ORIGINAL ARTICLE

COMPARISON OF FLUOROSCOPY REDUCING OBLIQUE LUMBAR INTERBODY FUSION L5-S1 (OLIF51) AND STANDARD TRANSFORAMINAL LUMBAR INTERBODY FUSION L5-S1 (TLIF51) METHODS IN THE SURGICAL TREATMENT OF ADULT SPINAL DEFORMITY

Floroskopi Kullanımını Azaltan Oblik Lumbar İnterbody Füzyon (OLIF51) ile Standart Transforaminal Lumbar İnterbody Füzyon (TLIF51) Yöntemlerinin Yetişkin Omurga Deformitesi Cerrahi Tedavisinde Karşılaştırılması

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ABSTRACT

Objective: The objective of the study was to evaluate the L5-S1 oblique lumbar interbody fusion (OLIF51) and L5-S1 transforaminal lumbar interbody fusion (TLIF51) techniques in relation to several key variables, including the duration of the operation, quantity of blood lost, fluoroscopy time used, radiological outcome and complications as regards the management of adult spinal deformity.

Material and Methods: In this retrospective study, a total of 60 patients who underwent surgical treatment for spinal deformities between January 2021 and December 2023 were included in the analysis. Patients were divided into two groups according to OLIF51 and TLIF51 methods. Demographic data, surgical time, blood loss, hospitalization, fluoroscopy time, and complication rates were recorded. visual analog scale (VAS) and oswestry disability index (ODI) were used for clinical evaluation. Radiological parameters were analyzed using disc height and lumbar lordosis angle.

Results: The OLIF51 group exhibited a shorter surgical duration ($p<0.001$), reduced blood loss ($p<0.001$), and a shorter hospital stay ($p=0.002$) compared to the control group. Moreover, the OLIF51 procedure demonstrated a notable reduction in the utilization of fluoroscopy, with a statistically significant difference ($p<0.001$). In terms of radiological outcomes, the OLIF51 group exhibited superior disc height and lumbar lordosis angle measurements compared to the TLIF51 group, with statistical significance ($p<0.05$). No significant difference was observed between the two groups in terms of clinical improvement.

Conclusion: The OLIF51 procedure offers several advantages over TLIF51, including a shorter operative time, reduced blood loss, and less fluoroscopy time. Additionally, radiological outcomes are more favorable for OLIF51. For this reason, OLIF51 can be regarded as a secure and effective alternative for the management of spinal deformities.

Keywords: *OLIF; TLIF; Spinal Deformity; Fluoroscopy*

ÖZET

Amaç: Bu çalışmada, yetişkin omurga deformitesinin tedavisinde L5-S1 oblique lumbar interbody fusion (OLIF51) ve L5-S1 transforaminal lumbar interbody fusion (TLIF51) yöntemlerinin cerrahi süre, kan kaybı, floroskopi kullanımı, radyolojik sonuçlar ve komplikasyonlar açısından karşılaştırılması amaçlanmıştır.

Gereç ve Yöntemler: Retrospektif olarak yapılan bu çalışmada, Ocak 2021 ile Aralık 2023 tarihleri arasında omurga deformitesi nedeniyle cerrahi uygulanan 60 hasta incelenmiştir. Hastalar OLIF51 ve TLIF51 yöntemlerine göre iki gruba ayrılmıştır. Demografik veriler, cerrahi süre, kan kaybı, hastanede yatış süresi, floroskopi süresi ve komplikasyon oranları kaydedilmiştir. Klinik değerlendirme için vizüel analog skala (VAS) ve oswestry bel özürlülük indeksi (ODI) kullanılmıştır. Radyolojik parametreler, disk yüksekliği ve lumbar lordoz açısı ile analiz edilmiştir.

Bulgular: OLIF51 grubunda, cerrahi sürenin daha kısa ($p<0,001$), kan kaybının daha az ($p<0,001$) ve hastanede kalış süresinin daha kısa olduğu saptanmıştır ($p=0,002$). Ayrıca, OLIF51'in floroskopi kullanımını anlamlı derecede azalttığı görülmüştür ($p<0,001$). Radyolojik olarak, OLIF51 grubunda disk yüksekliği ve lumbar lordoz açısının TLIF51'e göre daha iyi olduğu bulunmuştur ($p<0,05$). Klinik iyileşme açısından ise iki grup arasında belirgin bir fark bulunmamıştır.

Sonuç: OLIF51 yöntemi, TLIF51'e göre daha kısa cerrahi süre, daha az kan kaybı ve daha az floroskopi kullanımı gibi avantajlara sahiptir. Radyolojik sonuçlar da OLIF51 lehine daha olumludur. Bu nedenle, OLIF51, omurga deformitesi tedavisinde güvenli ve etkili bir alternatif olarak değerlendirilebilir.

Anahtar Kelimeler: *OLIF; TLIF; Omurga Deformitesi; Floroskopi*

INTRODUCTION

There are many studies comparing the efficacy of L5-S1 oblique lumbar interbody fusion (OLIF51) and standard L5-S1 transforaminal lumbar interbody fusion (TLIF51) methods, which reduce the use of fluoroscopy in the treatment of adult spinal deformity. The OLIF51 technique offers a minimally invasive approach with advantages over TLIF51 in terms of surgical time, blood loss, and hospitalization (1). It has been reported in the literature that both methods offer similar results in terms of clinical recovery and that there is no significant difference in pain and functional recovery measures (2). However, radiologically, OLIF51 has been reported to provide better results in terms of disc height and lumbar lordosis angle compared to TLIF51 (3). Both methods have been observed to be effective in spinal deformity correction (4). It has also been emphasized that OLIF51 has lower complication rates and is more efficient in terms of operation time (4-6).

The primary hypothesis of our study is that the OLIF51 method will yield superior results in parameters such as surgical time, blood loss, and length of hospital stay compared to TLIF51. It is hypothesized that OLIF51 is a minimally invasive procedure that facilitates surgical access through a lateral approach. Additionally, it is postulated that OLIF51 requires less fluoroscopy time and has a lower incidence of intraoperative complications. According to the available literature, both methods are clinically reported to give similar results in terms of pain and functional recovery. However, OLIF51 has been shown to shorten the surgical time, cause less blood loss, and offer better results than TLIF51 in terms of radiologic parameters, especially disc height and lumbar lordosis angle (7).

It has also been reported that OLIF may have higher complication rates in some cases, and therefore, clinical results may be heterogeneous (4). The purpose of our study was to assess the outcomes of two surgical techniques, specifically OLIF51 and TLIF51, through comparison of surgical time, intraoperative blood loss, fluoroscopy time, radiological parameters and the incidence of complications.

MATERIALS AND METHODS

This retrospective study included a total of 60 patients who underwent surgical treatment for adult spinal deformity in our clinic between January 2021 and December 2023. The study was approved by the ethics committee of the relevant institution (Hitit University Faculty of Medicine Research Ethics Committee No: 2023-18) and was conducted in accordance with the principles of the Declaration of Helsinki. Informed consent was obtained from all patients. The inclusion criteria comprised patients aged 60 years and older, with a sagittal vertical axis (SVA) of ≥95 mm, a pelvic tilt (PT) of ≥30°, or a coronal Cobb angle of ≥30°. Furthermore, patients who exhibited a lack of response to conservative treatment and presented with severe lower back pain and impaired ambulation were included. Patients with spinal deformities resulting from acute or chronic infection, spinal tumors, or a history of previous spine surgery were excluded from the study. The 60 patients in the study were divided into two groups, with 30 patients in each group: OLIF51 group (Group O, n=30) and TLIF51 group (Group T, n=30). In Group O, patients underwent the navigation-assisted OLIF51 technique, which reduces the use of fluoroscopy, while Group T underwent the TLIF51 technique with standard fluoroscopy. In the OLIF51 procedure, patients were prepared in the right lateral decubitus position, and intraoperative CT images were obtained using an O-arm scanner (Medtronic, USA). Surgical planning was performed with the Stealth Station navigation system (Medtronic, USA), and the L5-S1 disc was accessed with a minimally invasive approach. After the disc space was cleaned, an appropriately sized cage was placed, and pedicle screws were inserted percutaneously under navigation guidance.

In the TLIF51 procedure, patients were prepared in the prone position, and a midline incision was made under standard fluoroscopic guidance. During the surgical procedure, L5-S1 facetectomy and laminectomy were performed, followed by disc space clearance and TLIF cage placement. Pedicle screws were placed, and rods were connected.

During the data collection process, patients' demographics, duration of surgery, blood loss, length of hospital stay, and complications were recorded. Clinical outcomes were assessed using the Visual Analog Scale (VAS) to measure the degree of low back and leg pain and the Oswestry Disability Index (ODI)

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to assess functional capacity. In addition, radiologic evaluations were performed preoperatively and postoperatively by measuring SVA, pelvic incidence-lumbar lordosis deficit (PI-LL), PT, L5-S1 angle, and L5-S1 disc space height. Fusion rates were evaluated by computed tomography (CT) at 6 and 12 months postoperatively.

Statistical analyses were performed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA). Mann-Whitney U test was used for continuous variables, the chi-square test was used for categorical variables, and the statistical significance level was accepted as $p<0.05$.

RESULTS

In our study, no significant difference was found between the two groups in terms of demographic and preoperative characteristics such as age, gender distribution, body mass index (BMI), and preoperative SVA. The mean age was 68.5 years in the OLIF51 group and 70.3 years in the TLIF51 group. Gender distribution was similar in both groups, with female patients being the majority in both groups. Body mass indexes, preoperative PI, PT, and PI-LL values did not show statistically significant differences between the groups. These findings suggest that both groups were comparable at baseline and included a homogeneous patient population (Table 1).

A comparison of the surgical outcomes between the OLIF51 and TLIF51 methods revealed that the operation time was significantly shorter in the OLIF51 group. The mean operative time was 186.5 minutes in the OLIF51 group compared to 245.2 minutes in the TLIF51 group. In addition, less blood loss was observed in the OLIF51 group; while the average blood loss was 285.7 mL, this amount reached 475.3 mL in the TLIF51 group. The mean length of hospitalization was also shorter in the OLIF51 group, with an average duration of 4.2 days. Conversely, the fluoroscopy time was significantly shorter in the OLIF51 group, with an average of 15.3 seconds compared to 68.7 seconds in the TLIF51 group. These findings indicate that the OLIF51 method optimizes the surgical process and significantly reduces the necessity for fluoroscopy. (Table 1) (Figure 1).

When the clinical outcomes between the OLIF51 and TLIF51 groups were evaluated, significant improvements were observed in both groups. A significant reduction in VAS scores for low back pain and leg pain was observed in both groups at all postoperative follow-up periods. In the OLIF51 group, the VAS score for low back pain decreased from 7.8 preoperatively to 1.8 at 24 months. Similarly, in the TLIF51 group, the low back pain VAS score decreased from 7.6 preoperatively to 2.0 at 24 months. Similar reductions in leg pain VAS scores were also observed between the two groups, and the postoperative improvements in both groups were statistically significant. ODI scores also decreased significantly in both groups, with the ODI score decreasing from 62.5% preoperatively to 20.3% at 24 months in the OLIF51 group. In the TLIF51 group, the ODI score decreased from 63.8% preoperatively to 21.8% at 24 months. There was no significant difference between the groups (Table 2) (Figure 2).

A comparative analysis of the radiological outcomes of the OLIF51 and TLIF51 groups revealed that both techniques resulted in an improvement in sagittal balance. Although preoperative SVA values were high in both groups, a significant improvement was observed in the postoperative period. While the preoperative SVA was 98.7 mm in the OLIF51 group, it decreased to 32.1 mm at 12 months. In the TLIF51 group, this value decreased from 102.4 mm preoperatively to 40.5 mm at 12 months. In addition, the PI-LL decreased significantly in both groups. In the OLIF51 group, the PI-LL angle decreased from 28.4° preoperatively to 7.3° at 12 months postoperatively. In the TLIF51 group, the PI-LL angle decreased from 30.2° preoperatively to 11.5° at 12 months. Statistically significant differences were found in SVA and PI-LL corrections between the groups (Table 3).

When early and late complication rates were compared between the OLIF51 and TLIF51 groups, it was observed that the complications were lower in the OLIF51 group. While dural injury and implant failure were not observed in the OLIF51 group, these complications were recorded in the TLIF51 group with rates of 6.7% and 3.3%, respectively. The incidence of complications, including transient neurologic deficit, superficial wound infection, and pseudoarthrosis, was statistically similar in both groups. The total complication rate was 20% in the OLIF51 group and 40% in the TLIF51 group, but this difference was not statistically significant. In

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Table 1. Demographic Data, Preoperative Characteristics and Parameters of Surgical outcomes

Characteristics	OLIF51 Group (n=30)	TLIF51 Group (n=30)	p-value
Age (years)	68.5 ± 7.2	70.3 ± 6.8	0.312
Gender (F/M)	22/8	20/10	0.573
BMI (kg/m²)	26.3 ± 3.8	27.1 ± 4.2	0.428
Preoperative SVA (mm)	98.7 ± 42.5	102.4 ± 38.9	0.715
Preoperative PI (°)	55.8 ± 10.2	54.3 ± 9.7	0.561
Preoperative PT (°)	32.6 ± 8.4	33.9 ± 7.8	0.524
Preoperative PI-LL (°)	28.4 ± 15.7	30.2 ± 14.9	0.643
Parameters			
Surgery duration (minutes)	186.5 ± 45.3	245.2 ± 52.7	<0.001*
Blood loss (mL)	285.7 ± 120.8	475.3 ± 180.5	<0.001*
Hospital stay (days)	4.2 ± 1.5	5.8 ± 2.1	0.002*
Fluoroscopy time (seconds)	15.3 ± 5.2	68.7 ± 18.4	<0.001*

Abbreviations: OLIF51: Oblique Lateral Interbody Fusion; TLIF51: Transforaminal Lumbar Interbody Fusion; F: Female; M: Male; BMI: Body Mass Index; SVA: Sagittal Vertical Axis; PI: Pelvic Incidence; PT: Pelvic Tilt; PI-LL: Pelvic Incidence-Lumbar Lordosis; *p<0.05 indicates a statistically significant difference.

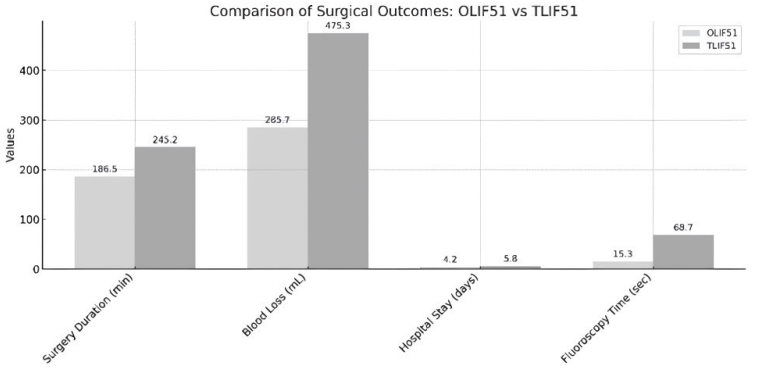

Figure 1. Clinical Outcomes Over Time: OLIF51 vs TLIF51

Table 2. Clinical Outcomes

Parameter	Group	Preoperative	Postop 6 months	Postop 12 months	Postop 24 months	p-value (within group)	p-value (between groups)
VAS Back	OLIF51	7.8 ± 1.2	3.2 ± 1.5	2.1 ± 1.3	1.8 ± 1.1	<0.001*	0.423
	TLIF51	7.6 ± 1.3	3.5 ± 1.6	2.3 ± 1.4	2.0 ± 1.2	<0.001*	
VAS Leg	OLIF51	6.9 ± 1.5	2.8 ± 1.3	1.9 ± 1.1	1.7 ± 1.0	<0.001*	0.512
	TLIF51	7.1 ± 1.4	3.0 ± 1.4	2.1 ± 1.2	1.9 ± 1.1	<0.001*	
ODI (%)	OLIF51	62.5 ± 8.7	28.3 ± 7.2	22.1 ± 6.5	20.3 ± 6.1	<0.001*	0.378
	TLIF51	63.8 ± 9.1	30.1 ± 7.8	23.5 ± 7.1	21.8 ± 6.7	<0.001*	

Abbreviations: VAS: Visual Analog Scale; ODI: Oswestry Disability Index; OLIF51: Oblique Lateral Interbody Fusion; TLIF51: Transforaminal Lumbar Interbody Fusion; Postop: Postoperative. *p<0.05 indicates a statistically significant difference.

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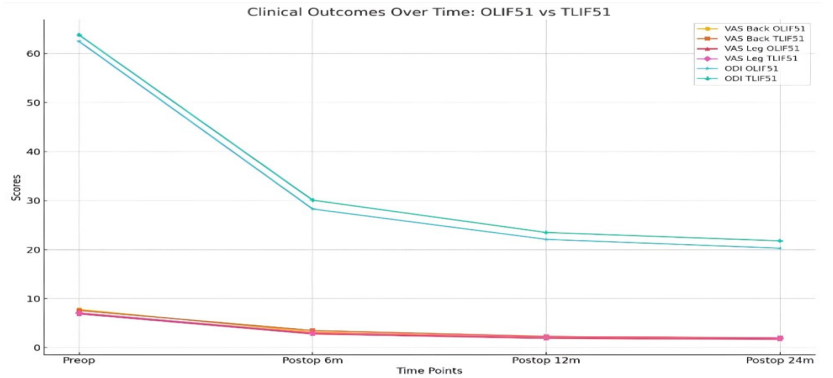

Figure 2. Comparison of Surgical Outcomes: OLIF51 vs TLIF51

Table 3. Radiological Outcomes

Parameter	Group	Preoperative	Postop 6 months	Postop 12 months	p-value (within group)	p-value (between groups)
SVA (mm)	OLIF51	98.7 ± 42.5	35.2 ± 18.6	32.1 ± 16.8	<0.001*	0.042*
	TLIF51	102.4 ± 38.9	42.8 ± 20.3	40.5 ± 19.1	<0.001*	
PI-LL (°)	OLIF51	28.4 ± 15.7	8.6 ± 7.2	7.3 ± 6.5	<0.001*	0.035*
	TLIF51	30.2 ± 14.9	12.3 ± 8.1	11.5 ± 7.8	<0.001*	
PT (°)	OLIF51	32.6 ± 8.4	21.3 ± 5.7	20.1 ± 5.2	<0.001*	0.128
	TLIF51	33.9 ± 7.8	23.5 ± 6.1	22.8 ± 5.8	<0.001*	
L5-S1 angle (°)	OLIF51	12.3 ± 4.6	20.8 ± 3.9	21.2 ± 3.7	<0.001*	0.003*
	TLIF51	11.8 ± 4.9	16.5 ± 4.2	16.9 ± 4.0	<0.001*	
L5-S1 height (mm)	OLIF51	7.2 ± 2.1	11.8 ± 1.8	11.5 ± 1.7	<0.001*	0.008*
	TLIF51	7.5 ± 2.3	10.2 ± 1.9	9.8 ± 1.8	<0.001*	

Abbreviations: SVA: Sagittal Vertical Axis; PI-LL: Pelvic Incidence-Lumbar Lordosis; PT: Pelvic Tilt; OLIF51: Oblique Lateral Interbody Fusion; TLIF51: Transforaminal Lumbar Interbody Fusion; Postop: Postoperative. *p<0.05 indicates a statistically significant difference.

terms of fusion rates, high fusion rates were achieved in both groups at 12 months postoperatively, with a fusion rate of 93.3% in the OLIF51 group and 86.7% in the TLIF51 group. This difference was not statistically significant (Table 4).

DISCUSSION

Our study aimed to compare the OLIF51 and standard TLIF51 methods, which reduce the use of fluoroscopy in the treatment of adult spinal deformity. The findings indicated that the OLIF51 technique exhibited significant advantages in comparison to TLIF51. The OLIF51 group exhibited significantly reduced surgical time (186.5 vs. 245.2 minutes, p<0.001), blood loss (285.7 vs. 475.3 mL, p<0.001), and hospital stay (4.2 vs. 5.8 days, p=0.002) compared to the TLIF51 group. In particular, fluoroscopy time was significantly reduced in the OLIF51 group (15.3 vs 68.7 seconds, p<0.001), indicating a significant reduction in radiation exposure. Both techniques provided similar improvements in clinical outcomes (VAS and ODI scores), but OLIF51 gave superior results in radiologic parameters, especially sagittal balance correction (SVA and PI-LL). Although complication rates were lower in the OLIF51 group, this difference was not statistically significant. These findings suggest that the OLIF51 technique is an effective, safe, and less invasive alternative for adult spinal deformity surgery. Additionally, this approach has the potential to minimize radiation exposure.

Considering the OLIF51 and TLIF51 surgical techniques

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Table 4. Complications and Fusion Rates

Parameter	OLIF51 Group (n=30)	TLIF51 Group (n=30)	p-value
Early Complications			
Dural tear	0 (0%)	2 (6.7%)	0.492
Transient neurological deficit	1 (3.3%)	3 (10%)	0.612
Superficial wound infection	1 (3.3%)	2 (6.7%)	1.000
Ileus	2 (6.7%)	0 (0%)	0.492
Late Complications			
Adjacent segment disease	1 (3.3%)	2 (6.7%)	1.000
Implant failure	0 (0%)	1 (3.3%)	1.000
Pseudoarthrosis	1 (3.3%)	2 (6.7%)	1.000
Total Complication Rate	6 (20%)	12 (40%)	0.091
Fusion Rates			
6 months	25 (83.3%)	22 (73.3%)	0.347
12 months	28 (93.3%)	26 (86.7%)	0.671

Abbreviations: OLIF51: Oblique Lateral Interbody Fusion; TLIF51: Transforaminal Lumbar Interbody Fusion.

from this study and those examined in the literature shows some important principles. Many authors in the literature are pointing to the advantage of the OLIF51 approach over TLIF51 in terms of operative and intraoperative blood loss. In particular, a meta-analysis claimed that OLIF is associated with a lower amount of blood loss and shorter surgical time than TLIF (10). This finding is parallel to the results of our study. The mean time taken for surgery was 186.5 minutes in the group of patients who underwent the OLIF51 procedure and 245.2 minutes in the TLIF51 group, as observed in our study. It is noteworthy that the mean blood loss was 285.7 mL and 475.3 mL, respectively, in the two groups. These results are consistent with the data in the literature where the OLIF51 is performed with significantly less blood loss than the TLIF51 technique.

Additionally, the literature indicates that the utilization of fluoroscopy in the OLIF51 procedure was significantly reduced in terms of both time and radiation exposure when compared to TLIF51. Earlier research has demonstrated that patients treated with OLIF exhibited reduced radiation exposure in comparison to those treated with TLIF (11). In this study, the use of fluoroscopy was markedly reduced to 15.3 seconds in the OLIF51 and 68.7 seconds in the TLIF51. This is also evident from the literature.

There have also been many discussions regarding the effects of the minimally invasive attributes of the OLIF51 procedure on the surgical outcomes as well. Yang et al. reported that OLIF resulted in a shorter hospital admission period and a more rapid recovery time (12). The mean duration of hospital stay for the OLIF51 group was 4.2 days, while the mean duration of hospital stay for the TLIF51 group was 5.8 days, as evidenced by our data.

Regarding the learning curve, it was noted in another study that learning OLIF51 is perhaps more gradual and the surgeon's experience has some correlation to the outcomes (13). This indicates that irrespective of the benefits associated with OLIF51, the surgeon's experience has an effect on the effectiveness of the method. In conclusion, these comparisons demonstrate that the results of the study are largely consistent with the existing literature, and that, in comparison to TLIF51, OLIF51 is, in several aspects, a superior procedure.

In terms of clinical and radiologic results, similar improvements in VAS and ODI scores in the OLIF51 and TLIF51 groups can be explained by the fact that both techniques provide significant improvement in low back and leg pain. It is also reported in the literature that OLIF and TLIF techniques yield similar results in terms of pain and functional improvement, which is consistent with the findings of our study.

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Radiologic parameters, especially SVA and PI-LL differences are important factors affecting the restoration of spinal alignment after surgery. The possible reason why OLIF is more effective than TLIF in restoring sagittal balance is that the lateral approach provides better spinal alignment. Indeed, it has been reported in the literature that OLIF corrects sagittal balance better than TLIF (14).

In terms of long-term clinical effects, the minimally invasive features of OLIF, such as low blood loss and shorter recovery time, seem to contribute to faster patient recovery. However, the long-term clinical outcomes of OLIF were reported to be similar compared to TLIF. These findings suggest that the minimally invasive nature of OLIF provides faster postoperative recovery, but in the long term, both techniques offer similar clinical and functional outcomes (15).

The implications of following OLIF51 and TLIF51 techniques on the patients' safety are worth emphasizing. On the other hand, lower complication rates were observed in the OLIF51 group, which could indicate the potential for OLIF's minimally invasive nature to reduce postoperative complications. The literature also shows that the OLIF technique results in lower dural and nerve injuries due to the preservation of the posterior elements compared to the TLIF (16). Conversely, the OLIF group demonstrated fewer incidences of complications like dural tears and transient neurologic deficit. Owing to the unique characteristics of OLIF, this technique is also termed a minimally invasive surgery, which helps in reducing risk significantly (17).

OLIF technique is also associated with less expected loss of blood, and it requires shorter durations for the surgery to be completed. OLIF has also been documented to have better fusion rates, and together with this, OLIF is also associated with better long-term results. For example, in one study, it was demonstrated that OLIF had better fusion rates compared to TLIF, and the authors reported that this improved disc restoration parameters (18). Further studies improvise that intraoperative complications were minimal, and furthermore, patients' recovery was rather fast (19).

The homogeneity of the patient cohort and the standardization of surgical techniques represent noteworthy strenghts of this study. At the same time, important drawbacks of this study include the study's retrospective design and the limited number of patients. There is a need to conduct a prospective study with a longer time frame. The OLIF51 has its place in clinical practice, possibly in selected high-risk patients. Such techniques, which minimize the amount of tissue damage as well as radiation exposure, are thought to become even more important in the future of spine surgery. In relation to these results, more research is necessary for the improvement and application of the OLIF51 technique.

CONCLUSION

The results of our study demonstrate that OLIF51 is a more effective surgical treatment for adult spinal deformities than TLIF. Apart from the advantages cited, such as decreased surgical time, blood loss, and hospital stay, OLIF51 also considerably decreases fluoroscopic imaging utilization. Although both procedures yield comparable clinical improvement, OLIF51 has been demonstrated to exhibit superior performance with respect to radiological parameters, particularly in the correction of sagittal balance. Given the benefits of a minimally invasive approach, as well as shorter recovery periods and low rates of complications, OLIF51 will become more significant in the management of spinal deformity. This approach may be useful in high-risk patients and, more importantly, in scenarios requiring attenuation of radiation dose. More prospective studies with sufficient follow-up and a larger sample may help to have more clarity on the long-term outcomes as well as the safety of OLIF51. In conclusion, OLIF51 appears to be safe, effective, and clinically promising in treating adult patients with spinal deformities.

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