

Transforaminal Lumbar Interbody Fusion: Does it Affect Lumbar Lordosis and Disc Height Really?

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Abstract

Background: Measurement of lumbar lordosis (Cobb's angle) and disc height in cases of single level lumbar fixation operated by posterolateral fixation with transforaminal interbody fusion and compare them with traditional posterolateral fixation without cage insertion.

Aim of Study: To determine if the usage of transforaminal interbody fusion would affect both lumbar lordosis and disc height or not.

Patients and Methods: The present study retrospectively was done for 40 patients who underwent single level lumbar fixation in Cairo and Fayoum University Hospitals, between January 2019 and December 2020. The patients were divided in two groups 20 in each, group A in which patients operated upon by transforaminal interbody fusion (TLIF) together with transpedicular screws and group B in which patients operated upon by posterolateral fixation with transpedicular screws without cage insertion. In this study, the disc height and lumbar lordosis variations were evaluated by analysing spinal radiographs preoperatively, postoperatively and at 6 months follow-up.

Results: In group A, there was a statistically significant increase in the mean of disc height immediately postoperative, then decrease after 6 months follow-up with p -value <0.05 . In addition, there was a statistically significant increase in the mean of lumbar lordosis immediately postoperative with p -value <0.05 , but no significant change after 6 months follow-up with p -value >0.05 . In group B there was no statistically significant change in the mean of disc height immediately postoperative, but there was a statistically significant increase after 6 months follow-up with p -value <0.05 . Regarding lumbar lordosis, there is no statistically significant change in the mean of lumbar lordosis postoperatively with p -value >0.05 .

Conclusion: Transpedicular fixation with transforaminal interbody fusion (TLIF) shows statistically significant increase in disc height and lumbar lordosis compared to posterolateral fixation without cage insertion.

Key Words: Lumbar fixation – TLIF – Disc height – Lumbar lordosis.

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Introduction

IN the last decade, there has been a dramatic increase in the number of lumbar instrumentations performed. Indications for lumbar instrumentations include, but are not limited to, discogenic back pain, spondylosis, spondylolisthesis, and post decompression instability [1].

A common goal of lumbar spinal surgery is to improve or restore sagittal balance. Loss of lumbar lordosis is common in degenerative lumbar pathology secondary to disk space collapse. Loss of lumbar lordosis associated with positive sagittal balance has been repeatedly identified as a factor which is strongly associated with patient dissatisfaction [2-5].

Studies indicate that the reestablishment and the increase of the disc height obtained by the interbody fusion provide an increase in the lumbar lordosis, an indirect decompression of the neural foramen, as well as improved clinical postoperative results [6].

Recent clinical evidence indicated that if fusion surgery was undertaken, good short- and long-term outcomes could be achieved when the spine had a good improvement in postoperative sagittal alignment. It seems that surgeons should pay more attention to the postoperative changes of the spinopelvic parameters [7].

There is evidence that after the realization of the lumbar fusion techniques, the reduction in lumbar lordosis may cause degenerative processes of adjacent segments and anterior body inclination, resulting in chronic pain. Therefore, the lumbar lordosis analysis in patients who underwent lumbar fusion procedures is relevant [8].

Material and Methods

This is a retrospective study conducted in Cairo University Hospitals and Fayoum University Hospitals, in the Department of Neurosurgery. All patients were reviewed for detailed history, clinical examination and investigations. The operations were performed on those who had persistent low back pain, radicular pain, or neurological claudication despite conservative treatment for at least 3 months.

This study is designed to include 2 groups. Group A includes 20 patients with transpedicular screws and TLIF while Group B includes 20 patients with posterolateral transpedicular fixation with total number of 40 patients of both groups. Inclusion criteria were single level spondylolisthesis (degenerative or lytic spondylolisthesis) and discogenic back pain with no specific gender. Exclusion criteria were spondylodiscitis, traumatic spondylolisthesis, scoliosis, multilevel TLIF, recurrent conditions.

All patients were subjected to thorough history taking and clinical examination with special attention to age, gender, neurological deficits include spontaneous progressive weakness, sphincteric troubles and sensory changes in both lower limbs, history of chronic illness, osteoporosis, hormonal disturbance, steroid therapy or radiation therapy, and special habits e.g. smoking, alcoholism.

Clinical findings include assessment of general condition of the patient, assessment of surgical fitness and neurological examination: Motor function (power, superficial & deep reflexes), sensory affection (anaesthesia with sensory level or hypoesthesia) and sphincter affection.

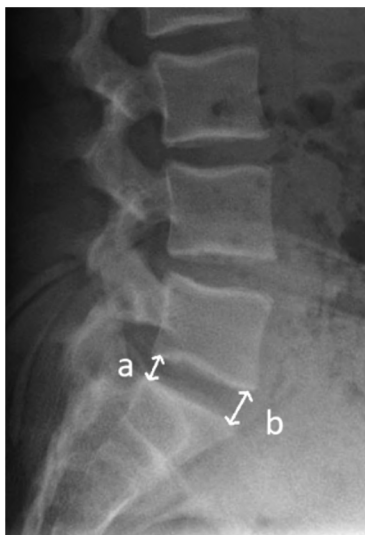
Radiological investigations include plain X-rays of the lumbar spine with lateral view and anteroposterior view from which:

- Lumbar Lordosis (LL) was measured via Cobb's angle as the angle of superior end plate of S1 vertebra to the superior end plate of L1 vertebra (Fig.1-A).
- Disk Height was measured as the mean value of the foremost intervertebral disk height and the most posterior one (Fig.1-B).

Also, MRI of the lumbar spine was performed for all patients to assess the neural elements with good visualization of neural canal components and intervertebral discs.

Patients were assigned into two groups:

- Group (1): 20 patients were operated upon via posterior approach by fixation with transpedicular screws then insertion of transforaminal interbody cage (TLIF).
- Group (2): 20 patients were operated upon via posterior approach by fixation with transpedicular screws without interbody cages.



(A)



(B)

Fig. (1): (A) Measurement of lumbar lordosis (cobb's angle), (B) Measurement of disk height.

Postoperative medical treatment includes antibiotics, analgesics, gastric protecting drugs, IV fluids and neurotropic drugs. Early follow-up includes post-operative neurological status, radiological evaluation of the fixation system and cage. Later follow-up after 6 months was done for assessment of functional outcome regarding improvement of back pain and lower limb pain (via Oswestry disability index) and radiological assessment of lumbar lordosis and disc height.

Results

In all patients, the pathology was at L4-5 or L5-S 1. In group (A) there were 15 patients with L4-5 pathology and 5 patients with L5-S 1. In group (B) there were 11 patients with L4-5 pathology and 9 patients with L5-S 1 (Fig. 2).

All patients (100%) in the study were complaining from dull aching low back pain. Nine patients (22.5%) had unilateral radiculopathy, and thirty-one patients (77.5%) had bilateral radiculopathy, three patients (7.5%) had sphincteric disturbance and only one patient (3%) had weakness.

In group (A) 20 patients with low back pain, 15 patients with bilateral radiculopathy, 5 patients with unilateral radiculopathy, 2 patients with sphincteric disturbances and no weakness.

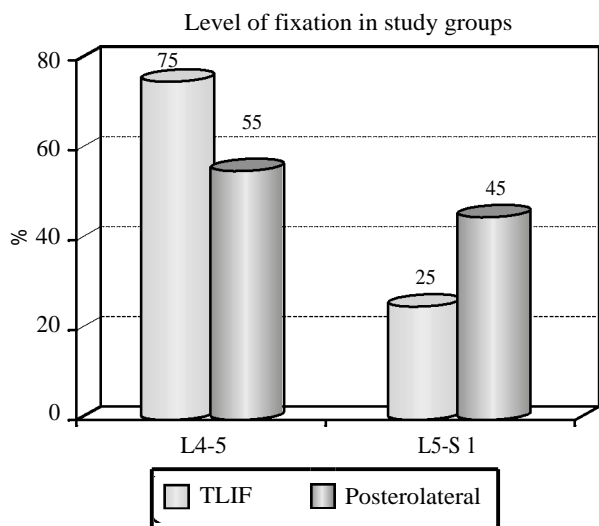


Fig. (2): Comparison of level of fixation in both.

In group (B) 20 patients with low back pain, 16 patients with bilateral radiculopathy, 4 patients with unilateral radiculopathy, 1 patient with sphincteric disturbances and 1 patient with weakness in dorsiflexion.

Postoperative pain was assessed using the Oswestry Disability Index (OWI) pre and postoperatively in last follow-up in both groups. In group

(A) the average OWI score preoperatively was 60.9 with improvement postoperative in last follow-up to 20.1 while in group (B) the average preoperative OWI score was 58.8 which improved to 29.1 in last follow-up (Fig. 3). In group (A) there was a statistically significant decrease in mean OWI postoperative with *p*-value <0.05 unlike group B with statistically insignificant results.

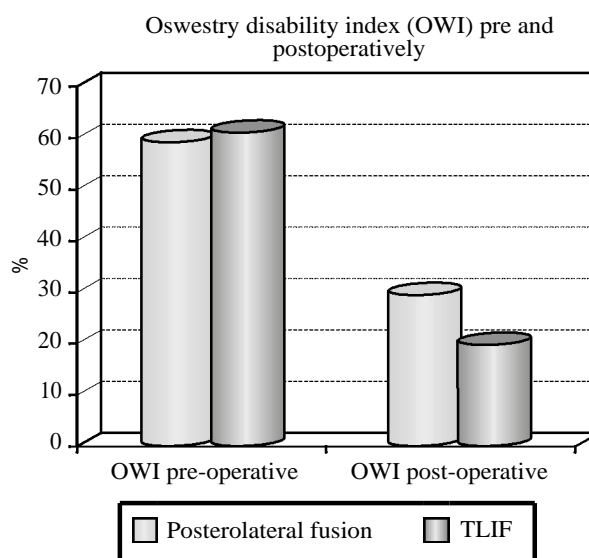


Fig. (3): Comparison between pre- and post-operative Oswestry Disability index in both groups.

In our study, Disc Height (DH) and Lumbar Lordosis (LL) were evaluated preoperatively, immediate postoperatively and on follow-up. The average time for follow-up was 6 months.

Preoperative disc height in group (A) was 3-10.4mm with mean of 8.28 and SD of 1.62 while in group (B) DH was 6.5-12.2mm with mean of 10.1 and SD of 1.8mm. Postoperative disc height in group (A) was 9.14-14.2mm with mean of 11.7 and SD of 1.23 and on follow up the average was 11.1mm, while in group (B) it was 8-13.2mm with mean of 10.3 and SD of 1.83 and on follow-up the mean was 10.4 (Fig. 4).

Preoperative lumbar lordosis (cobb's angle) in group (A) was 28.5-57° with mean of 41.3° and SD of 8.26 while in group (B) the LL was 27-68° with mean of 49.6° and SD of 11.3°. Postoperative lumbar lordosis (cobb's angle) in group (A) was 30-65° with mean of 49.1° and SD of 9.69° and on follow-up mean LL was 48.6° while in group (B) LL was 30-66° with mean of 50.9° and SD of 9.62° and on follow-up mean LL was 50.5° (Fig. 5).

There was a statistically significantly higher mean of immediate postoperative disc height, and lower mean of OWI among TLIF group with *p*-

value <0.05 . On the other hand, there was no statistically significant difference with p -value >0.05 as regards immediate postoperative and 6

months follow-up of lumbar lordosis, also for 6 months follow-up for disc height between both study groups.

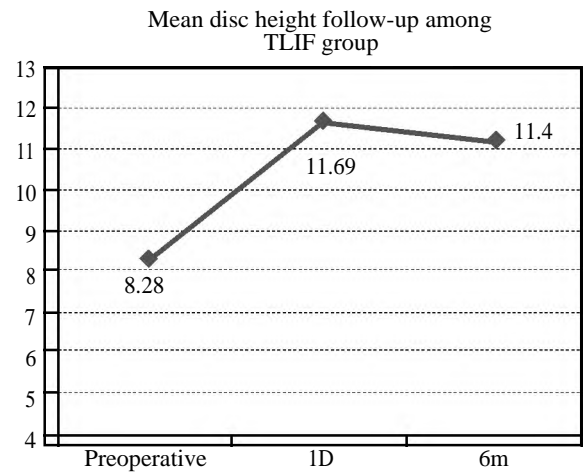
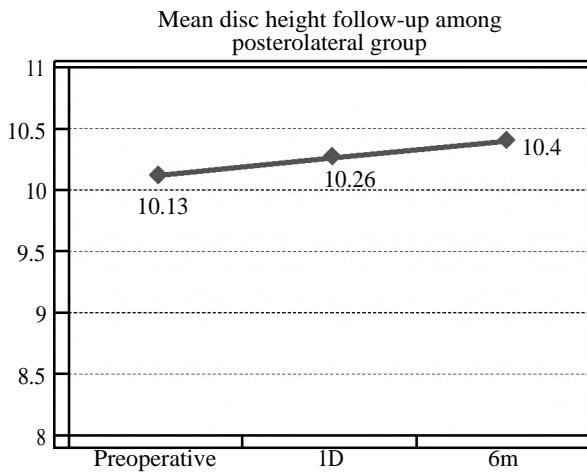


Fig. (4): Shows mean disc height in preoperative, postoperative and follow-up among TLIF group (right) and postero-lateral group (left). 1D refers to immediate postoperative and 6 m refers to follow-up after 6 months.

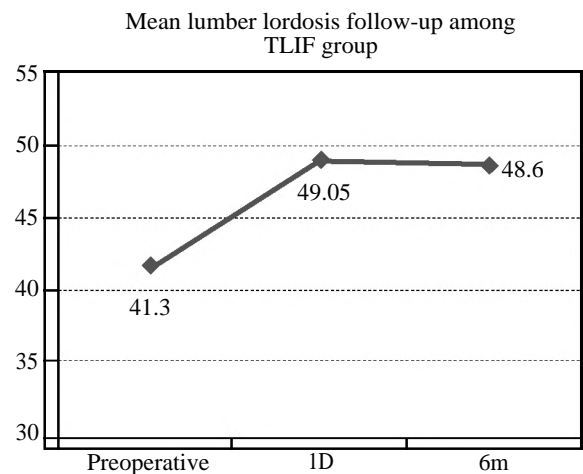
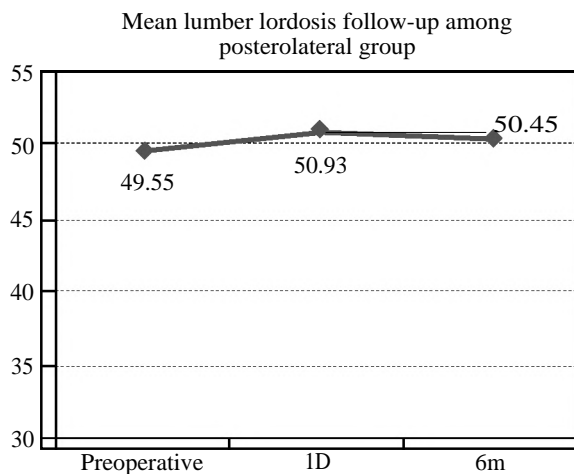


Fig. (5): Shows mean lumbar lordosis in preoperative, postoperative and follow-up among TLIF group (right) and postero-lateral group (left). 1D refers to immediate postoperative and 6 m refers to follow-up after 6 months.

Among TLIF group, there was a statistically significant increase in the mean of disc height immediate postoperative, then decrease after 6 months follow-up with p -value <0.05 . In addition, there was a statistically significant increase in mean of lumbar lordosis in immediate postoperative follow up with p -value <0.05 , but no significant change after 6 months follow-up with p -value >0.05 . As regards OWI there was a statistically significant decrease in mean OWI postoperative with p -value <0.05 (Table 1).

Among postero-lateral fusion group there was no statistically significant change in mean of disc height in immediate postoperative, but there was a statistically significant increase after 6 months

follow-up with p -value <0.05 . On the other hand, there was no statistically significant change in mean lumbar lordosis and OWI postoperative with p -value >0.05 (Table 2).

In group (A) most of interbody cages was in the middle of intervertebral (IV) space (65%) and (20%) of cage was in the anterior part of IV space while (15%) of cages was in posterior part.

In our study all patients showed no postoperative complication except 2 patients had superficial wound infection with mild discharge managed successfully by suitable antibiotics with repeated dressing and 3 cases of unintended durotomy with no postoperative complications.

Table (1): Comparisons of preoperative and follow-up disc height, lumbar lordosis and OWI among TLIF group.

Variables	TLIF		P-value	Sig.
	Mean	SD		
<i>Disc height:</i>				
Preoperative	8.28	1.62	<0.001 ^a	HS
1 day postoperative	11.69	1.22	0.002 ^b	
6 months postoperative	11.14	1.34		
<i>Lumber lordosis:</i>				
Preoperative	41.30	8.26	0.001 ^a	S
1 day postoperative	49.05	9.69	0.34 ^b	NS
6 months postoperative	48.6	9.23		
<i>OWI:</i>				
Preoperative	60.85	8.04	<0.001	HS
Postoperative	20.10	7.15		

a: Significant difference between pre and early after operation.
b: Significant difference between early and late postoperative.
S: Significant, NS: Non-significant, HS: Highly significant.

Discussion

The TLIF technique has been used with the theory that the interbody device, with additional bone graft, would improve the fusion rate compared with posterolateral fusion. The restoration of disc height (DH) and lumbar lordosis (LL) are additional objectives of the TLIF procedure [3].

In our study we operated upon 40 patients, 20 operated by posterolateral fixation and TLIF (group A) and the other 20 by posterolateral fixation without cage insertion (group B). In group A mean age was 41.4 years with 4 males 16 females. In group B mean age was 42 with 7 males and 13 females. Patients had degenerative or lytic spondylolisthesis and discogenic back pain. In group (A) there was 15 patients with L4-5 pathology (75%) and 5 patients with L5S1 pathology (25%). In group (B) there was 11 patients with L4-5 pathology (55%) and 9 patients with L5S1 pathology (45%). Clinical outcome evaluated by Oswestry Disability Index (OWI) pre and postoperative. In group A, OWI score preoperative was 60.9±8.03 and postoperative was 20.1±7.15. In group B, OWI score preoperatively was 58.8±7.85 and postoperative 29.1±11.63.

Kepler et al included 45 patients 23 males and 22 females with mean age of 47.3 years and all patients had single level degenerative condition. 2 patients had undergone fusion at L2-L3 (4%), 3 at L3-L4 (7%), 22 at L4-L5 (49%), and 18 at L5-S1 (40%) all operated by TLIF. In total, 32 patients (71.4%) had either "excellent" or "good" outcomes. The average final back pain VAS score was 2.3

Table (2): Comparisons of preoperative and follow up disc height, lumbar lordosis and OWI among posterolateral fusion group.

Variables	Posterolateral		P-value	Sig.
	Mean	SD		
<i>Disc height:</i>				
Preoperative	10.13	1.79	0.25 ^a	NS
1 day postoperative	10.26	1.82	0.004 ^b	HS
6 months postoperative	10.40	2		
<i>Lumber lordosis:</i>				
Preoperative	49.55	11.29	0.29 ^a	NS
1 day postoperative	50.93	9.62	0.27 ^b	NS
6 months postoperative	50.45	9.71		
<i>OWI:</i>				
Preoperative	58.80	7.85	0.42	NS
Postoperative	29.10	11.63		

a: Significant difference between pre and early after operation.
b: Significant difference between early and late postoperative.
S: Significant, NS: Non-significant, HS: Highly significant.

and average final leg pain VAS score was 2.0. Preoperative disc height averaged 5.3mm (range, 1-12mm). Postoperative disc height averaged 10.3mm (range, 6-14mm) initially, and 9.8mm (range, 6-14mm) at most recent follow-up. Average disc height measurements between preoperative, immediate postoperative and final postoperative radiographs were all statistically significantly different from one another ($p<0.001$). Preoperative lumbar lordosis averaged 39.2° (range, 5°-56°). Initial postoperative lumbar lordosis averaged 43.9° (range 10°-65°) and lumbar lordosis at most recent follow-up averaged 42.8° (range, 11°-65°) (Table 1). Average lumbar lordosis measurements on preoperative, immediate postoperative and final postoperative radiographs were all statistically significantly different from one another ($p<0.001$) [6].

Kim et al., operated upon 26 patients 9 males and 17 females with mean age of 55. The conditions of the patients were spondylolisthesis in 12 patients, spinal stenosis in 7, segmental instability in 2, herniation of the intervertebral disc in 3 and a failure of primary surgery in 2. The fused segments were L2-3 in 1, L3-4 in 2, L4-5 in 19 and L5-S1 in 4 patients. The mean disc height at the fused segment preoperatively was 9.13±2.92mm, immediately after surgery was 11.64±1.94mm, 3 months postoperatively was 11.37±1.92mm and at the last follow-up was 10.90±2.02mm. The increases were significant from before surgery to the last follow-up period ($p=0.000$). However, the values at the 3rd postoperative month were lower than those obtained immediately after surgery ($p=0.01$) and slight decreases were also observed at the last

follow-up. The mean whole lumbar lordosis preoperatively was 39.10 ± 11.10 , immediately after surgery was $39.01 \pm 8.48^\circ$, 3 months postoperatively was $42.05 \pm 11.77^\circ$ and at the last follow-up was $42.55 \pm 12.17^\circ$ at the last follow-up. The difference between the preoperative and immediate postoperative periods was not significant ($p=0.935$). On the other hand, remarkable increases in the preoperative values were observed at the 3rd postoperative month ($p=0.003$) and last follow-up ($p=0.000$)

[9].

Yan et al., operated upon 91 patients 46 males and 45 females with single level TLIF and mean age of 57.51. All patients had degenerative spondylolisthesis. Fusion levels were L4-5 in 44 patients and L5-S1 in 47 patients. The average disk was 6.7 ± 1.7 preoperatively, 11.4 ± 1.6 on the initial postoperatively, and 11.3 ± 1.4 on the follow-up in TLIF. The disc height and intervertebral foramen height were better than preoperational ($p < 0.01$)

[10].

Martinelli et al., operated upon 30 patients 56.66% males and 43.33% females with TLIF with mean age is 46.6. Patients had disc degenerative disease, low-grade spondylolisthesis or lumbar spinal stenosis, with compromised L4-L5 level. The results of the 0-10 VAS from post-operative period is a mean of 2.7 for the TLIF group. The lumbar lordosis presented in the patients who underwent the TLIF technique was $49.5^\circ \pm 13.7^\circ$ in pre and $47.9^\circ \pm 11.3^\circ$ in postoperative radiographs

[11].

In our study, most cases in group (A) showed cage subsidence less than 0.5mm in last follow-up compared to immediate postoperative radiograph. Five cases showed subsidence 0.5-1mm for example, one case showed increase in disc height from 7.1mm to 11.1mm in immediate follow-up then in follow up after 6 months disc height became 10.2mm (Fig. 6). There is only one case showed cage subsidence by more than 2mm (Fig. 7).



Fig. (6): (A) Preoperative X-ray Lateral view showing L4-5 spondylolisthesis. (B) Immediate postoperative X-ray of same patient operated by L4-5 fixation and TLIF with increases of DH from 7.1mm to 11.1mm. (C) follow-up X-ray after 6 months shows cage subsidence about 0.9mm.

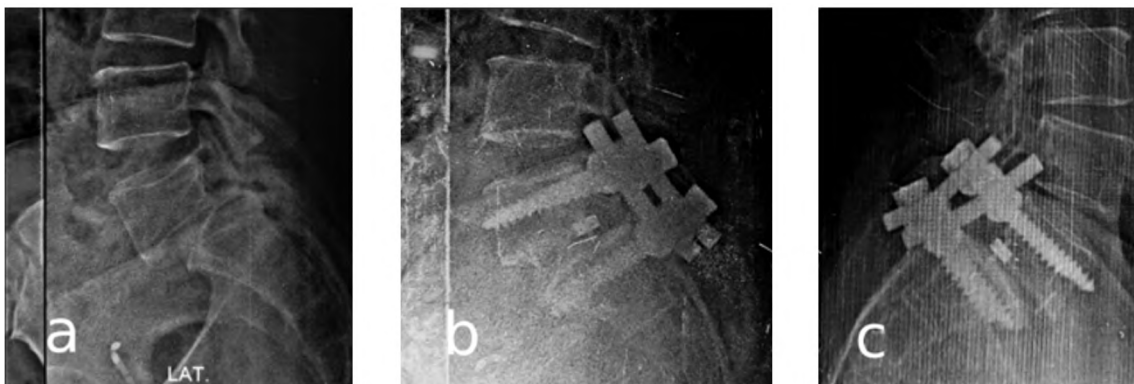


Fig. (7): (A) Preoperative X-ray Lateral view showing L5-S1 spondylolisthesis. (B) Immediate postoperative X-ray of same patient operated by L5-S1 fixation and TLIF with increases of DH from 7.6mm to 11mm. (C) Follow-up X-ray after 6 months shows cage subsidence about 3.2mm.

Some reports showed that low LL was related to the chronic low back pain, and patients with low postoperative LL were more likely to have back pain [6,12].

Other studies showed that increased LL may reduce the likelihood of the adjacent segment degeneration [13,14].

Conclusion:

Our Study shows in cases of transpedicular fixation with transforaminal interbody fusion shows statistically significant increase in disc height and lumbar lordosis compared to posterolateral fusion without cage insertion.

This increase in the disc height resulted in an indirect decompression of the nerve roots in their neural exit foramina.

Also the restoration of lumbar lordosis resulted in improved sagittal balance and improved posture of our patients.

We recommend using TLIF techniques especially when it comes to correction of lumbar lordosis and sagittal balance especially when there is loss of disc height. However, better surgical outcomes depend mainly on patient selection, good decision making and the experience.

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إستخدام الأقفاص الكربونية عن طريق قناة مخرج العصب بين الفقرات القطنية ؛ هل يؤثر فعليا على التقعر القطنى والارتفاع الغضروفى ؟

أظهرت الدراسة التى قمنا بها أن الحالات التى أستخدمنا فيها التثبيت الفقارى بواسطة شرائح ومسامير خلفية من خلال العنق الفقارى مع تركيب أقفاص كربونية بين الفقرات القطنية من خلال قناة مخرج العصب مقارنة بالحالات التى تم التثبيت فيها فقد بدون استخدام أقفاص كربونية زيادة ذات دلالة إحصائية فى كل من الارتفاع الغضروفى والتقعر القطنى فى حالة إستخدام الأقفاص الكربونية ونحن نصح فى نهاية هذه الدراسة بإستخدام الأقفاص الكربونية من خلال قناة مخرج العصب عند الحاجة لتصحيح الإرتفاع الغضروفى والتقعر القطنى وإستعادة الإرتزان الطولى. مع الوضع فى الإعتبار أن أفضل النتائج الجراحية يمكن الحصول عليها عن طريق الأختيار السليم للمرضى المناسبين لهذا الإجراء الجراحى، إتخاذ القرار الجراحى الملائم وكذلك خبرة الفريق الجراحى.