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Unilateral Posterior Fixation, Bone Grafting and Fusion in Treatment of Lumber Spinal Degenerative Disc Disease

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Abstract

Background: The relative high cost of pedicular screws is still an obstacle in treatment of long standing symptomatic degenerative disc disease in developing countries, the health system authorities and the patients are always seeking the lowest cost surgery with the most optimum efficiency and safety.

Aim of Study: To determine the efficacy of unilateral pedicular instrumentation in treatment of single level DDD in terms of fusion, hospital stay, time of surgery, blood loss, screw complications and cost.

Patients and Methods: The present study was case series study conducted on 40 patients with long standing DDD had unilateral posterior pedicular fixation with interbody bone grafting and posterolateral fusion, Follow-up was carried on up to 24 months with radiographs done 1st day P.O, 3 and 12 months. Oswestry Disability Index (ODI) was applied to evaluate the patients preoperatively and after 12 months.

Results: This study found that 12.5% had excellent improvement, 70% of patients had good improvement, while 12.5% had fair improvement and 5% had poor improvement. Also, 95% of patients had fusion by radiological assessment.

Conclusion: Unilateral pedicle screw fixation is recommended as an optimal surgical method for single level lumbar degenerative disc disease compared to bilateral fixation.

Key Words: *Bone grafting – Fixation – Fusion – Spinal degenerative disc disease.*

Introduction

THE degenerative disease of the intervertebral disc and back pain are chronic conditions that are caused by several factors and represent an important cause of morbidity and mortality in everyday clinical practice **[1]**.

Nevertheless, degenerative disc disease is one of the most common sources of back pain and affects approximately 30 million people every year. With symptomatic degenerative disc disease, the pain can vary depending on the location of the affected disc. A degenerated disc in the lower back can result in lower back pain, sometimes radiating to the hips, as well as pain in the buttocks, thighs or legs. If pressure is being placed on the nerves by the exposed nucleus pulposus, sporadic tingling or weakness through the knees and legs can also occur **[2]**.

The most widely accepted algorithm in the literature is medical treatment for an appropriate period of time, physical therapy and minimally invasive pain-relieving therapies, if necessary, followed by surgical interventions. The most common surgical intervention is the decompression of neural elements followed by pedicle screw fixation (PSF) for fusion. Together with the definition of transforaminal lumbar interbody fusion (TLIF) by Harms, particularly after 1990s, TLIF procedures are added to the pedicle screw practices, and many authors in the literature reported that a more strong and reliable fusion could be possible with this technique **[3]**.

In recent years, there is an ongoing discussion in the literature on whether the pedicle screw fixation implemented together with TLIF in order to have a more strong, reliable, less invasive, less expensive fusion with less complications, should be implemented unilaterally or bilaterally **[4]**. In fact, traditionally practiced bilateral PSF and instrumentation performed together with TLIF can be regarded as a convenient procedure for a reliable, effective and biomechanically sufficient fusion **[5]**.

The aim of the present study was to determine the efficacy of unilateral pedicular instrumentation in treatment of single level DDD in terms of fusion,

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hospital stay, time of surgery, blood loss, screw complications and cost.

Patients and Methods

This study included 40 patients of degenerative lumber disc disease. Inclusion criteria was failure of at least 3 months of non-surgical treatment, single level DDD with unilateral sciatica or bilateral, no pervious spinal surgery, no previous spinal tumor or fracture, no history of vascular peripheral LL surgery. No history of peripheral ischemia or symptomatic peripheral nerve diseases.

Total of 63 patients had unilateral instrumented fusion (Posterolateral fusion augmented by transpedicular screws and rods. 3 fixation systems were used included CDH (medtronic), expeduim (J&J), (megatech), with TLIF. Only 40 continued the follow-up where 23 patients didn't have regular follow-up, the data were collected from the hospital records. All cases were operated upon Nasrcity Insurance Hospital, Cairo, between June 2012 - June 2015. The mean follow-up period was 30 months (range 24-36 months).

The following methods were applied for the studied cases History Taking, Examination including Vital signs (pulse, arterial blood pressure and temperature, Sensory deficits, Motor deficits, Sphincteric disturbances, Back examination and deformity.

Routine laboratory investigations including During preoperative preparation of the patients all cases were subjected to complete blood picture, blood glucose, liver and kidney functions and bleeding profiles.

Radiological investigations including Plain X-ray lumbosacral spine (Anteroposterior view and Lateral view) and magnetic resonance imaging lumbosacral spine: It was performed in all cases to define.

Preoperative preparation includes history taking, clinical examination, laboratory and radiological investigations, selection for surgery, surgical technique, prophylactic antibiotics, shading of skin at the operative field and proper sterilization using betadinc antiseptic solution.

Operative procedures by Transpedicular Screw Fixation with Posterolateral Fusion and interbody fusion by cage.

Postoperative management includes removal of Drain after 24 to 48 hours or less than 50ml/12 hrs of output, Preoperative antibiotics were continued for 2 days postoperative, Non-steroidal anti-inflammatory drugs were used for seven to ten days, Oral diet, rich in protein, vitamins and calcium was started in the second day, Patients were ambulant in the second postoperative day, Stays in hospital 4-6 days before discharge, Wear a lumber brace for 3 months, Patients can return to a desk job at 1 month, light duty labor jobs at 3 to 6 months, and heavy duty labor jobs at 6 to 12 months.

Patients were followed clinically by oswestry disability index assessment and physical examination and radiologically by anteroposterior & lateral radiograph immediately postoperative, at three, 3, 6, 12, 18, then annually up to 66 months postoperative, with minimum of 12 months and maximum of 66 months.

Statistical methods:

Results were analyzed using SPSS (ver. 25.0; IBM, Chicago, IL, USA). Quantitative data was displayed in the form of mean ± standard deviation (SD). Qualitative data was demonstrated through figures of frequency and percentage. Charts were be used to illustrate data and relations where appropriate and $p<0.05$ was accepted as indicating statistical significance.

Results

Regarding patients different grades of post-operative improvement, 70% of patients had good improvement, 12.5% had excellent improvement while 5% had poor improvement and 12.5% had fair improvement. Also, 95% of patients had fusion by radiological assessment (Table 1).

Statistically significant difference was found between pre and post-operative score ($p<0.0001$) (Table 2).

Table (1): Post-operative improvement among the patients included.

	No.	%
Degree of improvement:		
Poor	2	5
Fair	5	12.5
Good	28	70
Excellent	5	12.5
Fusion	38	95

Table (2): Comparison between pre and post score the patients included.

Score	Mean ± SD	Test-value	*p*-value
Pre-score	68.15±4.7	38.33	<0.000*[1]
Post-score	17.25±8.2		

1 Paired *t*-test used. *Statistical significant as $p<0.05$.

There was no statistical significant difference between patients with different grades of improvement as regards age and gender (p>0.05) (Table 3).

There was no statistical significant difference between patients with different grades of improvement as regards clinical presentations (p>0.05) (Table 4).

There was no statistical significant difference between patients with different grades of improvement as regards duration and pre-operative score (p>0.05), while post-operative score was lowest among patients with excellent degree of improvement with statistical significant difference (p<0.0001) (Table 5).

Patients had mean duration of disease of 18.07±3.5 months. Their pre-operative score mean was 68.15±4.7 while their post-operative score mean was 17.25±8.2 (Fig. 2).

Table (3): Characteristics of the patients included according to degree of improvement.

Items	Degree of improvement				Test value	*p*-value
	Poor	Fair	Good	Excellent		
Age	46.5±3.5	48±6.4	49.04±5.4	47.6±7.6	0.212	0.887[1]
Gender:						
Male	1 (2.5%)	4 (10%)	15 (37.5%)	1 (2.5%)	3.4	0.341[2]
Female	1 (2.5%)	1 (2.5%)	13 (32.5%)	4 (10%)		

1. ANOVA test used.
2. Fisher-exact test used.
*Statistical significant as p<0.05.

Table (4): Clinical presentations of the patients included according to degree of improvement.

Items	Degree of improvement				Test value	*p*-value
	Poor	Fair	Good	Excellent		
Back pain	2 (5%)	5 (12.5%)	27 (67.5%)	5 (12.5%)	2.8	0.491[1]
Sciatica	2 (5%)	4 (10%)	19 (47.5%)	3 (7.5%)	1.18	1.00[1]
Claudication	0 (0%)	3 (7.5%)	12 (30%)	1 (2.5%)	2.65	0.477[1]

1. Fisher-exact test used.
*Statistical significant as p<0.05.

Table (5): Oswestry disability index (ODI) of patients according to degree of improvement.

Items	Degree of improvement				Test value	*p*-value
	Poor	Fair	Good	Excellent		
Duration (months)	14±0.0	14.2±4.9	18.6±3.2	18.4±1.1	2.74	0.058[1]
Pre-score	68±5.7	66.8±4.1	67.9±5.1	70.8±2.3	0.673	0.574[2]
Post-score	42±2.8	26.8±3.6	15.07±4.2	10±0.0	47.14	<0.0001*[2]

1. ANOVA test used.
2. Kruskal-wallis test used.
*Statistical significant as p<0.05.

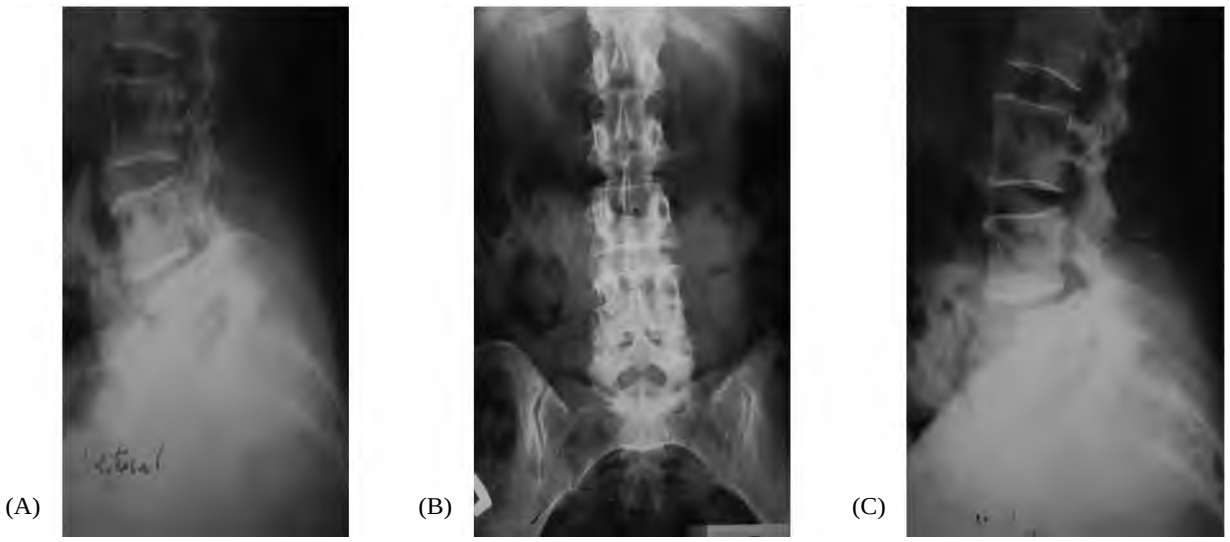

Fig. (1): Preoperative X-ray (A: Neutral, B: A/P, C: Lateral standing).

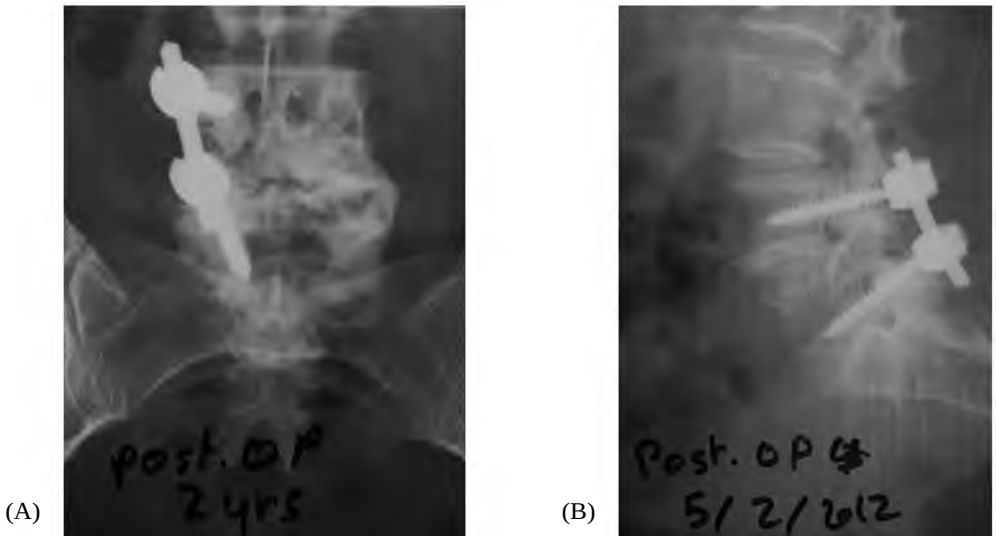

Fig. (2): Post op X-ray (A: A/P and B: Lateral views).

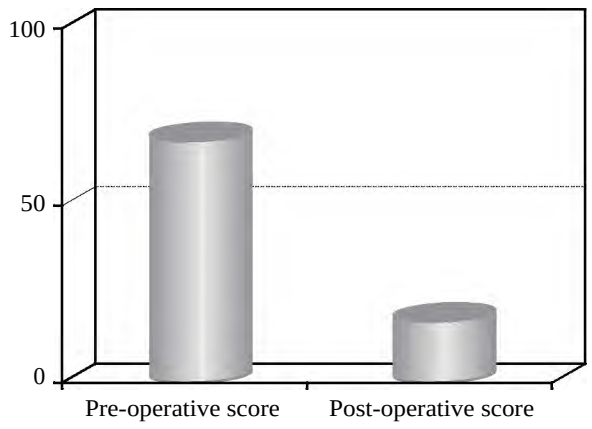

Fig. (2): Oswestry disability index (ODI) in the patients included.

Discussion

Unilateral pedicle screw fixation has been found to achieve stability and fusion rates similar to those of bilateral pedicle screw fixation in the treatment of patients with single-segment degenerative lumbar instability as well as in the treatment of patients with double-segment degenerative lumbar instability **[6].**

However, these studies used conventional lumbar fusion surgery that has drawbacks, such as the need for extensive soft tissue dissection with resulting iatrogenic tissue injury, which can lead to increased pain postoperatively, longer recovery duration, and impairment of spinal function **[7].**

While making a traditional lumbar midline incision, the dorsal and medial rami of the lumbar spinal nerves may be easily damaged during the stripping of the paraspinal muscles, leading to denervation of the multifidus muscle that plays an important role in maintaining the dynamic stability of the spine. In addition, the prolonged traction during the operation can also result in edema and ischemic necrosis of the muscle. These constitute the important factors that contribute to postoperative intractable low-back pain **[8]**.

After Goel et al., **[9]** first reported the benefits of unilateral pedicle screw fixation; several clinical trials have found that unilateral pedicle screw fixation is as effective as bilateral pedicle screw fixation in lumbar spinal fusion.

In spinal fusion surgery, the need for unilateral or bilateral instrumentation is a controversial matter. Nevertheless, wide-ranging destruction of tissue structures, which exacerbated considerably the unsteadiness of the spine, was used in these in vitro biomechanical studies. In addition, the maintenance of lumbar stability simply relied on unilateral pedicle screw fixation without any support device. At present, a general consensus was that unilateral instrumentation should be confined to a single-level fusion and not be extended to multilevel fusion becauseof its inadequate fixation strength **[10]**.

Although minimally invasive techniques for treating patients with lumbar instability have been increasingly advocated, prospective studies directly comparing minimally invasive techniques with conventional techniques are lacking **[11]**.

So this study aimed to decrease the cost and time of surgery for treatment of single degenerative lumber disc disease. This quasi-experimental study included forty patients diagnosed with symptomatic lumber degenerative disc disease with or without other chronic diseases. The participants were selected from those attended to Orthopedic Department, Nasrcity Insurance Hospital, Cairo.

This study patients' age ranged from 40 to 59 years with mean of 48.6±5.55 years. Male was 52.5% of studied group while female was 47.5%. 97.2% of patients presented with back pain, 68.3% had sciatica and 39% had claudication. In this study, patients had mean duration of disease of 18.07±3.5 months. Their pre-operative score mean was 68.15±4.7 while their post-operative score mean was 17.25±8.2. Patients had mean hospital stay of 5.3±1.3 days. Blood loss mean was 86.25± 22.15ml. Also their mean improvement rate was 75.03±11.7.

Similar to the demographic characteristics of patients in Dong et al., **[11]** study which a total of 39 consecutive patients with single-segment degenerative lumbar instability were enrolled. The mean age of patients was 55.3±13.3 years and the mean hospital stay was 17.2±5.0 days. The majority of patients were female (69.2%). Most patients experienced pain at L4-5 (69.2%). The unilateral group had a significantly shorter operative duration (p=0.038) and less blood loss (p<0.001) compared with the bilateral group. All patients in the 2 groups were followed-up between 28 and 43 months (mean 36 months).

It is not uncommon clinically to have patients suffering from degenerative lumbar instability concomitant with unilateral radicular symptoms of a lower extremity undergo treatment using ipsilateral nerve root decompression and interbody fusion, which results in a favorable clinical outcome **[12]**.

It has also been found in biomechanical and clinical studies that unilateral fixation can help restore enough stability in single-segment degenerative instability and instability after decompression to meet the needs of patients for interbody fusion of the diseased segment. This can avoid contralateral surgical procedures and reduce intraspinal procedures, muscle stripping, operative time, intraoperative blood loss, and medical expenses, and quicker recovery can be expected for patients after unilateral surgery in comparison with conventional bilateral fixation. Similar postoperative inter-body fusion rates and a similar incidence of complications as compared with bilateral fixation can be expected, and reduced stiffness at the level that has been internally fixed is theoretically able to help reduce the incidence of adjacent-segment degeneration **[13]**.

Although no uniform criteria have been established, it has been generally accepted that interbody fusion for the treatment of degenerative lumbar instability can be performed. However, there has been a debate about whether there is a need to perform bilateral fixation, an internal fixation of high stiffness, if simple lumbar instability is shown only by dynamic radiography or if there is just mild instability in patients with spondylolisthesis of less than Grade 2 **[14]**.

This is why unilateral fixation is performed in unilateral PLIF or TLIF intended for patients with mild degenerative instability who present with

unilateral radicular symptoms. Suk et al., **[15]** and Fernández-Fairen et al., **[16]** went even further, applying such a technique to fix Grade 2 degenerative spondylolisthesis, isthmic spondylolisthesis, and double-segment lumbar instability, but the incidence of failed internal fixation was found to have increased.

Therefore, the indications should be strictly followed; the patients selected should be limited to only those suffering from unilateral radicular symptoms before surgery, and careful radiographic evaluation should be conducted to exclude the presence of contralateral nerve root canal stenosis. Due to the limitations and difficulties in operating the tubular retractor, its application is not advocated in severely obese patients or those with high-seated iliac crests. Because a patient with mild degenerative instability at a single segment, as occurs in spondylolisthesis less than Grade 2, can have the displaced segment restored to different extents simply by placing the patients prone (which may not be done), unilateral fixation can be expected to prepare the patient well for interbody fusion **[17]**.

Deutsch and Musacchio **[18]** reported mean blood loss of 100ml using minimally invasive surgery, it was higher than in our study (86.25ml). The light source attached to the retractor blades can provide clear visualization for the precise and focused decompression of the nerve root canal, and the surgery should be focused on procedures that involve the nerve roots, such as decompression. The utilization of a nerve root retractor along with the other instruments to protect the nerve root is the key to avoiding injury to the nerve roots. As a result, no nerve root injury occurred in the unilateral group of this study.

In our study we had one incidental dural tear which was detected and managed intra-operatively, there is no nerve root injury in this patient or any other .

Deutsch and Musacchio **[18]** reported no permanent neurological injuries in their study. Previous clinical practice and a recent biomechanical study have shown that unilateral fixation can be used in patients with double-segment degenerative instability for interbody fusion **[12,17]**. However, we did not include patients with double-segment lumbar instability in our study.

In our study, patients with different grades of post-operative improvement which showed that 70% of patients had good improvement, 12.5% had excellent improvement while 5% had poor improvement and 12.5% had fair improvement. Also, 95% of patients had fusion by radiological assessment with statistically significant difference between pre and post-operative score ($p<0.0001$) with statistical significant differences between patients with different grades of improvement as regards hospital stay, improvement rate and fusion ($p<0.05$).

In Dong et al., **[11]** study the time trends of the 2 groups were slightly different. In the unilateral group, the back pain VAS score decreased from 8.5 at the beginning to 2.38 at 1 week, 1.23 at 3 months, 0.55 at 1 year, and 0.25 at 2 years after the operation; the back pain VAS score significantly decreased through the whole study period. However, the decrease of the back pain VAS score in the bilateral group was only significant during the 1st year after surgery (from 8.29 before surgery to 0.61 at 1 year after surgery); after that, the VAS score slightly and nonsignificantly declined to 0.45 at the end of the study. The preoperative leg pain VAS scores in both groups were similar ($p=0.0633$) and significantly declined over time ($p<0.001$). The preoperative leg pain VAS score in both groups was 7.14 initially and then significantly declined to 0.53 at 3 months, 0.10 at 12 months, and 0.06 at 2 years.

In our study, after 1 year, 12.5% had excellent improvement in their back pain, 67.5% had good improvement, 10% had fair improvement while only 5% had poor improvement. Regarding sciatica, 7.5% had excellent improvement, 47.5% had good improvement, 10% had fair improvement and 5% had poor improvement. Lastly, claudication improved in 2.5% excellently, 30% had good improvement, 7.5% had fair improvement and no one had poor improvement.

Suk et al., **[15]** found a lower fusion rate for unilateral pedicle screw fixation than bilateral pedicle screw fixation (91.5% vs 97.5%, respectively) after posterolateral fusion.

Xue et al., **[19]** also reported a lower fusion rate for unilateral pedicle screw fixation (91.9% vs 93.0%), although this difference was not statistically significant.

In Ohtori et al., **[20]** study, the proportion of patients with, or rate of successful bone union in the unilateral fusion group was significantly higher than that in the bilateral group. There was no significant difference in the total amount of local bone graft between the 2 groups; however, the volume in the unilateral group was twice that in the bilateral group.

Deutsch and Musacchio **[18]** conducted a prospective study of 20 patients who underwent minimally invasive TLIF with unilateral pedicle screw fixation and were followed-up from 6 to 12 months. The patients were evaluated postoperatively with the ODI, and a 20-point reduction was defined as a good result. A good result was achieved in 85% of the patients. Computed tomography showed that 13 patients had some degree of fusion at the 6-month follow-up. Although the patients were not followed-up for longer than 1 year, the results suggested that the minimally invasive procedure was effective.

In Suk et al., **[15]** study, the clinical outcomes of lumbar fusion (L3-L4, L4-L5, L3-L5) in the unilateral group were 84.3% satisfactory. The fusion rate in lumbar fusion in the unilateral group was 90.6%.

In this study, we had 95% fusion mass on x-ray after 3-6 months, no symptomatic pseudoarthrosis was detected throughout the follow-up of the patients included. In agreement with Suk et al., **[15]** study in which the clinical outcomes of one-segment fusion in the unilateral group was 84.4% satisfactory. The fusion rate of one-segment fusion in the unilateral group was 93.7%.

Our study found significant direct moderate correlation between post-operative score and hospital stay. Post-operative score had significant indirect perfect correlation with degree of improvement while had significant indirect moderate correlation with fusion.

This is in agreement with a recent meta-analysis in which twelve RCTs including 808 patients (unilateral pedicle screw fixation=393, bilateral pedicle screw fixation=415) were included in this meta-analysis. There was a significant difference between unilateral pedicle screw fixation and bilateral pedicle screw fixation in terms of the fusion rate (risk ratio (RR)=0.96, 95%CI [0.92, 1.00], p= 0.073), visual analog scale (VAS) at final follow-up, Oswestry Disability Index (ODI), Japanese Orthopedic Association scores (JOA), short-form health survey (SF-36), and length of hospital stay. Compared with bilateral pedicle screw fixation, unilateral pedicle screw fixation was associated with a reduction of the total blood loss and operation time (p<0.05). Unilateral pedicle screw fixation was associated with an increase of the cage migration than bilateral pedicle screw fixation (17.1% vs 7.1%, RR=2.40, 95% CI=1.17 to 4.93; p=0.017) **[21].**

There was no detection of cage migration throughout our study in all the included patients.In Zhang et al., **[8]** the operation time, blood loss, and the length of hospital stay were took for evaluating surgical trauma and economic costs. The results showed that unilateral pedicle screw fixation was associated with a reduction of the operation time and blood loss than bilateral pedicle screw fixation. No significant difference was found for the length of hospital stay. Since unilateral pedicle screw fixation only needs dissection on one side of the soft tissue and paravertebral muscles and insertion on the side of the pedicle screw, it can accordingly reduce the operation time and blood loss as compared with bilateral pedicle screw fixation. Moreover, lesser soft tissue dissection may allow for early functional recovery. In theory, unilateral pedicle screw fixation may be related with the short length of hospital stay. In the current meta-analysis, we found no significant difference between the two groups in terms of the length of hospital stay.

In Dahdaleh et al., **[13]** study the average estimated blood loss was significantly lower in the unilateral instrumentation group than in the bilateral instrumentation group (95ml vs 156ml, respectively; p=0.03). The average duration of hospitalization was less in the bilateral group than in the unilateral group (2.8 days vs 4.1 days, respectively; p=0.02).

In our study, the average blood loss mean was lower as 86.ml among all the included patients as follow, 88ml in patients with excellent improvement, 83.9ml in patients with good improvement, 100ml in fair improvement patients, and 80ml in poor improvement patients. Regarding hospital stay the average hospital stay was 5.3 days in our study.

Conclusion:

Unilateral pedicle screw fixation had low total blood loss and operation time for lumbar degenerative diseases. Post-operative score had significant indirect perfect correlation with degree of improvement while had significant indirect moderate correlation with fusion. Unilateral pedicle screw fixation is recommended as an optimal surgical method for single level lumbar degenerative disc diseases.

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التثبيت الخلفى الاحادى والترقيع العظمى فى علاج خشونة الغضاريف القطنية

المقدمة : التكلفة العالية لعمليات تثبيت الفقرات مع مخاطر الجراحة فى علاج أمراض خشونة الغضاريف القطنية تمثل عائق أمام النظم الصحية فى البلاد النامية.

الأهداف : تحديد مدى كفاءة إجراء جراحات تثبيت مستوى واحد فى الفقرات القطنية بالتثبيت الاحادى الخلفى مع الترقيع العظمى.

الوسائل : تم إجراء الجراحة لتثبيت لعدد مريض مصاب بخشونة مستوى واحد بالفقرات القطنية، متابعة المرضى بعد الجراحة لمدة سنتان وقياس المعدلات المختلفة قبل وأثناء وبعد الجراحة ومعدلات الشفاء والتحسن طبقاً لمعيار علمى معتمد دولياً.

النتائج : وجدت الدراسة تحسن نسبة ١٢.٥٪ تحسن ممتاز، ٧٠٪ تحسن جيد، ١٢.٥٪ تحسن عادل، ٥٪ تحسن طفيف. والتئام عظمى للتثبيت بنسبة ٩٥٪.

الخلاصة : خشونة غضاريف الفقرات القطنية، تثبيت الفقرات على ناحية واحدة، ترقيع عظمى.