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Surgical outcomes of degenerative lumbar spondylolisthesis: A cohort study

Saif Saood Abdlrazaq Alabid[1], Abdulrahman Kamal Faisel[2], Tarik Abdulwahid Abdulhameed[3]

[1]"Al Hussein" Teaching Hospital, Al-Muthanna, Sammawa, Iraq
[2]"Ibn Sina" Teaching Hospital, Erbil, Iraq
[3]Scientific Council of Spine Surgery Subspecialty, Arab Council of Health Specializations, Baghdad, Iraq

ABSTRACT

Background. DLS is defined as the slippage of one vertebra over the one below, in association with intervertebral disc degeneration and arthritis of the facet joints of the involved vertebrae, which will cause canal stenosis.

Purpose. The primary objective of this study is to compare the outcome after surgical intervention (with neural decompression, fusion and fixation) in proved patients with lumbar degenerative spondylolisthesis (DLS).

Patients and methods. Fifty patients with symptomatic DLS, in the period between October 2021 and March 2023, graded using Myerding scale, operated on by instrumented posterolateral fusion and decompression. Mean patients' age at surgery was 50 years (range, 49–69). Surgical results were evaluated using ODI. Lumbar spine radiographs were used to evaluate the status of fixation constructs, the sagittal balance and the status of fusion.

Results. Intraoperative and postoperative complications were encountered, but all were relatively not significant. Follow up time was 18 months. Clinical outcome was good or very good in 30 patients and satisfactory in 13 patients. This research showed that surgical intervention in patients with DLS is a valid option for addressing the clinical symptoms, surgical outcome, planned pain relief and return to daily activity.

Conclusion. DLS is a common pathology, many treatment options are available including conservative and surgical, surgery is a valid option for candidates with DLS as it aims to decompress the neural tissue and correct sagittal balance.

Keywords: degenerative lumbar spondylolisthesis, posterolateral spinal fusion, pedicle instrumentation

INTRODUCTION

Derived from the Greek (spondylo spine, olisthesis slip), spondylolisthesis describe a spectrum of conditions that share the common ingredient of one vertebra having shifted forward relative to its neighbor. Spondylolisthesis may manifest with symptoms ranging from back discomfort to cauda equina syndrome. For those with mild symptoms with minimal deformity, observation is often all that is necessary. For others with neurologic impairment and progressive deformity, spinal decompression, deformity correction, and fusion may be advisable. Gravity and longitudinal muscle contraction on the lordotic lumbar spine and pelvis apply force to lower lumbar vertebrae with a caudal–ventral vector. Left unchecked, these forces would cause the lower lumbar vertebrae to slip and rotate forward relative to the sacrum. Such forces are normally counteracted by several anatomic structures: the superior and inferior facets, the posterior arch, pedicles, and disc. It is the failure of one or more of these structures that lead to the forward slippage of the vertebra over time—the condition of spondylolisthesis. As the vertebra shifts forward, it carries the cephalad levels of the spine with it. This pathologic spinal malalignment can lead to the development of axial back pain; spinal stenosis; compensatory changes to other regions of the spine, pelvis, and lower extremities; and, in severe cases, regional or global sagittal malalignment [1].

Several pathologic conditions can lead to the radiographic finding of spondylolisthesis. Five etiologies of spondylolisthesis are defined by the broadly

Corresponding author:
Abdulrahman Kamal Faisel
E-mail: Medicalresearch64@yahoo.com

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adopted classification of Wiltse et al. [2]. Recognition of the potential for surgical decompression to destabilize the spine led to the addition of a sixth type: iatrogenic. Most spondylolisthesis cases are of the dysplastic, isthmic, and degenerative types [2].

Dysplastic congenital anomalies of the posterior elements can significantly compromise their normal buttressing function. Spina bifida and elongation of the facets are common findings. As L5 shifts forward relative to the sacrum, stenosis at the lumbosacral junction can occur. Even in low-grade slips (less than 50%) severe stenosis can occur with cauda equina compression [1].

Failure of the pars interarticularis in the child is termed spondylolysis. The pars can fail by three mechanisms: Fatigue fracture (most common), Elongated pars due to repetitive healed fractures, and Acute traumatic fracture of the pars [2].

Degenerative spondylolisthesis is the end product of the cascade of disc degeneration and facet complex osteoarthritis. As the disc height narrows, the vertebra subluxes forward (anterolisthesis) or backward (retrolisthesis) relative to its neighbor below. Dynamic translation of the vertebra in combination with spinal stenosis produces the typical symptoms of axial back pain, radiculopathy, and neurogenic claudication. It predominantly affects individuals older than 40 years, women, individuals of African descent, and the L4-5 level. The slip rarely progresses beyond grade II (50%). Initial nonoperative treatment is appropriate and includes anti-inflammatory medications, physical therapy, and occasionally an epidural steroid injection. For patients with persistent or progressive symptoms, surgical intervention provides a high rate of improvement. The benefits of surgery were highlighted in a 2009 report by Weinstein et al. [3] in the multicenter prospective (SPORT) comparison of surgical and nonoperative treatment for degenerative spondylolisthesis.

Analysis of the as-treated groups showed superior functional outcomes with surgery at all early postoperative time points with maintenance of superior results with surgery at 4-year follow-up.

Many forms of surgical intervention are proposed for degenerative spondylolisthesis. Decompression alone is reserved strictly for those patients with a very stiff and degenerative disc at the level to be decompressed. In general, concomitant arthrodesis is recommended to minimize the risk of progressive slip and recurrence of symptoms after decompression. While non-instrumented fusion has a role in select cases, most surgeons prefer the concomitant use of instrumentation to reduce nonunion rates and to improve functional outcomes [4].

In recent years, many surgeons have utilized interbody fusion techniques in their treatment of degenerative spondylolisthesis. Theoretical benefits of interbody fusion are increased surface area for fusion, restoration of foraminal height, augmentation of lordosis, and reduced risk for screw loosening due to partial stress shielding by the interbody support. Popular interbody techniques are the TLIF (transforaminal lumbar interbody fusion), PLIF (posterior lumbar interbody fusion), XLIF (extreme lateral interbody fusion), and ALIF (anterior lumbar interbody fusion).

DLS is best visualized on lateral, standing radiographs (Figure 1) because spondylolisthesis is a dynamic condition, and supine positioning can cause the slip to reduce into normal alignment [5]. For the same reason, computed tomography or magnetic resonance imaging (MRI) can miss spondylolisthesis (Figure 2). In one study, MRI missed 22% of occurrences of lumbar spondylolisthesis that were visible on lateral plain radiographs [6]. Dynamic lateral imaging with flexion-extension views is extremely valuable to determine instability. There is, however, a normal range of motion between lumbar segments. A study looking at asymptomatic individuals showed that 90% had between 1 mm and 3 mm of translation. The researchers concluded that 4 mm of translation was abnormal [7]. Although MRI does not show the degree of slip as consistently, distended facets with increased T2 hyperintensity in the joint can be used as a surrogate. Facet effusions greater than 1.5 mm have been found to be highly predictive of DLS [8]. Given the growing evidence supporting the appropriate assessment and treatment of global spinal balance and pelvic alignment, 36-inch scoliosis films should also be obtained. Significant sagittal imbalance, high pelvic tilt (>20°), or lumbar lordosis–to–pelvic incidence mismatch (>10°) may necessitate treatment beyond management of just the spondylolisthesis.

The Myerding classification is the most commonly applied grading system for spondylolisthesis, rating slip percentage with grades of 0 to V (Figure 1 and box 2); they are defined as follows: Grade 0: spondylolysis without any slip Grade I: a slip of 0% to 25% Grade II: a slip of 26% to 50% Grade III: a slip of 51% to 75% Grade IV: a slip of 76% to 100% Grade V: spondyloptosis, or a slip of more than 100%. Other grading systems have been described but are not widely used. The majority of cases of DLS are known to be grade I or II. There is, however, a large degree of interobserver variation (around 15%) in the radiographic estimate of the amount of slip [9].

PATIENTS AND METHODS

Prospective, multicenter study of fifty patients diagnosed as lumbar degenerative spondylolisthesis (DLS) had at least three months symptoms of backpain and leg symptoms (neurogenic claudica-

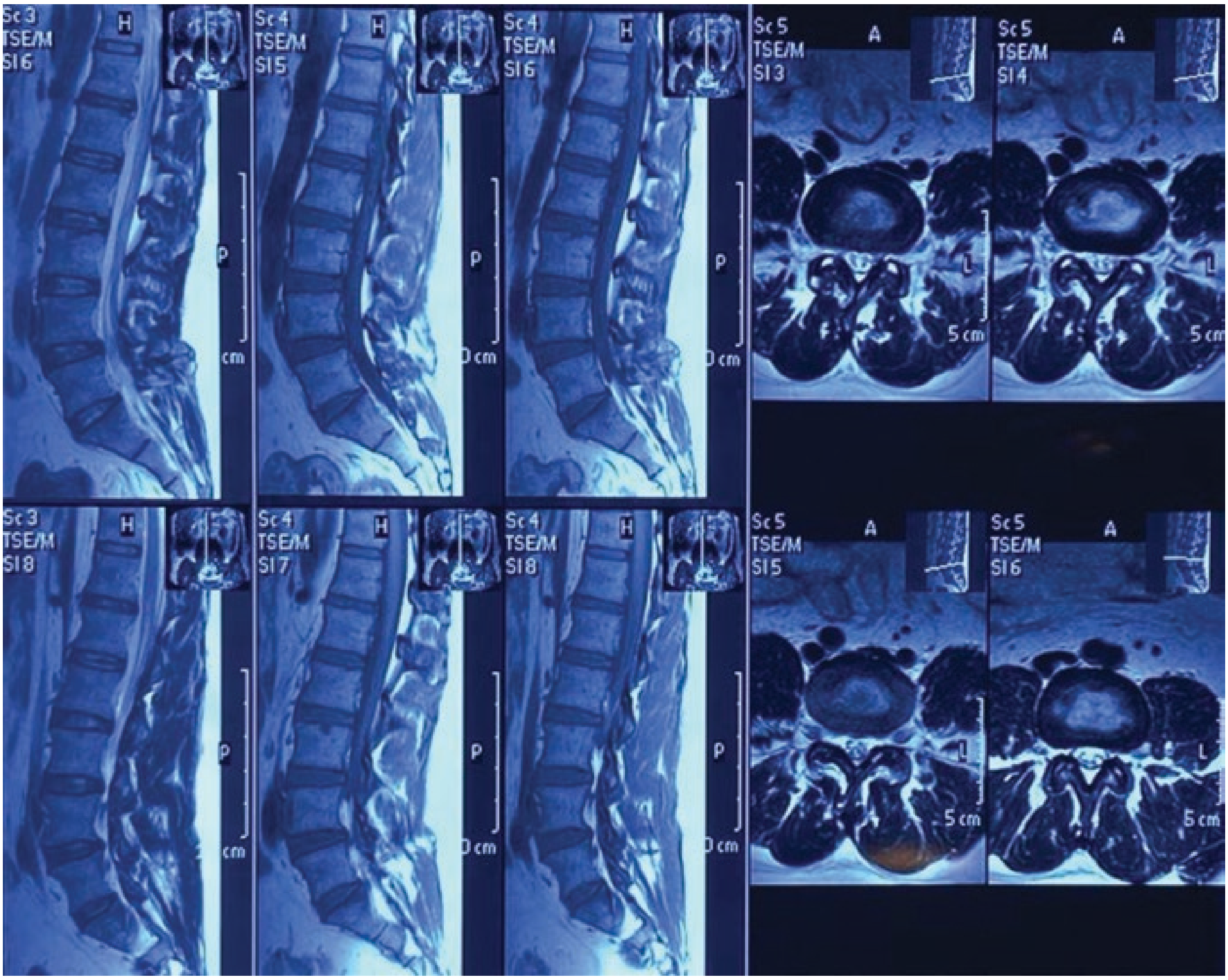

FIGURE 1. Sagittal and axial MR looks normal in DLS patient apart from facet effusion

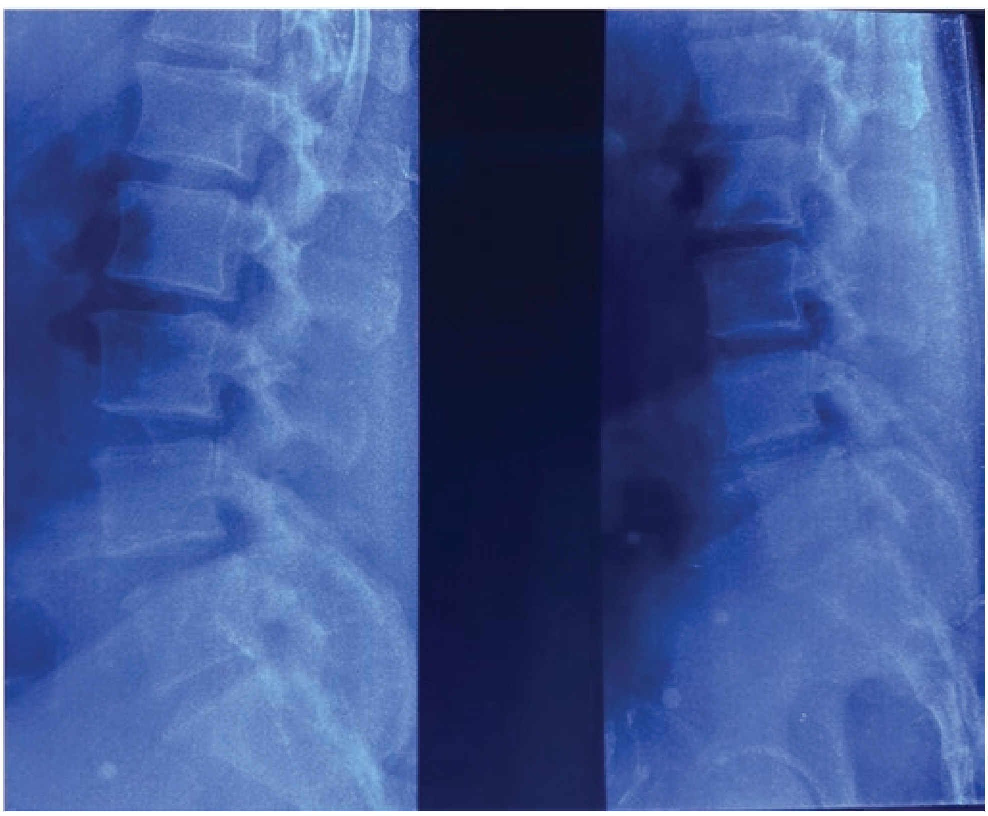

FIGURE 2. Dynamic X-ray showing grade I spondylolisthesis

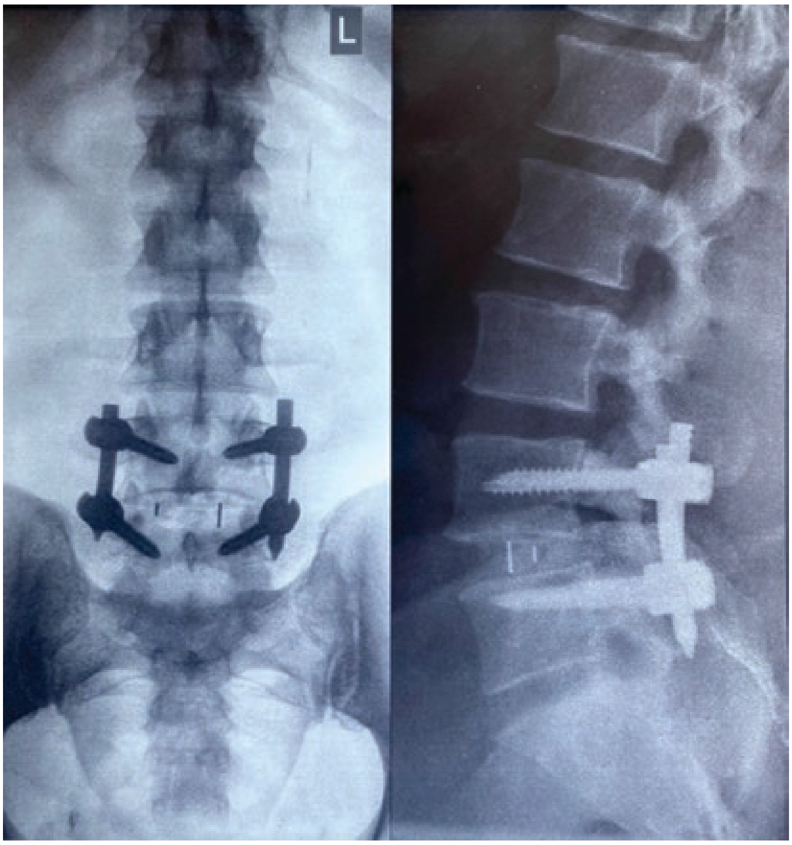

FIGURE 3. Fixation + interbody fusion

tion, radiculopathy or both) and had radiological confirmation of DLS of 50% or less slippage comparing pre and postoperatively in the period between October 2021 and March 2023. All included participants had received conservative management last for about six weeks trial that ended with failure.

The selected patients had an informed consent. Fulfilled the required the radiological, laboratory tests. The treatment includes posterolateral fusion (pedicle screws and rods fixation) with or without interbody fusion (Figure 3).

The outcome observed in many periods, the Oswestry Disability Index is used (a questionnaire of 100 grades scale, the lower the scores the less severe symptoms) immediate post operative within 1st week, 3 months and 6 months intervals. Myerding grading system is used (mentioned earlier). Statistical analysis done by IBM, SPSS version 26. Statistical significance is less than 0.05.

Body mass index (body weight divided by square of height) is depended to evaluate patients' weight. Complications were encountered as following: dural tear, wound complication, implant malposition, neural injury (roots tear), recurrent symptoms and other complication (such as wound hematoma and fixation construct related as loosening).

Inclusion criteria

Patients aged more than 18 years clinically and radiologically confirmed as DLS and are candidates for surgical intervention with documented clinical and radiological follow up for at least six months. Some of them had comorbid risk factors (diabetes mellitus and/or hypertension).

Exclusion criteria

Patients who had history of spine trauma, spine tumor, congenital malformation, infection, metabolic bone disease (apart from treated osteoporosis), had previous lumbar spine operation, or any other pathological disorder related to spine or peripheral nerves.

RESULTS

In Table 1, the middle and old-age groups are more common (62%), this is the expected as the DLS is more common with increasing age, females are more commonly involved in our study (62%). The degeneration of facet joint and disk space will get increase with age (tear and wear theory) so this may explain the rarity in younger age groups.

TABLE 1. Demographics

	No.	%
Age (Years)		
30-39	5	10
40-49	14	28
50-59	28	56
60-69	3	6
Gender		
Male	19	38
Female	31	62

Clinical features were predominantly back pain and leg pain increasing during movement, all patients are graded as I or II according to Myerding scale, Lumbosacral transition vertebra is common condition is (14%) (n.7).

Facet effusion play an essential role in pathogenesis of DLS, this is found in 48% of cases.

Other radiological (high lumbar index and high pelvic incidence) features were not significant in our study (n. 1).

BMI plays an important role in DLS, about three quarters are abnormal. Other comorbid factors may predispose to the condition and the results (postoperative) due to the effects of cell apoptosis and microvascular changes.

In Table 4 the levels that are diagnosed as symptomatic DLS ant involved in the treatment plan.

TABLE 2. Clinical features, Myerding grade, radiological features and disability indices

	No.	%
Symptoms		
Back pain	29	58
Leg symptoms	18	36
Both	3	6
Myerding grade		
Grade 1	10	20
Grade 2	40	80
Preoperative ODI		
25-34	14	28
35-50	36	72
Radiological features		
Sacralized L5	5	10
Lumberized S1	2	4
Facet effusion	24	48
Other*	1	2
None	18	32

**Other radiological features (i.e., increased lumbar index, high lumbar lordosis, Denovo scoliosis)*

TABLE 3. Body mass index and comorbidity risk factors

	No.	%
BMI		
Normal 18.5 - 24.9	13	26.0
Overweight 25 - 29.9	22	44.0
Obese >30	15	30.0
Comorbidity risk factors		
None	27	54
Smoking	10	20
Chronic diseases	10	20
Both	3	6

Some of patients get more than single segment. A significant change in the clinical and functional outcome when compared to preoperative ODI, some of patients had deterioration due to some of the complications that's there is drop in outcome in the 3 months period, most of these are addressed and so that the outcome gets improved again.

Table 5 shown the complication encountered, the dural tear were addressed intra-operatively, the wound related managed while following up the patients they were almost all not significant, some of the implants are corrected post operatively.

Statistical table showing the significant outcomes postoperatively when compared to the preoperative condition regarding the clinical and functional outcomes.

TABLE 4. Levels operated, immediate, 3 months and 6 months postoperative clinical and functional outcomes.

	No.	%
Levels operated		
L5-S1	15	30
L4-5	30	60
L3-4	3	6
L2-3	1	2
L4-5 & L5-S1	1	2
Preoperative ODI		
0-4	15	30
5-14	15	30
15-24	13	26
25-34	6	12
35-50	1	2
ODI post 3 months		
0-4	6	12
5-14	23	46
15-24	15	30
25-34	4	8
35-50	2	4
ODI post 6 months		
0-4	15	30
5-14	15	30
15-24	13	26
25-34	6	12
35-50	1	2

TABLE 5. Complications

Intra and postoperative complications	No.	%
Dural tear	4	8
Wound complications	9	18
Implant malposition	2	4
Neural injury	2	4
Recurrent symptoms	2	4
None	28	56
Other complications*	3	6

**such as wound hematoma, fixation construct related*

TABLE 6. Correlations between pre and post operative ODI

	Preoperative ODI	Postoperative ODI*
Pearson Correlation	1	0.359
Sig. (2-tailed)		0.011**

** Immediate postoperative and six months.*
***Significant P value (less than .05)*

DISCUSSION

In the current study, all patients with DLS associated with a certain degree of canal and/or neuroforamen stenosis, and all underwent spinal decompression and posterolateral instrumented fusion with or without anterior implant. Pedicular screws allows slight distraction and compression between the posterior spinal elements, which may contribute to indirect neuroforaminal decompression and restore the appropriate lordosis. At a mean follow-up time of 18 months, clinical results were good or fairly satisfied in 86% of the patients. No major failure of fixation devices occurred, deep wound infection, significant complications or death along the follow up period.

The middle and old-age groups in this study are more common (62%), this is the expected as the DLS is more common with increasing age, comparable to Da He, et al study [9], in which middle and old age groups were (64%), Females are more commonly involved in our study (62%) and this is identical to The Copenhagen Osteoarthritis Study (62%) are females and this may support the hormonal effects and ligamentous laxity [10].

Clinical features were predominantly back pain and leg pain increasing during movement, this is compatible to Vibert, Silva and Herkowitzs' research [11].

All patients in our results are graded as I or II according to Myerding scale, this is also shown in many researches such as Sansur CA, Reames DL, Smith JS, et al., in which (1760 of 1767 patients) are low grade (grade I and II) [12].

Lumbosacral transition vertebra is common condition, in our study about (14%), this explained that transitional vertebra increases the stress on the proximal vertebral segment (L4-5) and this is comparable to Sekharappa V, Amritanand R, Krishnan V, David KS. study (Lumbosacral transition vertebra), in which (13 %.) [13].

Facet effusion play an essential role in pathogenesis of DLS, this is found in 100% [14], while in our study a 48% had effusion this may be due to different study designs and objectives.

Other radiological (high lumbar index and high pelvic incidence) features were not significant in our study (n. 1) in contrast to Devine JG, Schenk-Kisser JM, Skelly AC. study (Risk factors for degenerative spondylolisthesis) in which those factors were significant [15], this may be attributed to relatively small sample size in our results.

BMI is also significant comorbid factor according to Schuller S, Charles YP, Steib JP. (71.4% above 25 kg/m^2) [16], in our study, 22 patients are overweighted and 15 are obese (74% above the normal BMI range).

Many other factors such as smoking, chronic illnesses and other may affect pre and post management outcomes, and even may contribute to early DLS [17,18]. This may explain some of the complications such as wound breakdown, improved ODI in none smoking group, recurrent symptoms and others, as well as in the pathogenesis as it causes early devascularization and cell apoptosis.in our study (20%) where smokers, this is comparable to Asher Al et al. study (18%).

The DLS segment is most commonly found at the L4-L5 level (70%) in Enyo Y. study [19]. In our study the L4-5 level was 60% (n 30).

In this study the preoperative ODI were 100% equal to or above 25 points, compared to post operative (86%, 78% and 86%) immediate, three months and six months respectively which were equal or below 24 points (improvement), significant effect of surgical intervention is obvious both clinically and statistically (p value=0.011). These relatively good results are compatible with (SPORT) trial in which patients who underwent surgery (more than 80% improvement) appeared to have statistically significantly better outcomes [20,21]. In the 3 months follow up period nine patients developed wound infection this explain the deterioration in ODI.

The complications where comparable in case of dural tear and implant malposition to Feroz Jadhakhan, David Bell, Alison Rushton's research (6%, 1.2%) [22], but not the case for other complications this may be explained by different surgical techniques, surgical skills, and maybe smaller sample size.

CONCLUSIONS

DLS is more common in females (62%) older than 50 years. Epidemiology is expected to increase as the population age increases. Comorbidities and symptoms must be carefully considered to choose the best treatment strategy for each patient individually. Symptomatic patients with DLS will benefit from the appropriate surgery as supported by evidence (86% improved clinical outcome). There is an increasing frequency in lumbar fusion techniques and the most common is posterolateral fusion (out of all cases in our study, interbody fusion appeared only in five patients). Patient selection for surgery is prerequisite for a successful management plan. Randomized controlled studies, longer follow up periods and larger patients' population are required. Comparative studies of different surgical techniques and approaches (i.e., decompression only, posterolateral fusion versus TLIF, ALIF and OLIF) are required.

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