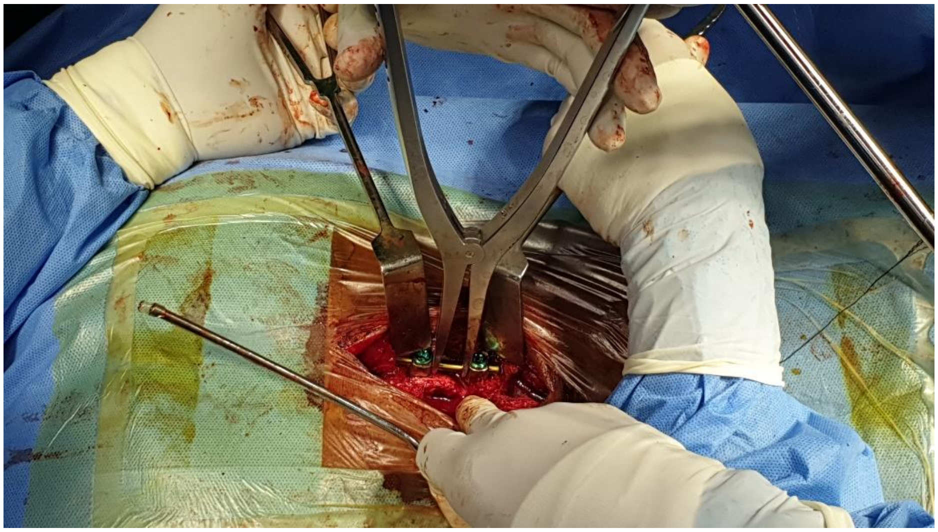


Figure 28- The disc space is distracted for restoration of the normal disc height

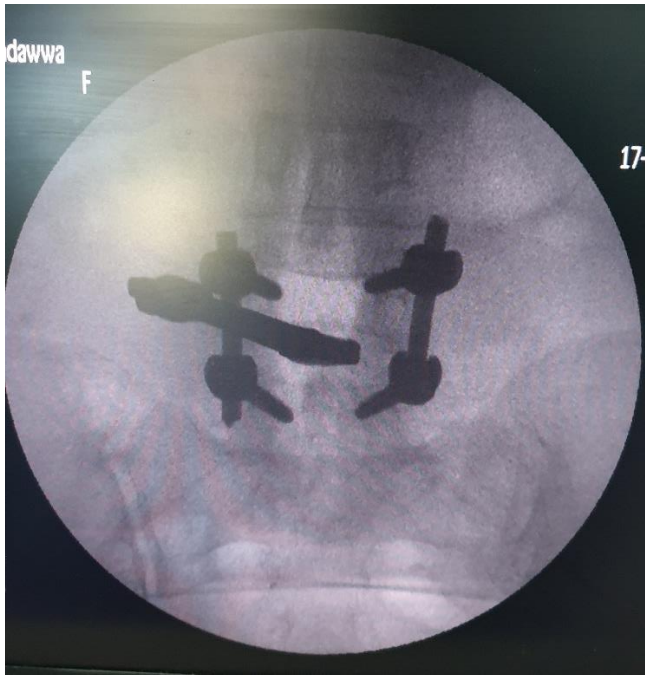


Figure 29- The correct placement of the spacer – AP view

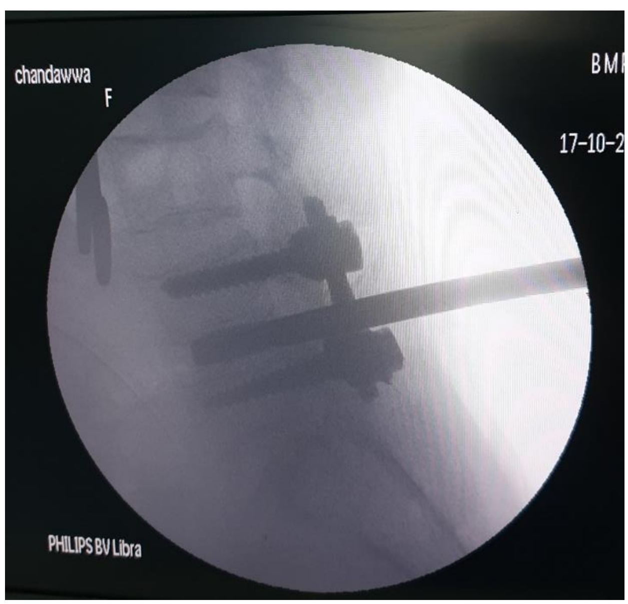


Figure 30- The correct placement of the spacer- Lateral view

Figure 31- Final placement of cage- lateral view

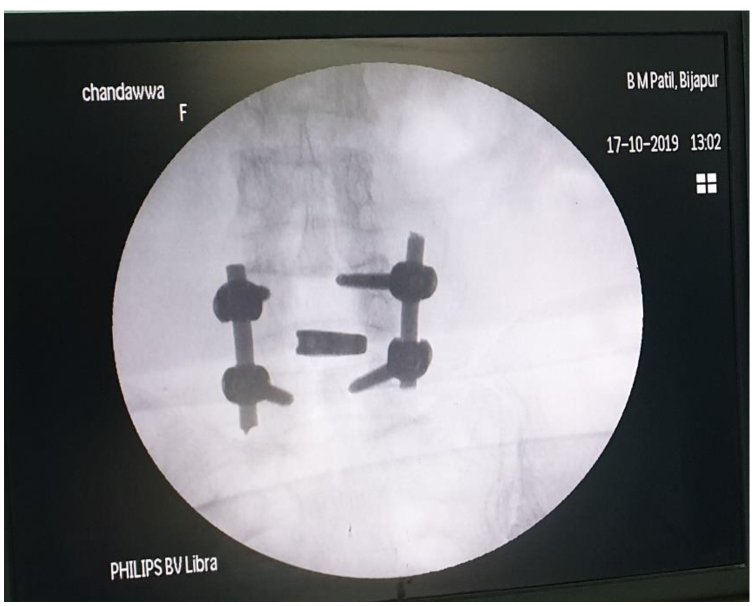


Figure 32-Final placement of cage- AP view

Figure 33- Wound closure

Figure 34- Wound after suture removal

Post-Operative Care:

The wound dressing is changed on postoperative days 2,5,7,9 during the hospital stay The patients are usually discharged after suture removal on day 12(fig 34) after the surgery. They are given proper instructions and training for physical therapy and occupational therapy. Patients are advised not to bend or twist at the waist, not to lift weight above five pounds in the first 2-4 weeks. They can do these by 4-6 weeks, when pain decreases and muscle strengthens.

Brace:

A back brace is not usually required. If necessary, in the early postoperative period, a lumbar corset can be used.

Wound Care:

A sterile gauze pad with tape should be used to cover the wound area. The bandage should be changed on day 2, 5, 7, 9.

Shower/Bath:

During bathing, the incision area must be covered with a bandage and tape and water should not be allowed to hit directly over the surgical area. Once the bath is finished, the area should be cleaned, dried and the wound dressing should be changed. The wound heals completely in about 2 weeks after which the patient can bath normally.

Driving:

The patient's pain begins to subside 7-14 days after the surgery and they may then begin driving. Patients should not drive while on narcotics. They should start with short drives, accompanied by another person and gradually as the pain they can drive alone more.

Resumption of Work and Sporty activities:

Physical therapy should be done. Light work duties may be resumed in 2-3 weeks of surgery. Patients may resume moderate level work and light recreational sports 3 months post surgery, once pain decreases and the back strength is adequate. They are advised to avoid lifting heavy weight, laborious work, and impact sports.

Doctor's Visits and Follow-Up:

Visits are scheduled on 4-6 weeks after suture removal, 1 month,3 ,6 months. An x-ray was taken during each visit to ensure the stability of the fused area and its healing. Physical therapy for gentle back exercises is begun 8-12 weeks after surgery.

Assessment of fusion is difficult with titanium cage insitu. Still with reference to major studies, we assessed fusion.

Interbody fusion is said to be present if:

1. Bridging trabecular bone between the vertebral bodies, (fig.35)or
2. Visible bone within the hollow fusion cage, (fig.36)or
3. On lateral flexion-extension X-rays, less than 5 ° of motion. (fig.37)

Figure 35 Figure 36

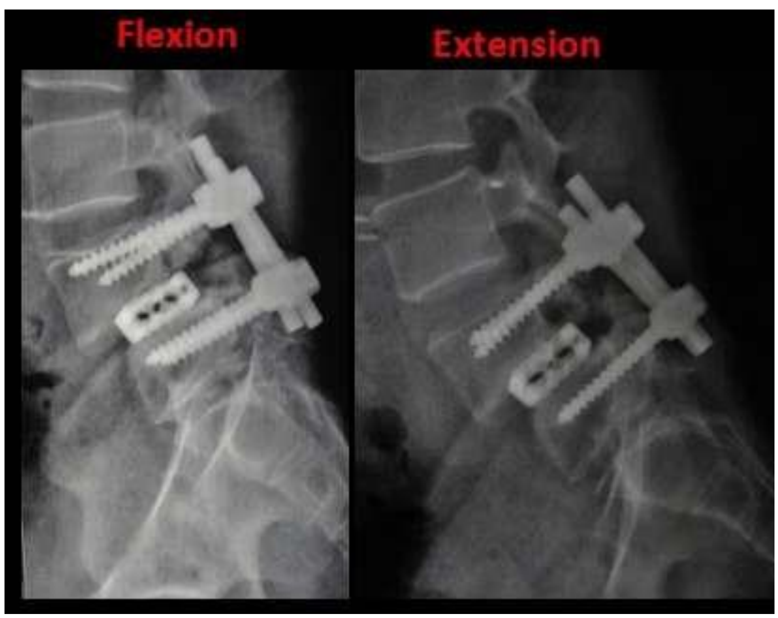


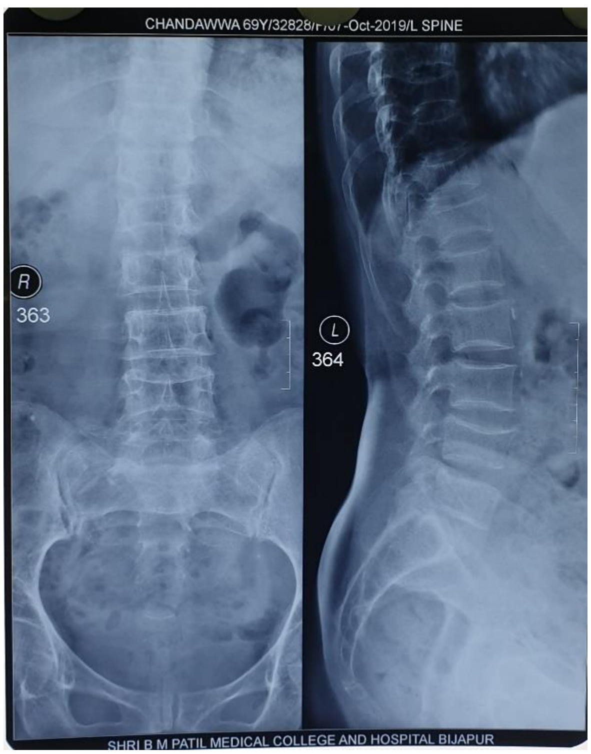
Figure 37

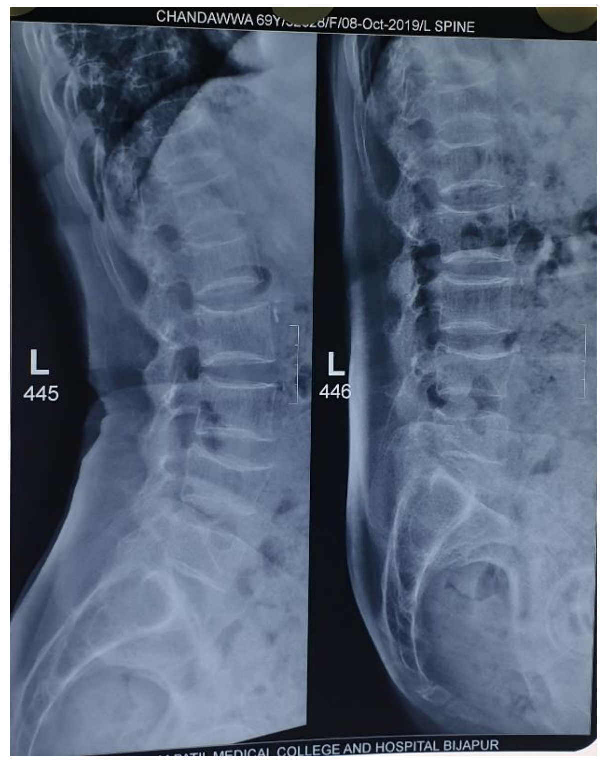
CASE ILLUSTRATIONS

Case 1

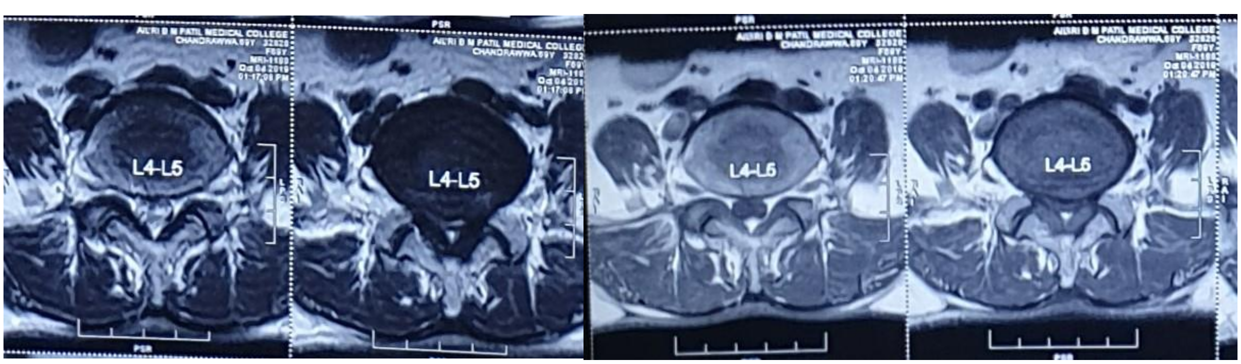
Diagnosis: L4-L5 spinal canal stenosis with degenerative disc disease

PRE OP XRAYS

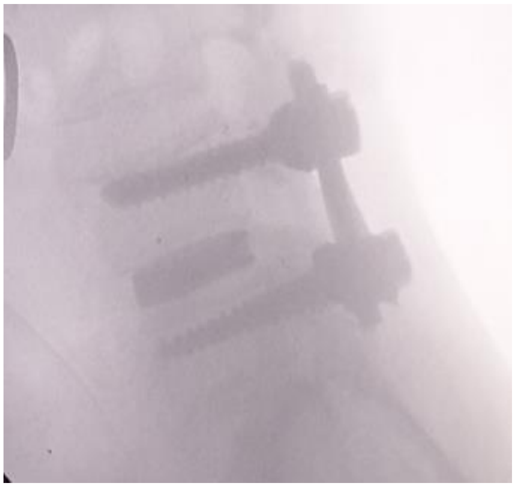


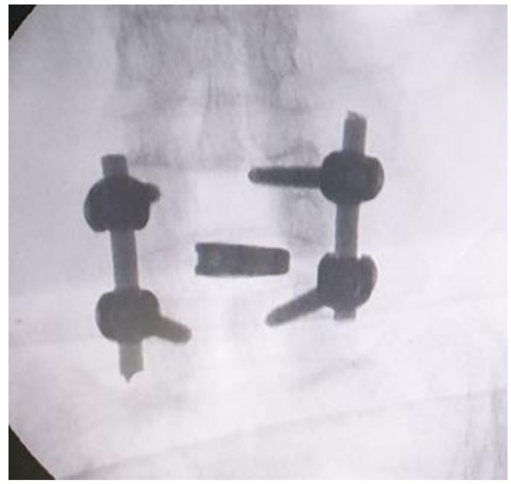


PREOP MRI-



POST OP XRAY-





CLINICAL PICTURE PREOP-

PRE OP SLRT- 60 DEGREE LEFT SIDE

PRE OP SLRT- 50 DEGREE RIGHT SIDE

PRE OP FLEXION

POST OP CLINICAL PICTURE-

patient has regained upto 90 degree SLRT LEFT SIDE

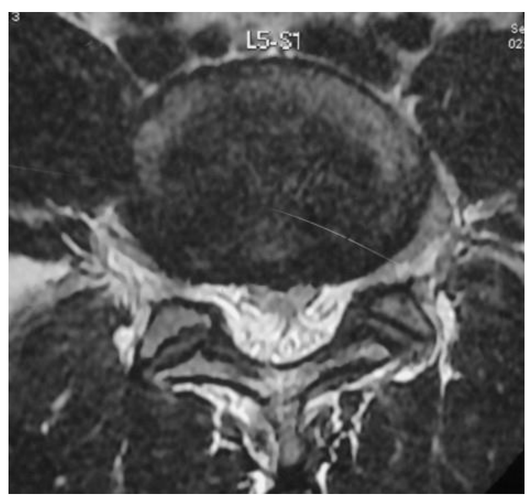
patient has regained upto 90 degree SLRT RIGHT SIDE

POST OP FLEXION

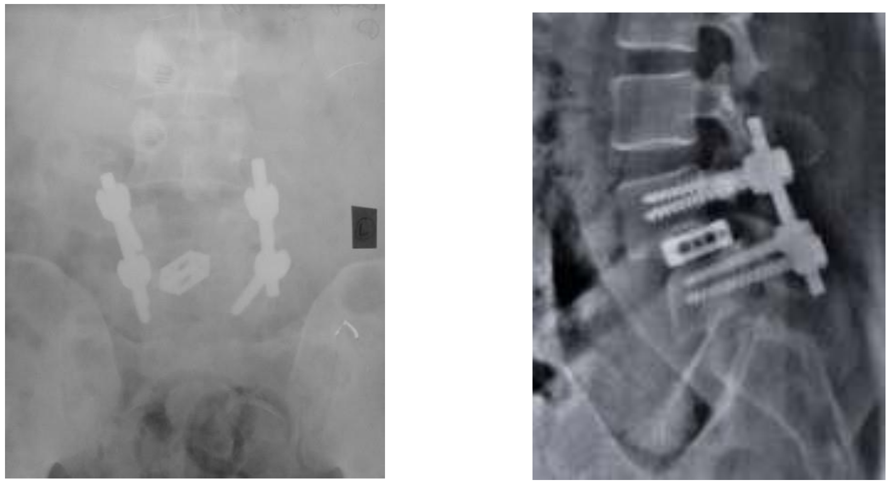
Case 2-

Diagnosis: Grade 1 isthmic spondylolisthesis L4-L5 with neurological deficit S1

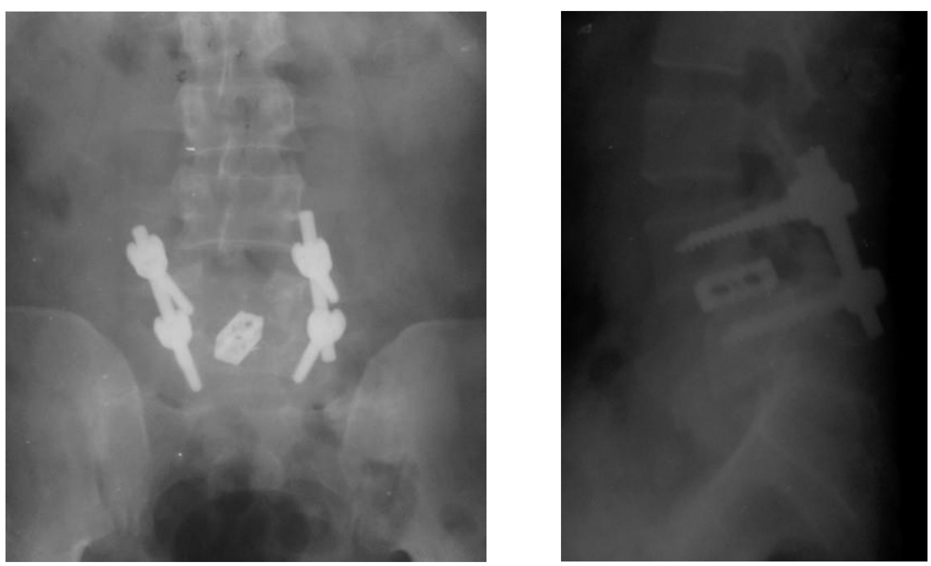
Pre op X rays



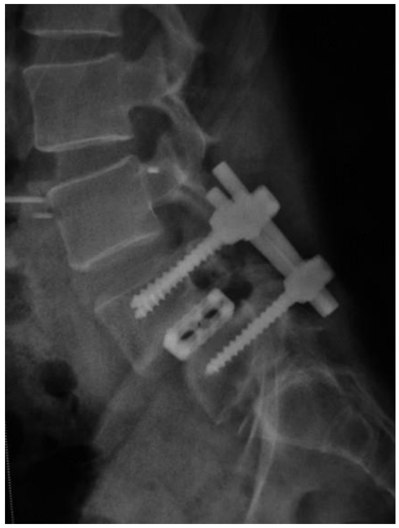
Pre op MRI



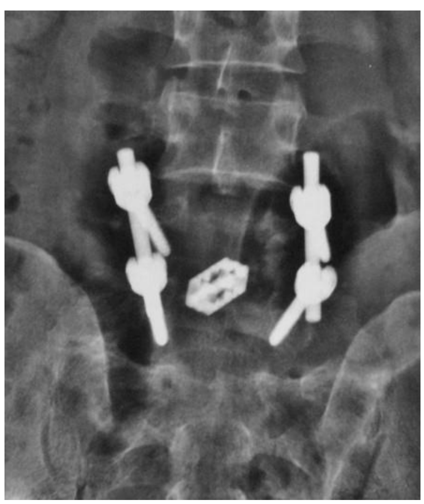
Immediate post op X rays

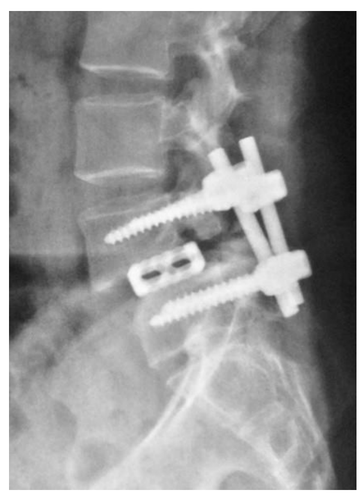


1 months post op X-rays



3 months post op X-rays





6 months post op X-rays

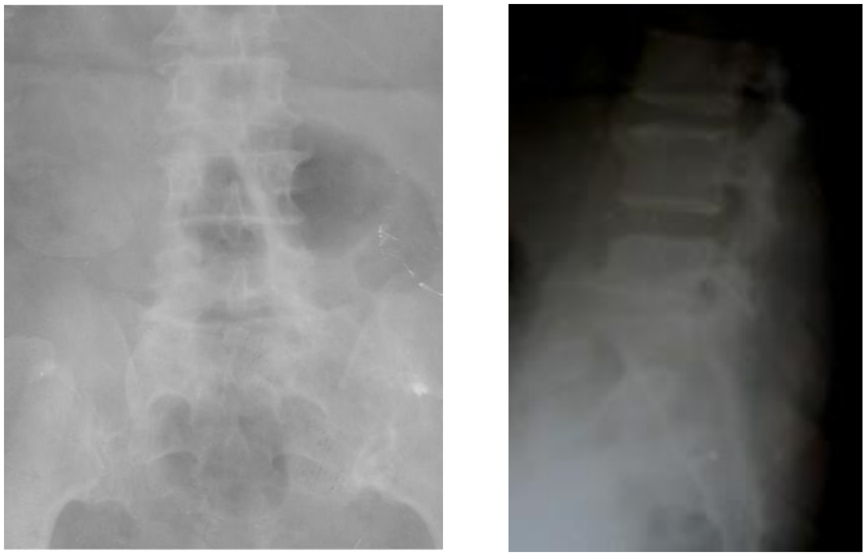
post op clinical picture

POST OP SLRT- 80 DEGREE RIGHT SIDE

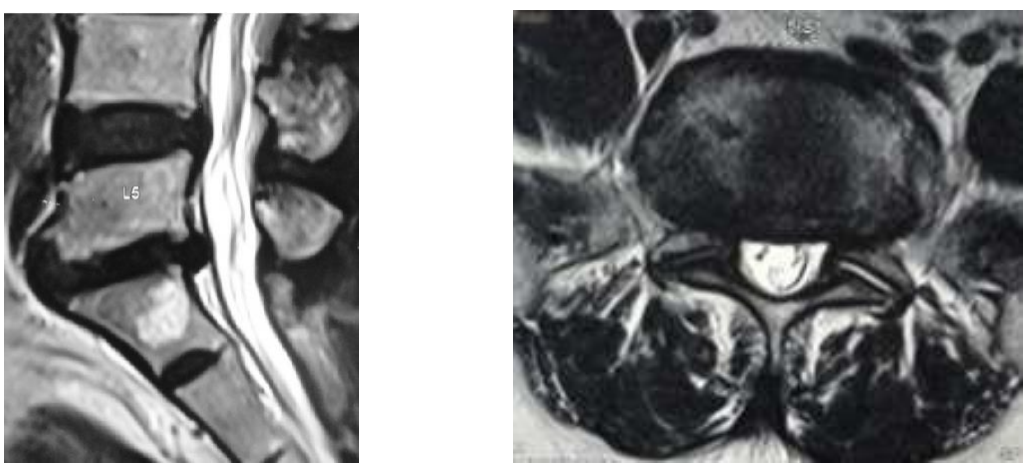
POST OP SLRT- 80 DEGREE LEFT SIDE

Case 3

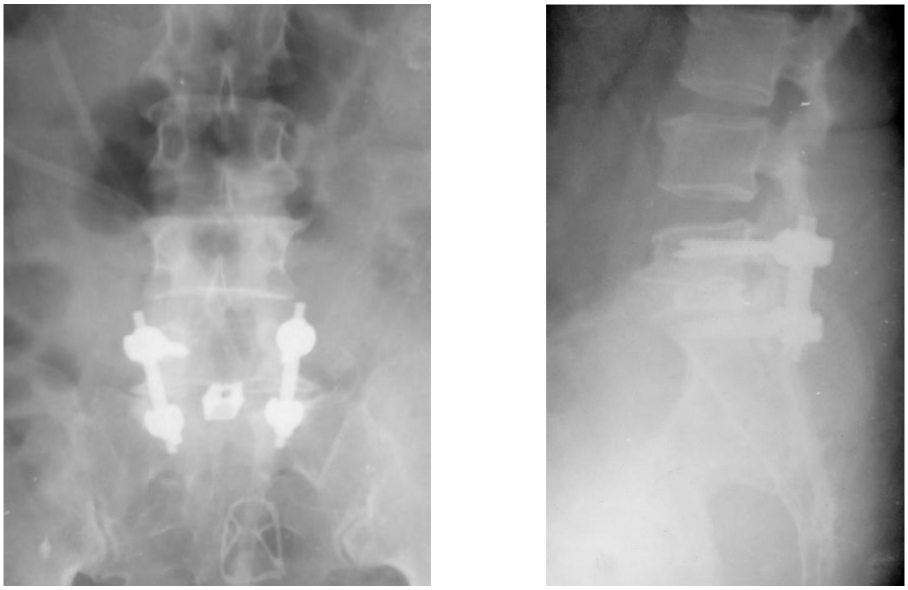
Diagnosis: L4-L5 degenerative disc disease with neurological deficit S1



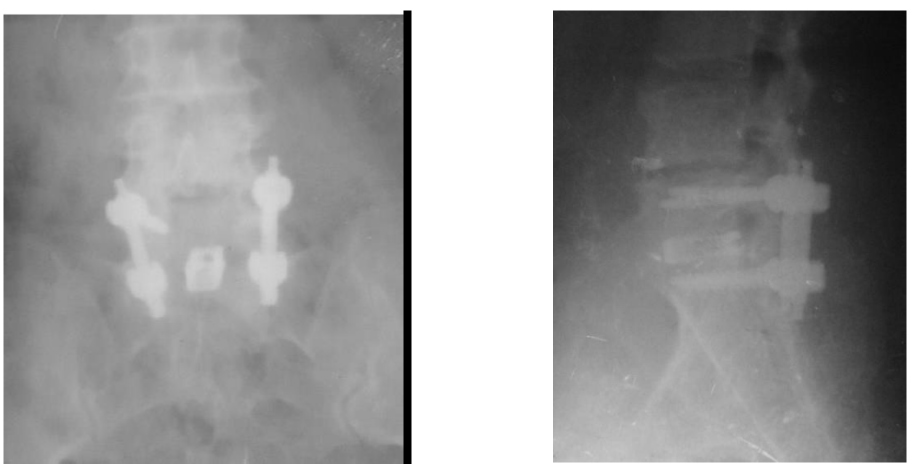
Pre op X-rays



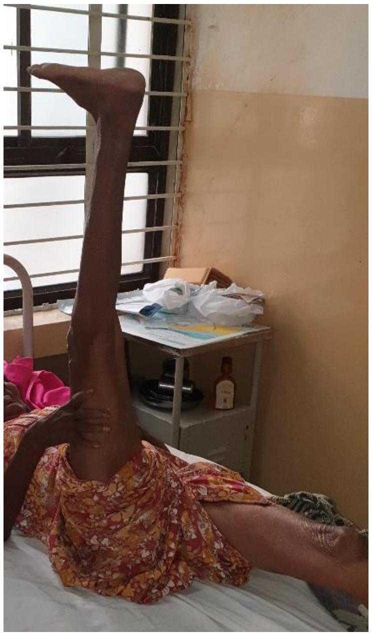
Pre op MRI

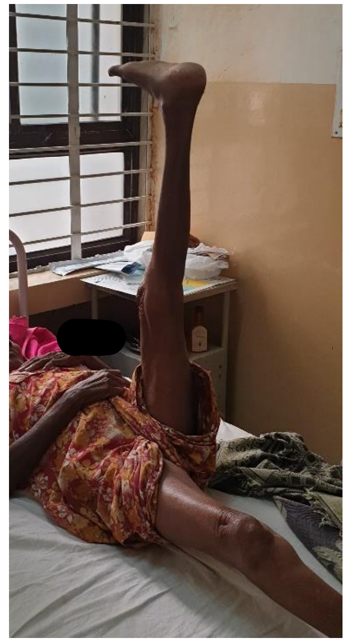


Immediate post op X-rays



6 months post op X-rays showing union





POST OP SLRT- 90 DEGREE ON RIGHTSIDE

90 DEGREE ON LEFT SIDE

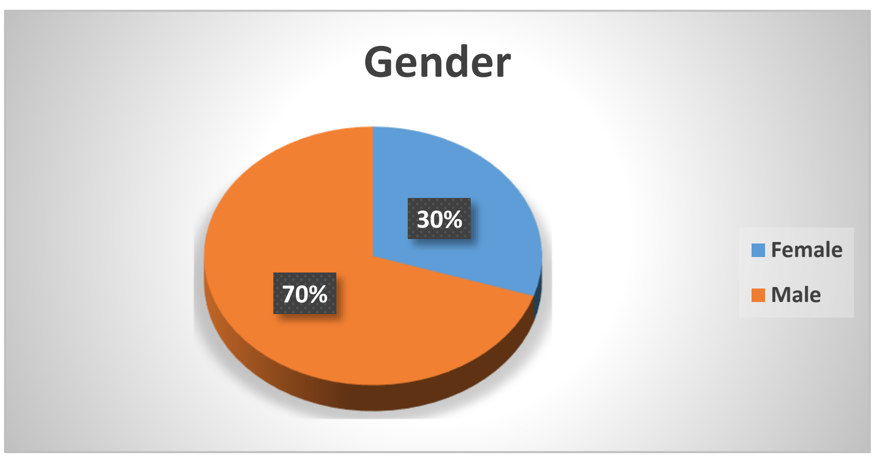
OBSERVATIONS AND ANALYSIS

Gender

Graph 1 and Table 1 shows that male accounted for 70% and female was 30%

Gender	No. of patients	Percentage
Female	9	30.0
Male	21	70.0
Total	30	100.0

Table 1



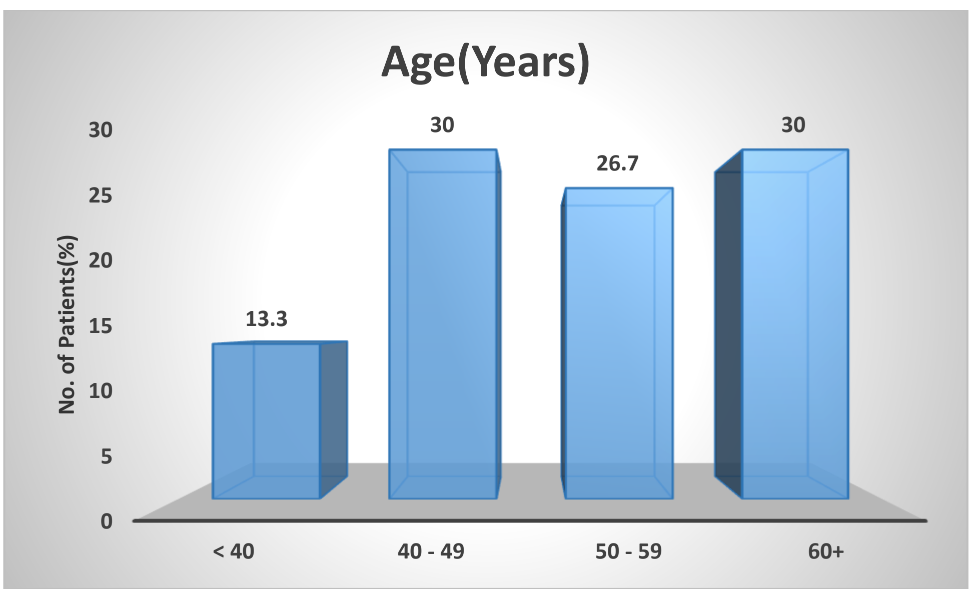
Graph 1

Age distribution

Graph 2 and Table 2 shows age distribution of patients

Age(Years)	No. of patients	Percentage
< 40	4	13.3
40 - 49	9	30.0
50 - 59	8	26.7
60+	9	30.0
Total	30	100.0

Table 2



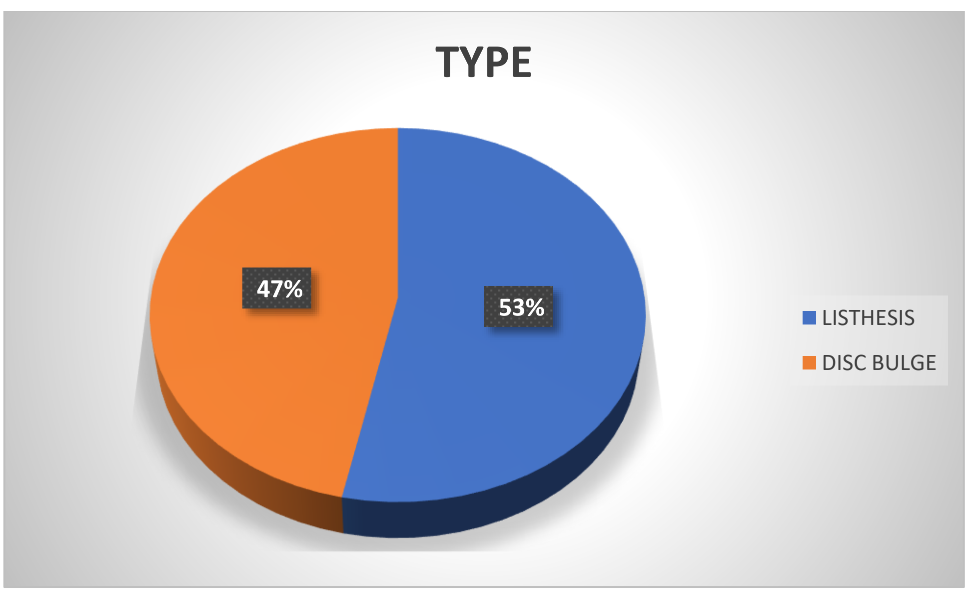
Graph 2

Pathology

Graph 3 and Table 3 shows category of patients belonging to spondylolisthesis and disc bulge

TYPE	No. of patients	Percentage
LISTHESIS	16	53.3
DISC BULGE	14	46.7
Total	30	100.0

Table 3



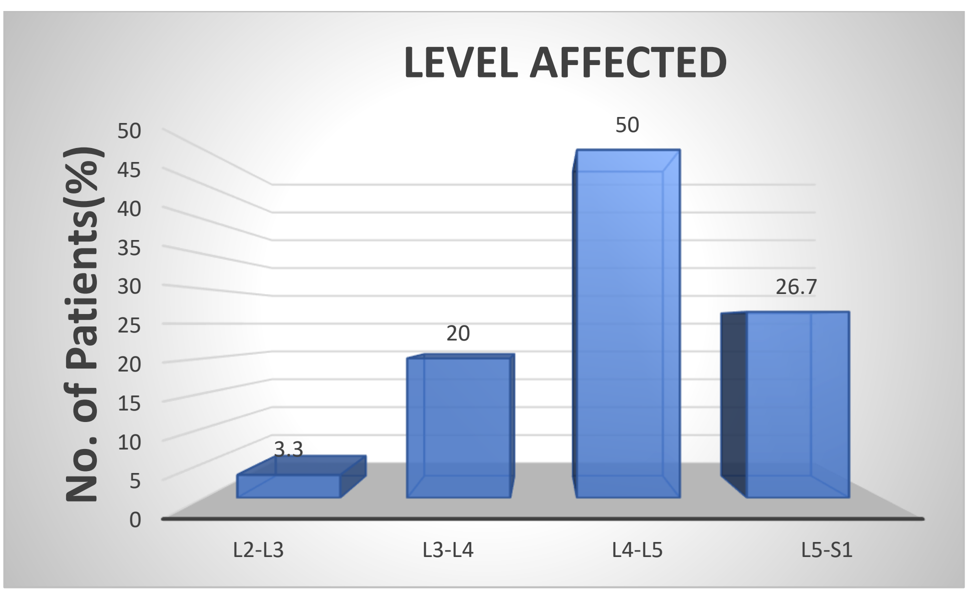
Graph 3

LEVEL AFFECTED

Graph 4 and Table 4 shows spinal level affected in the patients

Level	No. of patients	Percentage
L2-L3	1	3.3
L3-L4	6	20.0
L4-L5	15	50.0
L5-S1	8	26.7
Total	30	100.0

Table 4



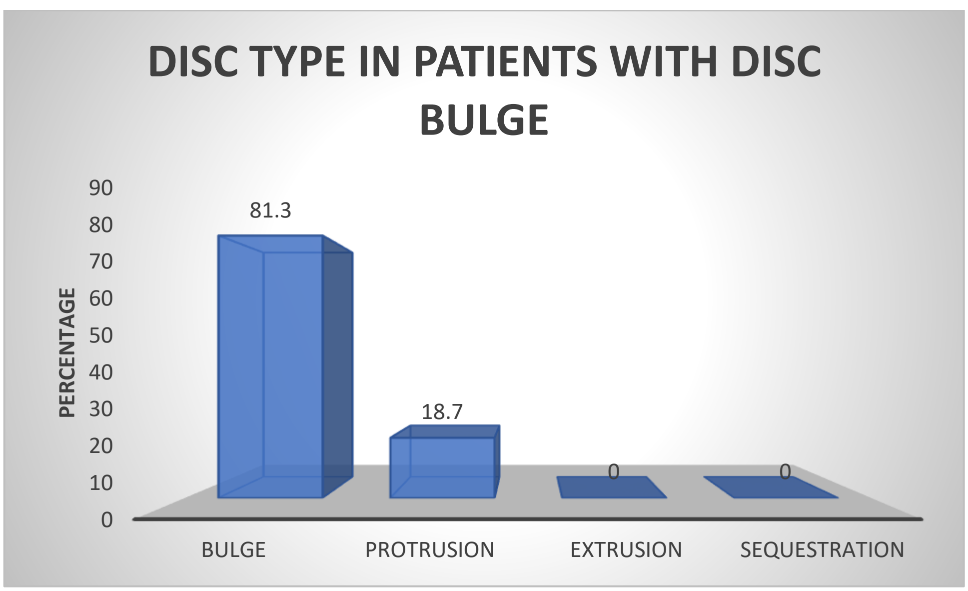
Graph 4

DISC TYPE IN PATIENTS WITH DISC BULGE

Graph 5 and Table 5 shows classification of disc bulge in patients

Disc type	No. of patients	Percentage
Bulge	13	81.3
Protrusion	3	18.7
Extrusion	0	0
Sequestration	0	0
Total	16	100

Table 5



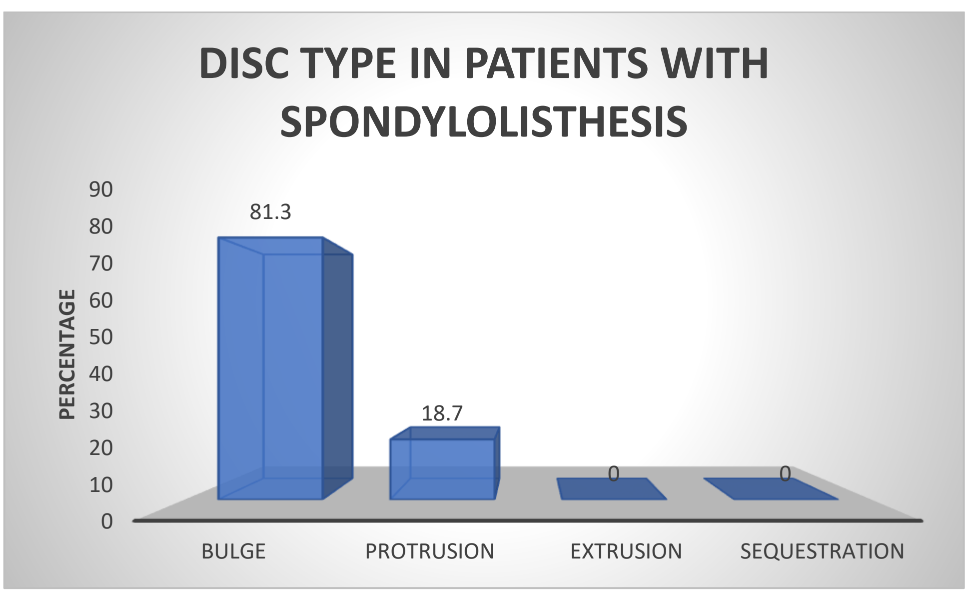
Graph 5

SPONDYLOLISTHESIS TYPE IN PATIENTS WITH SPONDYLOLISTHESIS

Graph 6 and Table 6 shows classification of spondylolisthesis according to meyerding classification

Spondylolisthesis type	No. of patients	Percentage
Meyerding type 1	10	62.5
Meyerding type 2	6	37.5
Meyerding type 3	0	0
Meyerding type 4	0	0
Total	16	100

Table 6



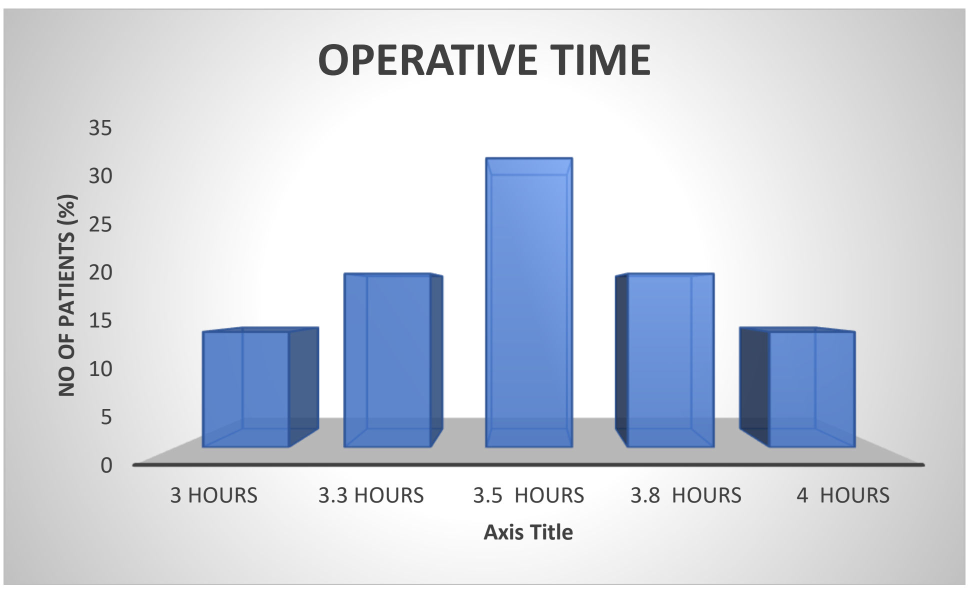
Graph 6

Operating time

The calculation of operating time was from the surgical incision to wound closure and there was no significant change. Graph 7 and table 7 shows the operating time. The mean was 3.5 hours.

Minimum time(Hr)	Median time(Hr)	Maximum time(Hr)
3.0000	3.5000	4.0000

Table 7



Graph 7

Blood loss

The calculation of blood loss was from the number of surgical mops used (each corresponded to 50ml) and also from the collection in suction apparatus after subtracting volume of saline used in wash. In our study mean blood loss was about 237ml.

No:of cases	Mean blood loss(ml)	Minimum	Maximum
30.0000	237.3333	150.0000	320.0000

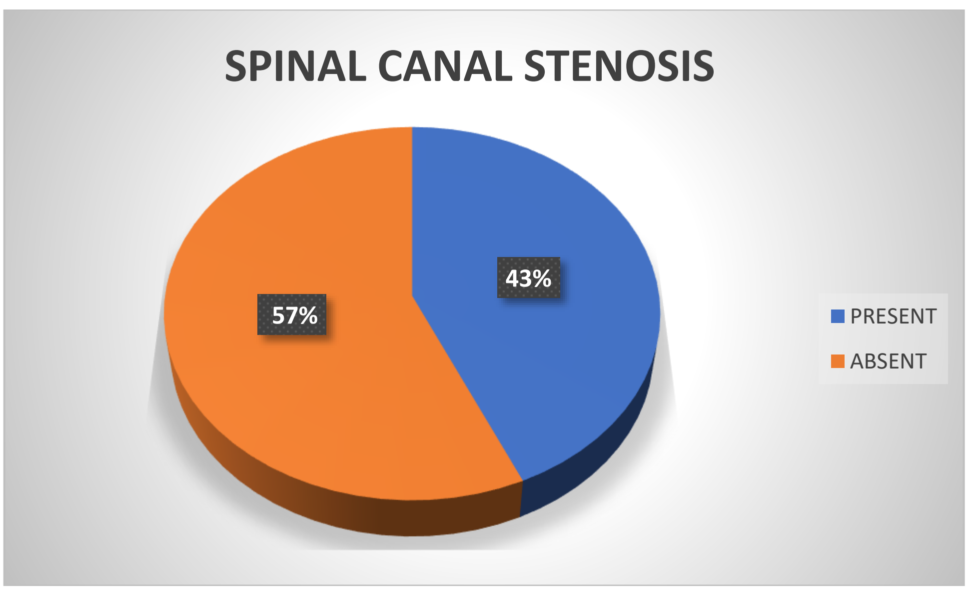
Table 8

Spinal canal stenosis

Graph 8 and Table 9 shows patients associated with spinal canal stenosis

SPINAL CANAL STENOSIS	No. of patients	Percentage
PRESENT	13	43.3
ABSENT	17	56.7
Total	30	100.0

Table 9



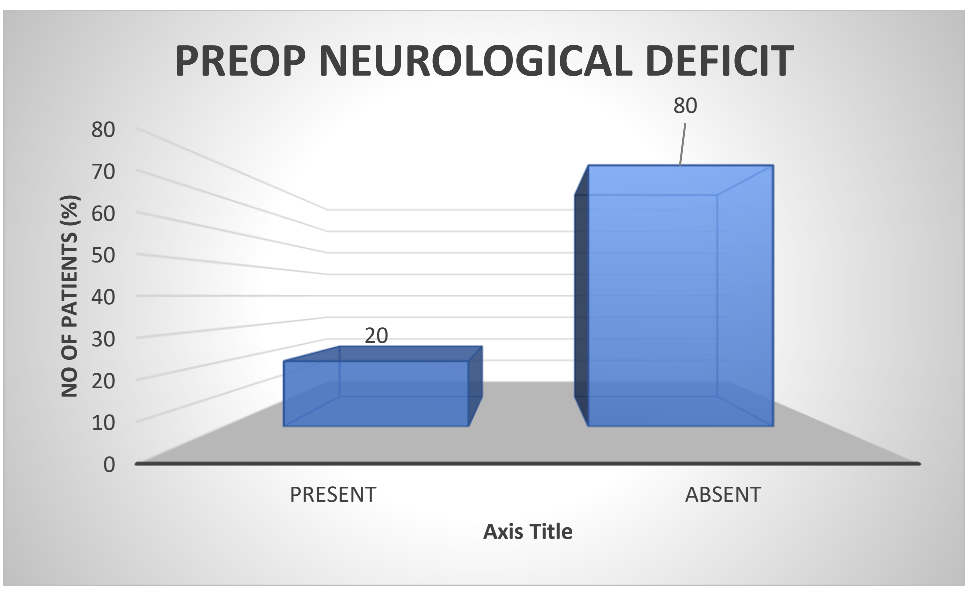
Graph 8

Neurological deficit

Graph 9 and Table 10 shows patients associated with pre op neurological deficit

PRE OP NEUROLOGICAL DEFICIT	No. of patients	Percentage
PRESENT	6	20.0
ABSENT	24	80.0
Total	30	100.0

Table 10

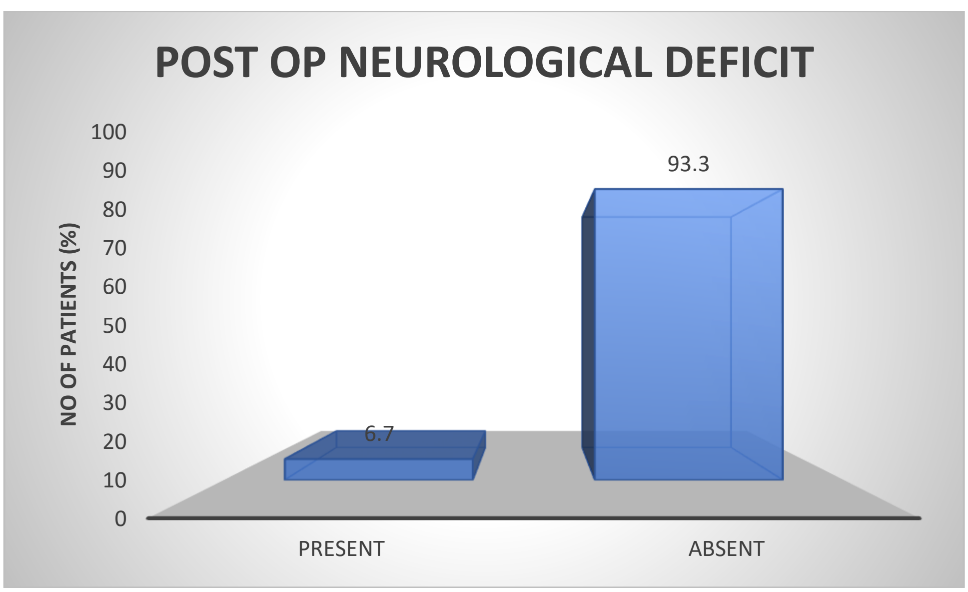


Graph 9

Graph 10and Table 11 shows patients associated with post op neurological deficit

POST OP NEUROLOGICAL DEFICIT	No. of patients	Percentage
PRESENT	2	6.7
ABSENT	28	93.3
Total	30	100.0

Table 11



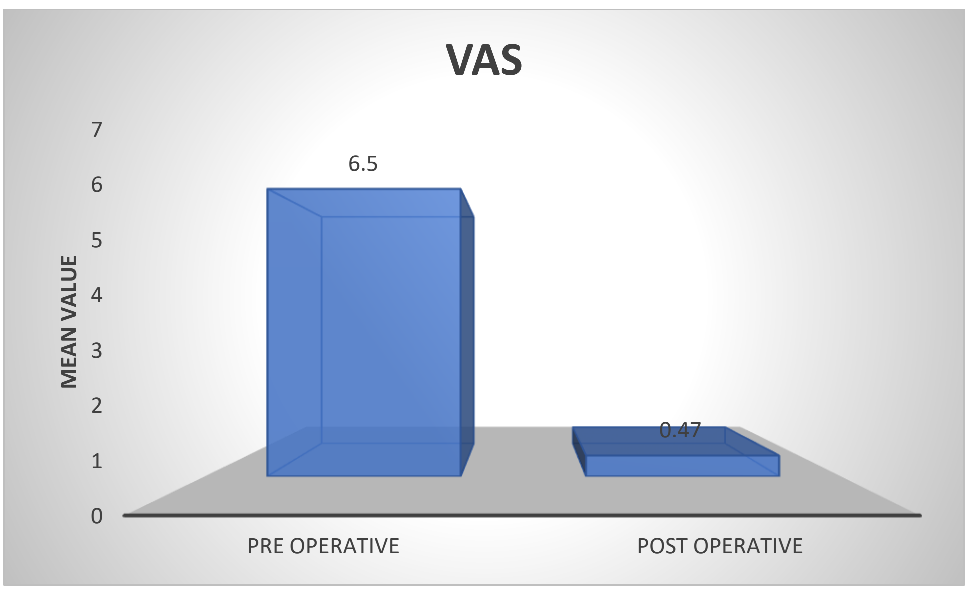
Graph 10

Pain relief

Wilcoxon signed rank test was used to compare the Pre and post op Visual Analogue Scale.

Variables	Pre		Post		Wilcoxon signed rank test	P value
	Mean	±SD	Mean	±SD		
VAS	6.50	1.009	0.47	.937	-4.824	0.0001*
*:Statistically significant						

Table 12



Graph 11

The table 12 shows pre operative VAS score versus post operative VAS score at 6th month indicates a “p value” < 0.0001 and hence a significant comparison. The pain relief was drastic and significant.

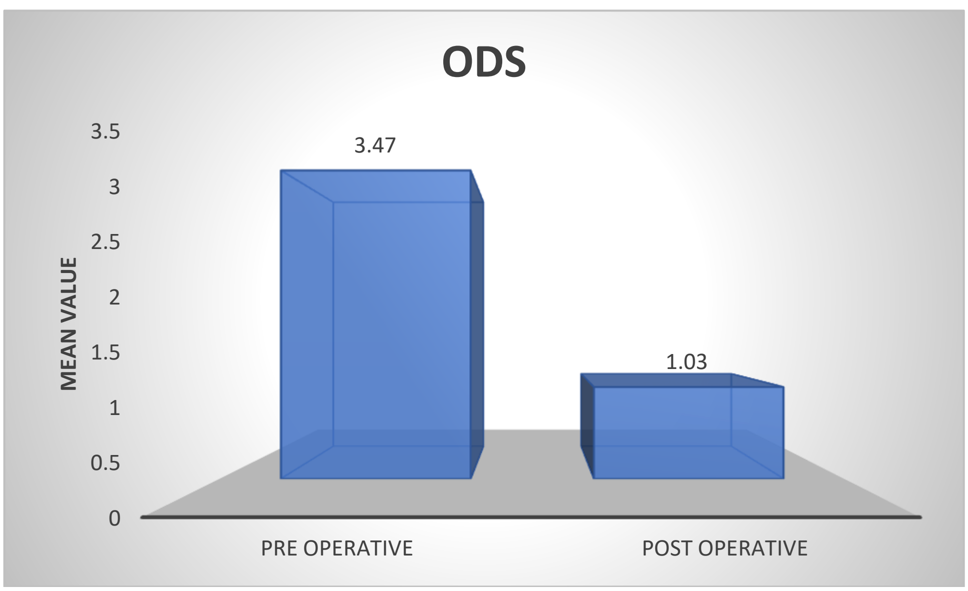
Improvement in quality of life

The assessment was based on the Wilcoxon signed rank test comparing pre and post op Oswestry Disability score (ODS) and Oswestry Disability index (ODI)

Paired Samples Statistics

Variables	Pre		Post		Wilcoxon signed rank test	P value
	Mean	±SD	Mean	±SD		
ODS	3.47	.571	1.03	.183	-4.939[b]	0.0001*
*:Statistically significant						

Table 13

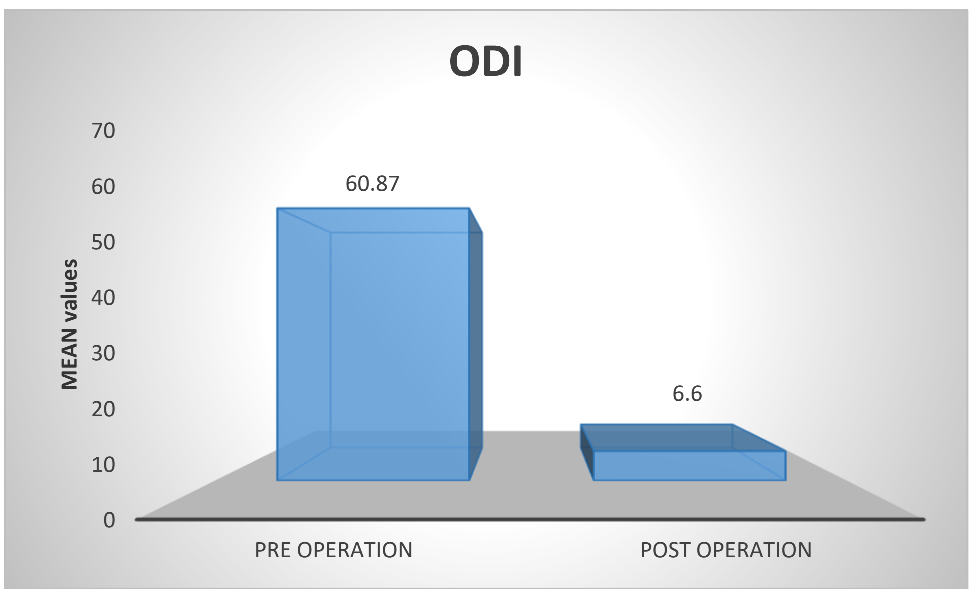


Graph 12

Paired Samples Test

Variables	Pre		Post		Wilcoxon signed rank test	P value
	Mean	±SD	Mean	±SD		
ODI	60.87	8.577	6.60	5.946	4.788	0.0001*
*:Statistically significant						

Table 14



Graph 13

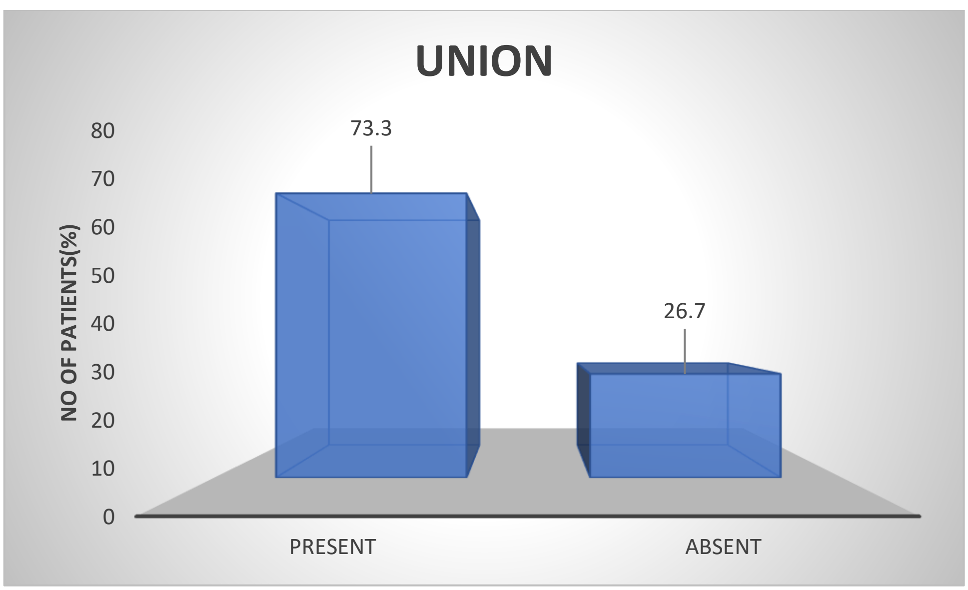
There was statistically significant reduction in Oswestry Disability index postoperatively, indicating significant improvement in the quality of life.

Radiological union

Graphs 14 and table 15 shows the radiological union after posterior lumbar interbody fusion

UNION	No. of patients	Percentage
PRESENT	22	73.3
ABSENT	8	26.7
Total	30	100.0

Table 15



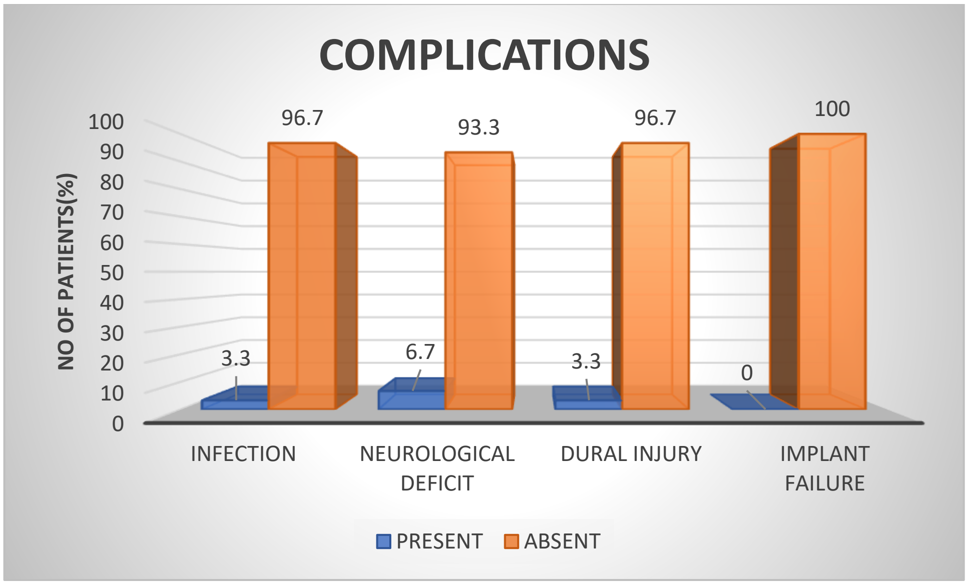
Graph 14

Complications:

Graphs 15 and table 16 shows the complications after posterior lumbar interbody fusion

COMPLICATIONS	No. of patients	Percentage
INFECTION		
PRESENT	1	3.3
ABSENT	29	96.7
NEUROLOGICAL DEFICIT		
PRESENT	2	6.7
ABSENT	28	93.3
DURAL INJURY		
PRESENT	1	3.3
ABSENT	29	96.7
IMPLANT FAILURE		
PRESENT	0	0
ABSENT	30	100
TOTAL	30	100

Table 16


COMPLICATIONS
NO OF PATIENTS(%)
100
90
80
70
60
50
40
30
20
10
0
96.7
93.3
96.7
100
3.3
6.7
3.3
0
INFECTION
NEUROLOGICAL DEFICIT
DURAL INJURY
IMPLANT FAILURE
PRESENT
ABSENT

Graph 15

RESULTS

The radiological union rate was found to be 73.3 percent.

From surgical incision to wound closure, the average operating time was 3.5 hours. The average blood loss was 237 millilitres.

The improvement in the post-operative VAS score at the six-month mark was drastic and significant, as proven by a "p value" of < 0.0001.

Improvement in quality of life, as assessment, based on the Wilcoxon signed rank test comparing preoperative and postoperative Oswestry Disability score (ODS) and Oswestry Disability index (ODI), was statistically significant, showing reduction in Oswestry Disability index and score postoperatively, indicating significant improvement in the quality of life.

Complications

We came across one case of intra operative dural injury, which was well sutured with no further complications to the patient.

1 patient had post operative wound infection on day 8 which was controlled with thorough debridement, IV antibiotics and the case showed radiological union and the quality of life improved.

1 patient with pre operative neurological deficit didn’t improve with the surgery and post operatively didn’t show union.

1 patient developed post operative neurological deficit but also showed union.

There was no Screw breakage or cage failure. Progression of slip did not occur in any of the cases.

DISCUSSION

Bony fusion is the goal in the treatment of lumbar or lumbosacral spondylolisthesis. Fusion rates rise with years of follow-up, regardless of instrumentation.

Despite the small sample size, fusion results were comparable to those achieved in previous standard studies for the course of the short follow-up period. After interbody arthrodesis, fusion rates improved from 66 percent in the first year (of 83 patients evaluated by Stauffer and Coventry[60]) to 91 percent at two years when Bagby and Kuslich titanium cages were utilised [61,62,63] and 96 percent when Ray titanium cage was used. [64]. They believe that with further follow-up, the fusion rates will be higher.

Though the radiological union rate in our study was only 73.3 percent, the clinical outcome, as measured by improvements in socioeconomic and functional indicators as measured by the Oswestry Disability Index and score, was excellent. Because the interbody spaces have a greater vascular supply than the posterolateral spaces, there is more fusion.

Our study's average operation duration was 3.5 hours, which was comparable to previous research [65]. Primary bleeding, basal atelectasis, shock from blood loss, postoperative wound infection, and paralytic ileus are some of the problems linked with lengthy surgery.

Our study's mean blood loss was 237 mL, which was comparable to Curt Freudenberger et al study .'s of 250 mL blood loss.

The choice to conduct a single level PLIF for degenerative disc disease was made following discussion with the patients in the study by Nick Birch, Sean Grannum, and Nadim Aslam.[66] Degenerated disc disease is a good indication for PLIF, according to the findings of this study. Many studies have shown that interbody arthrodesis can reduce discomfort that persists following a successful discectomy for degenerative disc disease. The nerve supply of the disc has been discovered in studies, which is more in the event of a deteriorated disc. As a result, discectomy alone can result in failed back surgery syndrome and instability. To avoid this, the disc, which is the source of discomfort, should be removed. Fusion with a spacer should only be performed when a black disc is linked with intervertebral disc space narrowing.

The **advantage** of a pure Posterior Lumbar Interbody Fusion surgery is that it provides anterior fusion between adjacent vertebra without a second incision, unlike an anterior with posterior spine fusion surgery where it is approached by two sites.

The following are some of the disadvantages of PLIF surgery:

- A posterior approach allows only limited disc space to be removed
- An anterior approach allows for a more thorough drainage of the disc space and hence a larger surface area for fusion.

- An anterior approach allows a significantly larger bone graft and/or spinal implant to be inserted.
- Reducing spinal abnormalities with only a posterior approach is more difficult (e.g. isthmic spondylolisthesis)
- A posteriorly placed bone graft or cage may occasionally retro pulse back into the canal, causing neural compression.

The cage with bone graft is implanted in the anterior region of the disc space during PLIF surgery. The anterior gutter has higher surface area than the posterolateral gutter. The bone in the anterior portion is compressed, resulting in better healing since the bone is stressed (Wolff's law). The bone is not under enough tension in posterolateral fusions. Because of these two factors, PLIF surgery has a higher success rate than posterolateral fusion.

The Risks and Complications of PLIF Surgery includes:

1. Non union- Fusion rates for a PLIF should be as high. The risk factors for non union are as follows:

   - prior spine surgery
   - smoking
   - multiple level fusion surgery
   - obesity
   - radiotherapy for cancer

Even if the joint is stable and the patient is symptomatically well, a subsequent fusion treatment is not required if the joint is stable and the patient is symptomatically well.

2. Infection & bleeding. (1% to 3% occurrence).(3.3% in our study)
3. Persistent back pain in spite of achieving spinal fusion.

Posterior instrumentation provides immediate surgical stability, and bone fusion was formed subsequently, preventing slip advancement.

Patients who had pedicle-screw instrumentation had a considerably higher rate of fusion than those who did not. Instrumentation's success is based on establishing and maintaining disc space height, giving it a better alternative for people with mechanical back pain, foraminal stenosis, and radiculopathy.

The biomechanics of a pedicle screw is that it resists axial force by tightly buttressing the spine; however, because the anterior column does not share load, stress occurs at the screw plate or rod junction, resulting in screw breakage. Deformities are caused by the flexion and extension components of the applied moment arm. During axial loading, pedicle screw fixation may fail, resulting in parallelogram-like translation deformity, hardware failure, screw pull out, breakage, and toggling. To avoid complications, we must utilise an interbody cage.

X ray showing Breakage of pedicle screw when used alone

When used for interbody fusion, nonstructural autologous cancellous bone graft has a high risk of collapsing or migrating. As a result, a cage is preferred.

Use of cage

- Better immediate stabilization of segment
- Restoration and maintenance of disc height, foramen height
- Biomechanically capable of anterior vertebral body load sharing
- Will not be resorbed
- Prevent slip progression
- Prevent kyphotic deformity
- Bone fusion is early
- Excellent results for fusion

CONCLUSION

Despite the fact that this study included a small number of patients and a short follow-up period, the results suggest that the PLIF procedure can successfully treat painful spinal disorders such as degenerative disc disease and spondylolisthesis.

The key to success is proper patient selection, which is the outcome of correctly identifying the etiopathogenesis, diagnosis, and natural history of low-back pain and its treatment (both non operative and operative).

Patients with an incompetent annulus found in central disc herniation have a higher risk of post-discectomy instability, which can lead to disabling low back and leg pain, than those with a fully intact annulus.

A degenerated disc with disc space narrowing, spinal canal stenosis or a case of spondylolisthesis that hasn't responded to conservative treatment, are indications for PLIF.

In light of the results and minimal complication rate, we would recommend the PLIF technique combined with bone grafting as an appropriate technique for spondylolisthesis and degenerative disc disease.

BIBLIOGRAPHY

1. Christian P. Dipaola, Robert W. Molinari. Posterior Lumbar Interbody Fusion. J Am Acad Orthop Surg [Internet]. 2008;16(3):130–9. Available from: http://journals.lww.com/corr/abstract/1983/11000/posterior_lumbar_interbody_fusion.19.aspx

2. Horeb M, Biakto K, Supriyadi W. Functional Outcome After Posterior Lumbar Interbody Fusion With Cage In Patient With Lumbar Spinal Stenosis At Wahidin Sudirohusodo Hospital, Makassar. Azerbaijan Med Assoc J. 2017;2(3):50.

3. Patil SS, Rawall S, Nagad P, Shial B, Pawar U, Nene AM. Outcome of single level instrumented posterior lumbar interbody fusion using corticocancellous laminectomy bone chips. Indian J Orthop. 2011;45(6):500–3.

4. Hsieh MK, Chen LH, Niu CC, Fu TS, Lai PL, Chen WJ. Combined anterior lumbar interbody fusion and instrumented posterolateral fusion for degenerative lumbar scoliosis: Indication and surgical outcomes. BMC Surg. 2015;15(1):1–7.

5. Lin B, Yu H, Chen Z, Huang Z, Zhang W. Comparison of the PEEK cage and an autologous cage made from the lumbar spinous process and laminae in posterior lumbar interbody fusion. BMC Musculoskelet Disord [Internet]. 2016;17(1):1–8. Available from: http://dx.doi.org/10.1186/s12891-016-1237-y

6. Lara-Almunia M, Gomez-Moreta JA, Hernandez-Vicente J. Posterior lumbar interbody fusion with instrumented posterolateral fusion in adult spondylolisthesis: Description and association of clinico-surgical variables with prognosis in a series of 36 cases. Int J Spine Surg. 2015;9.

7. Li H, Wang H, Zhu Y, Ding W, Wang Q. Incidence and risk factors of posterior cage migration following decompression and instrumented fusion for degenerative lumbar disorders. Med (United States). 2017;96(33):1019–25.

8. Liu H, Xu Y, Yang SD, Wang T, Wang H, Liu FY, et al. Unilateral versus bilateral pedicle screw fixation with posterior lumbar interbody fusion for lumbar degenerative diseases. Med (United States). 2017;96(21).

9. Population S, Tsiamalou PM, Fountas KN. for Lumbar Degenerative Disorders in a

Southern. 2010;23(7):444–50.

10. Haid RW, Branch CL, Alexander JT, Burkus JK. Posterior lumbar interbody fusion using recombinant human bone morphogenetic protein type 2 with cylindrical interbody cages. Spine J. 2004;4(5):527–38.

11. Park Y, Ha JW. Comparison of one-level posterior lumbar interbody fusion performed with a minimally invasive approach or a traditional open approach. Spine (Phila Pa 1976). 2007;32(5):537–43.

12. S. Terry Canale MD, James H. Beaty MD. Campbell's Operative Orthopaedics 12th ed: Philadelphia; Elsevier Mosby: 2013.

13. Wang Y, Battié MC, Boyd SK, Videman T. The osseous endplates in lumbar vertebrae: thickness, bone mineral density and their associations with age and disk degeneration. Bone. 2011 Apr 1;48(4):804-9.

14. Zindrick MR, Wiltse LL, Doornick A, Widell EH, Knight GW, Patwardhan G, Thomas JC, Rothaman SL, Fields BT. Analysis of morphometric charactristics of the thoracic and lumbar pedicles. Spine: 1987; 12:160-166.

15. Barr JS, Hampton AO, Mixter WJ. Pain low in the back and “sciatica” due to lesions of the intervertebral discs. JAMA:1937; 109:1265.

16. Bogduk N, Tynan W, Wilson AS. The nerve supply to the human lumbar intervertebral discs. J Anatomy: 1981; 132:39

17. Kuslich SD, et al. The Tissue Origin of Low Back Pain and Sciatica: A report of pain response to tissue stimulation during operations on the lumbar spine using local anesthesia. Orthopedic Clinics Of North America: 1991;22:181-187

18. Esses SI, Botsford DJ, Kostuik JP. The role of external spinal skeletal fixation in the assessment of low-back disorders. Spine. 1989;14:594–601

19. Stokes IA, Frymoyer JW. Segmental motion and instability. Spine. 1987;12:688–691

20. Wetzel FT, LaRocca SH, Lowery GL, et al. The treatment of lumbar spinal pain syndromes diagnosed by discography. Lumbar arthrodesis. Spine. 1994;19:792–800.

21. Mooney V, Robertson J. The facet syndrome. Clinical Orthopaedics And Related Reserch. 1976;115:149–56.

22. Kuslich SD, Ulstrom CL, Michael CJ. The tissue origin of low back pain and sciatica: a report of pain response to tissue stimulation during operations on the lumbar spine using local anesthesia. Orthopedic Clinics Of North America. 1991;22:181–187.

23. Kirkaldy-Willis WH, Farfan HF. Instability of the lumbar spine. Clinical Orthopaedics And Related Reserch. (165):110–123.

24. Kieffer SA, Cacyorin ED, Sherry RG. The radiological diagnosis of herniated lumbar intervertebral disk: a current controversy. JAMA. 1984; 251:1192

25. Postacchini F. Management of herniation of the lumbar disc. The *Journal Of Bone and Joint Surgery* British Volume. 1999;81:567–76

26. Paul C. Mcafee, M.D., Towson,Maryland. Current Concepts Review -Interbody Fusion Cages in *Reconstructive Operations* on the *Spine* The *Journal Of Bone and Joint Surgery* American Volume, *1999 Jun 01*;*81*(*6*):*859-80*.

27. Wiltse LL. The etiology of spondylolisthesis. The *Journal Of Bone and Joint Surgery* American edition 1962; 44-A:539-560.

28. Aruna Ganju, M.D. Isthmic spondylolisthesis. Neurosurg Focus 13 (1):Article 1, 2002

29. McPhee IB, O'Brien JP. Scoliosis in symptomatic spondylolisthesis. The *Journal Of Bone and Joint Surgery*. 1980; 62B:155.

30. Roche MA, Rowe GG. The incidence of separate neural arch and coincident bone variations: a survey of 4,200 skeletons. Anat Rec1951;109:233–52.

31. Turner RH, Bianco AJ. Spondylolysis and spondylolisthesis in children and teenagers.*Jornal Of Bone Joint Surgery [Am]*1971;53:1298–306.

32. Amato ME, Totty WG, Gilula LA. Spondylolysis of the lumbar spine: demonstration of defects and laminal fragmentation. *Radiology*1984;153:627–9.

33. Meyerding, 1932. Meyerding HW. Spondylolisthesis. Surg Gynecol Obstet 1932; 54:371.

34.DeWald, 1997. DeWald RL. Spondylolisthesis. In: Bridwell KH, DeWald RL. ed. The textbook of spinal surgery, 2nd ed. Philadelphia: Lippincott-Raven; 1997.

35. Wiltse LL, Jackson DW. Treatment of spondylolisthesis and spondylolysis in children. Clinical Orthopaedics And Related Reserch. 1976; 117:92

36. Bradford DS. Spondylolysis and spondylolisthesis.Current Practice in Orthopaedic Surgery 1979; 8:12.

37.Buck JE. Direct repair of the defect in spondylolisthesis. Journal of Bone Joint Surgery 1979; 61A:479.

38. Bradford DS. Repair of spondylolysis or minimal degrees of spondylolisthesis by segmental wire fixation and bone grafting. Orthopaedic Transactions 1982; 6:1.

39. Van Dam DE. Nonoperative treatment and surgical repair of lumbar spondylolysis. In: Bridwell KH, DeWald RL, ed. The textbook of spinal surgery, 2nd ed. Philadelphia: Lippincott-Raven; 1997.

40. Gill GG, Manning JG, White HL. Surgical treatment of spondylolisthesis without spine fusion The *Journal Of Bone and Joint Surgery*.1955; 37A:493

41. Bell DF, Ehrlich MG, Zaleske DJ. Brace treatment for symptomatic spondylolisthesis. Clinical Orthopaedics And Related Reserch.1988; 236:192.

42. Moller H, Hedlund R. Surgery versus conservative management in adult isthmic spondylolisthesis—a prospective randomized study: I. Spine. 2000; 25:1711-1715.

43. Warner WC. Kyphosis. In: Morrissy RT, Weinstein SL, ed. Lovell and Winter's pediatric orthopaedics, 6th ed. Philadelphia: Lippincott Williams & Wilkins; 2006.

44. Kuslich SD, Ulstrom CL, Griffith SL, et al. The Bagby and Kuslich method of lumbar interbody fusion: history, techniques, and 2-year follow-up results of a United States prospective, multicenter trial. Spine1998*;*23*:*1267*–1279*

45. Sacks S. Anterior interbody fusion of the lumbar spine. Journal of Bone Joint Surgery British volume. 1965; 47:211–223

46. Flynn JC, Hoque MA. Anterior fusion of the lumbar spine. Jornal of Bone Joint Surgery American volume 1979;61:1143–1150

47. Burkus JK, Gornet MF, Dickman CA, Zdeblick TA. Anterior lumbar interbody fusion using rhBMP-2 with tapered interbody cages. Journal of Spinal Disorders and Techniques. 2002;15:337–349

48. Kim NH, Kim HK, Suh JS. A computed tomographic analysis of the changes in the spinal canal after anterior lumbar interbody fusion. Clinical Orthopaedics And Related Reserch. 1993; 286:180-191

49. McAfee PC, Lee GA, Fedder IL, Cunningham BW. Anterior BAK instrumentation and fusion: complete versus partial discectomy Clinical Orthopaedics And Related Reserch. 2002 January;(394):55-63.

50. Lin PM. Posterior lumbar interbody fusion technique: complications and pitfalls. Clinical Orthopaedics And Related Reserch. *1985*;193:90–102.

51. Shinya Okuda, MD, Takenori Oda, MD, Akira Miyauchi, MD, Takamitsu Haku, MD, Tomio Yamamoto, MD, Motoki Iwasaki, MD. Surgical Outcomes of Posterior Lumbar Interbody Fusion in Elderly Patients: Surgical Technique. J Bone Joint Surg Am, 2007 Sep 01;89(2 suppl 2):310-320

52. Fogel GR, Toohey JS, Neidre A, Brantigan JW. Is *one cage enough* in *posterior lumbar interbody fusion*: a *comparison* of *unilateral single cage interbody fusion* to *bilateral cages*. *Joural of Spinal Disorders and Techniques*. *2007 Feb*;*20*(*1*):*60-5*.

53. Lars Hackenberg, Henry Halm, Viola Bullmann, Volker Vieth, Marc Schneider, and Ulf Liljenqvist. *Transforaminal lumbar interbody fusion*: a safe technique with satisfactory three to five year results. European Spine Journal. 2005 August; 14(6): 551–558

54.Humphreys SC, Hodges SD, Patwardhan AG, Eck JC, Murphy RB, Covington LA. Comparison of posterior and transforaminal approaches to lumbar interbody fusion. Spine. 2001;26:567–571.

55. Kim CW, Perry A, Garfin SR. *Current concepts review—lumbar arthrodesis* for the *treatment* of *back pain*. *J Bone Joint Surg Am*. *1999 May*;*81-* A(*5*):*716-30*.

56. Esses SI, Bednar DA. The spinal pedicle screw: techniques and systems. Orthop Rev 1989; 18:676

57. Saillant G. Anatomic study of vertebral pedicles: surgical application. Rev Chir Orthop 1976; 62:151.

58. Sam W. Lippincott Williams & Wilkins.Operative Techniques in Orthopaedic Surgery, Volume IV.1st edition: Chapter sp14

59. Fogel GR, Toohey JS, Neidre A, Brantigan JW. Is *one cage enough* in *posterior lumbar interbody fusion*: a *comparison* of *unilateral single cage interbody fusion* to *bilateral cages*. *Joural of Spinal Disorders and Techniques*. *2007 Feb*;*20*(*1*):*60-5*

60. Stauffer, R. N.,Coventry, M. B.. Anterior interbody lumbar spine fusion. Analysis of Mayo Clinic series. Journal Bone and Joint Surgery.,54-A: 756-768.

61. Alpert, S.. Summary of safety and effectiveness—BAK interbody fusion system—PMA P950002, PMA Document Mail Center (HFZ-401), Center for Disease and Radiological Health. Washington, D.C., Food and Drug Administration, Sept. 20, 1996.

62.Kuslich, S. D., Ulstrom, C. L., Griffith, S. L., Ahern, J. W.,Dowdle, J. D.. The Bagby and Kuslich method of lumbar interbody fusion. History, techniques, and 2-year follow-up results of a United States prospective, multicenter trial. Spine,23: 1267-1279 ,1998.

63. Yuan, H. A., Kuslich, S. D., Dowdle, J. A., Jr., Ulstrom, C. L. and Griffith S. L. Prospective multicenter clinical trial of the BAK interbody fusion system. Read at the Annual Meeting

of the North American Spine Society, New York, N.Y., Oct. 22, 1997.

64. Ray, C. D.. Threaded fusion cages for lumbar interbody fusions: An economic comparison with 360 degrees fusions. Spine,22: 681-685. 1997

65. Lei Cheng, Lin Nie, and Li Zhang. Posterior lumbar interbody fusion versus posterolateral fusion in spondylolisthesis: a prospective controlled study in the Han nationality. International Orthopaedics. 2009 August; 33(4): 1043–1047.

66. Nick Birch, Sean Grannum and Nadim Aslam, BMI Three Shires Hospital, Northampton, UK. Posterior Lumbar Interbody Fusion (PLIF) as a primary treatment for pan-annular failure presenting as a central disc herniation: medium term (2 to 5 year) follow-up. The *Journal Of Bone and Joint Surgery* British Volume. 2004;86-B:89-90.

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PROFORMA

CASE NO. :

NAME :

AGE/SEX :

I P NO :

DATE OF ADMISSION :

DATE OF SURGERY :

DATE OF DISCHARGE :

OCCUPATION :

RESIDENCE :

Presenting complaints with duration :

History of presenting complaints :

Family History :

Personal History :

Past History :

General Physical Examination

Pallor:	present/absent
Icterus:	present/absent
Clubbing:	present/absent
Generalized lymphadenopathy:	present/absent
Built:	poor/moderate/well
Nourishment:	poor/moderate/well

Vitals

PR: RR:

BP: TEMP:

Other Systemic Examination:

Local examination:

<u>Inspection</u>:

a) Attitude/ deformity- kyphosis/exaggrated lumbar lordosis

b) Abnormal swelling

- Site
- Size
- Shape
- Extent

d) Skin

<u>Palpation:</u>

a) Local tenderness –direct,rotational,thurst

b) Bony step

c) Abnormal movement

d) Swelling

Range of movements:

Neurological examination:

1.Tone

2.bulk

3.Power

4.reflexes

5.sensory examination

6.Special test

SLRT

Lasegue

Patrick

Femoral nerve stretch test

SPINE EXAMINATION:

INVESTIGATIONS:

PLAIN RADIOLOGY FINDINGS

STANDARD AP AND LATERAL

SPECIAL VIEW(FLEXION AND EXTENSION)

Normal- 1.Yes 2.No

Loss of Lordosis

Scoliosis

Claw osteophyte

Traction Spur

Loss of disc height

Listhesis 1.Yes 2.No

If Yes, Meyerding Grading
1. < 25% 2. 25 – 50% 3. 50 – 75% 4. >75% 5. Spondyloptosis

MRI

Level
1. L1 L2
2. L2 L3
3. L3 L4
4. L4 L5
5. L5 S1

Disc Degeneration
1. Yes
2. No

Stage Of Disc Prolapse
1. Bulge
2. Protrusion
3. Extrusion
4. Sequestration

Disc Prolapse
1. Central

2.Right Posterolateral
3.Left Posterolateral
Disc Height
1. Normal
2. Decreased

Canal Diameter
1 . >/= 11mm
2. < 11mm

Foraminal Stenosis
A. Right
B.Left

Meyerding Grading (If Spondylolisthesis)
1. < 25%
2. 25 – 50%
3. 50 – 75%
4. >75%
5. Spondyloptosis

DIAGNOSIS:

PRE OP PLANNING:

PEDICLE SCREW LENGTH

DIAMETER

INTRA OP ASSESSMENT:

ANAESTHESIA

POSITION

IMPLANT

DECOMPRESSION

REDUCTION

FIXATION

OPERATING TIME

BLOOD LOSS

FLUOROSCOPIC EXPOSURES

INTRA OP COMPLICATIONS OR DIFFICULTIES POST OP PERIOD

Anesthesia

Position

Implants Used

Reduction (Spondylolisthesis)

Blood loss

Operating time

Fluoroscopic exposures

Laminectomy 1. Partial 2. Hemi 3.Complete

Facet Joint Excision 0. No
1.Right 1. < 25% 2. 26 – 50% 3. >50%
2.Left 1. < 25% 2. 26 – 50% 3. >50%

Intra Op Complications/ Difficulties

FOLLOW UP

Back Pain 0. No 1.Central 2.Right 3.Left

Visual Analogue Scale 0 1 2 3 4 5 6 7 8 9 10

Radicular Pain 0. No 1. Radicular Pain Right 2. Radicular Pain Left

Claudication Pain 0. No 1. Yes

Painful catch 0. No 1. Yes

Oswestry Disability Index

Section 1 – Pain Intensity

- ☐ I have no pain at the moment.
- ☐ The pain is very mild at the moment.
- ☐ The pain is moderate at the moment.
- ☐ The pain is fairly severe at the moment.
- ☐ The pain is very severe at the moment.
- ☐ The pain is the worst imaginable at the moment.

Section 2 – Personal Care (washing, dressing, etc.)

- ☐ I can look after myself normally but it is very painful.
- ☐ I can look after myself normally but it is very painful.
- ☐ It is painful to look after myself and I am slow and careful.
- ☐ I need some help but manage most of my personal care.
- ☐ I need help every day in most aspects of my personal care.
- ☐ I need help every day in most aspects of self-care.
- ☐ I do not get dressed, wash with difficulty, and stay in bed.

Section 3 - Lifting

- ☐ I can lift heavy weights without extra pain.
- ☐ I can lift heavy weights but it gives extra pain.
- ☐ Pain prevents me from lifting heavy weights off the floor, but I can
- ☐ manage if they are conveniently positioned (i.e. on a table).
- ☐ Pain prevents me from lifting heavy weights, but I can manage light to
- ☐ medium weights if they are conveniently positioned.
- ☐ I can lift only very light weights.
- ☐ I cannot lift or carry anything at all.

Section 4 – Walking

- ☐ Pain does not prevent me walking any distance.
- ☐ Pain prevents me walking more than 1mile.
- ☐ Pain prevents me walking more than ¼ of a mile.
- ☐ Pain prevents me walking more than 100 yards.
- ☐ I can only walk using a stick or crutches.
- ☐ I am in bed most of the time and have to crawl to the toilet.

Section 5 – Sitting

- ☐ I can sit in any chair as long as I like.
- ☐ I can sit in my favorite chair as long as I like.
- ☐ Pain prevents me from sitting for more than 1 hour.
- ☐ Pain prevents me from sitting for more than ½ hour.
- ☐ Pain prevents me from sitting for more than 10minutes.
- ☐ Pain prevents me from sitting at all.

Section 6 – Standing

- ☐ I can stand as long as I want without extra pain.
- ☐ I can stand as long as I want but it gives me extra pain.
- ☐ Pain prevents me from standing more than 1 hour.
- ☐ Pain prevents me from standing for more than ½ an hour.
- ☐ Pain prevents me from standing for more than 10 minutes.
- ☐ Pain prevents me from standing at all.

Section 7 – Sleeping

- ☐ _My sleep is never disturbed by pain.
- ☐ My sleep is occasionally disturbed by pain.
- ☐ Because of pain, I have less than 6 hours sleep.
- ☐ Because of pain, I have less than 4 hours sleep.
- ☐ Because of pain, I have less than 2 hours sleep.
- ☐ Pain prevents me from sleeping at all.

Section 8 – Sex life (if applicable)

- ☐ My sex life is normal and causes no extra pain.
- ☐ My sex life is normal but causes some extra pain.
- ☐ My sex life is nearly normal but is very painful.
- ☐ My sex life is severely restricted by pain.
- ☐ My sex life is nearly absent because of pain.
- ☐ Pain prevents any sex life at all.

Section 9 – Social Life

- ☐ My social life is normal and cause me no extra pain.
- ☐ My social life is normal but increases the degree of pain.
- ☐ Pain has no significant effect on my social life apart from limitingmy
- ☐ more energetic interests, i.e. sports.
- ☐ Pain has restricted my social life and I do not go out as often.
- ☐ Pain has restricted social life to my home.
- ☐ I have no social life because of pain.

Section 10 – Traveling

- ☐ I can travel anywhere without pain.
- ☐ I can travel anywhere but it gives extra pain.
- ☐ Pain is bad but I manage journeys of over two hours.
- ☐ Pain restricts me to short necessary journeys under 30 minutes.
- ☐ Pain prevents me from traveling except to receive treatment.

B.L.D.E.U.'s SHRI B.M.PATIL MEDICAL COLLEGE HOSPITAL AND RESEARCH CENTER, VIJAYAPURA -586103

INFORMED CONSENT FOR PARTICIPATION IN DISSERTATION/RESEARCH

I, the undersigned,_______________ , S/O D/O W/O ________________, aged ____years, ordinarily resident of ____________ do hereby state/declare that Dr. Karthik M S of Shri. B. M. Patil Medical College Hospital and Research Centre has examined me thoroughly on ______________ at ______________ (place) and it has been explained to me in my own language that I am suffering from ________________ disease (condition) and this disease/condition mimic following diseases. Further Dr. Karthik M S informed me that he/she is conducting dissertation/research titled "A prospective study of functional outcome of lumbar diseases treated with single level instrumented posterior lumbar interbody fusion" under the guidance of Dr.Dayanand B B requesting my participation in the study. Apart from routine treatment procedure, the pre-operative, operative, post-operative and follow-up observations will be utilized for the study as reference data.

Doctor has also informed me that during conduct of this procedure like adverse results may be encountered. Among the above complications most of them are treatable but are not anticipated hence there is chance of aggravation of my condition and in rare circumstances it may prove fatal in spite of anticipated diagnosis and best treatment made available. Further Doctor has informed me that my participation in this study help in evaluation of the results of the study which is useful reference to treatment of other similar cases in near future, and also I may be benefited in getting relieved of suffering or cure of the disease I am suffering.

The Doctor has also informed me that information given by me, observations made/ photographs/ video graphs taken upon me by the investigator will be kept secret and not assessed by the person other than me or my legal hirer except for academic purposes.

The Doctor did inform me that though my participation is purely voluntary, based on information given by me, I can ask any clarification during the course of treatment / study related to diagnosis, procedure of treatment, result of treatment or prognosis. At the same time I have been informed that I can withdraw from my participation in this study at any time if I want or the investigator can terminate me from the study at any time from the study but not the procedure of treatment and follow-up unless I request to be discharged.

After understanding the nature of dissertation or research, diagnosis made, mode of treatment, I the undersigned Shri/Smt ____________________________ under my full conscious state of mind agree to participate in the said research/dissertation.

Signature of patient:

Signature of doctor:

Witness: 1.

2.

Date:

Place:

IEC/131/2019
22/11/2019

B.L.D.E. (DEEMED TO BE UNIVERSITY)

(Declared vide notification No. F.9-37/2007-U.3 (A) Dated. 29-2-2008 of the MHRD, Government of India under Section 3 of the UGC Act, 1956)

The Constituent College

SHRI. B. M. PATIL MEDICAL COLLEGE, HOSPITAL AND RESEARCH CENTRE

INSTITUTIONAL ETHICAL CLEARANCE CERTIFICATE

The ethical committee of this college met on 13-11-2019 at 3-15 pm to scrutinize the synopsis of Postgraduate students of this college from Ethical Clearance point of view. After scrutiny the following original/corrected and revised version synopsis of the Thesis has been accorded Ethical Clearance

Title: A prospective study of functional outcome of lumbar diseases treated with single level instrumented posterior lumbar inter body fusion

Name of PG student: Dr. Karthik M S. Department of Orthopaedics

Name of Guide/Co-investigator : Dr Dayanand.B.B, Associate Professor Department of Orthopaedics

DR RAGHVENDRA KULKARNI
CHAIRMAN
Institutional Ethical Committee
Medical College,BIJAPUR-586103

Following documents were placed before Ethical Committee for Scrutinization:

1. Copy of Synopsis / Research project
2. Copy of informed consent form
3. Any other relevant documents.

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MASTER CHART

MASTER CHART 1

S.NO	NAME	AGE	SEX	IP NO	TYPE	LEVEL	DISC TYPE	SPO_TYPE	CAN_STEN	PRE_ND	PRE-ODI	PRE_ODS	PRE_VAS
1	CHANDAWWA	69	F	32828	2	4	1		1	2	54	3	6
2	GOPAL	50	M	1298	1	3		1	2	2	74	4	7
3	SHANKAR	41	M	2671	1	5		2	2	2	68	4	7
4	MAHADEVAPPA	54	M	3502	1	4		1	2	2	52	3	5
5	GIRIMALLA	38	M	14655	2	4	2		2	1	84	5	9
6	SOHAM	42	M	6603	2	2	1		2	2	54	3	6
7	ZALEE NADAF	52	M	7508	1	4		1	2	2	48	3	7
8	RAHUL MATH	55	M	73222	1	3		1	1	2	66	4	6
9	SURESH SIDAPPA	63	M	73324	1	5		2	1	2	56	3	8
10	KAMALA	37	F	27397	2	5	1		1	1	70	4	7
11	PALLAVI	50	F	17075	2	4	1		1	1	74	4	7
12	YASEEN	38	M	32936	2	3	1		1	2	56	3	5
13	MALLAYYA	62	M	31842	2	4	1		1	2	58	3	6
14	KANTESH	61	M	8024	1	4		1	2	2	58	3	5
15	MALKAPPA	44	M	8064	2	3	1		1	2	54	3	6
16	ANIL KAMBAR	61	M	3296	2	3	1		1	1	64	4	7
17	UDAY	52	M	118266	2	4	1		1	1	52	3	8
18	RAMESH WALIKAR	62	M	153641	1	3	1	1	2	2	48	3	6
19	RATAN JOSHI	40	M	140420	1	4		2	2	2	58	3	5
20	PRAMOD	42	M	136629	1	4		2	2	2	72	4	7
21	MANJULA TIWARI	50	F	105291	1	4		1	2	2	56	3	6
22	LAXMAN	42	M	105299	1	5		1	2	2	52	3	5
23	DIVYA HORTI	53	F	79973	1	4		1	2	2	58	3	7
24	FAYAZ MULLA	43	M	29207	2	5	2		1	2	66	4	7
25	NARAYAN POTE	65	M	35974	2	4	2		1	2	64	4	6
26	ANJALI	45	F	7137	1	5		2	2	2	58	3	6
27	MAHADEVI	38	F	8717	2	5	1		2	2	56	3	7
28	VALUBAI CHAVAN	45	F	12598	1	5	1	1	2	2	68	4	8
29	MALLANNA	60	M	8196	2	4	1		1	1	66	4	7
30	HUSSAINBI	70	F	2419	1	4		2	2	2	62	4	6

MASTER CHART 2

S.NO	B_LOSS	O_TIME	PO_INF	PO_ND	PO_ODI	PO_ODS	PO_VAS	DUR_INJ	IMP_FAILURE	CAG_RET	UNION
1	160	3.5	2	2	0	1	0	2	2	2	1
2	200	3.8	2	2	6	1	3	2	2	2	1
3	240	3.3	1	2	8	1	0	2	2	2	1
4	150	3.5	2	2	8	1	0	2	2	2	2
5	280	4	2	1	24	2	3	2	2	2	2
6	300	3.3	2	2	0	1	0	2	2	2	1
7	240	3.5	2	2	4	1	0	2	2	2	1
8	220	3.8	2	2	10	1	0	2	2	2	1
9	260	3.5	2	2	6	1	0	2	2	2	2
10	150	3	2	2	10	1	2	2	2	2	1
11	160	3.3	2	2	8	1	0	2	2	2	2
12	280	4	2	2	16	1	0	2	2	2	1
13	320	3.5	2	1	12	1	2	2	2	2	1
14	260	3.8	2	2	12	1	0	2	2	2	2
15	160	3	2	2	6	1	0	2	2	2	1
16	260	3.3	2	2	0	1	0	2	2	2	1
17	200	4	2	2	4	1	0	2	2	2	2
18	320	3.8	2	2	0	1	0	2	2	2	1
19	220	3.5	2	2	8	1	1	2	2	2	1
20	300	3.5	2	2	0	1	0	2	2	2	1
21	260	3	2	2	8	1	0	1	2	2	1
22	180	4	2	2	0	1	0	2	2	2	1
23	160	3.3	2	2	12	1	2	2	2	2	1
24	280	3.5	2	2	0	1	0	2	2	2	1
25	260	3.8	2	2	0	1	0	2	2	2	2
26	300	3.5	2	2	8	1	0	2	2	2	1
27	240	3.5	2	2	12	1	0	2	2	2	2
28	260	3	2	2	2	1	1	2	2	2	1
29	220	3.8	2	2	0	1	0	2	2	2	1
30	280	3.3	2	2	14	1	0	2	2	2	1

LEGEND

Sex	1.male
	2.female
Type	1.listhesis
	2. disc bulge
Level	1. L1-L2
	2. L2-L3
	3. L3-L4
	4. L4-L5
	5. L5-S1
Disc type	1. Bulge
	2. Protrusion
	3. Extrusion
	4. Sequestration

Spo type (Spondylolisthetic type)-	1.Meyerding type 1
	2. Meyerding type 2
	3. Meyerding type 3
	4. Meyerding type 4
Can Sten (Canal stenosis)	1. Yes
	2. No
Pre ND (Preop Neurological deficit)	1. Yes
	2. No Pre

ODI (Preop Oswestry Disability Index)- in percentage

Pre ODS (Preop Oswestry Disability Score)	1. Minimal disability (0-20%)

2. Moderate disability (20-40%

3. Severe disability (40-60%)

4. Crippled (60-80%)

5. Bed bound(80-100%)

Pre VAS (Pre op Visual Analogue Scale) 0 1 2 3 4 5 6 7 8 9 10

B Loss- Intra op blood loss-in ml

O Time (Operating time)- in Hours

PO Inf (Post op infection) 1. Yes

2. No

PO Pain (Post op pain) 1. Yes

2.No

PO ND (Post op Neurological deficit) 1.Yes

2. No

PO ODI (Post op Oswestry Disability Index) in percentage

PO ODS (Post op Oswestry Disability Score)

1. Minimal disability(0-20%)

2. Moderate disability(20-40%)

3. Severe disability(40-60%)

4. Crippled (60-80%)

5.Bed bound(80-100%)

Pre op Visual Analogue Scale(VAS) 0 1 2 3 4 5 6 7 8 9 10

Dur Inj (Dural injury) 1. Yes

2. No

Imp Fail (Implant failure) 1. Yes

2. No

Cag Ret (Cage retropulsion) 1. Yes

2. No

Union (radiological) 1. Yes

2. No

Visual analog scale (VAS) is a psychometric response scale for pain. The patient is asked to indicate his degree of pain in the instrument.