LUMBAR FUSION THROUGH THE ANTEROLATERAL MINI-APPROACH: COMPARISON OF ANTERIOR INTERBODY (OLIF-AF) AND PERCUTANEOUS PEDICLE (OLIF-PF) FIXATIONS IN THE SURGICAL TREATMENT OF SINGLE-LEVEL STENOSIS

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Objective. To perform comparative analysis of the clinical efficacy and safety of indirect decompression of the spinal roots and interbody fusion through the lateral pre-psoas approach (OLIF) with anterolateral (OLIF-AF) and posterior percutaneous (OLIF-PF) screw fixations in the surgical treatment of single-segment lumbar stenosis.
Material and Methods. A retrospective comparative analysis of treatment of 88 patients aged 29 to 72 years with single-level lumbar stenosis was carried out. Posterior instrumental fixation (OLIF-PF) was performed in 60 cases, and anterolateral (OLIF-AF) – in 28.
Results. The compared groups did not statistically significantly differ from each other in terms of age, gender, body mass index, clinical picture and duration of symptoms before surgery, assessment of neurological status according to the Zurich Claudication Questionnaire (ZCQ), preoperative diagnosis, localization of stenosis, pain assessment in the back and leg before surgery according to a digital rating scale, physical status (ASA), health assessment (SF-12, ODI), follow-up period, as well as smoking and the presence of comorbidities ($p > 0.05$). In the OLIF-AF group, compared to the OLIF-PF group, a statistically significant advantage was found in terms of blood loss, duration of surgery and anesthesia, the level of radiological exposure, duration of patient's hospitalization and hospital stay in the postoperative period, as well as the duration of antibiotic prophylaxis and intraoperative volume of infusions ($p < 0.05$). Despite earlier discharge and less use of local anesthesia (35.7 % vs 73.3 %; $p = 0.001$), patients in the OLIF-AF group had statistically significantly lower level of back pain on the day of discharge (3.0 vs 3.5; $p = 0.034$) and were less likely to need opioids (3.6 % vs 31.7 %; $p = 0.003$). With regard to complications and adverse events, there were no statistically significant differences during dynamic follow-up period from 3 to 50 months in both groups (17.9 % vs 28.3 %; $p = 0.290$), including depending on the timing of complications (early or late). In addition, no statistically significant differences were found for neurological, infectious, gastrointestinal, urological, or implant-related complications ($p > 0.05$).
Conclusions. Indirect decompression of the spinal roots and interbody fusion through the lateral pre-psoas approach in combination with OLIF-AF is an effective and safe technique for the surgical treatment of single-segment lumbar stenosis. This method allows to reduce the invasiveness of surgery and severity of the pain syndrome and to create conditions for enhanced recovery after surgery. Further multicenter randomized trials are needed to comprehensively evaluate long-term outcomes.
Key Words: spine surgery, anterolateral screw fixation, interbody fusion, lateral pre-psoas approach, OLIF, OLIF-AF, enhanced recovery after surgery, spinal stenosis, spondylolisthesis.
Please cite this paper as: *Saifullin AP, Aleynik AYa, Bokov AE, Mlyavykh SG. Lumbar fusion through the anterolateral mini-approach: comparison of anterior interbody (OLIF-AF) and percutaneous pedicle (OLIF-PF) fixations in the surgical treatment of single-level stenosis. Khirurgia Pozvonochnika (Russian Journal of Spine Surgery) 2023;20(3):50–62. In Russian.*
DOI: http://dx.doi.org/10.14531/ss2023.3.50-62.

Symptomatic lumbar spinal stenosis is one of the most frequent causes for patients to consult a neurosurgeon and undergo surgical treatment [1–3]. Moreover, the number of complications in spinal and spinal cord surgery can reach 44–55 % [4–8]. This certainly increases the costs of healthcare, length of hospital stay and rehabilitation of patients. It also necessitates the search for technologies to optimize the perioperative management of the patient and surgical technique [9–14].

At present, one of the most optimal and effective treatment techniques for symptomatic lumbar spinal stenosis is indirect decompression of the spinal roots and interbody fusion through the lateral pre-psoas approach (oblique lateral interbody fusion – OLIF) in combination with posterior (posterior fixation – PF) percutaneous transpedicular fixation (OLIF-PF). Nevertheless, this technique requires an intraoperative change of the patient's position that increase injury rate and surgery duration, as well as radiation exposure to both a patient and a healthcare staff [15, 16]. The complications rate in OLIF varies from 3.7 % [17] to 48.3 % [4] and mean is 13.9 % [18].

One of the possible solutions to these challenges is the new technique of OLIF with anterolateral screw fixation (OLIF-AF) [15, 19, 20] that allows surgery to be performed from a single surgical approach. Nonetheless, isolated papers do not disclose the details of the effect of this technique on the number of complications, the degree of postoperative pain and the features of postoperative recovery in patients.

The objective is to perform a comparative analysis of the clinical efficacy and safety of indirect decompression of the spinal roots and interbody fusion through the lateral pre-psoas approach with anterolateral and posterior percutaneous screw fixations in the surgical treatment of single-segment lumbar stenosis.

Design: a single-center non-randomized interventional cohort comparative trial. Evidence level: 3b.

Material and Methods

This study is approved by the ethical committee (Protocol No. 02 as of 17.02.2023) of the Privolzhsky Research Medical University (Nizhny Novgorod, Russia). In the period from 2019 to 2023, the treatment of 88 patients aged 29–72 years old with single-level lumbar stenosis was studied retrospectively using the OLIF technique. The patients involved in the study were divided into two groups:

• The first group (n = 60): indirect decompression of spinal cord roots and interbody fusion through the lateral pre-psoas approach (OLIF) in combination with posterior percutaneous stabilization of a spinal motion segment (OLIF-PF);

• The second group (n = 28): OLIF in combination with anterolateral instrumented fixation (OLIF-AF) performed by author's modification.

The required sampling size was identified when calculating the power analysis performed on https://clincalc.com, with the significance value (α) = 0.05 and the power of test (1-β) = 0.80. The analysis confirmed the sufficiency of the number of patients in both groups; the calculation was performed with the identification of the required total sampling according to such compared criteria as duration of anesthesia (n = 4) and surgery (n = 2), volume of blood loss (n = 4), length of hospital stay (n = 18), radiological exposure (n = 24), degree of back pain on the day of discharge (n = 76), as well as use of opioids (n = 56) and local anesthesia (n = 52).

Inclusion criteria:

• age over 18;

• chronic (more than 6 months) progressive vertebral syndrome in combination with neurogenic intermittent claudication and/or nerve root syndrome corresponding to single-level unstable degenerative stenosis, as well as combined with degenerative spondylolisthesis;

• no effect from complex non-surgical treatment lasting at least 4 weeks;

• surgical treatment in the volume of single-level indirect decompression, oblique lateral interbody fusion followed by rigid instrumented fixation of the spinal motion segment.

Exclusion criteria:

• previous spinal surgery at the site of planned procedure with instrumented fixation;

• presence of competing pathology in the lumbar spine (pronounced osteoporosis, inflammatory infections, tumors, traumatic injuries).

Perioperative management

Perioperative management of patients in the surgical treatment of single-level spinal stenosis complies with the international protocol for enhanced recovery after surgery (ERAS® Society) during interbody fusion [21, 22], with the exception of the following protocol elements: combined therapy for smoking and alcohol cessation 4–8 weeks before surgery; assessment of nutritional status (albumin, transferrin, lymphocytes) for dietary supplementation; preoperative correction of nutrition and minimizing preoperative fasting (drinking water 2 hours and eating 6 hours before surgery) for patients with a low body mass index (BMI); antiseptic dressing at the site of surgical approach before surgery.

Surgical technique

Indirect decompression of spinal roots and interbody fusion through the lateral pre-psoas approach (OLIF) in combination with posterior percutaneous stabilization of a spinal motion segment (Fig. 1, 2) did not differ from the generally accepted ones [23]. Anterolateral instrumented fixation was performed in accordance with the technique described in the papers by Liu et al. [20], Xie et al. [19], Guo et al. [15]. However, there were the following differences: preliminary interfacial anesthesia of the musculus erector spinae and the infiltration of the surgical approach site by local anesthetics were performed. The cage was inserted with pre-filling of the graft with allobone or osteoplastic material only. Bi-cortical anterolateral insertion of titanium screws was performed into the vertebral bodies with an insertion point at a distance of 8 mm from the level of the endplate and at the angle of 30° at the level of L1–L2–L3–L4–L5 followed by their locking with a titanium rod and at the angle of 45° in a monocortical manner at the level of L5–S1 in the caudal or in combination with the cranial direction (Fig. 3, 4). A layered closure of the surgical wound was performed with the application of an aesthetic intradermal suture without the installation of drains (priority reference No. 2022130051 as of 18.11.2022). All surgeries were performed by three spine surgeons with more than 10 years of experience.

Statistical analysis

The data were analyzed using the IBM SPSS Statistics-23 software. Methods of descriptive statistics were used. The distribution of signs of normality was assessed using the Kolmogorov-Smirnov tests. The Mann-Whitney U Test and the Wilcoxon signed-rank test were used for a comparative analysis of non-parametric data. The data are presented by median and interquartile range in the form of Me [25; 75]. Pearson's chi-squared test was used for comparative analysis of nominal data. The differences were considered statistically significant at $p < 0.05$. Spearman's rank correlation coefficient for nonparametric data and Cramer's

V for nominal variables were used to assess the strength of the correlation. The interpretation of the results was done according to the recommendations of Rea & Parker [24].

Results

Demographic profile of patients

There were no statistically significant differences ($p > 0.05$) between the compared groups of OLIF-PF and OLIF-AF in terms of age, gender, BMI, clinical picture and duration of symptoms before surgery, assessment of neurological status according to the Zurich Claudication Questionnaire (ZCQ), preoperative diagnosis, localization of stenosis, pain assessment on the numeric rating scale (NRS) in the back and leg before surgery, physical status (ASA), health assessment (SF-12, ODI – Oswestry Disability Index), follow-up periods (Table 1), as well as smoking and the presence of concomitant diseases (Fig. 5).

Clinical outcomes

In the OLIF-AF group, compared with the OLIF-PF group, a statistically significant advantage was revealed (Table 2) in terms of the volume of blood loss, the duration of surgery and anesthesia, the level radiological exposure, the time of hospital admission and length of hospital stay of the patient in the postoperative period, as well as the duration of antibiotic prophylaxis and intraoperative volume of infusion ($p < 0.05$).

Despite earlier discharge and less use of local anesthesia (35.7 % vs 73.3 %; $p = 0.001$) associated with more frequent interfacial anesthesia of the musculus erector spinae (39.3 % vs 11.7 %; $p = 0.003$), patients in the OLIF-AF group had statistically significantly lower degree of back pain on the day of discharge (3.0 vs 3.5; $p = 0.034$) and needed fewer opioids (3.6 % vs 31.7 %; $p = 0.003$).

There were no statistically significant differences in the comparative assessment of repeated surgeries in the early postoperative period (up to 30 days), the length of the patient's hospital stay before surgery, the assessment of leg pain on the day of discharge or the formation of interbody fusion ($p > 0.05$).

Complications and adverse events

Despite the lower overall rate of complications and adverse events (Table 3) in the OLIF-AF group, there were no statistically significant differences during case follow-up from 3 to 50 months in both groups (17.9 % vs 28.3 %; $p = 0.290$). Moreover, there were no statistically significant differences in neurological, infectious, gastrointestinal, urological or implant-associated complications ($p > 0.05$). Damages to the great vessels, dura mater, abdominal

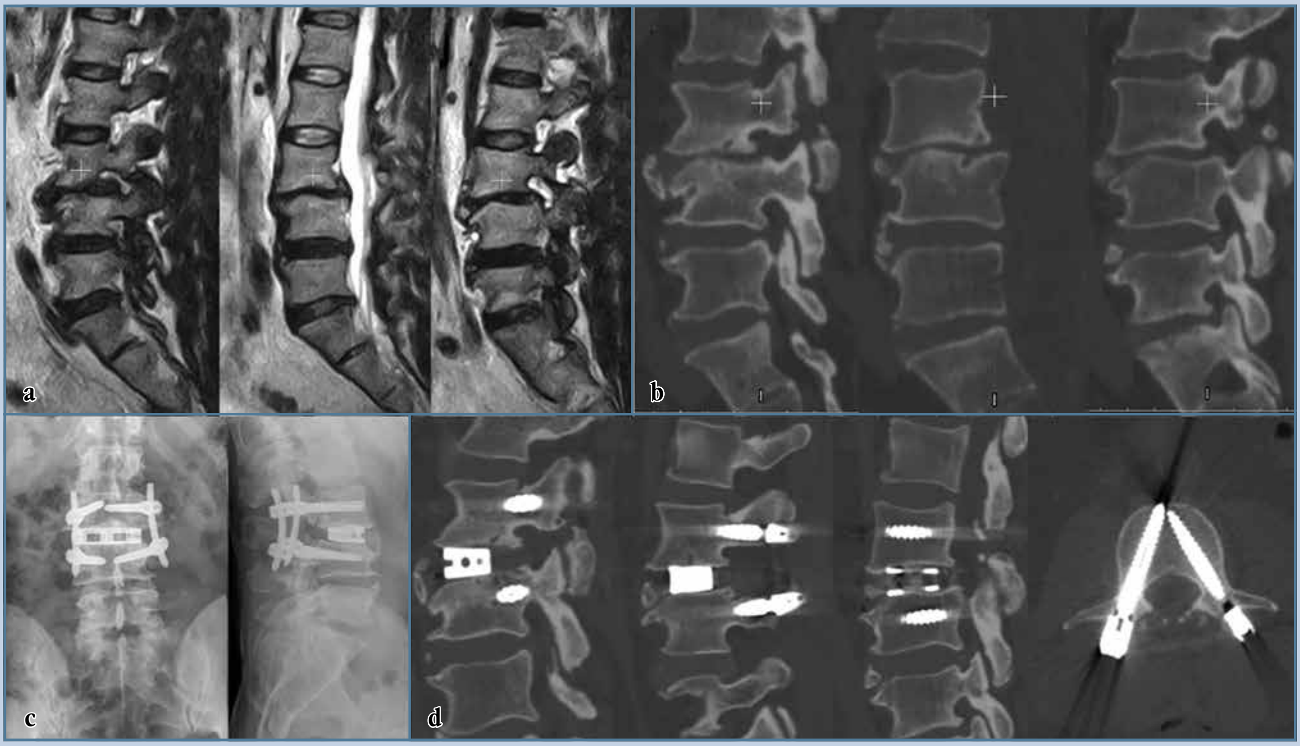

Fig. 1

Radiological findings of a 48-year-old man with spondylolisthesis of the L3 vertebra and a clinical picture of neurogenic claudication who underwent OLIF-PF: **a** – MRI before surgery; **b** – CT scan before surgery; **c** – radiographs after surgery; **d** – CT scan after surgery cavity organs and retroperitoneal space, thromboembolic complications, and other serious complications were not found in both groups.

In the OLIF-AF group, the overall complication rate was 17.9 % (5 out of 28). In the early postoperative period, one patient had an urinary infection associated with an acute respiratory viral infection; and there was an instrumentation malposition with the development of neurological manifestations in two patients with stenosis at the L4–L5 level: in one case, the occurrence of L4 radiculopathy with subsequent successful repeated surgery was noted in the early postoperative period; in the second case, the development of temperature asymmetry in the lower extremities without motor and sensory deficits. Due to the insignificant dynamics at the background of non-surgical treatment, the removal of the instrumentation was performed after 8 months. It is should be noted that these patients had a history of microdiscectomies at the L4–L5 level.

In the late postoperative period, adjacent segment disease developed at the proximal and distal levels in two patients two years after surgery. After that they underwent successful microsurgical decompression.

In the OLIF-PF group, the overall complication rate was 28.3 % (17 out of 60). In the early postoperative period, dynamic intestinal paresis with its regression associated with non-surgical treatment developed in 4 out of 8 patients; the remaining patients had complications associated with grafts (malposition of pedicle screws followed by successful repeated surgery, separation of tuning forks bilaterally followed by replacement of screws and screw extraction followed by augmentation of the vertebral body by allobone when trying to reduce the vertebral body, as well as cage subsidence in a female patient with hypothyroidism). An interbody fusion was formed in all of these patients over time.

Late complications and adverse events (more than 30 days) were noted in 9 patients: a superficial infection of the surgical site with secondary intention in two cases; the development of failed back surgery syndrome (FBSS) with the subsequent installation of the neurostimulation circuit in one case; six patients had implant-associated complications (the formation of pseudoarthrosis in a patient with a history of repeated microdiscectomies; five patients had the development of an adjacent level syndrome, while only one patient was referred for repeated stabilization surgery). The remaining patients underwent courses of non-

Fig. 2
Radiological findings of a 51-year-old man with spondylolisthesis of the L5 vertebra, foraminal stenosis, instability at the L5-S1 level and a clinical picture of bilateral radiculopathy of L5 who underwent OLIF-PF: **a** – MRI before surgery; **b** – CT scan before surgery; **c** – CT scan after surgery

surgical and rehabilitation treatment, as well as facet block or radiofrequency denervation with a positive effect.

Discussion

The technology of indirect decompression of spinal roots and interbody fusion through the lateral pre-psoas approach is a minimally invasive surgical technique with the approach to the intervertebral disc performed through an opening between the lumbar muscle and the great vessels to avoid injuries to the vessels and nerves of the lumbar plexus, as well as injury to the muscles, ligaments and bones of the lumbar spine. The performance of OLIF decreases the volume of blood loss, injury rate, duration of surgery and postoperative recovery significantly reducing the risk of complications [4]. In this regard, OLIF is an effective, universal and minimally traumatic option for lumbar fusion with a relatively small number of complications that indicates its advantage over TLIF, DLIF and ALIF techniques [18].

his surgical technique was first described by Mayer [25]. The term "OLIF" was first expound in 2012 in the paper of Silvestre et al. [23]. A detailed description of the anatomical approach with the possibility of safe surgery at the levels from L1 to S1 vertebrae has been confirmed in various studies [18, 26–28].

OLIF in combination with posterior percutaneous transpedicular fixation (OLIF-PF) [4, 18, 29] is widely used in the treatment of lumbar stenosis, instability of the spinal motion segment and spondylolisthesis. However, the need for an intraoperative change of the patient's position and additional incisions with an increased injury rate and duration of surgery caused further search for optimal surgical technique [15, 16].

In 2020, Liu et al. [20] and Xie et al. [19] published studies that showed the use of OLIF with anterolateral screw fixation in the treatment of degenerative diseases of the lumbar spine. Since the cage used in the OLIF is larger and covers the bilateral epiphyseal ring, the stability of fixation is greatly enhanced. This biomechanically defines the possibility of reliable instrumental stabilization of both one [19, 20] and two [30] spinal motion segments through a single approach during OLIF-AF. In our study, cancellous screws were used when performing anterior fixation at the L5-S1 level that, when considering the anatomy and biomechanical features of the OLIF of L5–S1, allowed to ensure fixation stability during interbody fusion without the need for posterior fixation in the OLIF-AF group of patients. Previously, it

Fig. 3
Radiological findings of a 59-year-old woman with spondylolisthesis of the L3 vertebra and a clinical picture of neurogenic claudication who underwent OLIF-AF: **a** – MRI before surgery; **b** – CT scan before surgery; **c** – radiographs after surgery; **d** – CT scan after surgery

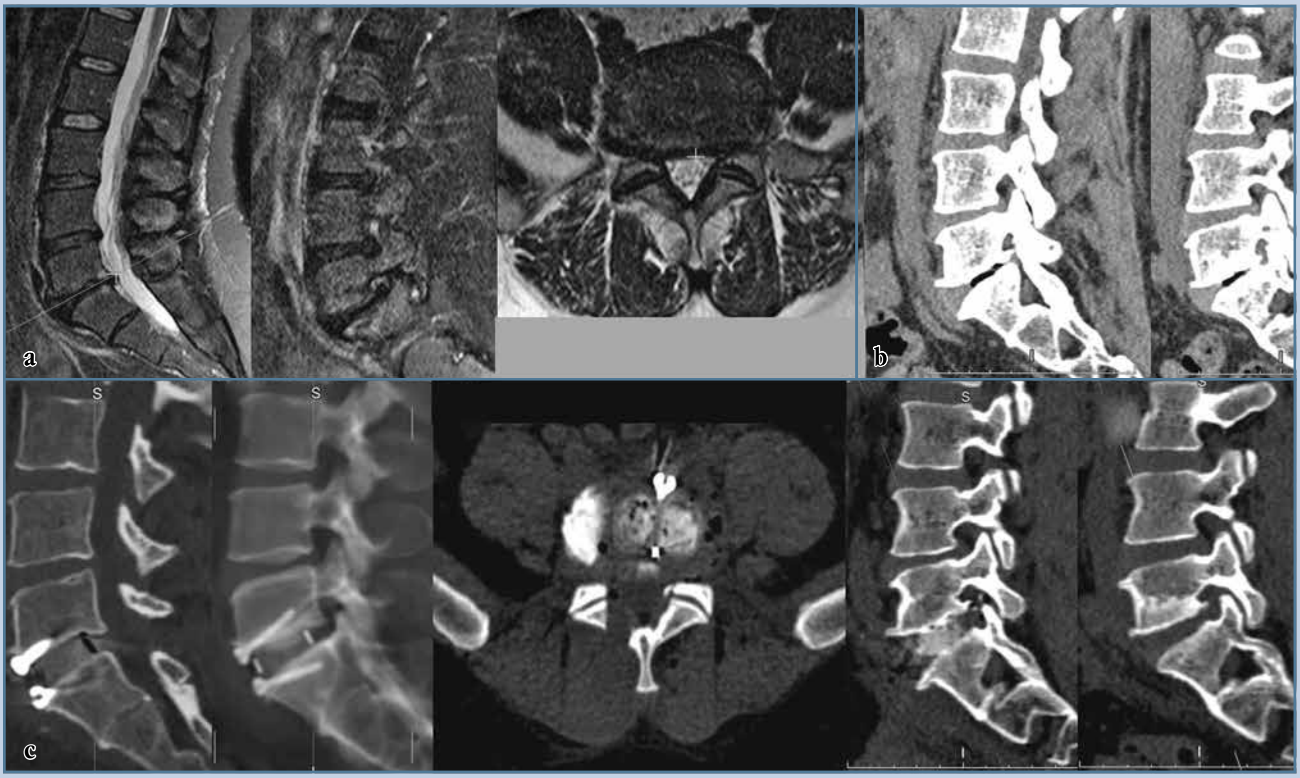

Fig. 4
Radiological findings of a 39-year-old woman with foraminal stenosis and instability at the L5-S1 level and a clinical picture of bilateral radiculopathy of L5 who underwent OLIF-AF: **a** – MRI before surgery; **b** – CT scan before surgery; **c** – CT scan after surgery

has been proven that an autonomic OLIF in comparison with OLIF-PF can ensure comparable clinical and radiological outcomes associated with the same complications rate. Some researchers consider pronounced osteoporosis [16] and injury to the endplates [31] to be factors limiting the comparison of these techniques that were considered in our paper.

This technique is innovative for the surgery of degenerative spinal lesions, since earlier the technique of anterolateral screw fixation was used only in the treatment of spinal injuries, tuberculosis and other spinal lesions [32, 33]. The disadvantage of OLIF compared to TLIF is the impossibility of performing direct decompression of neural structures. Zhou et al. [34] compensated for the latter by performing simultaneous OLIF-AF with percutaneous endoscopic transforaminal discectomy (OLIF-PETD). This made it possible not to injure the paraspinal muscles and bone structures and to minimize surgical trauma for the patient.

According to the eLibrary, it was impossible to find studies on the application of anterolateral fixation during indirect decompression of spinal roots and interbody fusion through the lateral pre-psoas approach (OLIF-AF) in the domestic literature at the time of writing this paper, and when analyzing the world literature (according to the Pubmed database), only several articles on this issue published from 2020 to 2022 were found [15, 19, 20, 35–38].

Injury rate assessment of surgery

The length of hospital stay, blood loss, the duration of surgery and anesthesia are among the most common parameters of injury rate of surgery. As in similar studies by other authors [15, 35], our study obtained a statistically significant advantage in the OLIF-AF group in terms of intraoperative blood loss and intravenous infusions, surgery duration and anesthesia, radiological exposure and length of hospital stay. Similar outcomes were obtained when comparing OLIF-AF with TLIF [37] and OLIF-PETD with MIS-TLIF [36, 38].

Assessment of radiological outcomes

We have discovered that there was a high percentage of the formation of an interbody fusion without the presence of statistically significant differences in both groups that was confirmed in other studies [15, 35].

There was no comparative analysis of the achieved radiological parameters after surgery in both groups in our study (foraminal height (FH), cross-sectional area (CSA), anterior (ADH), and posterior (PDH) disc height). Other authors have demonstrated that the outcomes obtained in the OLIF-AF and OLIF-PF

Table 1

Demographic profile of patients before surgery

Parameters		OLIF-PF (n = 60)	OLIF-AF (n = 28)	p	Assessment of the strength of the correlation
Age, years		56.5 [47.3; 61.8]	54 [46.3; 60.5]	0.431	-0.085**
Gender, n (%)	male	19 (31.7)	8 (28.6)	0.769	0.031**
	female	41 (68.3)	20 (71.4)		
BMI, kg/m²		30.9 [26.4; 33.4]	28.9 [25.2; 31.9]	0.130	-0.163**
Preoperative diagnosis, n (%)				0.082	0.238*
Spinal stenosis, instability		17 (28.3)	13 (46.4)		
Spondylolisthesis		34 (56.7)	8 (28.6)		
Condition after microdiscectomy		9 (15.0)	7 (25.0)		
Clinical picture before surgery, n (%)					
Axial pain syndrome		39 (65.0)	15 (53.6)	0.109	0.305*
Neurogenic claudication syndrome		32 (53.3)	14 (50.0)	0.771	0.031*
Radiculopathy		31 (51.7)	17 (60.7)	0.427	0.085*
Target level, n (%)				0.074	0.280*
L2–L3		0 (0.0)	2 (7.1)		
L3–L4		9 (15.0)	2 (7.1)		
L4–L5		41 (68.3)	16 (57.1)		
L5–S1		10 (16.7)	8 (28.7)		
Duration of symptoms, n (%)				0.715	0.039*
6–24 months		17 (28.3)	9 (32.1)		
Over 24 months		43 (71.7)	19 (67.9)		
Smoking, n (%)		11 (18.3)	9 (32.1)	0.150	0.153*
Pain assessment in the back according to NRS before surgery		6 [4.3; 7.8]	6.5 [3.3; 8]	0.968	0.004**
Pain assessment in a leg according to NRS before surgery		5 [2.3; 7.0]	6 [3.3; 8]	0.188	0.142**
Physical status (ASA) before surgery		2 [2.0; 3.0]	2 [2; 3]	0.497	-0.073**
Oswestry index (ODI) before surgery		39 [30.0; 54.0]	46 [22.0; 51.8]	0.860	0.019**
Zurich Claudication Questionnaire (ZCQ)					
Block SS-1 (Symptom Severity), S1–S4 (pain subgroup), points		3.5 [3.3; 3.8]	3.4 [2.8; 4.0]	0.547	-0.073**
Block SS-2 (Symptom Severity), S5–S7 (neuroischemic subgroup), points		2 [1.3; 2.7]	1.7 [1.4; 2.2]	0.449	-0.082**
PhF block (Physical Function), S8–S12, points		2.6 [1.6; 2.8]	2.4 [1.5; 3.2]	0.658	0.049**
RE block (Reliability Evaluation), S1–S12, points		2.7 [2.2; 2.9]	2.8 [1.9; 3.1]	0.918	0.011**
SF-12 Health Score					
Mental health		32.3 [23.6; 36.3]	29.7 [20.9; 33.9]	0.513	-0.071**
Physical health		39.3 [31.5; 47.9]	37.5 [28.6; 52.2]	0.848	0.021**
Follow-up period, months		18 [11.0; 34.0]	19 [6.5; 27.5]	0.449	-0.082**

* Cramer's V for nominal variables; ** Spearman's correlation analysis; BMI — body mass index; NRS — numerical rating scale for pain.

groups are comparable and do not differ ($p < 0.05$) from each other [15, 35].

Assessment of complications and adverse events

The probability of complications during OLIF is 13.9 % on mean [18] that is less in comparison with such techniques as ALIF – 14.1 % [39], TLIF – 19.25 % and ELIF – 31.4 % [40]. The frequency of serious complications during OLIF (injuries to the great vessels, ureters and nerves) is 1.9 % and the most frequent complications are temporary weakness, numbness of a hip (13.5 %) and injury to the endplate (18.7 %) [4].

The percentage of complications in the group with anterolateral fixation was lower in our study, though we did not get statistically significant differences (17.9 % vs 28.3 %; $p = 0.290$). According to other researchers, complications occurred in 14.3 % [20] to 45.8 % [15] of cases during OLIF-AF. Meanwhile, there

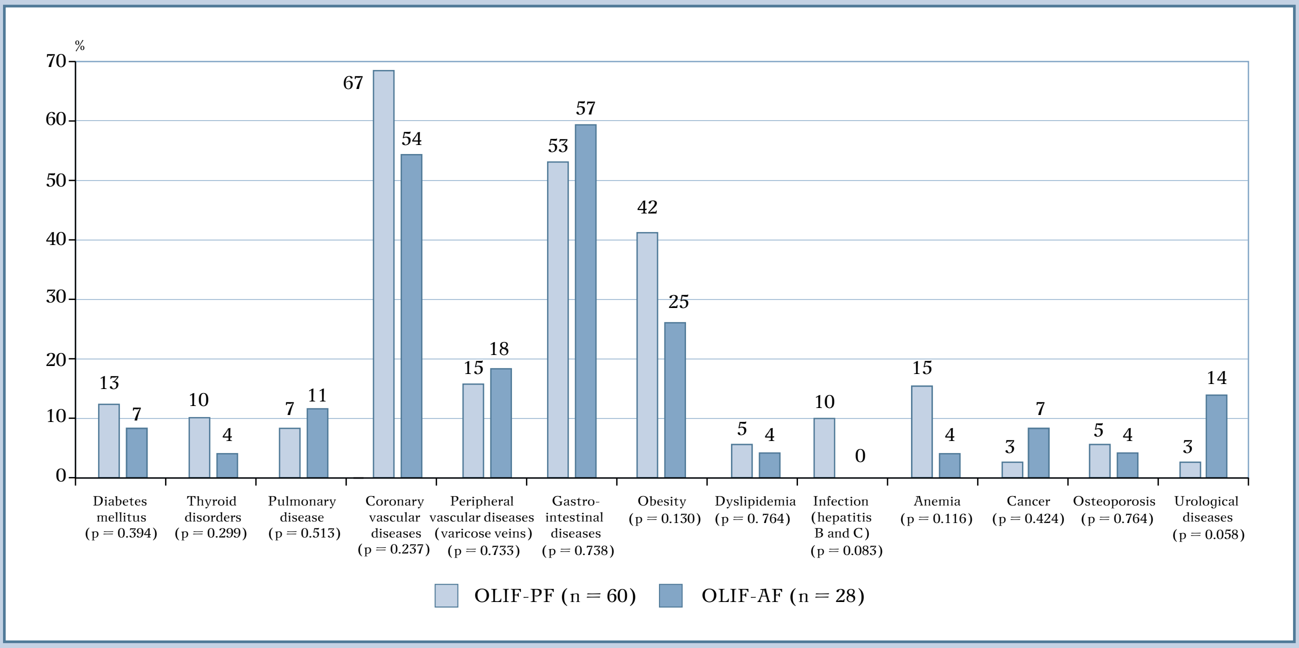

Fig. 5
Comparative profile of groups by concomitant diseases

Table 2
Comparison of clinical data between OLIF-PF and OLIF-AF groups

Parameters		OLIF-PF (n = 60)	OLIF-AF (n = 28)	p	Assessment of the strength of the correlation
Duration of antibiotic prophylaxis, days		2 [2; 3]	2 [1; 2]	0.002	-0.325**
Volume of intravenous infusions (intraoperative), ml		1000 [1000; 1100]	750 [500; 1100]	0.012	-0.267**
Use of local anesthesia, n (%)		44 (73.3)	10 (35.7)	0.001	0.360*
ESPB, n (%)		7 (11.7)	11 (39.3)	0.003	0.319*
Anesthesia time, min		240 [211.3; 275.0]	135 [110.0; 160.0]	0.000	-0.712**
Surgery time, min		195 [160.0; 213.8]	80 [66.3; 100.0]	0.000	-0.715**
Volume of blood loss, ml		80 [61.3; 100.0]	50 [20.0; 50.0]	0.000	-0.629**
Length of hospital stay (before surgery), days		2 [1.0; 3.8]	2 [1.0; 3.0]	0.474	-0.077**
Length of hospital stay (after surgery), days		5 [4; 6]	4 [3; 5]	0.000	-0.447**
Length of hospital stay (total), days		7 [7; 8]	6 [5; 7]	0.000	-0.410**
Radiological exposure (during hospital stay), mSv		7.2 [4.4; 11.9]	4.7 [1.6; 7.4]	0.005	-0.298**
Pain in the back according to NRS at discharge		3.5 [2.0; 5.0]	3 [1.3; 4.0]	0.034	0.227**
Pain in a leg according to NRS at discharge		3 [1; 5]	3 [2; 4]	0.673	0.045**
Opioid use, n (%)		19 (31.7)	1 (3.6)	0.003	0.312*
Repeated hospital admission (30 days), n (%)		0 (0)	0 (0)	–	–
Repeated surgery (30 days), n (%)		1 (1.7)	1 (3.6)	0.577	0.060*
MSCT in the postoperative period, n (%)		33 (55.0)	10 (35.7)	0.092	0.180*
Formed interbody fusion (n = 43), n (%)	Yes	32 (98.4)	10 (100.0)	0.213	0.188*
	No	1 (1.6)	0 (0.0)		

* Cramér's V for nominal variables; ** Spearman's correlation analysis; NRS — numerical rating scale for pain; ESPB (Erector spine plane block) — interfascial anesthesia of the musculus erector spinae.

Table 3

Comparison of complications and adverse events between OLIF-PF and OLIF-AF groups

Complications	OLIF-PF (n = 60)	OLIF-AF (n = 28)	p	Assessment of the strength of the correlation
Complications and adverse events, total	17 (28.3)	5 (17.9)	0.290	0.113*
Early complications and adverse events	8 (13.3)	3 (10.7)	0.464	0.078*
Late (more than 30 days) complications and adverse events	9 (15.0)	2 (7.1)	0.299	0.111*
Surgical site infection	2 (3.3)	0 (0.0)	0.328	0.104*
Neurological complications	1 (1.7)	0 (0.0)	0.492	0.073*
Gastrointestinal complications	4 (6.7)	0 (0.0)	0.162	0.149*
Implant-associated complications	10 (16.7)	4 (14.3)	0.517	0.069*
Urological complications	0 (0.0)	1 (3.6)	0.141	0.157*
Thromboembolic complications	0 (0.0)	0 (0.0)	–	–

* Cramer's V for nominal variables.

were also no statistically significant differences between the OLIF-AF and OLIF-PF groups (45.8 % vs 48.1 %; p = 0.869) [15]. There were no differences in the complications rate when comparing OLIF-AF with TLIF (25.0 % vs 23.9 %; p = 0.545) [37], as well as OLIF-PETD with MIS-TLIF (6.5 % vs 5.9 %; p = 0.924) [36].

Assessment of the effect on pain syndrome

OLIF-PF requires dissection of the paravertebral muscles to install instrumentation. Postoperative atrophy of the paravertebral muscles is closely associated with the denervation of the paravertebral muscles, the subsequent inefficiency of surgery and the presence of postoperative lower back pain in some patients [41]. OLIF-AF does not require dissection of the paravertebral muscles that theoretically results in lower postoperative pain. In a study by Guo et al. [15] and according to the outcomes of our study, the significantly lower degree of back pain was revealed in the early postoperative period in the OLIF-AF group. This confirms the significance of reducing injury to the paravertebral muscles for enhanced recovery of patients after surgery. Similar data were obtained when comparing OLIF-PETD with MIS-TLIF (2.4 ± 0.5 vs 3.1 ± 0.7; p = 0.009) [36].

Limitations and perspectives of the study

This clinical study had the following limitations:

• the retrospective type of the study that increases the risk of systematic errors;

• procedures were performed for single-level L2–S1 stenosis and the level of surgery can affect various parameters, the complications rate and the treatment outcomes;

• different periods of follow-up (from 3 to 51 months) and differences in the number of patients in the groups that could also impact the final outcomes of the study.

Despite the all limitations, the obtained results provide essential primary data for assessment of the reliability and effectiveness of anterolateral instrumented fixation during indirect decompression of spinal roots and interbody fusion through the lateral pre-psoas approach. These findings may contribute to the arrangement of further prospective randomized trials for the formulation of indications and limitations for the implementation of OLIF-AF.

Conclusion

Indirect decompression of the spinal roots and interbody fusion through the lateral pre-psoas approach with anterolateral instrumented fixation is an effective and reliable technique for the surgical treatment of single-segment lumbar stenosis. This technique allows to reduce injury rate of surgery and the severity of the pain syndrome and creates conditions for enhanced recovery after surgery. It is required to perform further multicenter randomized trials to comprehensively evaluate long-term outcomes.

The study had no sponsors.

The authors declare that they have no conflict of interest.

The study was approved by the local ethics committee of the institution.

All authors contributed significantly to the research and preparation of the article, read and approved the final version before publication.

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Received 18.05.2023
Review completed 26.07.2023
Passed for printing 01.08.2023

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