A PROSPECTIVE STUDY OF

'SHORT TERM CLINICAL AND RADIOLOGICAL ANALYSIS OF LUMBAR INTERBODY FUSION FOR DEGENERATIVE DISC DISEASE AND SPONDYLOLISTHESIS'

Dissertation submitted to

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CERTIFICATE

This is to certify that this dissertation entitled is a record of bonafide research work done by **Dr.RAKESH.S,** Postgraduate student under my guidance and supervision in fulfilment of regulations of The Tamilnadu Dr. M.G.R. Medical University for the award of M.S. Degree Branch II (Orthopaedic Surgery) during the academic period from 2011 to 2014, in the Department of Orthopaedics, Govt. Royapettah Hospital & Govt. Kilpauk Medical College, Kilpauk, Chennai-600010

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DECLARATION

I, **Dr. RAKESH.S**, solemnly declare that the dissertation, **'SHORT TERM CLINICAL AND RADIOLOGICAL ANALYSIS OF LUMBAR INTERBODY FUSION FOR DEGENERATIVE DISC DISEASE AND SPONDYLOLISTHESIS'** is a bonafide work done by me in the Department of Orthopaedics, Govt. Kilpauk Medical College, Chennai under the guidance of **Prof.S.Anbazhagan, M.S.Ortho, D.Ortho., DNB Ortho.,** Professor of Orthopaedic Surgery, Govt. Royapettah Hospital, Kilpauk Medical College, Chennai-600010.

This dissertation is submitted to "**THE TAMILNADU DR. M.G.R MEDICAL UNIVERSITY**", towards partial fulfilment of regulations for the award of M.S.DEGREE BRANCH II (Orthopaedic Surgery).

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TITLE

A prospective study of 'short term clinical and radiological analysis of lumbar interbody fusion for degenerative disc disease and spondylolisthesis'

AIM OF THE STUDY:

To study the pattern and morphology of degenerative disc disease and spondylolisthesis and outcome of lumbar interbody fusion in the selected group of patients fulfilling the criteria

MATERIALS AND METHODS

The study was conducted in 30 consecutive patients with degenerative disc disease or isthmic or degenerative spondylolisthesis who came to the out patient department of Government Royapettah Hospital, Chennai.

The Study is Prospective study from May 2011- October 2013. 14 months follow up was done in each case. The percentage of radiological union was found to be 63.3%.

RESULTS

The mean operating time, from the surgical incision to wound closure, was 3.5 hours. The mean blood loss was 237ml. The post op pain relief was drastic and significant as evidenced by the improvement in the postop VAS score at 14^{th} month as indicated by a "p value" $< 0.000\ 1$. Improvement in quality of life, as assessment, based on the T-Test comparing pre and postop 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 black degenerated disc if associated with disc space narrowing, or a case of spondylolisthesis, not responding to conservative methods are indications for PLIF.

We would suggest PLIF technique supplemented with bone grafting as an ideal technique in spondylolisthesis and degenerative disc disease in view of results and low complication rate.

INTRODUCTION

Back pain results in more loss of productivity than any other medical condition,[1,2] and it is the second most common symptom necessitating a person to approach a physician. Approximately 80% of population in the United States are reported to have suffered low back pain at some point in their lives.[3,4] There is little consensus even on the measurement of treatment success.

Lumbar arthrodesis remains a commonly practiced operative procedure for the management of low-back pain. The indications, techniques, and results have many controversies and lack clarity even now.[5] The procedure of spinal fusion for the management of back pain is on the rise in the developed nations. Along with the procedure, the criticism of the same and the study of available information on its outcomes are on the rise. The basis of spinal arthrodesis is fusion to treat painful joints, as in any part of the body. In the initial phase, spinal fusion was performed for the management of infectious conditions, deformity, and trauma of the spine. The successful experiences and advances in technology (imaging, surgical procedures, implants), made it possible to extend the application of spinal fusion in the surgical management of unstable motion between adjacent vertebrae or pain arising from the degenerated intervertebral disc.

The key to success in spinal arthrodesis is that, it should be attempted only after a specific pathoanatomical diagnosis can be attributed for the patient's symptoms. Once the abnormal spinal motion can be prevented or

the degenerated intervertebral disc is removed, lumbar spinal arthrodesis can decrease or make a stop to the pain.

A proper identification of the etiopathogenesis, diagnosis, and natural history of low-back pain and its management (both non operative and operative) should assist the surgeon in selecting the appropriate treatment for the patient.

AIM OF THE STUDY

To study the pattern and morphology of degenerative disc disease and spondylolisthesis and outcome of lumbar interbody fusion in the selected group of patients fulfilling the criteria

ANATOMY OF VERTEBRAE

The vertebral column

On an average the spinal column measures about 72 cm in males, whereas it is 7 to 10 cm less in females. The parts of a typical vertebra are an anterior body and a posterior arch which enclose the vertebral canal (Fig.1,2). The neural arch is constituted of two pedicles on lateral aspect and two laminae on the posterior aspect which unite to form the spinous process.[6]

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.

The facet joints

The synovial joints formed between the superior articular process of one vertebra and inferior articular processes immediately inferior to it are called the zygapophyseal joints or facet joints. The joint surfaces have an articular cartilage lining, a synovial membrane covering, and a joint capsule which encloses them. These joints are innervated by branches of the posterior primary rami.

Intervertebral disc:

These are considered the largest avascular structures in the human body and derive nutrition from a network of blood vessels of the end plate in the form of diffusion. These are present between two adjacent 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.3). The junctional zone, where annulus merges with nucleus has no strict demarcation. The nucleus pulposus is a remnant of notocord.

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.[7] The percentage of fibrocartilage compared to hyaline cartilage increases with advancing age.

Upto the 3 rd decade, 90% of pulposus is water, and in the next 4 decades 60 % of it is water. The proteoglycan content determines the hydration. Of its dry weight, the proteoglycan part is constituted by 65% and the collagen part 15% to 20%. The annulus fibrosus is made of twelve lamellae, which are concentrically arranged. The ability of spine disc to withstand multidirectional strain is due to alternating pattern of collagen fibers in the successive lamellae.

The annulus forms 1/3 of surface area of disc with 65% water. It consists of outer type 1 collagen and inner type 2 collagen. Of its dry weight, the collagen part constitutes 50% to 60% and the proteoglycan part 20%. As age increases, the proportions of proteoglycan and water decrease.

The Spinal Cord and Nerves

The spinal cord terminates as a bulbous part, the conus medullaris at the level of L1 vertebra in adults. Filum terminale is the fibrous band which attaches the conus to the dorsum of the first coccygeal segment. There are three protective membranes enclosing the spinal cord. These are the dura, arachnoid, and pia mater from outside in. The subarachnoid space separates the pia and arachnoid membranes and contains the cerebrospinal fluid.

Both anterior and posterior spinal nerve roots exit through the intervertebral foramen at each vertebral level and join at the outer border of foramen to form the spinal nerve. Before the dorsal root joins its ventral counterpart, there is a ganglion formed at the outer region of the foramen, known as the dorsal root ganglion, and if manipulated, cause a dysesthetic pain response.

Spinal nerves C2-7 passes above their corresponding pedicles. The C8 roots pass through the foramen between the C7 pedicle and that of T1. The rest of the nerve roots caudal to C8 pass through the foramen below their corresponding

pedicles. Compared to the vertebral column, the spinal cord is shorter. Hence, on progressing caudally, the spinal nerves pass more vertical.

The Lumbar Pedicles

A thorough knowledge of pedicle dimensions and angles is important when using the pedicle as a screw purchase site. Zindrick et al., Saillant, and others have studied pedicle dimensions.[8] These studies have provided knowledge about the pedicle morphological characteristics and about the depth to which screws can be inserted safely into the thoracolumbar spine. From the study of pedicles from T1 to L5, in the horizontal plane the widest pedicle was that of L5, and T5 had the narrowest pedicle. In the sagittal plane, T11 had the widest pedicles, and T1 had the narrowest pedicle. Compared to the horizontal plane, the width at the sagittal plane was more due to the oval shaped pedicle. Horizontal plane had the maximum pedicle angle at L5. The pedicle angle at L5 is caudad whereas at L3-T1, it is cephalad in the sagittal plane. Along the axis of pedicle, the depth to the anterior cortex was more than that of any line, which is parallel to the midline of the body of the vertebra. The exception found was that at T12 and L1.

Figure 1

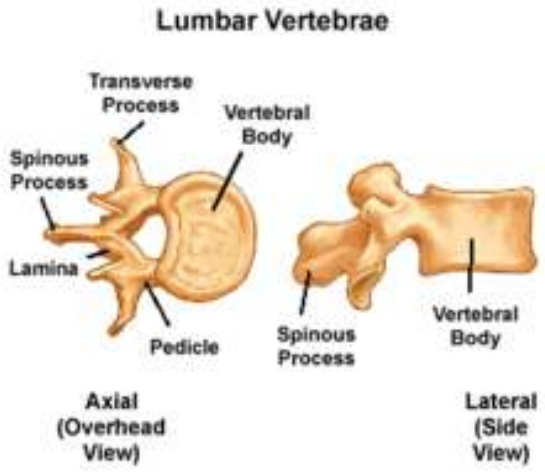


Figure 2

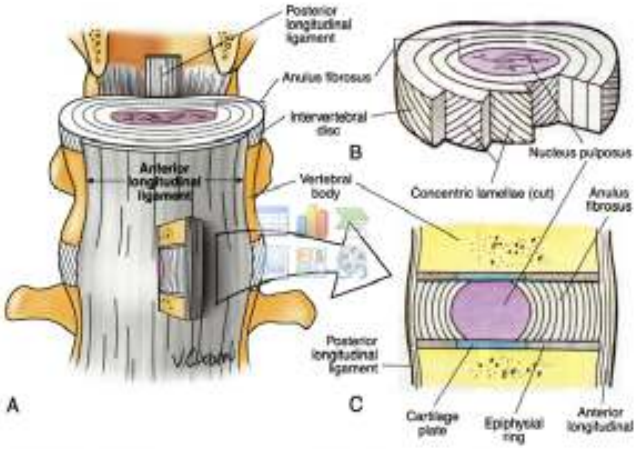


Figure 3 A- spine as seen from anterior aspect of anterior longitudinal ligament.

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

DEGENERATIVE DISC DISEASE

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

Stability of spine

It is provided by dynamic and static stabilizers. Dynamic stabilizers include muscles, ligaments and posture . Static include bony articulations and IV discs. The basic functional unit of the spine is the motion segment, which comprises the two adjacent vertebrae and the intervertebral disc.

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.[9,10] Annulus fibrosis tear is considered as one of most common cause for pain in the low-back axially. Pain production has relation to production of neuropeptides. Severely degenerated lumbar discs are extensively innervated than normal discs. During degeneration of the disc, there will be tear in the annulus fibrosus, which may stimulate these pain pathways. In those patients with degenerative disc disease, cartilage end-plates are considered to obtain more supply of sensory nerves and neuropeptides.

Irritation of the duramater by inflammatory substances causes extensive back pain. Irritation of nerve roots causes sciatica of lower limb.

When there is nerve root compression, lower motor neuron lesion can occur, with weakness, sensory disturbances and diminished reflexes of lower limb.

Typical symptomatology were reproduced by stimulation of annulus fibrosus of the posterior disc, on table, in about 66% of patients with intractable lower back.[11] The vertebral end plate stimulation produced pain in 61 percent of patients. Pain in the lower extremities was produced by application of stretch or pressure to the nerve root. When annulus fibrosus and nerve root were stimulated at the same time, pain was produced in the buttocks. As in many studies, the pain is often described as "lumbar segmental instability" [12,13]when it is due to degenerative disc disease,[14] or facet joint syndrome [14,15] even when no other features of abnormal motion or spondylolisthesis can be identified.[16] So many reports are available which show that continuing pain after successful discectomy can be relieved by complete disc excision with intervertebral body arthrodesis. [5]

KIRKALDY-WILLIS STAGES OF DISC DEGENERATION [17]

It is divided into 3 stages

- Dysfunction
- Instability
- Stabilization

Surgical treatment can be beneficial if an instability or deformity is corrected, if it provides relief to neural compression, or gives a positive answer to a combination of these case scenarios (6).

Stage of dysfunction

It usually occurs in the age group 15 to 45 years. Repeated micro trauma to disc causes circumferential annular tears in it, which leads to end plate destruction. Radial tears are formed by coalescence of the annular tears. Progressive migration of the nucleus pulposus to the periphery of the annulus occur, but will be contained within the posterior longitudinal ligament. Later the annulus fails, leading to disc herniation.

Stage of instability

This stage is found in the age group 35 to 70 years and is characterized by increased facet joint motion which leads to decreased resistance to joint forces. There will be internal disc disruption and disc resorption, degeneration of facet joint with capsular laxity, leading to subluxation and joint erosion. Loss of disc height causes narrowing of neural foramen. Exposed disc material in the epidural space, causes inflammatory response, leading to nerve ischemia.

Stage of stabilization

The final stage shows its entry in patients aged more than 60 years. There will be gradual formation of hypertrophic bone surrounding the disc and zygapophyseal joints, leading to stiffness and ankylosis segmentally. Facet joint bears more weight in response to degeneration of anterior column and causes fixed deformity. Stenosis of the spinal canal in degenerative arthritis occurs as a result of hypertrophic bone formation, which compromises the spinal nerve.

Pathology

Function of the disc can be disrupted in 2 ways: alteration of the water content or wear and tear in the annulus. These lead to decrease in disc space, bulging of annulus, proliferation of collagen, calcification and finally osteophyte formation.

Biochemical aspects of disc degeneration - Naylor (1970) [18]

There will be a decrease in GAG and increase in LMW glycoprotein. Fibrillation /fissuring and precipitation of collagen occur. Unequal stress in presence of these changes leads to increased intradiscal pressure causing protrusion and prolapse.

Pathological staging of disc herniation

(Eismont & Currier -1989) (fig-4)

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 4b)

Central

Paramedian

Lateral

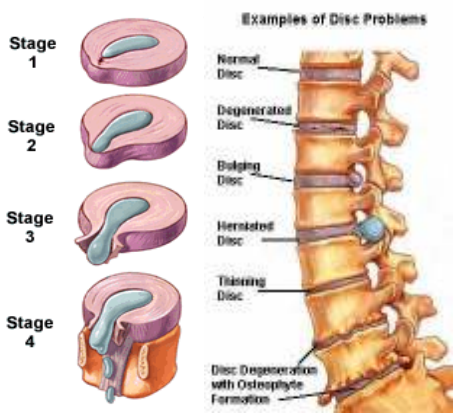


Figure 4a

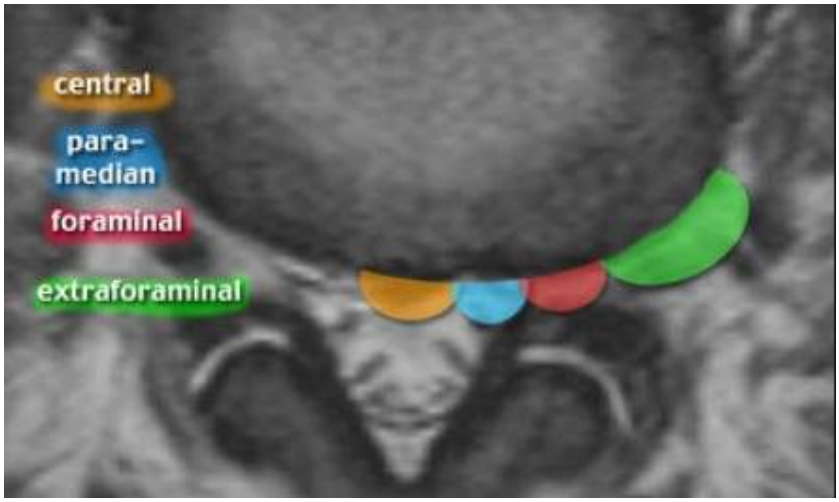


Figure 4b

INVESTIGATIONS

X-ray

Anteroposterior and lateral X rays of the affected spinal region have to be taken. In early stages, there will be absence of normal lordosis of the lumbar region by spasm of paraspinal muscles. As the stage progresses, disc space narrowing and osteophyte formation will be present.

Myelography

It shows all regions of the spine for any variation and defines intraspinal lesions. It is not necessary if a fruitful diagnosis has been reached clinically and MRI or CT reveals the problem. It's worth can be raised by using postmyelography CT in evaluating spinal stenosis

Magnetic Resonance Imaging

It is presently the standard for advanced spinal imaging and gives better details of the disc and neural elements. It can show the details of the nerve root 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. [19]

Computed Tomography

The reformatted imaging shows a three dimensional view of the spine. Greatest advantage of this is the possibility to see inside the dural sac and sleeves of the root. Cause of foraminal stenosis can be diagnosed and attributed to a bony cause or disc problem.

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. [20]

Operations done

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

- Laser discectomy
- Interbody fusion [5]

Usage of interbody cages is limited to those with postlaminectomy syndrome or collapse of the disc-space with narrowing of the neuralforamen.[21] Continued loading post discectomy does not ensure a long term success. The success lies in disc excision, followed by interbody fusion.

SPONDYLOLISTHESIS

DEFINITION

It is the anterior or posterior slipping of one segment of the vertebra over the next lower segment. It was first described by Herbiniaux (1782).The term was coined by Kilian (1854) (Spondylos means vertebra, Olisthesis means to slip). It is seen in about 5% of the general population.

Bony Hook

It prevents the slippage of one vertebra over the other. It is comprised of pedicle, pars-inter articularis, facet (fig-5).

CLASSIFICATION:

Wiltse,Newman and Macnab. (in the year 1975) [22]

Marchetti and Bartolozzi. (in the year 1986) [23]

Wiltse and Rothman. (in the year 1989) [24]

Wiltse, Newman & Macnab's Classification - 5types.

Type 1 – Dysplastic

Type 11 - Isthmic

Type 111 - Degenerative

Type 1V -Traumatic

Type V - Pathological

Type 1 - Dysplasic

Occur in Congenital abnormalities.

No pars-inter articularis defect is seen (fig-6).

Type 11 – Isthmic

Due to defect in pars-inter articularis. It is of 3 types:

1- Lytic- stress fracture of pars (fig-7)

2- Intact but elongated pars (fig-8)

3- An acute pars fracture (fig-9)

Type 111– Degenerative

It is due to long duration inter-segmental instability .remodelling

Type 1V – Traumatic

It is due to fracture in the bony hook except that of pars.

Type V – Pathological

It is due to generalized or localized disease affecting the bone.

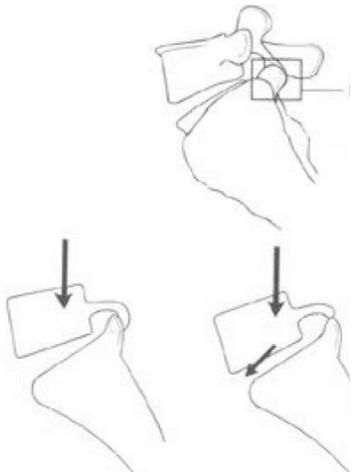
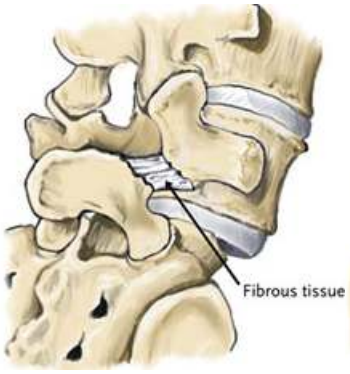
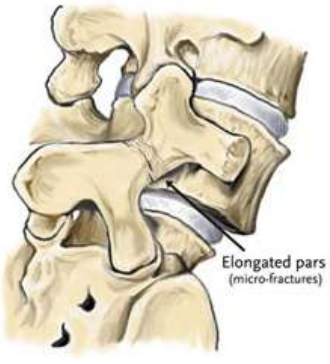


Figure 5 The contents in the box indicates the bony hook

Figure 6





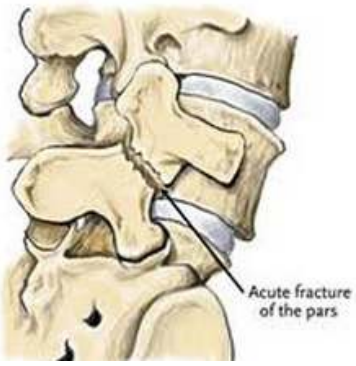


Figure 7 Figure 8 Figure 9

Wiltse and Rothman Classification

Type I-Congenital

Type II-Isthmic

Type III-Degenerative

Type IV-Traumatic

Type V-Pathological

Type VI-Post surgical

Marchetti and Bartolozzi Classification

Developmental

Acquired

Developmental: It is of two types:

High Dysplastic- 2 types: with Lysis or with Elongation.

Low Dysplastic- 2 types: with Lysis or with Elongation.

Acquired

1. Traumatic – due to Acute or Stress fracture.
2. Post Surgery- due to Direct or Indirect Surgery.
3. Pathological- due to Local or Systemic pathology.
4. Degenerative- due to Primary or Secondary.

Developmental

The birth of the child will be with a dysplastic bony hook. Hence, there will be increased 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 .[25]

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. [26]

Hormonal: It is uncertain whether advancement of slippage of the vertebra, which occurs during adolescence, is due to the influence of hormones.

Clinical findings

Usually the condition is asymptomatic in children, in whom it may present as a deformity of posture or abnormality of gait. Pain is the most common symptom. It is a dull aching type of pain which begins with adolescent growth spurts, worsens by high activities or competitive sports and gets relieved by limitation of activities and rest.

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.

A palpable prominence at the lumbosacral junction is found in higher grade listhesis, where the 5^{th} lumbar vertebra translates, then rotates

anteroinferiorly over 1st sacral vertebra, leading to kyphosis. This in turn proceeds to formation of compensatory lumbar hyperlordosis with manifestation of shortening of the trunk.

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.In children, 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:[27]

(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 [28,29] - 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 .30
- 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

1. Reverse Nepolian Hat Sign- In severe spondylolisthesis or Grade 5 Spondyloloptosis, slipped L5 viewed end-on through sacrum in AP X ray (fig-10).
2. Spondylosis- unilateral wedging of vertebral body, sclerosis of pars and lamina.

Anterior displacement was measured by:

Meyerding – 1932.

Laurent and Emole – 1961.

Lorenz and bubo– 1982.

Taillards – 1983.

Boxall – 1979.

LATERAL VIEW

Meyerdings grading [31]

The slip grade is calculated. It is the ratio between the anteroposterior diameter of top of sacral vertebra and the distance the L5 has slipped anteriorly (percentage of translation of the upper vertebral body over the lower one). (figure-11 a,b)

Grade I – 25% or less

Grade II – 25 – 50%

Grade III – 50% - 75%

Grade IV > 75%

Grade V – spondyloptosis

Dewald modification of Newman [32]

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-12)

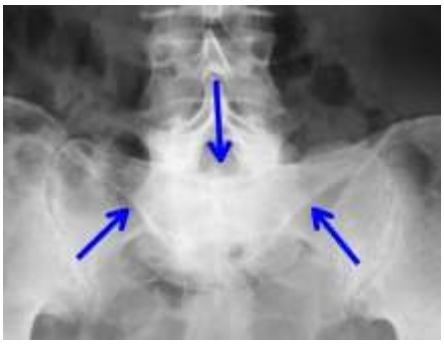


Figure 10 Show Reverse Nepolian Hat Sign

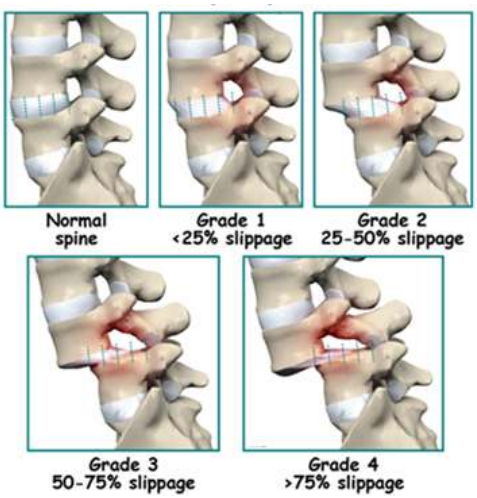


Figure 11a

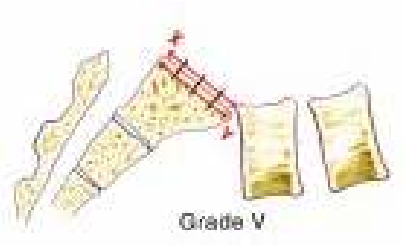


Figure 11b

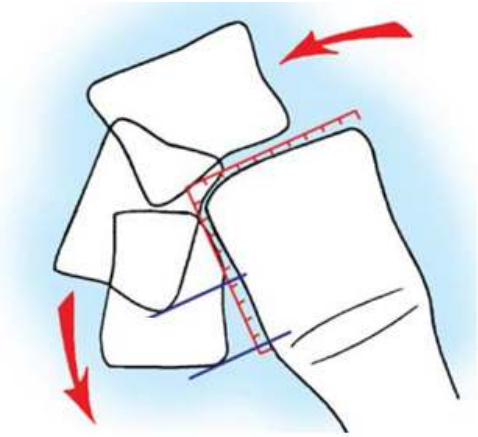


Figure 12

Slip angle

It is the angle subtended by the intersection of a line drawn parallel to the inferior aspect of L5 vertebra and a line drawn perpendicular to the posterior aspect of body of S1 vertebra (fig-13).

Normally, the angle formed measures zero. It is the best predictor of potential instability and also helps in the prognostication of slip progression. If the slip angle is above 55 degree, deformity progression will occur even after arthrodesis of the segment.

Sacral inclination/ tilt

It denotes the position of sacrum to the vertical plain. It is calculated as the angle formed by the intersection of a line drawn along the posterior border of S1 and the true vertical line (perpendicular line to the floor) (fig-14). Normally the angle is >30degree and is decreased in higher slips where sacrum becomes more vertical.

Sagittal rotation / roll

It denotes the angular relation between sacrum and L5 vertebra. It is measured by the angle subtended between the line extending along the anterior border of L5 vertebral body and the line drawn along the post border of S1 vertebra (fig-15).

Figure 13 Slip angle

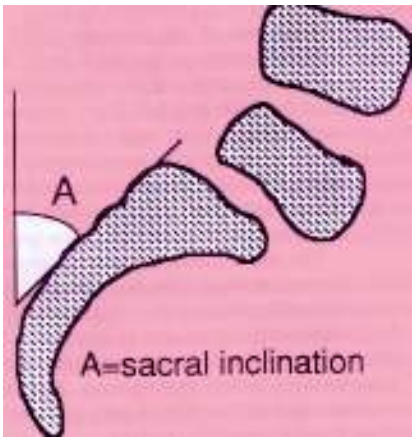


Figure 14 sacral inclination

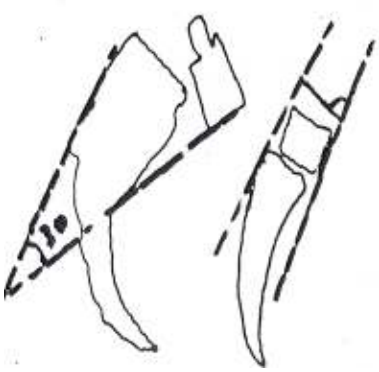


Figure 15 sacral rotation

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

1. Dysplastic listhesis
2. Dome shaped, vertical sacrum
3. Trapezoid shape L5 body
4. >50% slip, i.e Grade 111 & 1V
5. Increase in slip angle
6. 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

It is useful for correlating preoperatively with Magnetic Resonance Imaging in those with features of radicular affection and MRI showing multiple foci of pathology or persistent radiculopathy when MRI findings are within normal limit, or when there are contraindications for MRI

TECH-PYROPHOSPHATE BONE SCAN

It distinguishes between an acute pars fracture and lysis.

In acute injury, bone scan will be positive and X ray negative.

With the help of the scan, a decision can be made whether to immobilise or not.

Positive scan and negative X-ray indicate recent injury. Negative scan and positive X-ray indicate old injury.

Scan is not recommended for patients with symptoms >1yr or who are asymptomatic.

SPECT BONE SCAN

It is very sensitive and can show the presence of stress reaction stage, even prior to the occurrence of fracture. If the scan reveals an increased uptake in pars, a CT scan can be taken to differentiate between the thickened cortices indicative of a stress reaction and an acute stress fracture.

Treatment of Acquired Spondylolysis [33,34]

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

If SPECT scan shows metabolic activity and the CT scan shows pars thickening, avoid activities which aggravate the condition and core strengthening exercise.

Once SPECT scan shows metabolic activity and CT scan shows an acute stress fracture, an orthotic trial is indicated for three months.

Long duration spondylolysis

Non Operative is the usual treatment.

Restriction of vigorous activities and strengthening exercises of the back, abdomen, and core are advised.

If severities of the symptoms are more, a short period of bed rest or immobilization with brace may be advised.

A close watch for the development of spondylolisthesis is made with yearly standing spot lateral radiographs of LS region.

Asymptomatic patients need no activity limitation or avoidance of contact sports.

When there is failure of conservative measures and in those patients, in whom other etiology of back pain have been ruled out, operative treatment may be needed.

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 [35]

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 [36]

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 [37]

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-16).

Figure 11

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) [38]

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

Non operative treatment will suffice in majority. Surgery is not always indicated. Activity restriction, rehabilitation of the muscles of spine, abdomen and trunk), and intermittent usage of rigid back brace, anti-inflammatory medications, and in some patients, epidural steroid doses may be sufficient if minimal symptoms and mild slippage are present.

Activity restrictions are not necessary if mild degrees of listhesis are present. If slip is more than 25% but less than 50%, Wiltse et al. recommended avoiding contact sports and those activities that can lead to back injury. Till the completion of growth, standing spot lateral X rays of the LS region are to be taken every 6 to 12 months.

Bracing [39]

It is advocated by a few using externally applied brace for evaluating the possible effectiveness of the spinal arthrodesis if planned in future. But, its predictability is controversial.

In a study by Moller and Hedlund, it is highlighted that the result of management of isthmic spondylolisthesis in an adult with symptoms, which was not responding to conservative line (exercise program), was better with insitu posterolateral fusion [40].

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 [41]

- 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 treatments for spinal disorder. Neural arches are fused, which is induced by overlapping many small osseous flaps from lamina, spinous processes, and articular facets. Relief of symptoms is seen in 60-100% patients. Solid fusion is seen only in 40-85%.

Posterolateral fusion

Decortication of posterolateral spinal elements (transverse processes, lateral region of superior articular facet, and sacral ala) is done and autologous bone graft is placed. It is performed in children and adolescents, for listhesis grade 2 or less, where conservative treatment fails. Instrumentation in these patients with pedicle screws avoids the need for postoperative immobilization.

It is more effective than posterior fusion. According to Watkins, the facets, pars interarticularis, and bases of the transverse processes are fused using small chip grafts, and a larger bone graft is kept posteriorly on the transverse processes. Reduction of symptoms is seen in 70-100%. Solid fusion is seen in 50-100%. Progression of listhesis is prevented after fusion.

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 is started immediately post op, after the spine is supported with a single pantaloon brace and, confirming the stability of fixation. The brace is to be discontinued once the fusion is solid enough (normally 3 to 4 months postoperatively).

Anterior Lumbar Interbody Fusion (ALIF)

This procedure may be executed solitary or with supporting posterior instrumentation. In this technique, the spine is approached from the anterior aspect through a retroperitoneal approach. All lumbar vertebrae from L1 to sacrum can be approached.

Advantages

- Gives more wide access to the disc space and hence can accomplish complete discectomy, placement of optimal-sized devices is possible [42], 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. [43,44,45]

A study by Kim et al brought to light that an interbody fusion through anterior approach rectifies the abnormal position of the lumbar spine, regains disc height and relieves compression on nerve due to canal stenosis and foraminal narrowing [46].

Lumbar Interbody Fusion from posterior aspect

This procedure stays clear of the possible complications which can happen with the anterior approach. The biomechanical advantage of LIF is that the compression forces in the lumbar spine passes anteriorly through the disc space. First devised for the surgical management of tuberculosis, lumbar interbody arthrodesis by an approach posteriorly was published by Jaslow in 1946 and popularized by Cloward in 1945 to treat axial lumbar pain.

The high rate of pseudoarthrosis and graft dislodgement initially reduced its popularity. The forward leap in instrumentation and technique of lumbar interbody fusion has brought a widespread use of the procedure and interbody fusion cages.

Posterior lumbar interbody fusion (PLIF) and transforaminal lumbar interbody fusion (TLIF) make use of a posterior approach. Interbody fusion technique means the removal of the disc and replacing it using a spacer (bone graft or mechanical spacer).

Indirect nerve root decompression is obtained by restoring the height of intervertebral disc space, and hence reversing the vertical descent of vertebra above that narrows the neural foramen. [47,48]

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)

In the traditional PLIF technique, two bone graft spacers are placed, one on each side of the interbody space after gently retracting the nerve root and neurologic structures. [49] Facet joints are kept intact or trimmed. Recently single spacer is also used. Fusion and clinical success rates are not lowered by the use of a unilateral interbody cage rather than the standard two cages. [50]

Transforaminal Lumbar Interbody Fusion (TLIF)

It was described by Harms. The facet joint on one side is removed, and without retraction of the spinal nerves, single bone graft spacer is kept in the middle of the interbody space. [50]As no neural retraction is done, TLIF can be performed at higher lumbar levels. The chance of significant blood loss, duration of hospital stay, and operative time are almost the same for PLIF and TLIF, but complications are comparatively less for TLIF than PLIF. [51]

Circumferential Fusion

Here, separate anterior and posterior incisions are made to approach the spine. Technically, it is a demanding procedure and associated with high rate of complications. Hence, it is indicated in patients with marked spinal instability or significant anterior bone loss. In case of degenerative disease, this is indicated only in those patients with severe disability and also with previous multiple failed back surgeries.

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 . [52]

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 – Cast Reduction.

Posterior Distraction Instrumentation.

Anteroposterior Resection-reduction.

Vertebrectomy.

Pedicle Fixation.

Posterior Levered Reduction.

Traction Cast Reduction Techniques

The first described reduction method was by Jenkins. Application of cast was done several days after surgery. The patient was placed in cervical pelvic traction on Risser table. Reduction was by hyperextension of lower extremities combined with anterior translation of sacrum, usually by a posteriorly placed anteriorly directed force.

Vertebrectomy

This is a procedure done for the surgical management of spondyloptosis, and was described by Gaines & Nicholas for the first time. Here L5 vertebra resection was done, which led to shortening of spine. L5 vertebral body was removed by anterior resection, followed by the removal of posterior elements of L5 from posterior aspect with reduction of slip with Harringtons instrumentation. Fusion of L4 to sacrum was done. Spica cast immobilisation of the segment was given 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 allows permanent reduction and stabilisation of high grade listhesis, only in conjunction with combined interbody and posterolateral fusion. The

patients, in whom pedicle-screw instrumentation had been used, attained better fusion than those without instrumentation .[53]

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

It was introduced by Edward. It achieves full correction of deformity with less surgery & morbidity. It is based on 4 concepts:

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 Recomendations

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

It was in 1970 that Roy-Camille, guided by Judet, described the use of posterior plates with screws, which were positioned sagittally through the pedicles and articular processes, for the first time in history. In 1967, in the United States, transpedicular screw fixation was described by Harrington and Tullos for the first time.

High-quality antero-posterior and lateral radiographs of the lumbar spine and axial CT scanning are used for the assessment of individual spinal anatomy during preoperative planning. Coaxial fluoroscopy images are useful to assess the anatomy ofpedicle.

The three techniques for pedicle localization are as follows : [54,55]

(1) **The intersection technique**

It is the most commonly used method. A line is dropped from the lateral aspect of the facet joint, that intersects a line which bisects the transverse process, at a spot over the pedicle. (fig-17a)

(2) **The pars interarticularis technique**

The part of bone where the pedicle meets lamina is known as the pars interarticularis. In lumbar spine, the entry point is at the midpoint of the transverse process and 2 mm lateral to the pars interarticularis. [56]

(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.17b)

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

Preoperative CT scanning of the pedicle and intraoperative x-rays are used to determine the direction of drilling.

Roy-Camille, Saillant, and Mazel and Louis identified and described the locations for screw insertion . The most important reference points are the middle of the transverse process and the respective facet joint space. With a hand-held curet or drill, an opening is made in the pedicle. The self-tapping screw is passed through the pedicle into the vertebral body. Dural sac lies medial to the medial wall of the pedicle. The nerve root lies inferior to the medial wall of the pedicle.

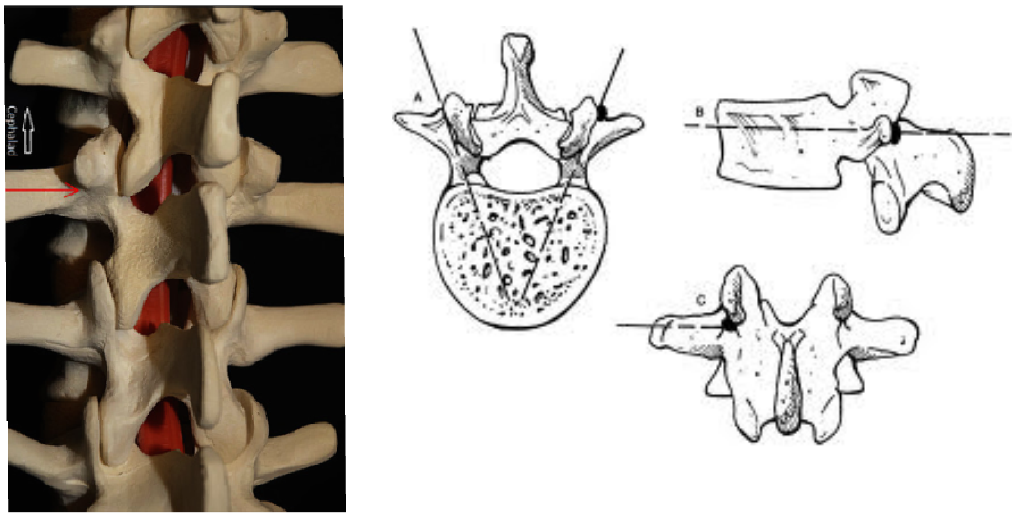


Figure 17a shows pedicle entry site by the intersection technique

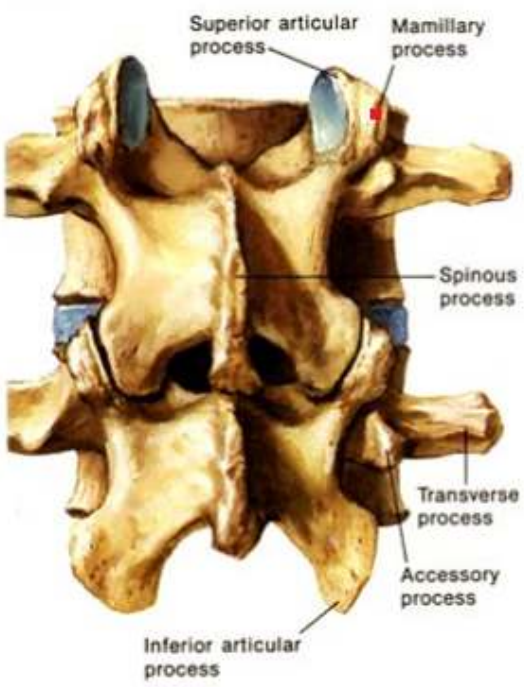


Figure 17b shows pedicle entry site through mamillary process

MATERIALS AND METHODS

Study Subjects : 30 consecutive patients with degenerative disc disease or isthmic or degenerative spondylolisthesis who came to the out patient department of Government Royapettah Hospital Chennai.

Type of Study : Prospective study

Duration Of Study : May 2011- October 2013. 14 months follow up was done in each case.

Inclusion Criteria :

- Degenerative disc disease or spondylolisthesis(grade 1 or 2)
- Severe intractable low back pain
- Absence of systemic infection
- No previous arthrodesis at target level
- Both male and female patients
- Adult patients

Exclusion Criteria :

- Pediatric age-skeletally immature
- Mentally unstable patients
- Paraplegias

Procedure

A complete primary survey was carried out to identify the neurological deficits. The level of the pathology was confirmed with X-rays and MRI scans. Further necessary investigations such as complete hemogram, blood sugar etc was done.

The patients were explained about the need for surgery, and its importance, and complications in detail. The pro forma 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 and CT scan 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 4 weeks, 12 weeks, 24 weeks 12 months and 14 months using postoperative Visual Analogue scale & Oswestry Disability Index and Scores, X rays and CT scan.

DESCRIPTION OF POSTERIOR LUMBAR INTERBODY FUSION SURGERY

Anesthesia:

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

Position:

Patient is catheterized and changed to prone position, on Halls frame placed on an operating radiolucent table .Pressure points are well padded. (fig.18)

Incision and procedure:

The surgical area is cleansed and sterile drapes are placed. A three-inch to six-inch long midline incision is made on the back, over the affected site. 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.19) Then, image intensifier confirms the spinal level for surgery.

Pedicle screw insertion:

Pedicle entry was made under fluoroscopic guidance. All walls were probed for integrity. Pedicle screws (Titanium) were inserted in the upper and lower vertebral bodies. (fig.20,21)

Decompression:

Laminectomy is done. After visualizing the nerve roots (fig.22),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.23.24)

Cage placement:

The disc space is distracted for restoration of the normal disc height, and also for determination of the appropriate size spacer to be placed. (fig.25) The cage is packed with morcellised compacted bone (local autograft). (fig.26)The next step is insertion of locally taken bone graft in the anterior aspect of intervertebral space, (fig.27) followed by an interbody cage with bone graft inside, into the disc space. (fig.28) (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) .[50] Two small metal rods are put, connecting the ipsilateral screws. The two vertebral bodies are compressed for good contact of cage with bone. (fig.29)Two small metal rods are put, connecting the ipsilateral screws. The correct placement of the spacer is confirmed using x-rays. (fig.30,31)

Closure:

The wound area is thoroughly washed with saline. The deep fascial layer and subcutaneous layers are closed with absorbable sutures. Non absorbable stitches are used for skin closure. A sterile dressing is applied..The surgery requires around 3 to 4 hours.

Surgical procedure illustration:

Figure 18

Figure 19

Figure 20

Figure 21

Figure 22 – after laminectomy, nerve root is identified

Figure 23

Figure 24

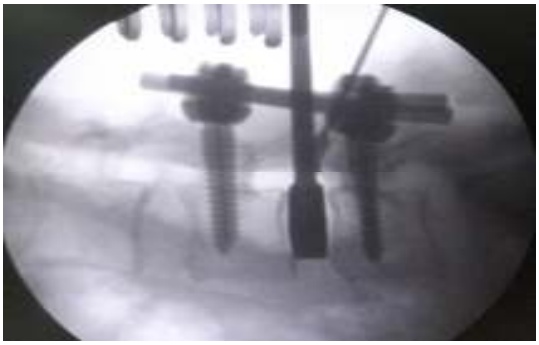


Figure 25

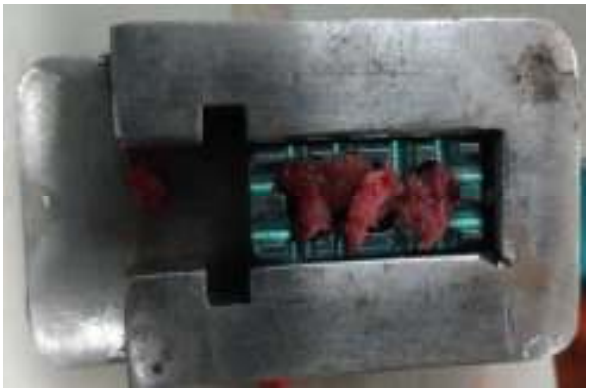


Figure 26

Figure 27

Figure 28

Figure 29

Figure 30

Figure 31

Post-Operative Care:

The wound dressing is changed on postoperative days 2,5,7,10,12 during the hospital stay The patients are usually discharged after suture removal on day 12 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, 10 and 12.

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, 12^{th} ,24^{th} weeks, 12^{th} month and 14^{th} month . 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.32)or
2. Visible bone within the hollow fusion cage, (fig.33)or
3. On lateral flexion-extension X-rays, less than 5 ° of motion. (fig.34)

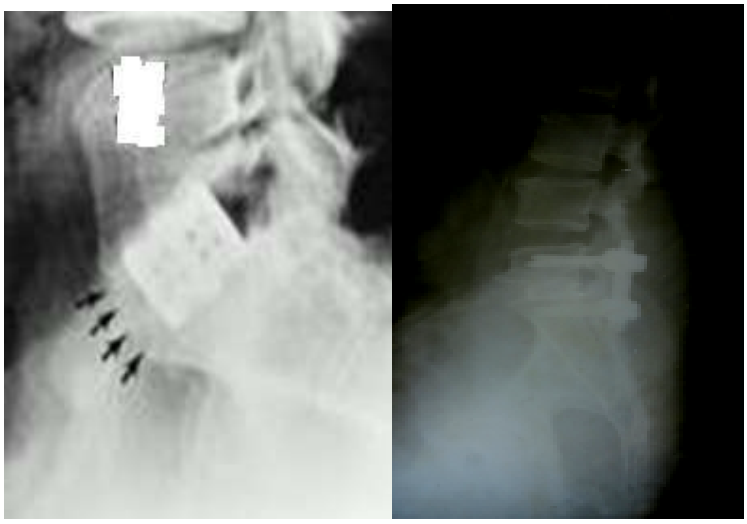


Figure 32 **Figure 33**

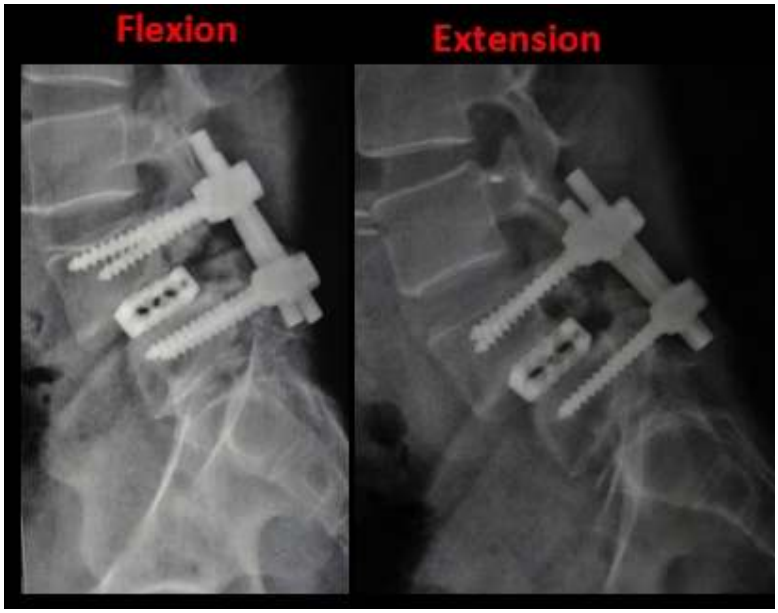


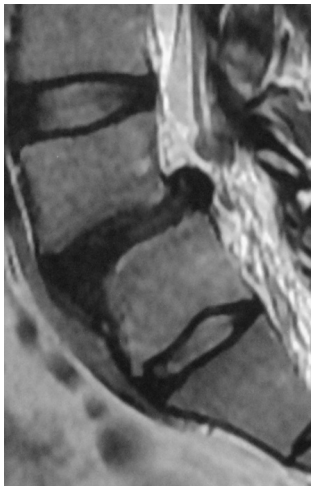
Figure 34

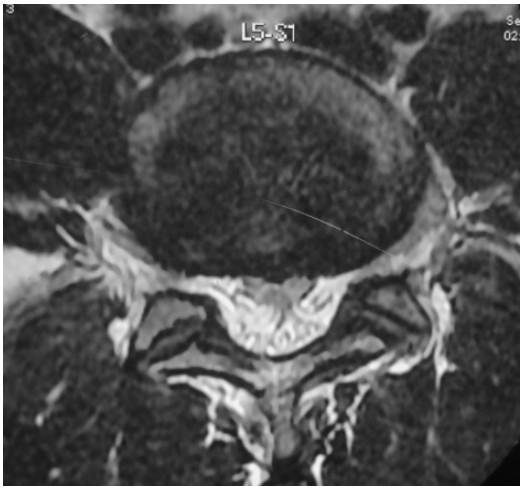
CASE ILLUSTRATIONS

Case 1

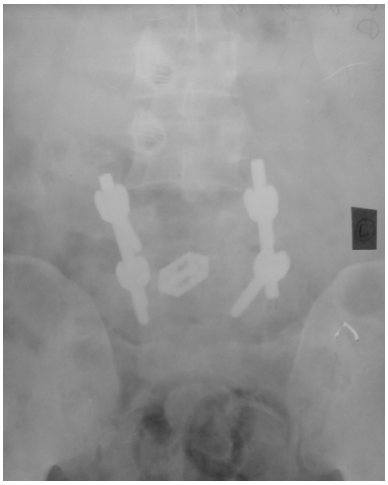
Diagnosis: Grade 1 isthmic spondylolisthesis L5-S1 with neurological deficit S1

Pre op X rays

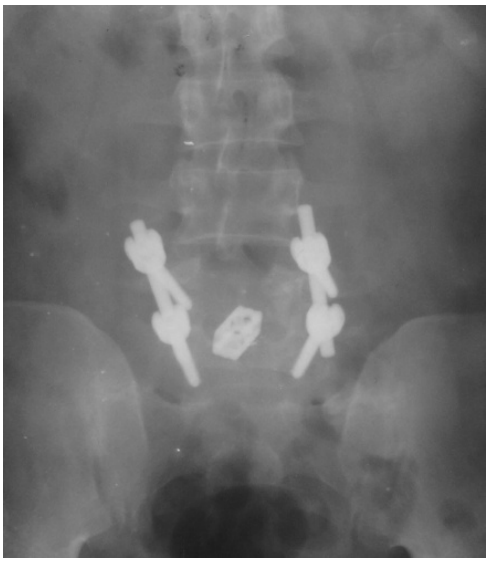
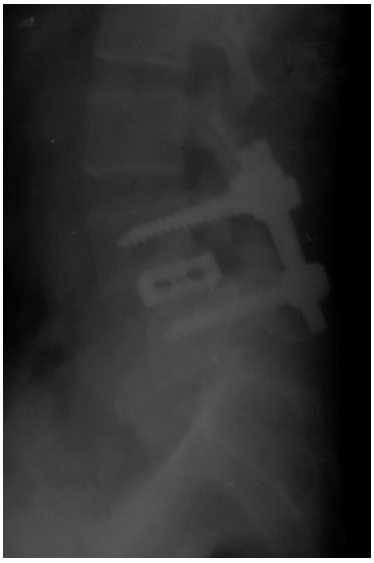




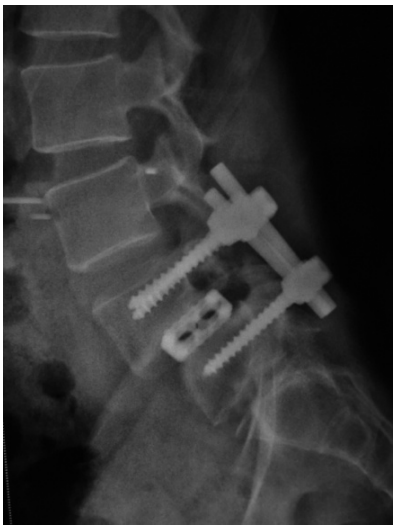
Pre op MRI



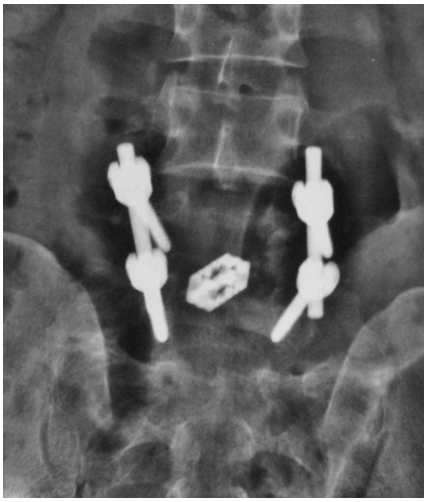

Immediate post op X rays

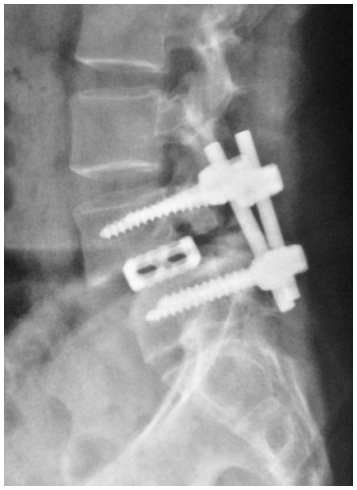



3 months post op X-rays

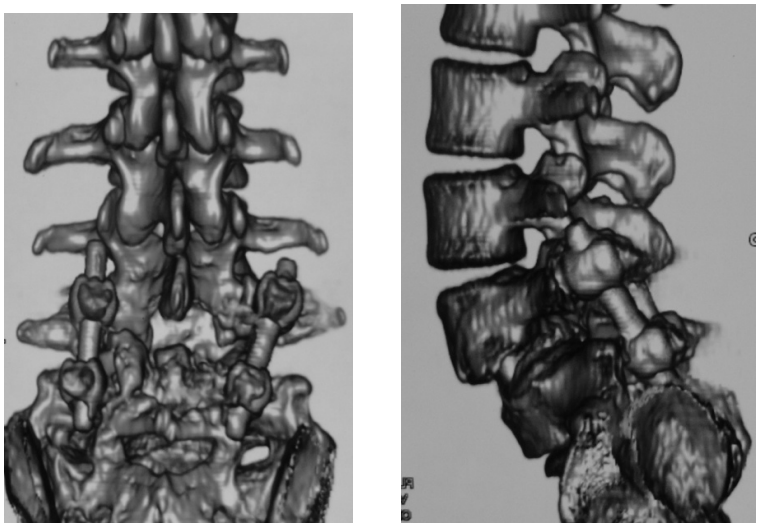


6 months post op X-rays





14 months post op X-rays



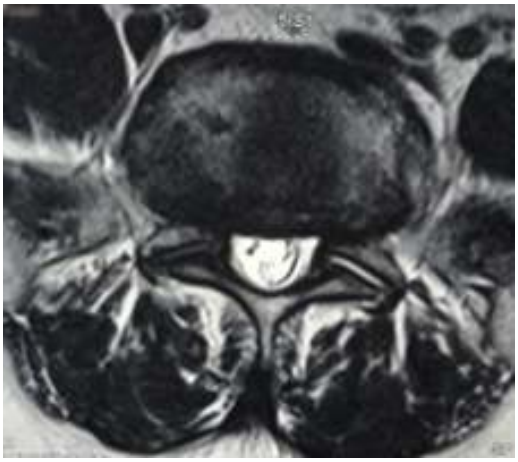
14 months post op CT scan showing interbody fusion

14 months post op clinical picture

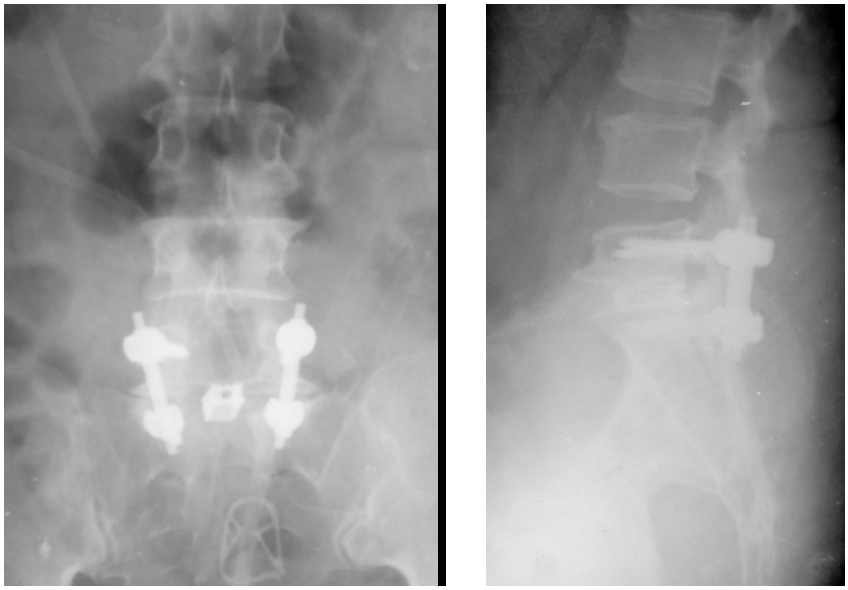
Case 2

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

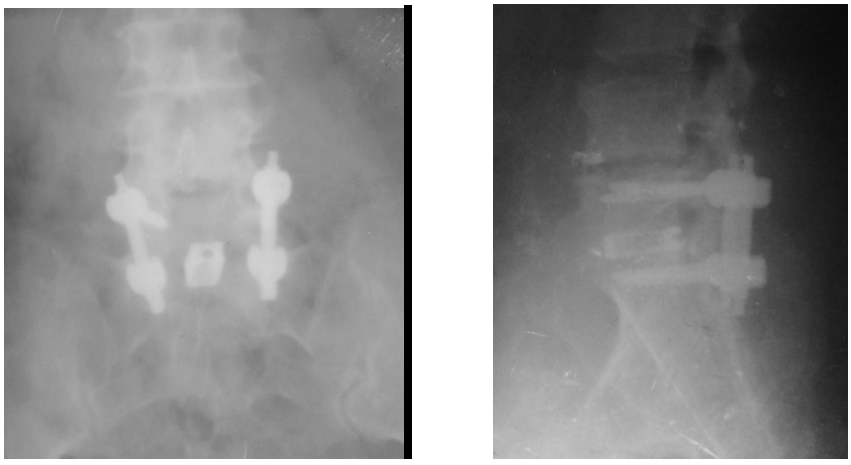
Pre op X-rays



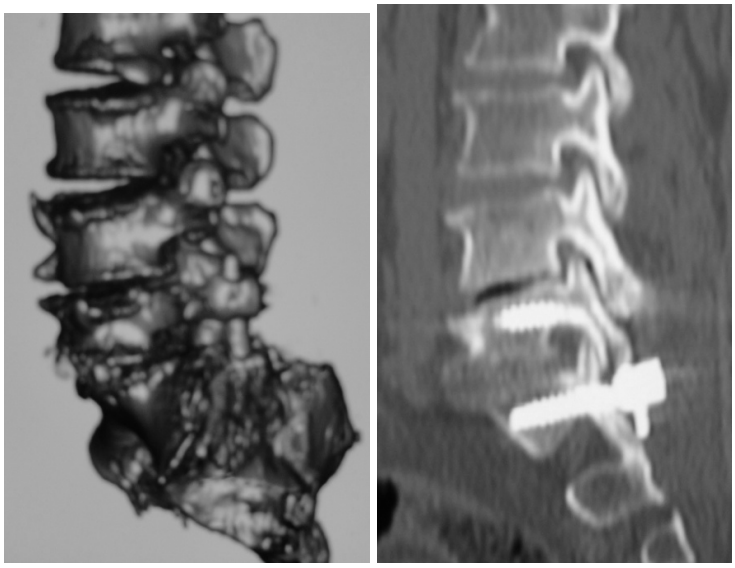
Pre op MRI



Immediate post op X-rays



14 months post op X-rays showing union

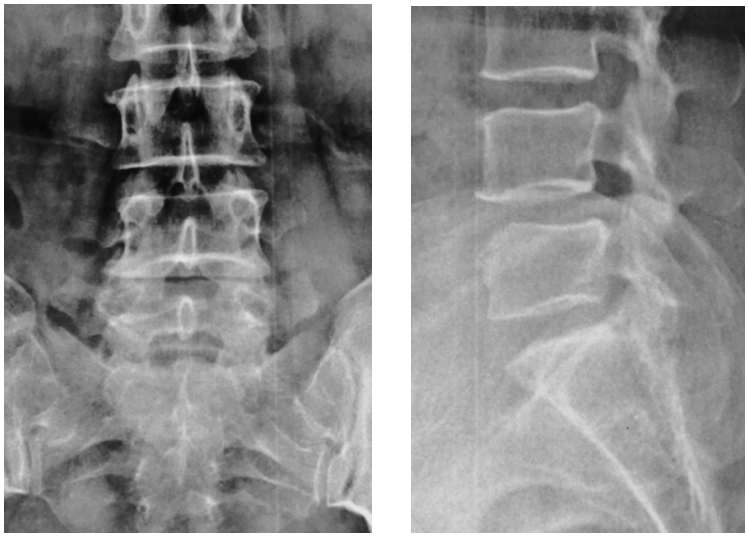


14 months post op CT scan showing interbody fusion

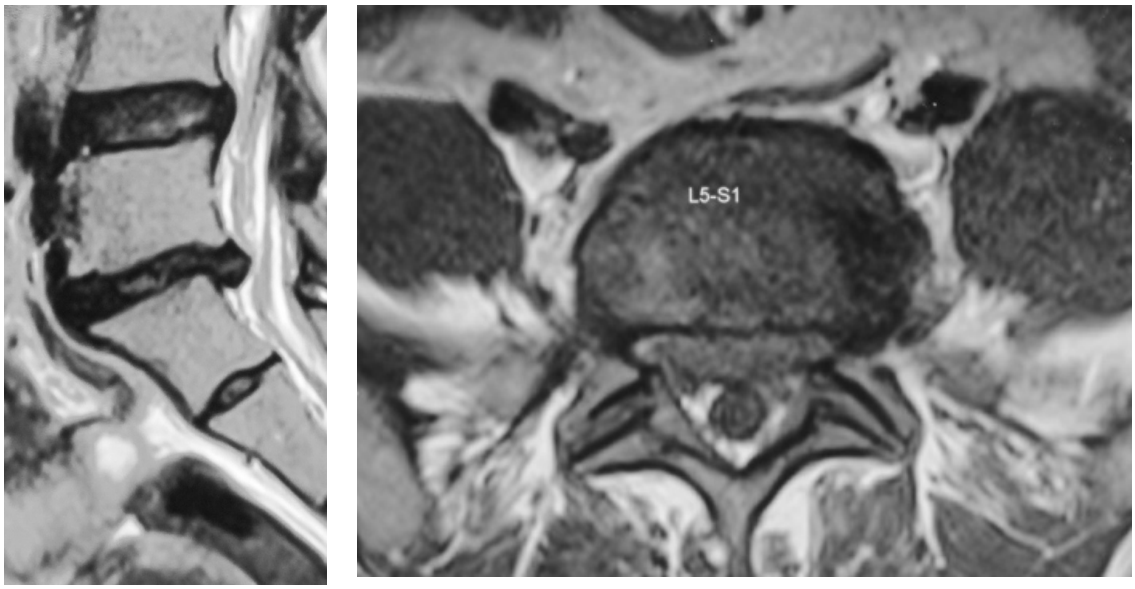
14 months post op clinical picture

Case 3

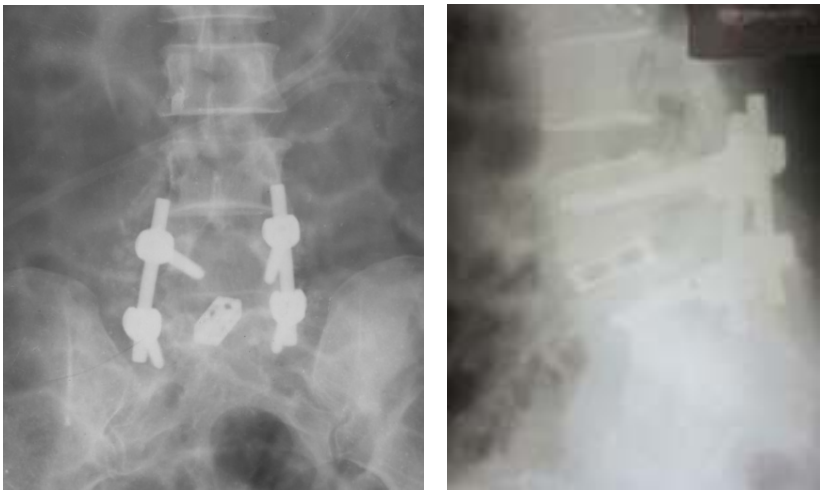
Diagnosis: L5-S1 Degenerative disc disease with neurological deficit S1



Pre op X-rays



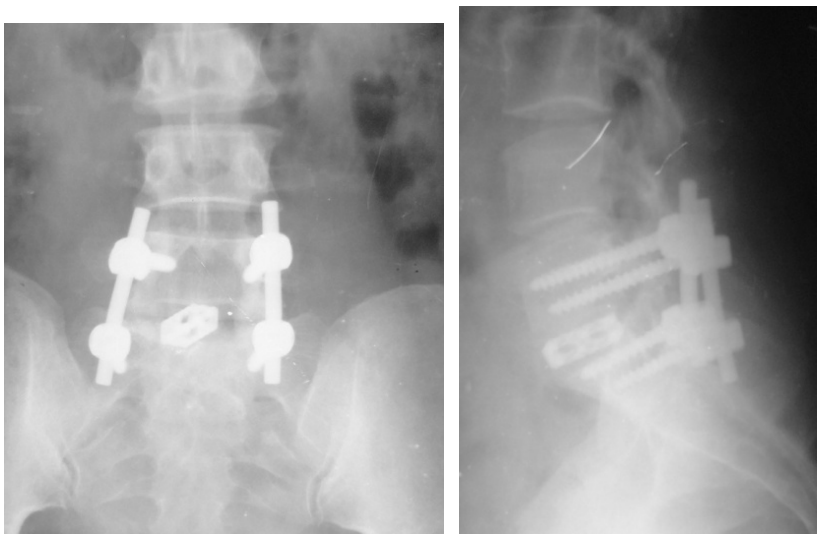
Pre op MRI



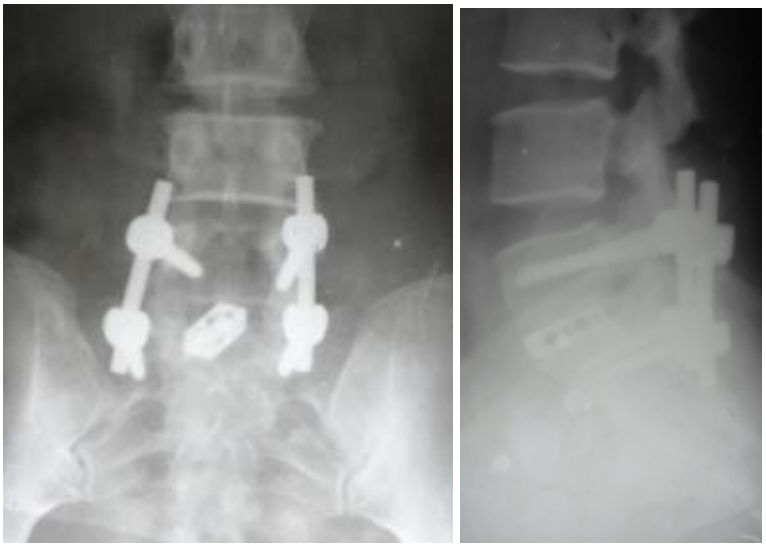
Immediate post op X rays

Surgical site infection occurred on post day 4 which was

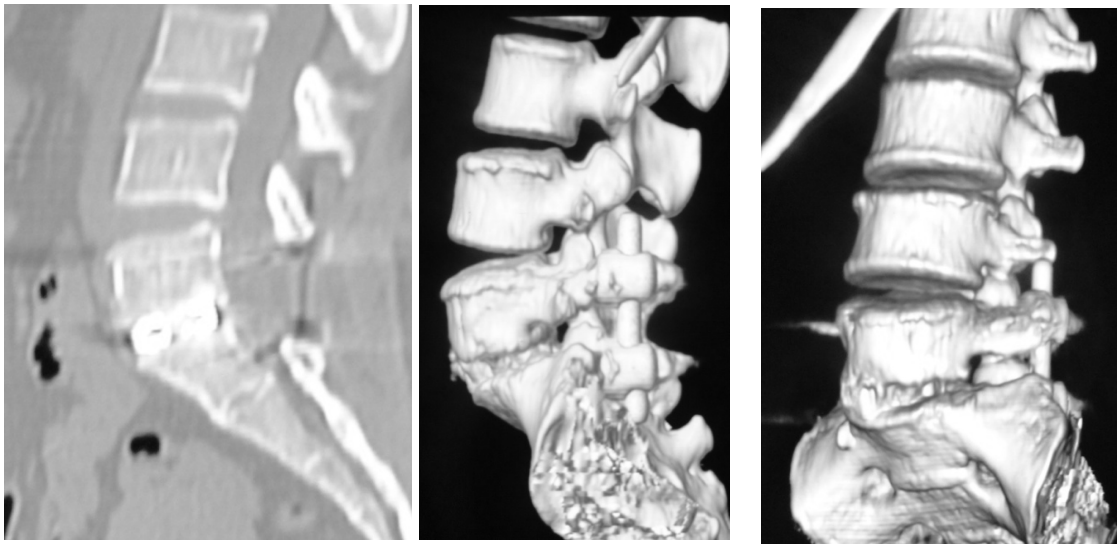
treated with debridement and flap cover



6 months post op X-rays



14 months post op X-rays showing union



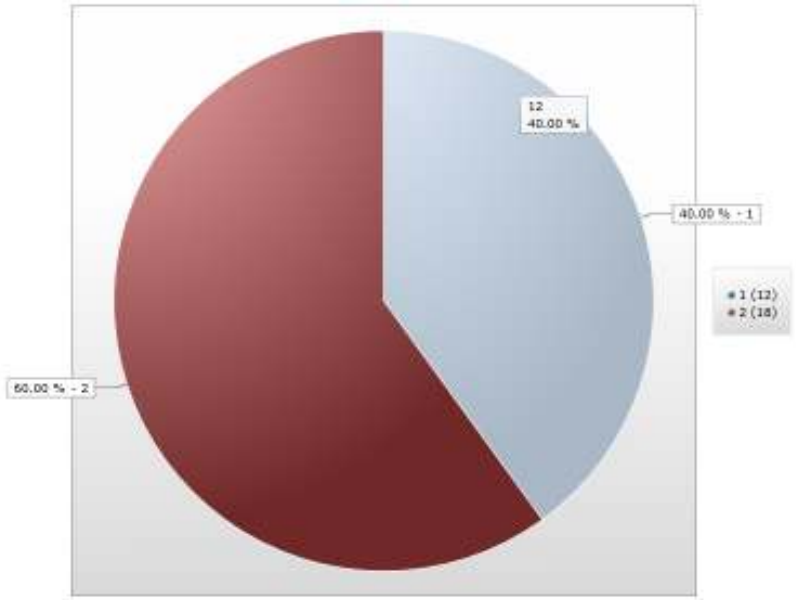
14 months post op CT scan showing interbody fusion

14 months post op clinical picture

OBSERVATIONS AND ANALYSIS

Gender

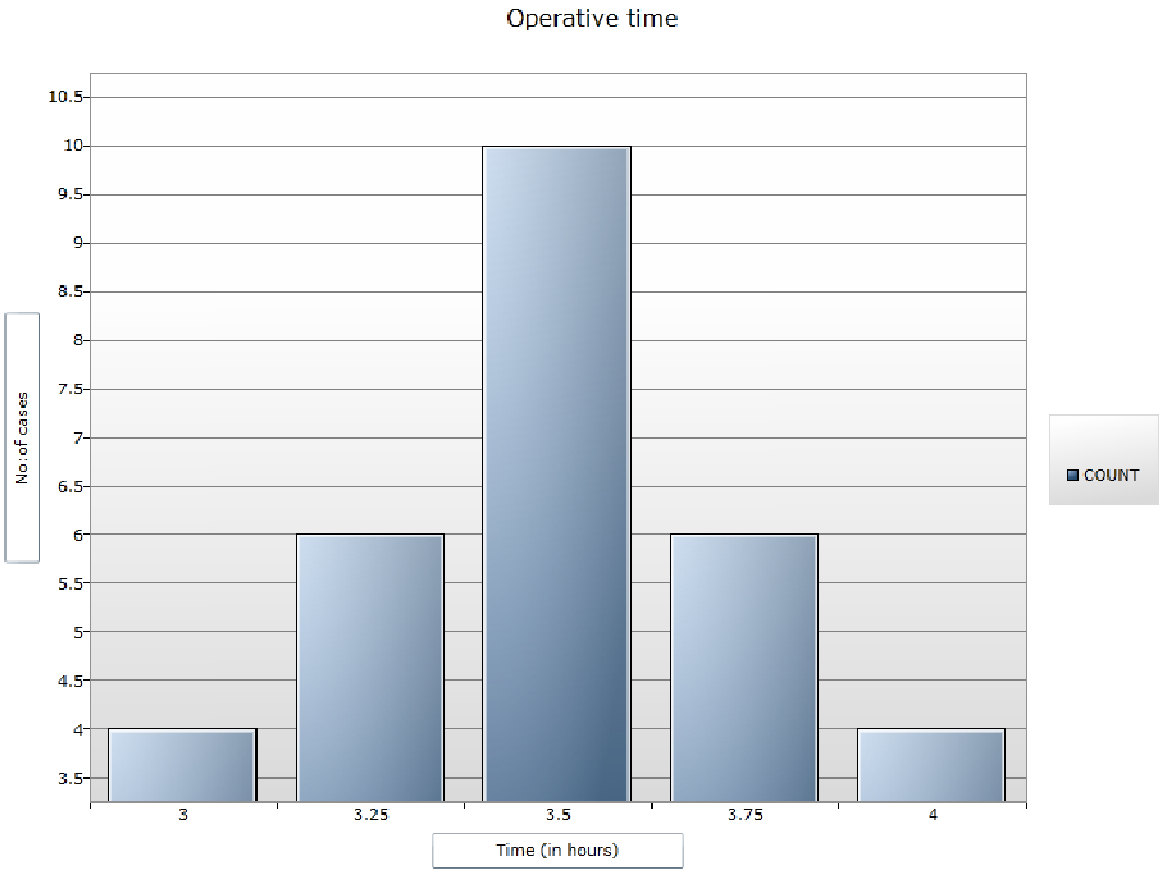
Graph 1 shows that male accounted for 40% and female was 60%



Graph 1

Operating time

The calculation of operating time was from the surgical incision to wound closure and there was no significant change. Graph 2 and table 1 shows the operating time. The mean was 3.5 hours.



Graph 2

Table 1

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

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.

Table 2

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

Pain relief

T-Test was used to compare the Pre and post op Visual Analogue Scale.

Table 3

	Mean	No: of cases	Std. Deviation	Std. Error Mean	P value
Pre op Visual Analogue Scale	6.30	30	0.877	0.160	
Post op Visual Analogue Scale	0.37	30	0.809	0.148	0.000

The table 3 shows pre operative VAS score versus post operative VAS score at 14th month indicates a "p value" < 0.000 1 and hence a significant comparison. The pain relief was drastic and significant.

Improvement in quality of life

The assessment was based on the T-Test comparing pre and post op Oswestry Disability score (ODS) and Oswestry Disability index (ODI)

Paired Samples Statistics

Table 4

		Mean	No: of cases	Standard Deviation	Standard Error Mean	P value
Pair 1	Pre op Oswestry Disability Index	58.13	30	7.664	1.399	0.000
	Post op Oswestry Disability Index	2.27	30	5.502	1.005	

Paired Samples Test

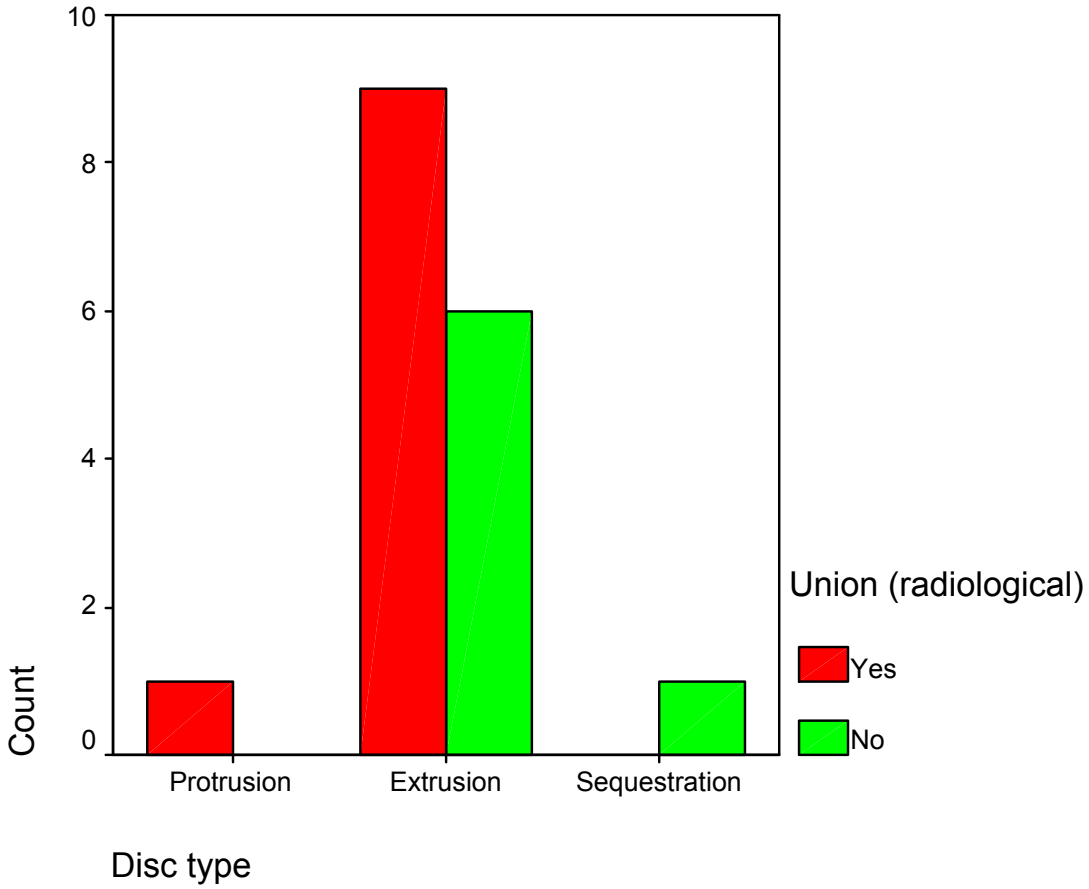
Table 5

		Paired Differences					t	df	P value
		Mean	Standard Deviation	Standard Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pre op Oswestry Disability Index - Post op Oswestry Disability Index	55.87	8.287	1.513	52.77	58.96	36.925	29	.000

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

Radiological union

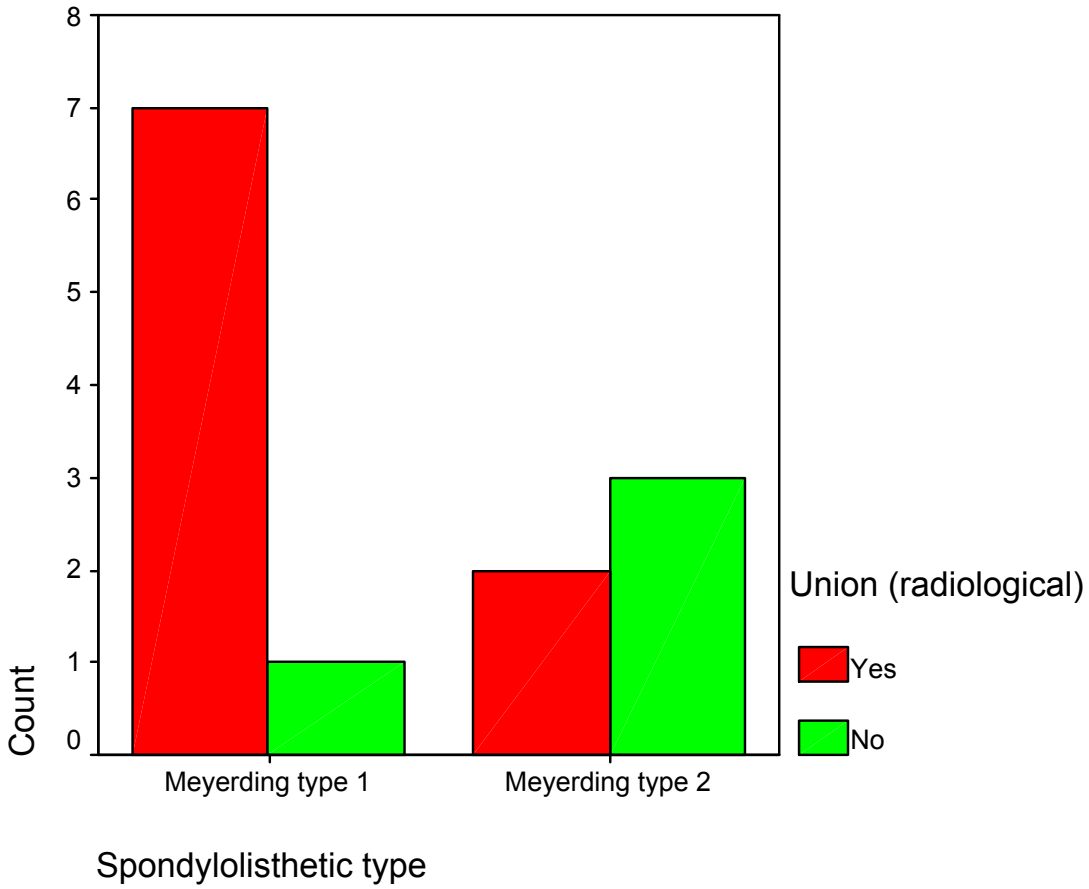
Graphs 3 and 4, table 6 and 7 shows the radiological union in degenerative disc disease and spondylolisthesis after posterior lumbar interbody fusion



Graph 3

Table 6

	Union (radiological)		Total
	Yes	No	
No: of cases (count)	10	7	17
% within Disc type	58.8%	41.2%	100.0%



Graph 4

Table 7

	Union (radiological)		Total
	Yes	No	
No: of cases (Count)	9	4	13
%within Spondylolisthetic type	69.2%	30.8%	100.0%

This table shows percentage of union in total

Table 8

	Union (radiological)		Total
	Yes	No	
No:of cases	19	11	30
% of cases	63.3%	36.7%	100.0%

RESULTS

The percentage of radiological union was found to be 63.3%.

The mean operating time, from the surgical incision to wound closure, was 3.5 hours. The mean blood loss was 237ml.

The post op pain relief was drastic and significant as evidenced by the improvement in the postop VAS score at 14th month as indicated by a "p value" < 0.000 1.

Improvement in quality of life, as assessment, based on the T-Test comparing pre and postop 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.

Another patient had post operative wound infection on day 4 which was controlled with thorough debridement and flap cover, and the case showed radiological union and the quality of life improved.

For a case of grade 1 spondylolisthesis, PLIF surgery was found uneventful intraoperatively, but there was blow out of a pedicle and displacement of screw

laterally, which was noted in immediate postoperative x ray. Still the patient had radiological union and the quality of life has improved.

There was no Screw breakage or cage failure.

Progression of slip did not occur in any of the cases.

DISCUSSION

In the treatment of lumbar or lumbosacral spondylolisthesis, the target is bony fusion. Irrespective of instrumentation, fusion rates increases with years of follow up.

Despite the small sample size, the results of fusion were comparable to that obtained with other standard studies during the short follow up. The fusion rates after interbody arthrodesis have improved, from 66 % in first year (of 83 patients studied by Stauffer and Coventry[57]) to two-year follow up of 91percent when Bagby and Kuslich titanium cage [58,59,60] and 96 percent when Ray titanium cage was used. [61]. According to them, the fusion rates will be higher on further follow up.

Though, in our study, the percentage of union radiologically was only 63.3%, the clinical outcome, depicted by the improvement in socioeconomic and functional parameters, as evidenced from the Oswestry Disability Index and score was found to be excellent. The interbody spaces have better vascular supply than the posterolateral spaces, so better fusion is seen [62]. Also, chance of progression of deformity is high when isolated posterolateral fusion alone has been performed.

The mean operating time of our study was 3.5 hours which was comparable to standard studies [63]. Shorter the surgical time, less will the complications associated with prolonged surgery including, primary hemorrhage, basal atelectasis, shock due to blood loss, postoperative wound infection and paralytic ileus.

The mean blood loss of our study was 237ml, comparable to 250 ml blood loss in a study by Curt Freudenberger et al.

In the study by Nick Birch, Sean Grannum and Nadim Aslam, the decision to perform a single level PLIF for degenerated disc disease was taken, after having discussion with the patients.[64] The outcome of this study shows that degenerated disc disease is a good indication for PLIF. So many articles show that the persisting pain after successful discectomy for degenerative disc disease can be relieved by interbody arthrodesis .[5] Studies have revealed the nerve supply of the disc, which is more in case of a degenerated disc. Hence discectomy alone can cause failed back surgery syndrome and instability results. To prevent this, the causative factor of pain, the disc itself should be removed. Only when a black disc is associated with intervertebral disc space narrowing, the fusion with spacer should be attempted.

The **advantage** of a pure PLIF surgery is that it provides anterior fusion between adjacent vertebra without a second incision, unlike an anterior with posterior spine fusion surgery.

The **disadvantages** of PLIF surgery are as follows:

- A posterior approach allows only limited disc space to be removed
- A more comprehensive evacuation of the disc space, and hence an increased surface area for fusion are possible with an anterior approach

- An anterior approach allows insertion of a much larger bone graft and/or spinal implant
- A posterior approach alone is more difficult in reduction of spinal deformities (e.g. isthmic spondylolisthesis)
- Rarely a bone graft or cage inserted posteriorly may retro pulse back into the canal and result in neural compression

In PLIF surgery, the cage with bone graft is placed in the anterior part of the disc space. There is more surface area in the anterior portion than in the posterolateral gutter. The bone in the anterior portion is under compression, and hence better healing because the bone is under stress (Wolff's law). In posterolateral fusions the bone is not under enough stress. For these two reasons, PLIF surgery rates have more success rates compared to 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
   - obesity
   - multiple level fusion surgery
   - radiotherapy for cancer

If the joint is stable, and the patient is symptomatically well, even in the presence of radiological nonunion, further fusion procedure is not needed.

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

Posterior instrumentation allows immediate postoperative stability and later on bony fusion was established, hence no progression of slip.

The patients with pedicle-screw instrumentation had a significantly higher fusion rate compared to those without instrumentation [5]. The success in using instrumentation lies in achieving and maintaining disc space height, therefore making it a better option in those with mechanical back pain , foraminal stenosis and resultant radiculopathy.

The biomechanics of pedicle screw is that it resist axial load by rigidly buttressing the spine ;due to absence of load sharing by the anterior column, stress occur at screw plate or rod junction,leading to screw breakage; Flexion and extension component to the applied moment arm leads to deformities; Pedicle screw fixation may fail during axial loading, Parallelogram like translation deformity, Hardware failure , screw pull out , breakage and toggle can occur .So we need to use interbody cage to prevent complications.

X ray showing Breakage of pedicle screw when used alone

Autologous cancellous bone graft which is nonstructural, when used for interbody fusion, has a high chance to collapse or migrate. So cage is considered better.

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

Although this study is limited by lesser number of patients and the duration of follow up was very short, the outcomes suggest that the management of painful spinal conditions of degenerative disc disease and spondylolisthesis can be accomplished successfully with PLIF technique.

Proper patient selection is the key to success, which is the result of the proper identification of the etiopathogenesis , diagnosis, and natural history of low-back pain and its management (both non operative and operative).

Post-discectomy instability, leading to disabling low back and leg pain has more chance of occurrance in those patients with an incompetent annulus seen in central disc herniation compared to those with a largely intact annulus.

A black degenerated disc if associated with disc space narrowing, or a case of spondylolisthesis, not responding to conservative methods are indications for PLIF.

In conclusion, we would suggest PLIF technique supplemented with bone grafting as an ideal technique in spondylolisthesis and degenerative disc disease in view of results and low complication rate.

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நோயாளி ஒப்புதல் படிவம் (Tamil Consent form)

ஆராய்ச்சியின் விவரம்: முதுகெலும்பில் உள்ள தேய்மானம் மற்றும் விலகலுக்கு உலோகத் தகட்டின் மூலம் எலும்புகளை இணைக்கும் அறுவை சிகிச்சையின் பயன்களை அறியும் ஆய்வரிக்கை.

ஆராய்ச்சி மையம்: அரசு கீழ்பாக்கம் மருத்துவக் கல்லூரி மருத்துவமனை

நோயாளியின் பெயர்: நோயாளியின் வயது:

பதிவு எண்:

நோயாளி கீழ்கண்டவற்றுள் கட்டங்களை (✔) செய்யவும்

1. மேற்குறிப்பிட்டுள்ள ஆராய்ச்சியின் நோக்கத்தையும் பயனையும் முழுவதுமாக புரிந்துகொண்டேன். மேலும் எனது அனைத்து சந்தேகங்களையும் கேட்டு அதற்கான விளக்கங்களையும் தெளிவுபடுத்திக் கொண்டேன். ☐

2. மேலும் இந்த ஆராய்ச்சிக்கு எனது சொந்த விருப்பத்தின் பேரில் பங்கேற்கிறேன் என்றும், மேலும் எந்த நேரத்திலும் எவ்வித முன்னறிவிப்புமின்றி இந்த ஆராய்ச்சியிலிருந்து விலக முழுமையான உரிமை உள்ளதையும், இதற்கு எவ்வித சட்ட பிணைப்பும் இல்லை என்பதையும் அறிவேன். ☐

3. ஆராய்ச்சியாளரோ, ஆராய்ச்சி உதவியாளரோ, ஆராய்ச்சி உபயத்தாரோ, ஆராய்ச்சி பேராசிரியரோ, ஒழுங்குநெறி செயற்குழு உறுப்பினர்களோ எப்போது வேண்டுமானாலும் எனது அனுமதியின்றி எனது உள்நோயாளி பதிவுகளை இந்த ஆராய்ச்சிக்காகவோ அல்லது எதிர்கால பிற ஆராய்ச்சிகளுக்காகவோ பயன்படுத்திக்கொள்ளலாம் என்றும், மேலும் இந்த நிபந்தனை நான் இவ்வாராய்ச்சியிலிருந்து விலகினாலும் தகும் என்றும் ஒப்புக்கொள்கிறேன். ஆயினும் எனது அடையாளம் சம்பந்தப்பட்ட எந்த பதிவுகளும் (சட்டபூர்வமான தேவைகள் தவிர) வெளியிடப்படமாட்டாது என்ற உறுதிமொழியின் பெயரில் இந்த ஆராய்ச்சியிலிருந்து கிடைக்கப்பெறும் முடிவுகளை வெளியிட மறுப்பு தெரிவிக்கமாட்டேன் என்று உறுதியளிக்கின்றேன். ☐

4. இந்த ஆராய்ச்சிக்கு நான் முழுமனதுடன் சம்மதிக்கின்றேன் என்றும் மேலும் ஆராய்ச்சிக் குழுவினர் எனக்கு அளிக்கும் அறிவுரைகளை தவறாது பின்பற்றுவேன் என்றும் இந்த ஆராய்ச்சி காலம் முழுவதும் எனது உடல் நிலையில் ஏதேனும் மாற்றமோ அல்லது எதிர்பாராத பாதகமான விளைவோ எற்படுமாயின் உடனடியாக ஆராய்ச்சி குழுவினரை அணுகுவேன் என்றும் உறுதியளிக்கின்றேன். ☐

5. இந்த ஆராய்ச்சிக்குத் தேவைப்படும் அனைத்து மருத்துவப் பரிசோதனைகளுக்கும் ஒத்துழைப்பு தருவேன் என்று உறுதியளிக்கின்றேன். ☐

6. இந்த ஆராய்ச்சிக்கு யாருடைய வற்புருத்தலுமின்றி எனது சொந்த விருப்பத்தின் பேரிலும் சுயஅறிவுடனும் முழுமனதுடனும் சம்மத்திக்கின்றேன் என்று இதன் மூலம் ஒப்புக்கொள்கிறேன். ☐

நோயாளியின் கையொப்பம் / பெருவிரல் கைரேகை ஆராய்ச்சியாளரின் கையொப்பம்

இடம்: தேதி:

PROFORMA

Name :

Age / Sex : Ip No:

Address :

Height :

Weight :

Date Of Admission :

Date Of Surgery :

Date Of Discharge :

Pre Op Evaluation

History

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 1. Yes 2. No

Painful catch 1. Yes 2. No

Oswestry Disability Index

1 – Pain intensity

0. The pain is very mild , it comes and goes.
1. The pain is mild, does not vary much.
2. The pain is moderate, comes and goes.
3. The pain is moderate, does not vary much.
4. The pain is severe, comes and goes.
5. The pain is severe, does not vary much.

2 – Personal care (washing, dressing, etc.)
0. I do not change my way of washing or dressing to avoid the pain
1. I do not normally change the way of my washing or dressing even though it causes some pain
2. Washing and dressing increases the pain but i can do it without changing my way of doing it.
3. Washing and dressing increases the pain, so i find it necessary to change the way of doing it.
4. Because of my pain i am not able to do some washing and dressing without help.
5. Because of my pain i am totally unable to do any washing and dressing without help.

3 – Lifting
0. I can lift heavy weights without having any extra pain.
1. I can lift heavy weights, but results in extra pain.
2. The pain prevents me from lifting heavy weights off the floor, but i can manage if they are positioned conveniently e.g., on a table.
3. The pain prevents me from lifting heavy weight off the floor, but i can manage light to
medium weights if they are positioned conveniently.
4. I am able to lift only very light weights.
5. I cannot lift or carry any weight at all.

4 – Walking
0. I have no pain while walking..
1. I have some pain while walking, but it does not increase with the distance.
2. I am not able to walk more than 1 mile without increasing the pain.
3. I am not able to walk more than ½ mile without increasing the pain.
4. I am not able to walk more than ¼ mile without increasing the pain
5. Pain prevents all forms of travel.

5 – Sitting
0. I can sit in chair as long as i like without pain.
1. I can sit only in the chair of my choice as long as i like.
2. Pain prevents me from sitting for more than 1 hour.
3. Pain prevents me from sitting for more than ½ hour.
4. Pain prevents me from sitting for more than 10 minutes.
5. I avoid sitting as it increases the pain immediately.

6 – Standing
0. I am able to stand as long as i want without pain.
1. I have got some pain on standing, though it does not increase with time.
2. I cannot stand for more than 1 hour without increased pain.
3. I cannot stand for more than ½ hour without increased pain.

4. I cannot stand for more than 10 minutes without increased pain.
5. I avoid standing as it increases the pain immediately.

7 – Sleeping
0. I have no pain when i am on bed.
1. I get pain in the bed, but it does not prevent me from sleeping well.
2. Because of pain my night sleep is decreased by less than one-quarter.
3. Because of pain my night sleep is decreased by less than one-half.
4. Because of pain my night sleep is decreased by less than three-quarters.
5. The pain prevents me from sleeping at all.

8 – Social life
0. My social life is quite normal, gives me no pain at all.
1. My social life is normal; still it increases the amount of pain.
2. Main has no significant effect on my social life, but it limits more energetic activities, (e.g., dancing, sports, etc.)
3. Main has limited my social life, not able to go out very often.
4. Pain has limited my social life to home.
5. I hardly have any social life due to the pain.

9 – Traveling
0. I get no pain while travelling.
1. I get some pain while travelling, but none of my usual forms of travel make it worse.
2. I get more pain while travelling, but it does not force me to seek alternative forms of travel.
3. I get more pain while traveling, which forces me to seek alternative forms.
4. My pain restricts me to shorten necessary journeys under ½ hour.
5. My pain restricts all forms of travel.

10– Sex life (if applicable)
0. My sex life is normal and causes no extra pain.
1. My sex life is normal but causes some extra pain.
2. My sex life is nearly normal but is very painful.
3. My sex life is severely restricted by pain.
4. My sex life is nearly absent because of pain.
5. Pain prevents any sex life at all.

Total Score

Score 1.0-20% Minimal Disability 2. 21-40% Moderate Disability
3. 41-60% Severe Disability 4. 61-80% Crippled
5. 80-100%

General Examination

Build And Nourishment
Pallor Icterus Cyanosis Clubbing
Lymphadenopathy Pulse Rate Blood Pressure

Neurological Examination

Higher Mental Functions
Cranial Nerves

Motor System Examination

Bulk –
- Thigh
- Leg circumference

Tone –
- Toes
- Ankle
- Knee
- Hip

Power
- Hip
  - Flexion
  - Extension
  - Adduction
  - Abduction
- Knee
  - Flexion
  - Extension
- Ankle
  - Dorsiflexion
  - Plantar Flexion
- Foot
  - Adduction
  - Abduction
- Hallux
  - Extension
  - Flexion

Reflexes

Superficial Reflexes

Cremastric

Bulbocavernous

Anal

Plantar

Deep Reflexes

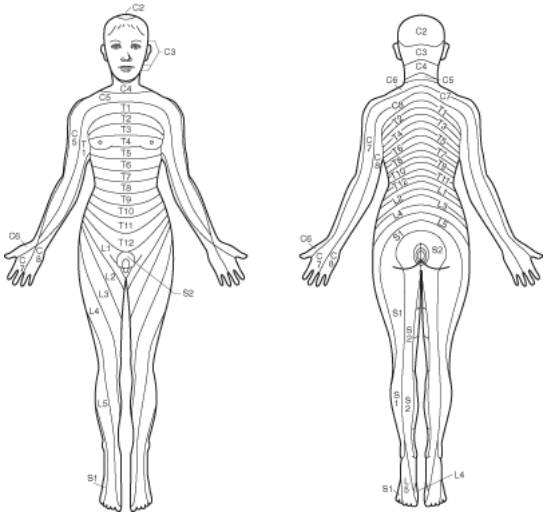
Knee

Ankle

Clonus – Patellar

Ankle

Sensory System



Bowel Control

Bladder Control

Straight Leg Raising Test

Right	1.(0 – 30 Deg)	2. (31 – 60 Deg)	3. (61 – 90 Deg)
Left	1.(0 – 30 Deg)	2. (31 – 60 Deg)	3. (61 – 90 Deg)

Investigations:

Complete Haemogram – Hb- TC- DC ESR

Blood Sugar - Urea Creatinine

Plain Radiology Findings (Standard Ap And Lateral, Flexion_Extention X Rays)

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 !. Normal 2. Decreased

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

3. Foraminal Stenosis A. Right B.Left

Meyerding Grading (If Spondylolisthesis)

1. < 25% 2. 25 – 50% 3. 50 – 75% 4. >75% 5. Spondyloptosis

Diagnosis:

Procedure:

Pre Op Planning And Templating:

Pedicle screw length
Pedicle screw diameter
Interbody cage size

Intra Op Assessment:

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

Post Op Period

Complications

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

Follow Up

Post op month of evaluation

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

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1 – Pain intensity
0. The pain is very mild , it comes and goes.

1. The pain is mild, does not vary much.
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2. Washing and dressing increases the pain but i can do it without changing my way of doing it.
3. Washing and dressing increases the pain, so i find it necessary to change the way of doing it.
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5. Because of my pain i am totally unable to do any washing and dressing without help.

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3. The pain prevents me from lifting heavy weight off the floor, but i can manage light to
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4. I am able to lift only very light weights.
5. I cannot lift or carry any weight at all.

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1. I have some pain while walking, but it does not increase with the distance.
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3. I am not able to walk more than ½ mile without increasing the pain.
4. I am not able to walk more than ¼ mile without increasing the pain
5. Pain prevents all forms of travel.

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0. I can sit in chair as long as i like without pain.
1. I can sit only in the chair of my choice as long as i like.
2. Pain prevents me from sitting for more than 1 hour.
3. Pain prevents me from sitting for more than ½ hour.
4. Pain prevents me from sitting for more than 10 minutes.
5. I avoid sitting as it increases the pain immediately.

6 – Standing
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1. I have got some pain on standing, though it does not increase with time.
2. I cannot stand for more than 1 hour without increased pain.
3. I cannot stand for more than ½ hour without increased pain.
4. I cannot stand for more than 10 minutes without increased pain.
5. I avoid standing as it increases the pain immediately.

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1. My social life is normal; still it increases the amount of pain.
2. Main has no significant effect on my social life, but it limits more energetic activities, (e.g., dancing, sports, etc.)
3. Main has limited my social life, not able to go out very often.
4. Pain has limited my social life to home.
5. I hardly have any social life due to the pain.

9 – Traveling
0. I get no pain while travelling.
1. I get some pain while travelling, but none of my usual forms of travel make it worse.
2. I get more pain while travelling, but it does not force me to seek alternative forms of travel.
3. I get more pain while traveling, which forces me to seek alternative forms.
4. My pain restricts me to shorten necessary journeys under ½ hour.
5. My pain restricts all forms of travel.

10– Sex life (if applicable)
0. My sex life is normal and causes no extra pain.
1. My sex life is normal but causes some extra pain.
2. My sex life is nearly normal but is very painful.
3. My sex life is severely restricted by pain.
4. My sex life is nearly absent because of pain.
5. Pain prevents any sex life at all.

.

Total Score

Score 1.0-20% Minimal Disability 2. 21-40% Moderate Disability
3. 41-60% Severe Disability 4. 61-80% Crippled
5. 80-100%

General Examination

Build And Nourishment

Pallor Icterus Cyanosis Clubbing
Lymphadenopathy Pulse Rate Blood Pressure

Neurological Examination

Higher Mental Functions
Cranial Nerves
Motor System Examination

Bulk –
Thigh
Leg circumference
Tone –
Toes
Ankle
Knee
Hip
Power
Hip
Flexion
Extension
Adduction
Abduction

Knee
Flexion
Extension

Ankle
Dorsiflexion

Plantar Flexion

Foot
Adduction
Abduction

Hallux
Extension
Flexion

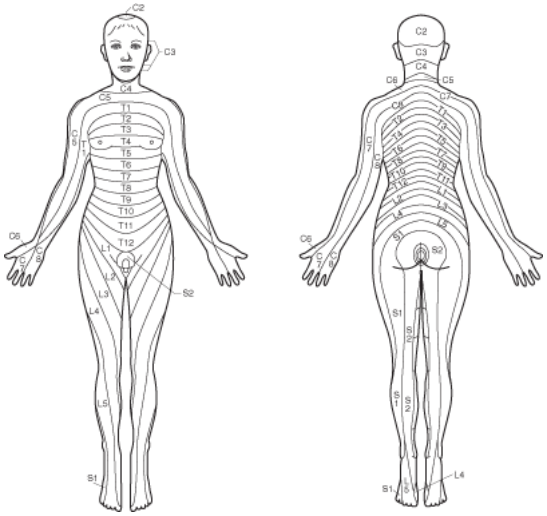
Reflexes

Superficial Reflexes
Cremastric
Bulbocavernous
Anal
Plantar

Deep Reflexes
Knee
Ankle

Clonus – Patellar
Ankle

Sensory System



Bowel Control

Bladder Control

Straight Leg Raising Test

Right	1.(0 – 30 Deg)	2. (31 – 60 Deg)	3. (61 – 90 Deg)
Left	1.(0 – 30 Deg)	2. (31 – 60 Deg)	3. (61 – 90 Deg)

Plain Radiology Findings (Standard AP And Lateral, Flexion_Extention X Rays)

Interbody fusion 1.Yes 2.No

Progression of Listhesis 1.Yes 2.No

CT Scan

Interbody fusion - 1.Yes 2.No

S.NO	NAME	AGE	SEX	TYPE	LEVEL	DISC TYPE	SPO_TYPE	CAN_STEN	PRE_ND	PRE_ODI	PRE_ODS	PRE_VAS
1	Balamurugan	38	1	1	5		1	1	1	54	3	6
2	Balmal	47	2	2	5	2		1	1	74	4	7
3	Lakshmi	49	2	2	5	3		1	1	68	4	7
4	Alamelu	45	2	2	4	3		1	1	52	3	5
5	Brahmayya	40	2	2	5	3		1	1	50	3	6
6	Vasantha	49	2	1	4		2	1	1	54	3	6
7	Krishnamoorty	58	1	2	5	3		1	1	48	3	7
8	Parvathy	52	2	1	4		2	1	1	66	4	6
9	Yamuna	55	2	1	4		2	1	1	56	3	8
10	Ramesh	50	1	2	5	3		1	1	48	3	6
11	Indira	56	2	2	5	4		1	1	74	4	6
12	Jayanthi	49	2	1	4		2	1	2	56	3	5
13	Kaliamoorthy	56	1	1	5		1	1	1	58	3	6
14	Kuppusamy	55	1	1	5		2	1	2	58	3	5
15	Parvathy	53	2	2	5	3		1	1	54	3	6
16	Raghu	55	1	2	4	3		1	1	64	4	7
17	Selvi	60	2	2	5	3		1	1	52	3	8
18	Annamayil	59	2	1	4		1	1	2	48	3	6
19	Kasimbee	59	1	2	5	3		1	1	58	3	5
20	Kantha	52	2	2	4	3		1	1	72	4	6
21	Rajagopal	53	1	1	5		1	1	1	56	3	6
22	Rafel	57	1	1	5		1	1	1	52	3	5
23	Ponnammal	50	2	2	4	3		1	1	58	3	7
24	ramamurthy	59	1	2	5	3		1	1	54	3	7
25	Malliga	61	2	1	4		1	1	1	50	3	6
26	Chellammal	62	2	2	5	3		1	1	58	3	6
27	Lalitha	59	2	1	5		1	2	1	56	3	7
28	Murasl	60	1	2	4	3		1	1	68	4	8
29	Pushpa	60	2	2	5	3		1	1	66	4	7
30	Kandasamy	59	1	1	5		1	1	1	62	4	6

S.NO	B_LOSS	O_TIME	PO_INF	PO_PAIN	PO_ND	PO_ODI	PO_ODS	PO_VAS	DUR_INJ	IMP_FAIL	CAG_RET	UNION
1	160	3.5	2	2	2	0	1	0	2	1	2	1
2	200	3.8	2	1	2	24	2	3	2	2	2	1
3	240	3.3	1	2	2	0	1	0	2	2	2	1
4	150	3.5	2	2	2	0	1	0	2	2	2	2
5	280	4.0	2	2	2	0	1	0	2	2	2	2
6	300	3.3	2	2	2	0	1	0	2	2	2	1
7	240	3.5	2	2	2	0	1	0	2	2	2	1
8	220	3.8	2	2	2	0	1	0	2	2	2	1
9	260	3.5	2	2	2	0	1	0	2	2	2	2
10	150	3.0	2	2	2	10	1	2	2	2	2	1
11	160	3.3	2	2	2	0	1	0	2	2	2	2
12	280	4.0	2	2	2	0	1	0	2	2	2	2
13	320	3.5	2	2	2	12	1	2	2	2	2	1
14	260	3.8	2	2	2	0	1	0	2	2	2	2
15	160	3.0	2	2	2	0	1	0	2	2	2	1
16	260	3.3	2	2	2	0	1	0	1	2	2	1
17	200	4.0	2	2	2	0	1	0	2	2	2	2
18	320	3.8	2	2	2	0	1	0	2	2	2	1
19	220	3.5	2	2	2	8	1	1	2	2	2	2
20	300	3.5	2	2	2	0	1	0	2	2	2	1
21	260	3.0	2	2	2	0	1	0	2	2	2	2
22	180	4.0	2	2	2	0	1	0	2	2	2	1
23	160	3.3	2	2	2	12	1	2	2	2	2	1
24	280	3.5	2	2	2	0	1	0	2	2	2	1
25	260	3.8	2	2	2	0	1	0	2	2	2	1
26	300	3.5	2	2	2	0	1	0	2	2	2	2
27	240	3.5	2	2	2	0	1	0	2	2	2	1
28	260	3.0	2	2	2	2	1	1	2	2	2	2
29	220	3.8	2	2	2	0	1	0	2	2	2	1
30	280	3.3	2	2	2	0	1	0	2	2	2	1

LEGEND

Sex 1.male

2.female

Type 1.listhesis

2. disc

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

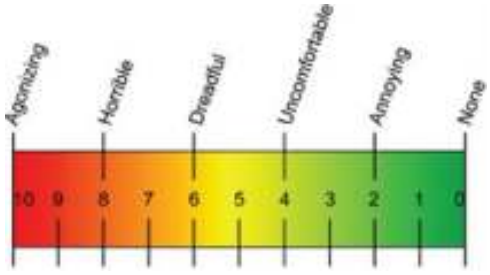
2. No

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.



INSTITUTIONAL ETHICAL COMMITTEE
GOVT.KILPAUK MEDICAL COLLEGE,
CHENNAI-10
Ref.No.3393/ME-1/Ethics/2013 Dt:02.05.2013
CERTIFICATE OF APPROVAL

The Institutional Ethical Committee of Govt. Kilpauk Medical College, Chennai reviewed and discussed the application for approval "A Study on short term clinical and radiological analysis of lumbar interbody fusion for degenerative disc disease and spondylolisthesis" – For Project Work submitted by Dr.S.Rakesh, MS (Ortho), PG Student, KMC, Chennai-10.

The Proposal is APPROVED.

The Institutional Ethical Committee expects to be informed about the progress of the study any Adverse Drug Reaction Occurring in the Course of the study any change in the protocol and patient information /informed consent and asks to be provided a copy of the final report.

GOVT. KILPAUK MEDICAL COLLEGE
09 OCT 2013
Kilpauk, Chennai-10

9/10/13.

CHAIRMAN,
Ethical Committee
Govt.Kilpauk Medical College,
Chennai