American Journal of Clinical and Experimental Medicine
2023; 11(1): 17-28
http://www.sciencepublishinggroup.com/j/ajcem
doi: 10.11648/j.ajcem.20231101.14
ISSN: 2330-8125 (Print); ISSN: 2330-8133 (Online)

Oblique Lateral Lumbar Interbody Fusion and Transforaminal Lumbar Interbody Fusion for Lumbar Degenerative Disease: A Meta-Analysis

Weibin Liang[1], Yukun Jia[2], Kaishuai Zhao[1], Guangye Wang[1, 2, *]

[1]Clinical Medicine School of Shenzhen Bao'an, Guangdong Medical University, Shenzhen, China

[2]Department of Orthopaedic Surgery, People's Hospital of Shenzhen Baoan District, Shenzhen, China

Email address:

kiela1230@163.com (Guangye Wang)

[*]Corresponding author

To cite this article:

Weibin Liang, Yukun Jia, Kaishuai Zhao, Guangye Wang. Oblique Lateral Lumbar Interbody Fusion and Transforaminal Lumbar Interbody Fusion for Lumbar Degenerative Disease: A Meta-Analysis. *American Journal of Clinical and Experimental Medicine*. Vol. 11, No. 1, 2023, pp. 17-28. doi: 10.11648/j.ajcem.20231101.14

Received: January 11, 2023; **Accepted**: February 8, 2023; **Published**: February 21, 2023

Abstract: Introduction: Oblique lateral lumbar interbody fusion (OLIF) and transforaminal lumbar interbody fusion (TLIF) are two commonly used procedures for the treatment of lumbar degenerative diseases, but the efficacy of the two procedures is not clear. Materials and Methods: PubMed, Embase, and Cochrane Library databases were searched for controlled studies of OLIF and TLIF in the treatment of lumbar degenerative diseases. Include all articles published before Oct 2022. Two researchers conducted quality evaluation and data extraction on the research respectively. Results: This meta-analysis finally included 27 studies. The VAS and ODI scores of the two groups decreased significantly after the operation. The decrease of the visual Analogue Score (VAS) and The Oswestry Disability Index (ODI) scores in the OLIF group was greater than that in the TLIF group within 6 months after the operation, but no difference was found in the follow-up for more than 6 months. The OLIF group was better than TLIF in restoring the lumbar lordosis angle and intervertebral height. The operation time, blood loss and hospital stay of the OLIF group were less than those of the TLIF group, and there was no significant difference between the two in terms of surgical complications and fusion rate. Conclusions: Although there was no significant difference between the OLIF and TLIF groups in terms of long-term pain relief and functional improvement, the OLIF group experienced greater short-term efficacy than the TLIF group and the surgical safety of OLIF was better than that of TLIF.

Keywords: Degenerative Lumbar Disease, Oblique Lateral Lumbar Interbody Fusion, Transforaminal Lumbar Interbody Fusion, Meta-Analysis

1. Introduction

Lumbar degenerative disease is a common clinical condition that may be caused by spinal stenosis, vertebral instability or disc herniation. It causes back pain and leg symptoms that affect patients' normal work and life. Lumbar fusion is the gold standard for the treatment of degenerative lumbar spine pathologies and can effectively improve symptoms [1].

Transforaminal lumbar interbody fusion (TLIF) was first reported by Harms [2] in 1982 and is now widely used in the treatment of lumbar degenerative diseases. It provides bilateral decompression through a unilateral approach without excessive stretching of the nerve and dural sac, thereby reducing the probability of nerve injury. Oblique lateral lumbar interbody fusion (OLIF) was proposed by Silvestre [3], a French scholar, in 2012, and involves a discectomy and implant fusion through the lumbaris major and aortic gaps, which protects the lumbar dorsalis muscle and posterior ligamentous complex and avoids damage to the dura and nerves in the spinal canal. Several studies have evaluated the surgical efficacy of TLIF and OLIF in the treatment of lumbar degenerative lesions, but it remains controversial which procedure leads to better outcomes [4]. A comparative study of the efficacy of the two procedures by Ye et al. in 2021 [5] showed that there was no significant difference in the surgical efficacy or surgical complication rates between the two groups. In contrast, other studies have reported significant differences in efficacy of the two surgical approaches [6, 7]. In a study by Li et al. [8], OLIF was shown to be superior to TLIF in terms of pain improvement and functional recovery of the lumbar spine, and the rate of surgical complications was lower than that of TLIF.

Therefore, to comprehensively evaluate the efficacy of TLIF and OLIF in degenerative lumbar spine disease, this meta-analysis was conducted to compare the effectiveness and safety of OLIF and TLIF in the treatment of degenerative lumbar spine disease.

2. Methods

2.1. Search Strategy and Inclusion Criteria

Electronic databases, including Pubmed, Embase, Cochrane Database, China Knowledge Network (CNKI), and Wanfang, were searched until Oct 2022 using the following terminology systems:

[(oblique lateral interbody fusion) OR (oblique lumbar interbody fusion) OR (OLIF)] AND [(transforaminal lumbar interbody fusion) OR (transforaminal) OR (TLIF)].

The inclusion criteria were as follows. (1) The study included a comparative design (OLIF vs. TLIF). (2) The study population included patients with degenerative lumbar spine disease (lumbar intervertebral herniation, lumbar spondylolisthesis or spinal stenosis). (3) At least one of the following outcomes was reported: perioperative outcomes (operative time, intraoperative blood loss or length of stay), Visual Analogue Scale (VAS), Oswestry Disability Index (ODI), complications, fusion rate. (4) Both groups had a minimum sample size of 15.

Studies with any of the following characteristics were excluded. (1) Patients with spinal deformities, trauma or spinal tumours. (2) Postoperative medication use, such as steroids or chemotherapeutic agents, that may have affected fusion rates. (3) Biomechanical studies and cadaveric studies. (4) Repeat studies.

Additionally, the references of included studies were checked to screen for potentially eligible studies. The two authors of this paper extracted data independently using standardised forms. Discrepancies between data were resolved through discussion and negotiation until consensus was reached.

2.2. Study Quality

Because this meta-analysis included both randomised and non-randomised studies, two assessment tools were used. For case-control studies, the Newcastle-Ottawa Scale (NOS) scale was used. For prospective randomised controlled trials, the Cochrane Risk of Bias Assessment Tool was applied.

2.3. Data Extraction

Data were extracted in the following categories. (1) Study year, country and study design. (2) Characteristics of the underlying study, including patient inclusion/exclusion criteria, number of enrolled patients and age ratio. (3) Perioperative outcomes: operative time, intraoperative blood loss and length of hospital stay for single and multiple segments. (4) Improvement in functional outcome at follow-up: VAS and ODI. (5) Imaging indices at follow-up: disc height (DH) and fused segment lordosis (FSL). (6) Methods of fusion assessment, fusion success criteria and fusion rate at the last follow-up. (7) Type and incidence of complications.

2.4. Primary and Secondary Results

The main outcome indicator was functional improvement, which was quantified according to the change values of the ODI and VAS scores. Secondary outcome indicators: radiological results, perioperative outcomes, statistics of complications and fusion rate.

2.5. Statistical Analysis

The meta-analysis was performed using STATA version 12.0 (STATA Corporation, College Station, TX). The mean difference (WMD) and 95% confidence interval (CI) were used to calculate continuous variables and the dominance ratio (OR) and 95% CI were used to calculate dichotomous variables. The heterogeneity of studies was assessed using the chi-square test and I^2 [9]. A chi-square $P < 0.05$ or $I^2 > 50\%$ indicated high heterogeneity and a random-effects model was used to combine the statistics, while a chi-square $P > 0.05$ or $I^2 < 50\%$ indicated low heterogeneity and a fixed-effects model was used to combine the statistics. $P < 0.05$ was considered statistically significant. Publication bias was assessed using Begg's test. The robustness of the meta-analysis results was tested by sensitivity analysis.

3. Results

3.1. Search Results

From a systematic search of the electronic databases, 321 studies were identified. A further manual search of the references revealed no additional suitable studies. Forty-two duplicate studies were removed using Endnote X9 (Version X9, Thompson Reuters, California, USA). An additional 242 studies were then excluded based on their titles and abstracts. The remaining 37 studies were read in their entirety, and 13 were excluded according to the exclusion criteria. Finally, 24 studies were included in this meta-analysis [5-8, 10-29]. The total number of patients was 2106, of whom 895 received OLIF and 1211 received TLIF. Of the TLIF patients, 429 received minimally invasive TLIF (MIS-TLIF). The flow diagram and PRISMA checklist of this meta-analysis is shown in Figure 1.

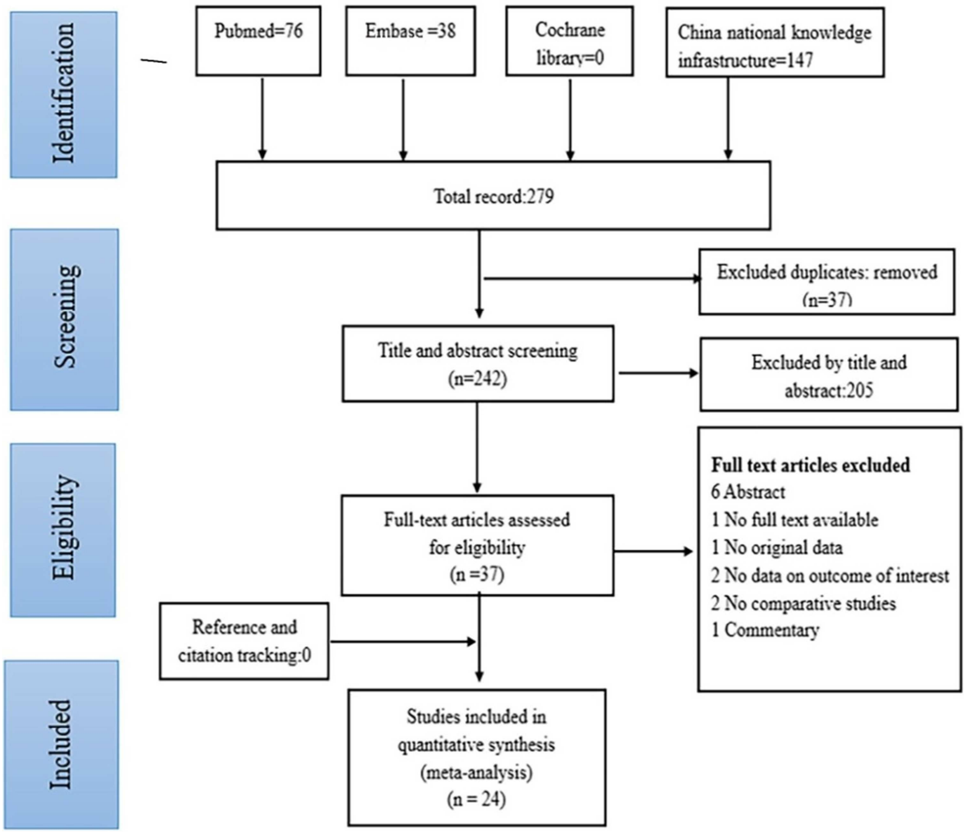

Figure 1. *Flowchart of the search strategy and study selection process.*

3.2. General Characteristics of the Included Studies

One of the 24 identified studies was a prospective randomised controlled study, while the remaining 23 studies were retrospective case-control studies. These studies were published between 2015 and 2021. Fourteen of these studies were followed up for more than 12 months. The NOS scale was used to assess the quality of the retrospective case-control studies, most of which were determined to be of moderate quality. Details of the selected studies are listed in Table 1.

Table 1. *The basic characteristics description of included studies.*

Study	Year	Sex (male/female) OLIF/TLIF	Age OLIF/TLIF	Study design	Country	Patients, n OLIF/TLIF	Follow-up, months	Quality score (NOS)	Conclusion
Abbasi[10]	2015	--	--	case-control	USA	69/55	12	6	OLIF is a safe and technically less demanding surgery than open or minimally invasive TLIF.
Abbasi[11]	2018	35/33 104/121	54.66/59.64	case-control	USA	68/225	--	5	OLIF significantly reduces surgery time, blood loss, and hospital stay compared to MIS-TLIF, and TLIF for all levels.
Champagne[12]	2019	15/23 18/27	62/63	case-control	Canada	38/45	--	8	OLIF approach might offer greater correction of sagittal balance over open and MIS TLIF
Chen[13]	2018	12/22 19/20	66/66	case-control	China	34/39	11	4	OLIF has obvious advantages over TLIF in terms of operation time and intraoperative bleeding
Chen[17]	2021	10/24 14/18	64.29/64.71	case-control	China	24/32	>6	6	OLIF and MIS-TLIF have the same clinical efficacy, safety and effectiveness, but OLIF has less blood loss, shorter hospital stay, and better postoperative recovery.
Du[6]	2021	23/14 16/12	53.6/52.8	case-control	China	28/37	22.1	6	Compared with TLIF, OLIF showed the advantages of less surgical invasion, better

Study	Year	Sex (male/female) OLIF/TLIF	Age OLIF/TLIF	Study design	Country	Patients, n OLIF/TLIF	Follow-up, months	Quality score (NOS)	Conclusion
									decompression effect, and faster postoperative recovery in single-level DLS surgery.
He[18]	2020	21/35 19/41	65.2/61.3	case-control	China	56/60	>6	5	OLIF can achieve similar clinical effects and better correction of coronal and sagittal imbalances compared to TLIF.
Huang[19]	2020	16/10 17/13	60.33/61.04	case-control	China	26/30	>24	5	OLIF and TLIF can achieve good short-term effects, but OLIF has less trauma, faster postoperative recovery, and fewer complications.
Koike[5]	2021	20/18 18/30	72.1/70.1	case-control	Japan	38/48	>12	6	The changes in physical function and QOL parameters after OLIF-LPF and MIS-TLIF were almost equivalent.
Kotani1[14]	2020	15/18 25/13	63.1/64.7	case-control	Japan	33/38	>24	6	OLIF is significantly better than MIS-TLIF in terms of back function.
Kotani2[15]	2020	46/46 17/33	72.0/70.0	case-control	Japan	92/50	>24	6	OLIF and MIS-TLIF are comparable in fusion rate, segmental radiologic alignment, and symptomatic ASD.
Lei[20]	2020	17/13 17/13	57.2/56.8	RCT	China	30/30	>6	5	OLIF can significantly reduce the short-term pain and dysfunction of patients after surgery, and improve the quality of life of patients than TLIF.
Li[8]	2021	7/21 8/27	57.5/59.3	case-control	China	28/35	>6	8	OLIF is better in restoring spinal alignment. Besides, due to the unique minimally invasive approach, OLIF did exhibit a greater advantage in early recovery after surgery.
Lin[29]	2018	8/17 8/17	64/64	case-control	Korea	25/25	>24	5	OLIF shows less blood loss and shorter operative time, better restoration of DH, and earlier time to fusion than the MI-TLIF.
Mun[7]	2020	20/54 24/50	64.1/66.4	case-control	Korean	74/74	22.3	5	OLIF was more effective for the indirect decompression of foraminal stenosis, and making a greater lordotic angle than with TLIF.
Qin[21]	2018	30/38	63.4/63.4	case-control	China	34/34	12.5	7	OLIF and TLIF have similar long-term clinical effects, but OLIF surgery there are irreplaceable short-term surgical advantages.
Qiu[22]	2020	15/5 13/7	50.3/51.7	case-control	China	20/20	>12	6	Compared with MI-TLIF, OLIF has the advantages of short operation time, less intraoperative and postoperative blood loss.
Sheng[16]	2020	30/8 30/25	65.29/60.62	case-control	China	38/55	12	4	The clinical findings associated with the two procedures were similar.
Wen[23]	2020	14/26 24/44	65.5/66.2	case-control	China	40/68	>6	6	OLIF and MIS-TLIF have the same therapeutic effect, but It is OLIF tissue damage is less, the operation time is shorter, and the postoperative recovery is faster.
Wu[24]	2019	16/8 15/11	53/53.5	case-control	China	24/26	6	6	OLIF has the advantages of less blood loss, rapid postoperative recovery, and obvious improvement of early symptom.
Ye[25]	2020	8/12 11/14	46.14/47.63	case-control	China	20/25	14.3	8	The efficacy of OLIF is similar to that of TLIF.
Zhang[26]	2019	6/9	50.2/51.5	case-control	China	15/15	>12	5	OLIF is superior to TLIF in the

Study	Year	Sex (male/female) OLIF/TLIF	Age OLIF/TLIF	Study design	Country	Patients, n OLIF/TLIF	Follow-up, months	Quality score (NOS)	Conclusion
		7/8							recovey of ODI, intervertebral height and intervertebral foramen height.
Zhang[27]	2021	12/8 11/9	67.07/65.21	case-control	China	20/20	--	6	The efficacy of OLIF is similar to that of TLIF.
Zhu[28]	2021	6/15 9/23	59.21/60.09	case-control	China	21/32	21.74	5	The efficacy of OLIF is similar to that of TLIF.

3.3. Meta-Analysis Results

3.3.1. Primary Results (Figures 2 and 3)

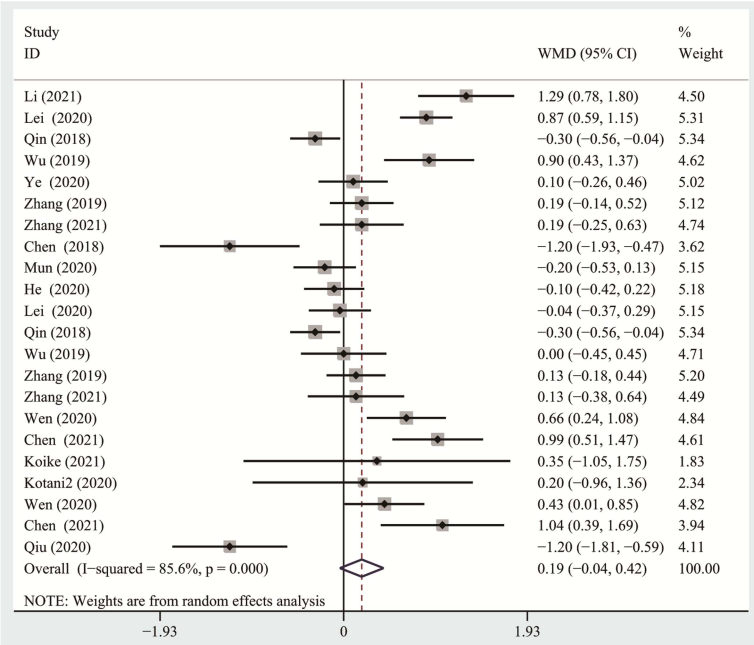

Figure 2. *Forest plot for comparing OLIF and TLIF results in terms of visual analogue scale. No significant difference was found between the two groups.*

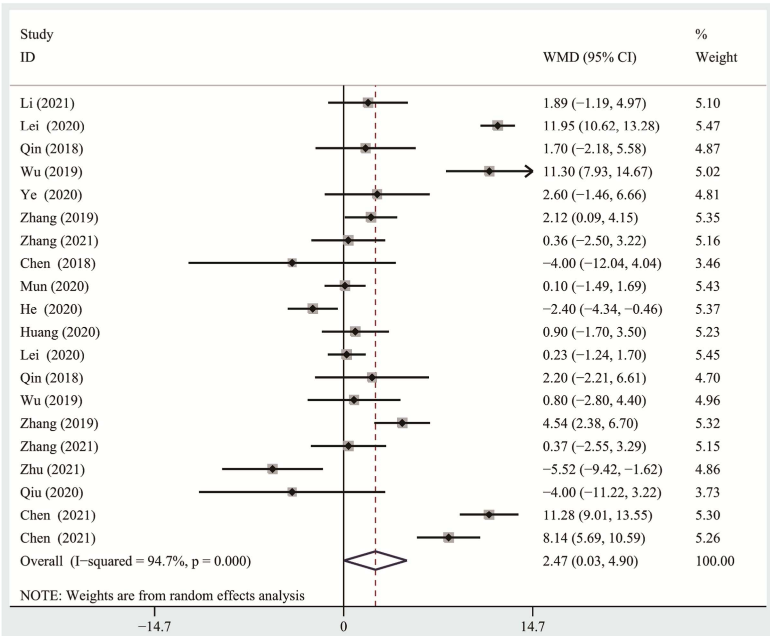

Figure 3. *Forest plot for comparing OLIF and TLIF results in terms of oswestry disability index. In this forest plot, the ODI postoperative recovery was better in the OLIF group than in the TLIF group.*

The most common methods to assess clinical function were the VAS and the ODI. Twenty-two studies investigated the results of the postoperative VAS and meta-analysis did not find any significant differences (WMD = 0.19, 95% CI = –0.04, 0.42; P = 0.105). Twenty studies reported postoperative ODI values and meta-analysis showed greater ODI improvement in the OLIF group than in the TLIF group (WMD = 2.47, 95% CI = 0.03, 4.9; P = 0.047).

3.3.2. Secondary Results

(i) Radiological results (Figure 4)

Seventeen studies investigated the outcome of postoperative intervertebral DH changes. This meta-analysis showed higher values of intervertebral space height restoration in the OLIF group than in the TLIF group (WMD = 1.149, 95% CI = 0.740, 1.558; P < 0.0001). Six studies investigated the results of FSL, with meta-analysis finding no statistically significant difference in postoperative lumbar FSL between the two groups (WMD = 1.014, 95% CI = –0.365, 2.393; P = 0.15).

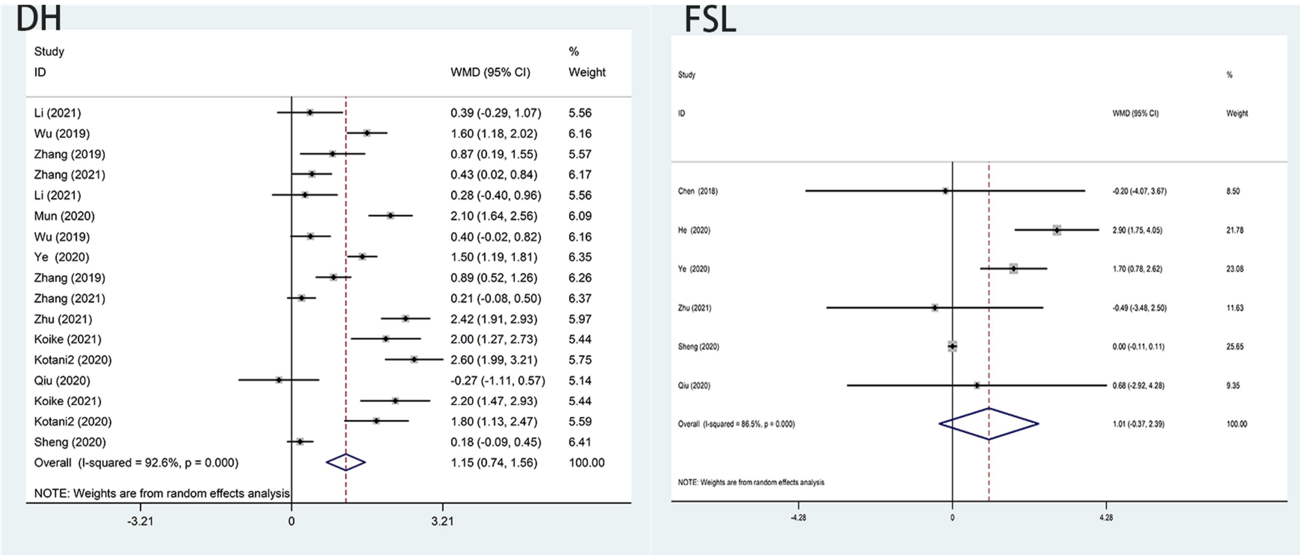

Figure 4. *Forest plot comparing OLIF and TLIF results in terms of disc height and fused segment lordosis.*

(ii) Perioperative outcomes (Figure 5)

Nineteen studies investigated the operative time for both approaches. Meta-analysis showed that the operative time was shorter for OLIF than for TLIF (WMD = –22.2, 95% CI = –36.094, –8.423; P = 0.002). Nineteen studies investigated the operative bleeding for both methods. Meta-analysis showed that OLIF had less operative bleeding than TLIF (WMD = –125.935, 95% CI = –177.329, –74.540; P < 0.001). Twelve studies investigated the length of hospital stay for both methods. Meta-analysis showed that OLIF patients had shorter hospital stays than TLIF patients (WMD = –2.245, 95% CI = –2.808, –1.681; p < 0.001).

(iii) Complications (Figure 6)

Fifteen studies investigated the complication rates of both methods. Meta-analysis showed that the complication rate of OLIF was not significantly different from that of TLIF (OR = 0.891, 95% CI = 0.630, 1.258; P = 0.511).

(iv) Fusion rate (Figure 6)

Six studies investigated the fusion rate of both methods. Meta-analysis showed that the fusion rate of OLIF was not significantly different from that of TLIF (OR = 2.48; 95% CI = 0.38, 16.27; P = 0.34).

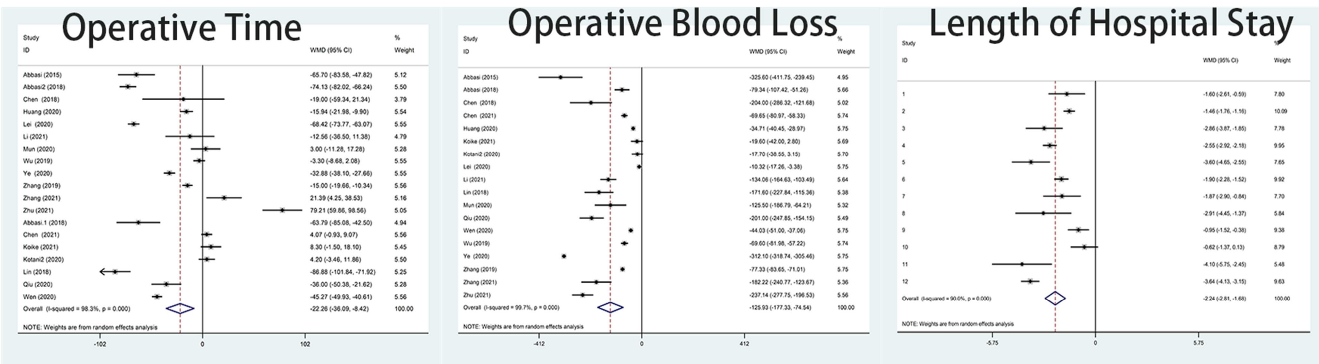

Figure 5. *Forest plot for comparing OLIF and TLIF operative time, operative blood loss and length of hospital stay.*

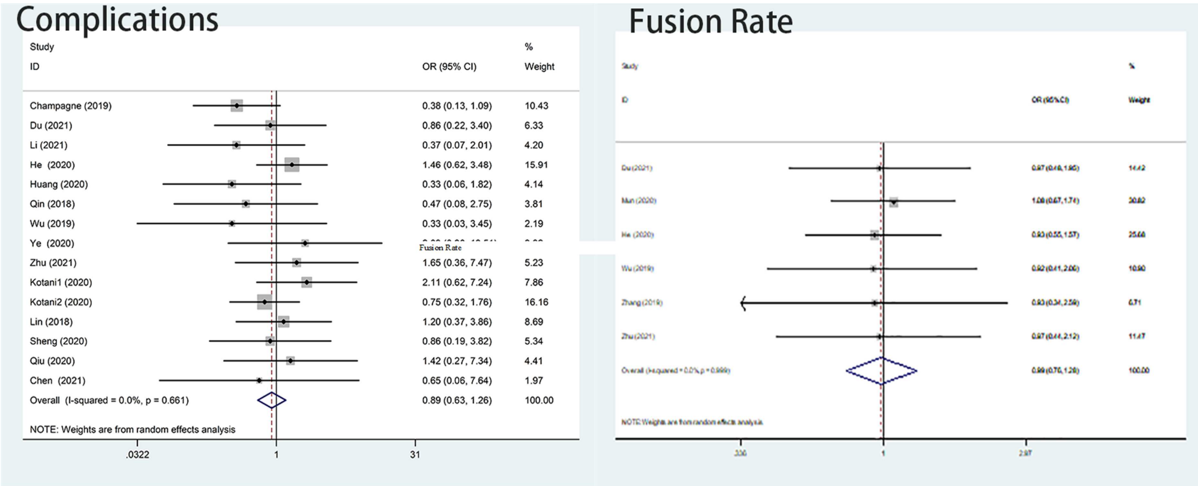

Figure 6. Forest plot comparing OLIF and TLIF complications and fusion rate.

3.4. Subgroup Analysis (Table 2)

Table 2. *Summary of meta analysis results.*

Index	WMD (95%CI)	P	Index	WMD (95%CI)	P
VAS	0.19 (-0.04,0.42)	0.105	VAS (surgical modality)		
ODI	2.47 (0.03, 4.90)	0.047	OLIF VS O-TLIF	0.12 (-0.12, 0.37)	0.332
DH	1.15 (0.74,1.56)	<0.001	OLIF VS MIS-TLIF	0.37 (-0.21, 0.95)	0.208
FSI	1.01 (-0.37,2.39)	0.150	ODI (follow-up time)		
Operative Time	-22.20 (-36.09,-8.42)	0.002	<6 months	4.67 (0.83,8.50)	0.017
Operative Blood Loss	-125.94 (-177.33,-74.54)	<0.001	>6 months	0.80 (-1.22,2.83)	0.436
Length of Hospital Stay	-2.25 (-2.81,-1.68)	<0.001	ODI (surgical modality)		
Subgroup analysis			OLIF VS O-TLIF	1.86 (-0.68, 4.41)	0.151
VAS (follow-up time)			OLIF VS MIS-TLIF	6.45 (1.03, 11.88)	0.020
<6 months	0.53 (0.17,0.89)	0.004			
>6 months	-0.07 (-0.32,0.17)	0.558			

Postoperative clinical function

Grouping by follow-up time (Figures 7 and 8)

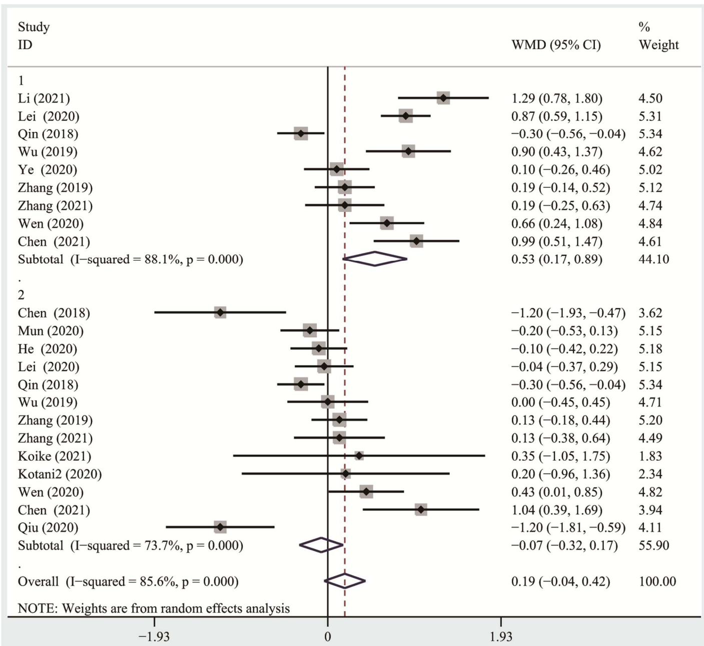

Figure 7. Forest plot for subgroup analysis of visual analogue scale (VAS). 1: Follow-up time <65 years; 2: Follow-up time >65 years. In this forest plot, VAS improvement was better in the OLIF group than in TLIF at a follow-up time of less than 6 months; at a follow-up time of more than 6 months, there was no significant difference in VAS improvement between the two groups.

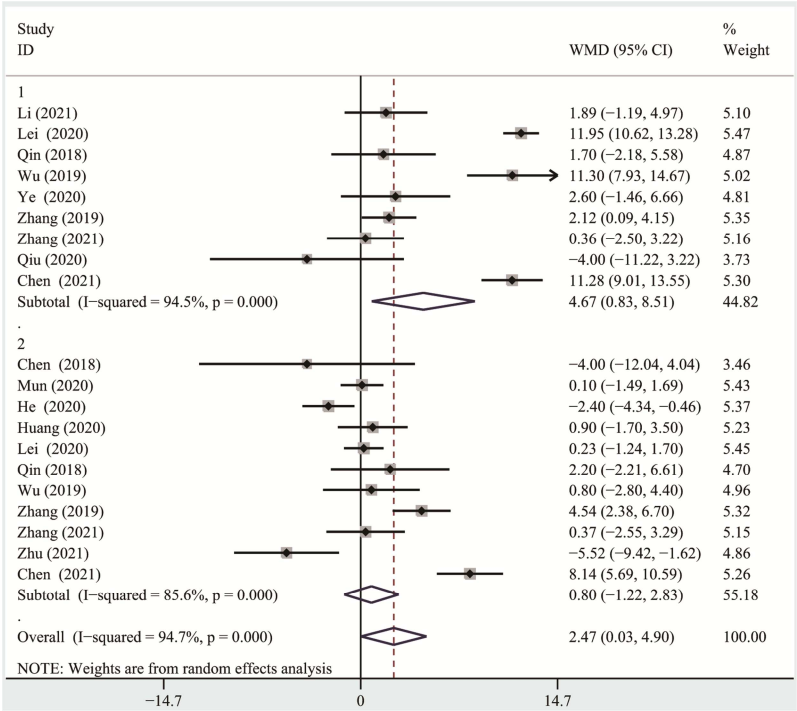

Figure 8. *Forest plot for subgroup analysis of oswestry disability index (ODI). 1: Follow-up time <65 years; 2: Follow-up time >65 years. In this forest plot, ODI improvement was better in the OLIF group than in TLIF at a follow-up time of less than 6 months; at a follow-up time of more than 6 months, there was no significant difference in ODI improvement between the two groups.*

Meta-analysis showed that there was greater improvement in both the VAS and ODI values within 6 months post-surgery for the OLIF group than for the TLIF group. Additionally, the improvement in VAS and ODI values more than 6 months post-surgery was not significantly different between the OLIF and TLIF groups.

Grouping by surgical modality (Figures 9 and 10).

Results showed that the postoperative improvement values of VAS and ODI in the OLIF group were not significantly different from those of the open transforaminal lumbar disc fusion (O-TLIF) and MIS-TLIF groups.

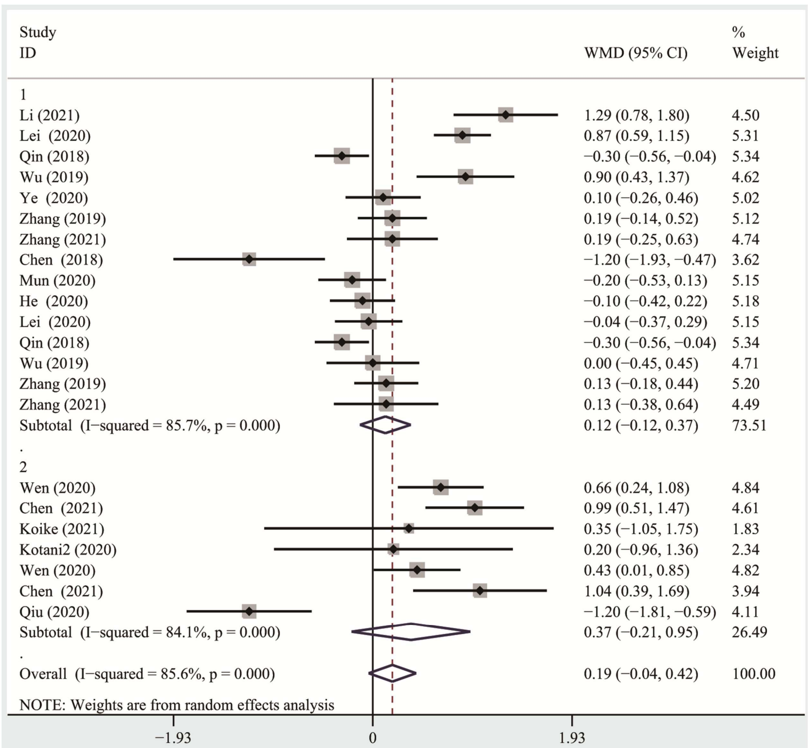

Figure 9. *Forest plot for subgroup analysis of visual analogue scale. 1: OLIF VS O-TLIF; 2: OLIF VS MIS-TLIF.*

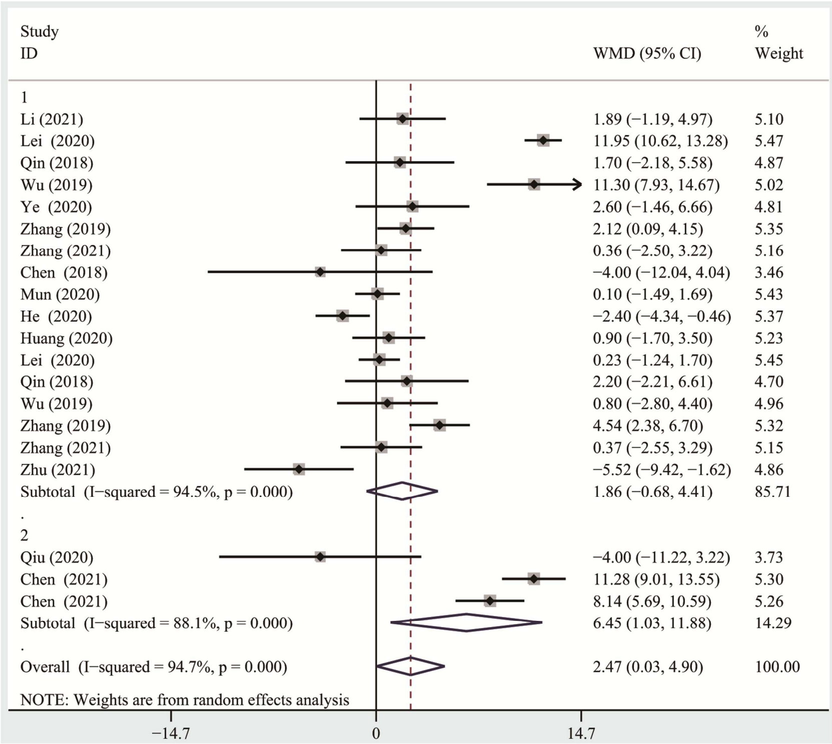

Figure 10. *Forest plot for subgroup analysis of oswestry disability index. 1: OLIF VS O-TLIF; 2: OLIF VS MIS-TLIF.*

3.5. Sensitivity Analysis and Publication Bias

3.5.1. Sensitivity Analysis

Studies with sources of heterogeneity were identified and removed by plotting sensitivity analyses in STATA. The final statistics were not substantially altered by eliminating these studies (Figures 11 and 12).

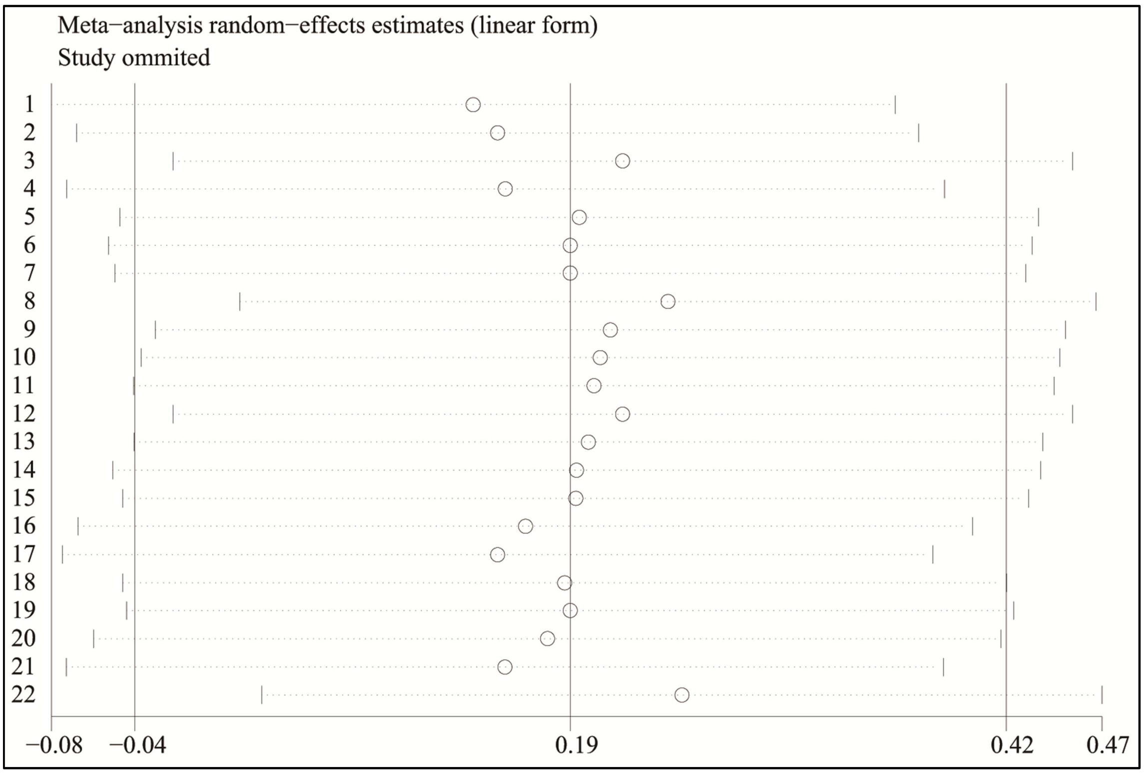

Figure 11. *Sensitivity analysis chart for visual analogue scale.*

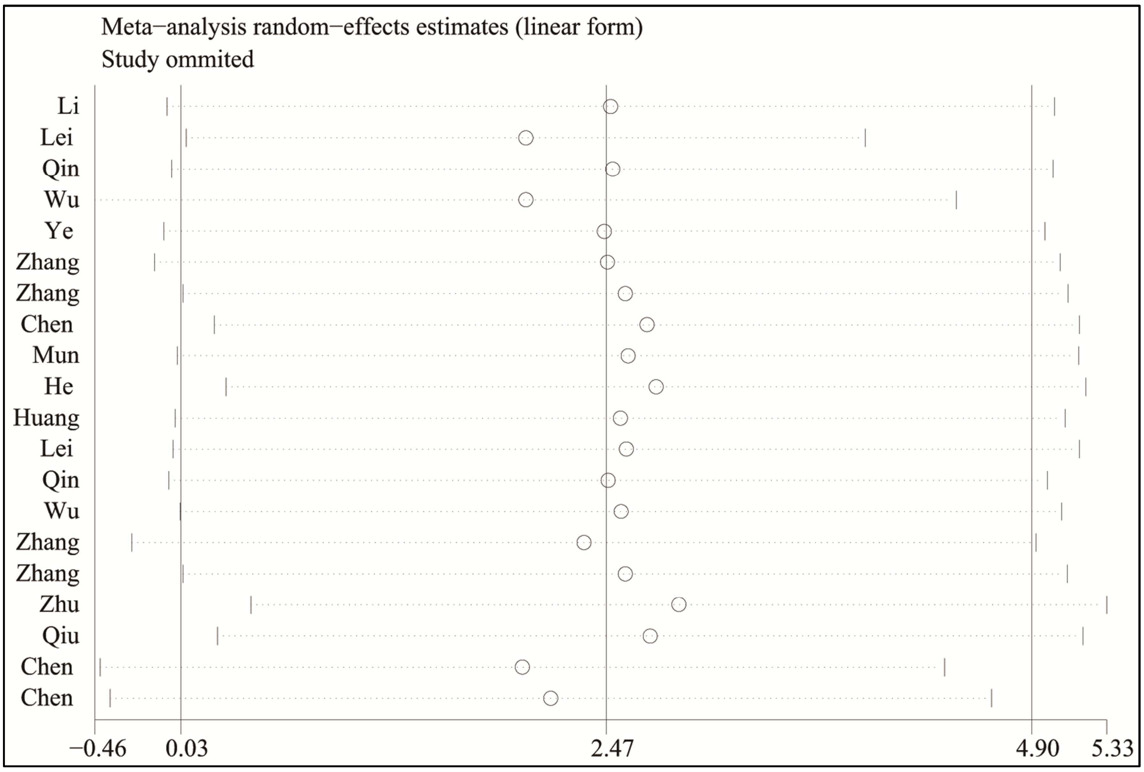

Figure 12. *Sensitivity analysis chart for oswestry disability index score.*

3.5.2. Publication Bias

Publication bias was analyzed using the begg test for functional improvement (SRS-22 and ODI), and both results suggested no significant publication bias (p=0.225, 0.77).

4. Discussion

Lumbar fusion is an effective treatment for degenerative lesions of the lumbar spine. TLIF is a commonly used posterior procedure with proven efficacy, while OLIF is a recently emerging procedure that exposes the disc through the retroperitoneal space and performs indirect decompression fusion. Although a 2018 systematic review compared the imaging and clinical efficacy of OLIF and TLIF for the treatment of lumbar degenerative disease, of the 47 studies included, 24 were retrospective case series [30]. Furthermore, several retrospective studies [5-19, 21-29] comparing the efficacy of OLIF and TLIF had been recently published and there were also new prospective studies [20]. This meta-analysis was conducted to summarise the evidence in the literature and compare the efficacy and safety of OLIF and TLIF in the treatment of lumbar degenerative disease.

In this meta-analysis, satisfactory clinical outcomes of both approaches were reported in all included studies. There were no significant differences between OLIF and TLIF in terms of pain relief, complication rates and fusion rates, but OLIF was significantly better than TLIF in terms of postoperative lumbar function improvement, restoration of interbody height and perioperative outcomes.

One interesting finding from the subgroup analysis was that OLIF did not differ significantly from TLIF in terms of long-term lumbar function and pain recovery, but the short-term outcomes of OLIF were superior to TLIF. The possible reasons for this are as follows. (1) The retroperitoneal space between the psoas major muscle and the aorta is used in OLIF, which avoids posterior surgery on the paravertebral muscles and small joints injury [31, 32]. (2) The OLIF procedure does not require access to the spinal canal, avoiding the risk of disturbing the dural sac and nerve roots [3, 33]. (3) The paravertebral muscles had recovered in both groups at long-term follow-up, and most patients had achieved implant fusion, which may explain the lack of significant differences in long-term comparisons of lumbar spine function and pain recovery after surgery.

Normal lumbar lordosis can maintain the physiological curve and postural equilibrium of the spine. Studies have shown that the restoration of lumbar lordosis can contribute to the recovery of function after lumbar fusion and help prevent the degeneration of adjacent segments of the lumbar spine [34]. The restoration of the lumbar anterior lordosis angle largely depends on the restoration of intervertebral height [35]. The present meta-analysis showed that the recovery of intervertebral space height after surgery was significantly higher in the OLIF group than in the TLIF group, which was maintained until the final follow-up. This may have been because OLIF uses orthogonal manipulation, which allows for a safer placement of the fusion in the posterior and thus facilitates recovery of the disc and foraminal height [36]. In addition, OLIF usually uses a wider fusion device.

The meta-analysis showed that there was no significant difference in the incidence of surgical complications between the two procedures, but the operative time, intraoperative bleeding and postoperative hospital stay were significantly shorter in the OLIF group than in the TLIF group, and the OLIF procedure appeared to be safer than TLIF.

Nevertheless, the current study had some limitations. First, most of the included studies were observational trials; only one randomised controlled trial was included in this analysis. Second, the included studies were in English and Chinese only, excluding articles with potentially high-quality data that were published in other languages and potentially leading to a language bias. Third, the included randomised controlled trial and non-randomised controlled trials had some methodological flaws. Additionally, the number of studies that compared the surgical efficacy of OLIF and MIS-TLIF was too small to enable the comparison of OLIF and MIS-TLIF regarding VAS, ODI and other indicators. But this study still has some advantages. First, the meta-analysis used strict inclusion and exclusion criteria and selected appropriate studies, including both prospective randomised controlled studies and retrospective case-control studies. Second, regression analyses were performed to identify sources of heterogeneity, stratified analyses were performed to reduce heterogeneity and sensitivity analyses were performed to verify the reliability of the results.

5. Conclusion

This meta-analysis showed no significant difference between OLFI and TLIF in terms of long-term clinical outcomes, but the short-term clinical and radiological outcomes of OLIF were better than those of TLIF, and the surgical safety of OLIF was higher than that of TLIF; therefore, OLIF is recommended for the treatment of degenerative lumbar spine disease.

Abbreviation

RCT: Randomized Controlled Trial
OLIF: oblique lateral lumbar interbody fusion
TLIF: transforaminal lumbar interbody fusion
MIS-TLIF: minimally invasive transforaminal interbody fusion
O-TLIF: open- transforaminal lumbar interbody fusion
DLS: Degenerative lumbar scoliosis
QOL: Quality of life
Study^{number}: reference numbers to the studies included
ODI: oswestry disability index
VAS: visual analogue scale
DH: disc height
FSL: fused segment lordosis
NOS: newcastle-ottawa scale
MD: mean difference

References

[1] Phillips FM, Slosar PJ, Youssef JA, Andersson G, Papatheofanis F. Lumbar spine fusion for chronic low back pain due to degenerative disc disease: a systematic review. *Spine*. Apr 1 2013; 38 (7): E409-22. doi: 10.1097/BRS.0b013e3182877f11

[2] Harms J, Rolinger H. [A one-stager procedure in operative treatment of spondylolistheses: dorsal traction-reposition and anterior fusion (author's transl)]. *Zeitschrift fur Orthopadie und ihre Grenzgebiete*. May-Jun 1982; 120 (3): 343-7. Die operative Behandlung der Spondylolisthese durch dorsale Aufrichtung und ventrale Verblockung. doi: 10.1055/s-2008-1051624

[3] Silvestre C, Mac-Thiong JM, Hilmi R, Roussouly P. Complications and Morbidities of Mini-open Anterior Retroperitoneal Lumbar Interbody Fusion: Oblique Lumbar Interbody Fusion in 179 Patients. *Asian spine journal*. Jun 2012; 6 (2): 89-97. doi: 10.4184/asj.2012.6.2.89

[4] Gibson JN, Waddell G. Surgery for degenerative lumbar spondylosis: updated Cochrane Review. *Spine*. Oct 15 2005; 30 (20): 2312-20. doi: 10.1097/01.brs.0000182315.88558.9c

[5] Koike Y, Kotani Y, Terao H, Iwasaki N. Comparison of Outcomes of Oblique Lateral Interbody Fusion with Percutaneous Posterior Fixation in Lateral Position and Minimally Invasive Transforaminal Lumbar Interbody Fusion for Degenerative Spondylolisthesis. *Asian spine journal*. Feb 2021; 15 (1): 97-106. doi: 10.31616/asj.2019.0342

[6] Du X, She Y, Ou Y, Zhu Y, Luo W, Jiang D. Oblique Lateral Interbody Fusion versus Transforaminal Lumbar Interbody Fusion in Degenerative Lumbar Spondylolisthesis: A Single-Center Retrospective Comparative Study. *BioMed research international*. 2021; 2021: 6693446. doi: 10.1155/2021/6693446

[7] Mun HY, Ko MJ, Kim YB, Park SW. Usefulness of Oblique Lateral Interbody Fusion at L5-S1 Level Compared to Transforaminal Lumbar Interbody Fusion. *Journal of Korean Neurosurgical Society*. Nov 2020; 63 (6): 723-729. doi: 10.3340/jkns.2018.0215

[8] Li R, Shao X, Li X, Liu Y, Jiang W. Comparison of clinical outcomes and spino-pelvic sagittal balance in degenerative lumbar spondylolisthesis: Minimally invasive oblique lumbar interbody fusion (OLIF) versus transforaminal lumbar interbody fusion (TLIF). *Medicine*. Jan 22 2021; 100 (3): e23783. doi: 10.1097/md.0000000000023783

[9] Higgins JP, Thompson SG, Deeks JJ, Altman DG. Measuring inconsistency in meta-analyses. *BMJ (Clinical research ed)*. Sep 6 2003; 327 (7414): 557-60. doi: 10.1136/bmj.327.7414.557

[10] Abbasi H, Abbasi A. Oblique Lateral Lumbar Interbody Fusion (OLLIF): Technical Notes and Early Results of a Single Surgeon Comparative Study. *Cureus*. Oct 15 2015; 7 (10): e351. doi: 10.7759/cureus.351

[11] Abbasi H, Grant A. Effect of Body Mass Index on Perioperative Outcomes in Minimally Invasive Oblique Lateral Lumbar Interbody Fusion versus Open Fusions: A Multivariant Analysis. *Cureus*. Mar 8 2018; 10 (3): e2288. doi: 10.7759/cureus.2288

[12] Champagne PO, Walsh C, Diabira J, et al. Sagittal Balance Correction Following Lumbar Interbody Fusion: A Comparison of the Three Approaches. *Asian spine journal*. Jun 2019; 13 (3): 450-458. doi: 10.31616/asj.2018.0128

[13] Chen YL, Zhu ZH, Wang YK, et al. [Effects of oblique lateral interbody fusion and transforaminal lumbar interbody fusion for lordosis correction in degenerative lumbar diseases]. *Zhonghua yi xue za zhi*. Jul 3 2018; 98 (25): 1990-1995. doi: 10.3760/cma.j.issn.0376-2491.2018.25.005

[14] Kotani Y, Ikeura A, Tokunaga H, Saito T. Single-level controlled comparison of OLIF51 and percutaneous screw in lateral position versus MIS-TLIF for lumbosacral degenerative disorders: Clinical and radiologic study. *Journal of Orthopaedic Science*. 2020; 12: 12.

[15] Kotani Y, Koike Y, Ikeura A, Tokunaga H, Saito T. Clinical and radiologic comparison of anterior-posterior single-position lateral surgery versus MIS-TLIF for degenerative lumbar spondylolisthesis. *Journal of Orthopaedic Science*. 2020; 16: 16.

[16] Sheng SR, Geng YB, Zhou KL, Wu AM, Wang XY, Ni WF. Minimally invasive surgery for degenerative spondylolisthesis: transforaminal or oblique lumbar interbody fusion. *Journal of comparative effectiveness research*. Jan 2020; 9 (1): 45-51. doi: 10.2217/cer-2019-0055

[17] Chen Kaiwei, Peng Xiaozhong, Wu Zhenguo: Comparison of the efficacy of oblique lateral lumbar interbody fusion and minimally invasive transforaminal lumbar interbody fusion in the treatment of lumbar spondylolisthesis. China Health Care & Nutrition. 2021, 31 (4): 23-24.

[18] He Da, He Wei, Sun Yuqing, Xing Yonggang, Yuan Qiang, Liu Bo, Wang Yumei, Tian Wei: A comparative study of the efficacy and complications of oblique lumbar interbody fusion and transforaminal lumbar in-terbody fusion in lumbar degenerative scoliosis. Chin J Orthop. 2020 (08): 515-516-517-518-519-520-521-522-523-524-525.

[19] Huang Kai, Yang Jinhua, Pan Wenming, Zhang Wei, Shen Yixin: Comparison of the effect of oblique lateral approach and transforaminal approach for lumbar interbody fusion in degenerative lumbar spondylolisthesis. The Journal of Cervicodynia and Lumbodynia. 2020, 41 (02): 237-239.

[20] LEI Hongjun, CHEN Zhongxian, FU Zhaozong, XIANG Shanshan: Comparison of the Short-term Effects of the Treatment of Lumbar Spondylolisthesis with OLIF and TLIF. Chinese and Foreign Medical Research. 2020, 18 (34): 61-63.

[21] Qin Shiqiang, Sun Yuqing, Ni Wenzhuo, Song Aiguo, Xing Yonggang: Comparison of OLIF and TLIF in the treatment of degenerative lumbar spondylolisthesis with lumbar spinal stenosis. Journal of Practical Orthopedics. 2018, 24 (07): 628-632.

[22] Qiu Tianqiang, Qiu Renhua, Pang Zhengbao, Pang Banglei, Cui Deyong, Ye Fuguo, Hu Zhijun, Xu Wenbin, Fang Xiangq-ian, Fan Shunwu: A comparative study on the treatment of degenerative lumbar spondylolisthesis by oblique interbody fusion and mini-mally invasive transforminal lumbar interbody fusion. Chin J Orthop. 2020 (08): 526-527-528-529-530-531-532-533-534-535.

[23] Wen Tao, Sun Kai: Comparison of the efficacy of OLIF and MIS-TLIF in the treatment of single-segment degenerative lumbar spondylolisthesis with lumbar spinal stenosis. Electronic Journal of Clinical Medical Literature. 2020, 7 (15): 75+123.

[24] WU Rui-hui, DENG Dong-hai, HUANG Xing-qiu, SHI Cheng-long, ZHOU Yun-fei, LIANG Dong-liang, LIAO Xu-qiang: Comparison of early clinical effect between OLIF and TLIF in treatment of lumbar spondylo.listhesis. Chin J Bone Joint Injury. 2019, 34 (11): 1140-1144.

[25] Ye Zhiwei, Zhu Shijie, Peng Longhai, Zhou Rongping: Comparison of the efficacy of OLIF and TLIF in the treatment of L4-5 single-segment degenerative lumbar spondylolisthesis. Practical Clinical Medicine. 2020, 21 (01): 19-24.

[26] ZHANG Qiang, SHI Guo-dong, DING Hong-wei, XU Ning, SHI Hong-yang, SUN Xiao-hai: Short-term effects of oblique/transforaminal lumbar interbody fusion for degenerative lumbar spondylolisthesi J Spinal Surg. 2019, 17 (06): 369-373+393.

[27] Zhang Shengfei, Zhang Liang, Zhang Zhiqiang, Cai Jun, Huang Jijun, Feng Xinmin: Treatment of lumbar spinal degenerative diseases with OLIF approach combined with posterior inter-nal fixation under expandable channels. Jilin Medicine. 2021, 42 (02): 325-329.

[28] Zhu Lei, Zhang Liang, Shan Yuzhou, Wang Shuguang, Feng Xinmin: Comparison of the efficacy of oblique lateral and transforaminal interbody fusion in the treatment of lumbar spinal stenosis. Ournal of Practical Orthopaedics. 2021, 27 (04): 348-353.

[29] Lin GX, Akbary K, Kotheeranurak V, et al. Clinical and Radiologic Outcomes of Direct Versus Indirect Decompression with Lumbar Interbody Fusion: A Matched-Pair Comparison Analysis. *World neurosurgery*. Nov 2018; 119: e898-e909. doi: 10.1016/j.wneu.2018.08.003

[30] Li HM, Zhang RJ, Shen CL. Radiographic and Clinical Outcomes of Oblique Lateral Interbody Fusion Versus Minimally Invasive Transforaminal Lumbar Interbody Fusion for Degenerative Lumbar Disease. *World neurosurgery*. Feb 2019; 122: e627-e638. doi: 10.1016/j.wneu.2018.10.115

[31] He W, He D, Sun Y, et al. Quantitative analysis of paraspinal muscle atrophy after oblique lateral interbody fusion alone vs. combined with percutaneous pedicle screw fixation in patients with spondylolisthesis. *BMC musculoskeletal disorders*. Jan 14 2020; 21 (1): 30. doi: 10.1186/s12891-020-3051-9

[32] Pradhan BB, Nassar JA, Delamarter RB, Wang JC. Single-level lumbar spine fusion: a comparison of anterior and posterior approaches. *Journal of spinal disorders & techniques*. Oct 2002; 15 (5): 355-61. doi: 10.1097/00024720-200210000-00003

[33] Mobbs RJ, Phan K, Malham G, Seex K, Rao PJ. Lumbar interbody fusion: techniques, indications and comparison of interbody fusion options including PLIF, TLIF, MI-TLIF, OLIF/ATP, LLIF and ALIF. *Journal of spine surgery (Hong Kong)*. Dec 2015; 1 (1): 2-18. doi: 10.3978/j.issn.2414-469X.2015.10.05

[34] Kim KH, Lee SH, Shim CS, et al. Adjacent segment disease after interbody fusion and pedicle screw fixations for isolated L4-L5 spondylolisthesis: a minimum five-year follow-up. *Spine*. Mar 15 2010; 35 (6): 625-34. doi: 10.1097/BRS.0b013e3181bb8168

[35] Phan K, Thayaparan GK, Mobbs RJ. Anterior lumbar interbody fusion versus transforaminal lumbar interbody fusion--systematic review and meta-analysis. *British journal of neurosurgery*. 2015; 29 (5): 705-11. doi: 10.3109/02688697.2015.1036838

[36] Jin J, Ryu KS, Hur JW, Seong JH, Kim JS, Cho HJ. Comparative Study of the Difference of Perioperative Complication and Radiologic Results: MIS-DLIF (Minimally Invasive Direct Lateral Lumbar Interbody Fusion) Versus MIS-OLIF (Minimally Invasive Oblique Lateral Lumbar Interbody Fusion). *Clinical spine surgery*. Feb 2018; 31 (1): 31-36. doi: 10.1097/bsd.0000000000000474