Neurospine 2023;20(4):1450-1456.
https://doi.org/10.14245/ns.2346678.339

Neurospine
pISSN 2586-6583 eISSN 2586-6591

Original Article

Corresponding Author
Weerasak Singhatanadgige
https://orcid.org/0000-0001-7166-1381

Department of Orthopedics, Faculty of Medicine, Chulalongkorn University and King Chulalongkorn Memorial Hospital, 1873 Rama IV Road, Pathumwan, Bangkok 10330, Thailand
Email: dr.weerasaks@gmail.com

Received: June 27, 2023
Revised: September 1, 2023
Accepted: September 1, 2023

An Expanded Surgical Corridor of Oblique Lateral Interbody Fusion at L4–5: A Magnetic Resonance Imaging Study

Worawat Limthongkul[1,2], Pakawas Praisarnti[1], Teerachat Tanasansomboon[2], Natavut Prasertkul[1], Vit Kotheeranurak[1,2], Wicharn Yingsakmongkol[1,2], Weerasak Singhatanadgige[1,2]

[1]Department of Orthopedics, Faculty of Medicine, Chulalongkorn University and King Chulalongkorn Memorial Hospital, Bangkok, Thailand
[2]Center of Excellence in Biomechanics and Innovative Spine Surgery, Chulalongkorn University, Bangkok, Thailand

Objective: We introduced a new preoperative method, the "expanded surgical corridor," to evaluate the actual safety corridor, which may expand the possibility of performing oblique lateral interbody fusion (OLIF).
Methods: Axial T2-weighted magnetic resonance images at the L4–5 disc level of 511 lumbar degenerative disease patients was evaluated. The distance between the medial edge of the left-sided psoas muscle and the major artery was measured as the conventional surgical corridor (CSc). The distance between the major vein and lumbar plexus was measured as the expanded surgical corridor (ESc).
Results: The mean CSc and ESc were 13.9 ± 8.20 and 37.43 ± 10.1 mm, respectively. No surgical corridor was found in 7.05% of CSc and 1.76% of ESc, small corridor (≤ 1 cm) was found in 27.40% of CSc and 0.59% of ESc, moderate corridor (1–2 cm) was found in 42.07% of CSc and 1.96% of ESc, and large corridor (> 2 cm) was found in 23.48% of CSc and 95.69% of ESc. A total of 33.83% (45 of 133) of whom were preoperatively categorized as having a limited surgical corridor by conventional measurement, underwent OLIF L4–5 successfully.
Conclusion: By using the ESc, only 2.35% were categorized as having a limited surgical corridor. The other 97.65% of the patients had an approachable corridor that could be successfully operated by experienced spine surgeons who employ meticulous surgical dissection and thorough understanding of the anatomical structures. The ESc may represent true accessibility to the disc space for OLIF, particularly at the L4–5 level.

Keywords: Oblique surgical corridor, Oblique lateral interbody fusion, Lateral lumbar interbody fusion

INTRODUCTION

Oblique lateral interbody fusion (OLIF) is a minimally invasive procedure that is reported to be safe and effective for lumbar degenerative diseases.[1-4] In appropriately selected patients, indirect decompression has been shown to improve both clinical and radiographic outcomes.[3-8] The oblique surgical corridor, which lies between the psoas muscle and the great vessels in the retroperitoneal space, is the working soft tissue interval for the OLIF procedure. Several studies demonstrated the preoperative methods, including radiographic and anatomical measurements, to evaluate the distance between the psoas muscle and the great vessels in the surgical corridor.[9-11] In clinical practice, during the operation, a corridor width of at least 18 mm after retraction of the psoas muscle is typically required for interbody placement, aligned with the width of a commonly employed cage.[12,13] Patients with a corridor less than 18 mm in width might not be suitable for the OLIF procedure,[13-16] particularly for the surgeons who are early adopters of the technique. Regarding the preoperative radiographic evaluation, a distance of approximately 10 mm between the psoas muscle and the major vessels is typically considered the minimum width required for performing OLIF.[17,18] The surgical corridor can be expanded through psoas muscle retraction up to the minimum corridor width required during the surgical approach to the targeted intervertebral disc level.[15,19] Although the narrow or no oblique corridor is not an absolute contraindication for performing OLIF, it does require surgical expertise to manipulate the psoas muscle and widen the corridor for proper exposure of the operated disc space and cage insertion.

The ability to mobilize the anatomical structures surrounding the surgical corridor is one of the key factors in a successful OLIF procedure. It is usually easier to mobilize and manipulate arterial than venous structures during the surgical approach. The venous structures and the lumbar plexus are relatively fixed structures.[20] On the other hand, studies also showed that the psoas muscle could also be retracted during the OLIF.[15,19] Those structures can safely be mobilized while approaching the disc space. So, the accessible surgical corridor for the anterior-to-psoas approach could be wider than previously described in the literature.[9,14-16,19]

The aim of this study is to introduce a new preoperative evaluation method, an "expanded surgical corridor," to define the potential actual safety corridor, which may expand the possibility of performing the OLIF surgery, particularly in patients with a narrow or no surgical corridor, as classified by the conventional surgical corridor (CSc).

MATERIALS AND METHODS

The patients' lumbosacral spinal magnetic resonance (MR) images from January 2015 to December 2022 in King Chulalongkorn Memorial Hospital database were assessed. The axial T2-weighted MR images of the L4–5 disc level with the patient in the supine position were studied. Patients aged over 40 years who were diagnosed with symptomatic L4–5 degenerative lumbar diseases, and required surgical intervention were included in the study. Conditions potentially causing distortion in the anatomy of the lumbar spine and surrounding structures, such as spinal trauma, infection, congenital anomalies, tumors, and malignancy, were excluded. Patients with prior lumbar spine or abdominal surgeries, as well as those with lumbar scoliosis and lumbosacral transitional vertebra (e.g., sacralization of L5 or lumbarization of S1) leading to significant anatomical alterations, were also excluded. Additionally, patients with a high-rising psoas muscle, categorized as modified Moro's AII, AIII, or AIV17 were excluded due to the potential complexity and risks associated with surgical approaches to the lumbar spine, including tension on the lumbar plexus during psoas mobilization.

The patients who underwent the OLIF procedure were subjected to a subgroup analysis. This methodology was implemented with the intent of mitigating the potential impact of selection bias on the surgical procedure selection for each included patient. The OLIF procedure was performed by 2 spine surgeons who have at least 5 years of experience performing this procedure. The study protocol was approved by the Ethics Committee of the Faculty of Medicine, Chulalongkorn University, Bangkok, Thailand (IRB No. 0862/65). The informed consent was waived for this study.

The oblique corridor measurements were performed by 2 orthopedic surgeons. Each surgeon measured on 2 occasions more than 2 weeks apart. The measurements were performed on the T2-weighted axial sections, where the psoas margins and lumbar plexus were optimally visualized. The sequence of T2-weighted axial MR images was systematically examined to accurately ascertain the precise location of the lumbar plexus.[13] The CSc was defined as the shortest distance between the anteromedial border of the left-sided psoas muscle and the posterolateral border of the major artery, which could be either the aorta or the left-sided common iliac artery. The "expanded surgical corridor" (ESc) was defined as the distance between the posterolateral edge of the major vein, which could be either the inferior vena cava or the left-sided common iliac vein, and the anterior edge of the left-sided lumbar plexus, as illustrated in Fig. 1.

The surgical corridor was categorized into 4 types: no corridor; small ($\leq$ 1 cm); moderate (1–2 cm); and large ($>$ 2 cm) according to the recently proposed oblique corridor grading system by Ng et al.[16] in 2020. The authors had categorized cases with no measurable corridor as "no corridor" type.[16] Furthermore, for the ESc, we also identified cases in which the vein aligned along the anterior border of the vertebral body, contiguous to the psoas muscle, as had no corridor. The differences between surgical and ESc types were analyzed.

Categorical data are expressed as frequencies and percentages and were compared using the chi-square test or Fisher exact test. Continuous variables were compared using the Student t-test

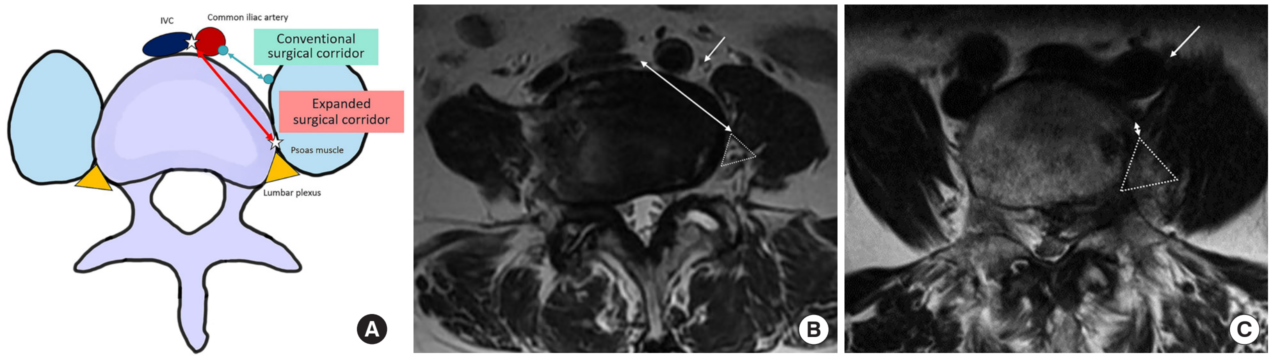

Fig. 1. (A) Illustration of the L4–5 intervertebral disc level with the 2 measurement methods. Axial T2-weighted magnetic resonance images of the L4–5 intervertebral disc level showing: (B) a small conventional surgical corridor (1 head arrow) versus a large expanded surgical corridor (2 head arrow), and (C) no conventional surgical corridor (1 head arrow) versus a small expanded surgical corridor (2 head arrow). IVC, inferior vena cava.

Table 1. Demographic and descriptive data from a total of 511 patients (L4–5 level)

Variable	Value
Age (yr)	65.35 ± 9.6 (40–88)
Conventional surgical corridor (CSc) (mm)	13.88 ± 8.2*
Expanded surgical corridor (ESc) (mm)	37.43 ± 10.07*
Amount of expansion (mm)	23.55 ± 8.78

Values are presented as mean ± standard deviation (range).
*Significant difference between the CSc and ESc was observed ($p < 0.001$).

Table 2. Surgical corridor data from a total of 511 patients

Grade	Conventional surgical corridor	Expanded surgical corridor
No corridor	34 (7.05)	9 (1.76)
Small	142 (27.40)	3 (0.59)
Moderate	213 (42.07)	11 (1.96)
Large	122 (23.48)	488 (95.69)
Total	511	511

Values are presented as number (%).

or the Wilcoxon rank-sum test. The intraclass correlation coefficient was used to evaluate the intrarater, and interrater reliability analyses. IBM SPSS Statistics ver. 23.0 (IBM Co., Armonk, NY, USA) was used for statistical analysis. A p-value of less than 0.05 was deemed statistically significant.

RESULTS

The axial T2-weighted MR images at L4–5 disc level of 511 lumbar degenerative disease patients were evaluated. The average age was 65.35 ± 9.6 years (range, 40–88 years). Demographic and descriptive data are shown in Table 1. Of the 511 patients, 136 underwent OLIF surgery, and 133 of the 136 patients underwent a single-level OLIF at L4–5.

The mean conventional and EScs were 13.88 ± 8.20 mm and 37.43 ± 10.07 mm, respectively. In comparison to the conventional measurement, the average amount of expansion of the ESc was 23.55 ± 8.78 mm, which showed statistical significance ($p < 0.001$).

According to the oblique corridor grading system, no surgical corridor was found in 7.05% (34 patients) of the CSc and 1.76% (9 patients) of the ESc group. The small surgical corridor was found in 27.40% (142 patients) of the CSc group and 0.59% (3 patients) of the ESc group. The moderate surgical corridor was found in 42.07% (213 patients) of the CSc group and 1.96% (11 patients) of the ESc group, and the large surgical corridor was found in 23.48% (122 patients) of the CSc group and 95.69% (488 patients) of the ESc group. A limited surgical corridor of less than 1 cm was observed in 34.45% (176 patients) of the CSc group and 2.35% (12 patients) of the ESc group. The intraclass correlation coefficients showed intrarater reliability of 0.911 (95% confidence interval [CI], 0.909–0.915) and 0.899 (95% CI, 0.891–0.903) for the CSc and ESc groups, respectively. The inter-rate reliability was 0.878 (95% CI, 0.871–0.883) and 0.813 (95% CI, 0.808–0.817) for the CSc and ESc groups, respectively. The data are shown in Table 2 and Fig. 2.

Among the 133 patients who underwent OLIF L4–5 successfully, no surgical corridor was found in 9.77% (13 patients). The small surgical corridor was identified in 24.06% (32 patients). The moderate surgical corridor was recognized in 39.10% (52 patients), and the large surgical corridor was found in 27.07% (36 patients) according to the CSc measurement (Table 3). A

 https://doi.org/10.14245/ns.2346678.339

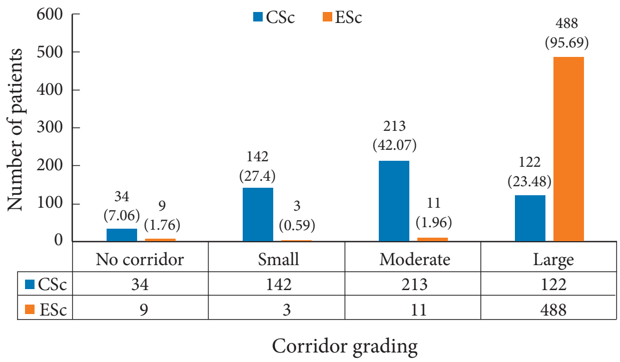

Fig. 2. Comparison of conventional (CSc) and expanded surgical corridor (ESc) in 511 patients.

Table 3. Surgical corridor data from patients who underwent OLIF L4–5

Grade	Conventional surgical corridor	Expanded surgical corridor
No corridor	13 (9.77)	4 (3.01)
Small	32 (24.06)	0 (0)
Moderate	52 (39.10)	5 (3.76)
Large	36 (27.07)	124 (93.23)
Total	133	133

Values are presented as number (%).

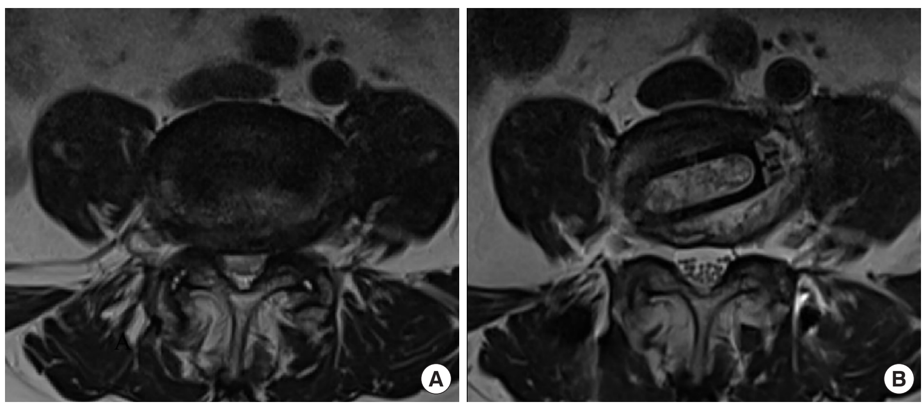

Fig. 3. Preoperative (A) and postoperative (B) axial T2-weighted magnetic resonance images of oblique lateral interbody fusion L4–5 in a patient with no conventional surgical corridor.

total of 33.83% (45 of 133) of these patients were preoperatively categorized as having a limited surgical corridor by the CSc measurement. Examples of these cases are shown in Fig. 3. However, approximately 3.01% of the population had a corridor measuring less than 1 cm when classified according to the ESc.

Our study did not observe any major approach-related vascular complications. There were no cases of major lumbar plexus injuries noted, and no significant weakness or persistent anterior thigh symptoms were found in this series.

DISCUSSION

Evaluation of the surgical corridor in the OLIF procedure is usually performed by measuring the corridor from the preoperative lumbar spine MR images. The commonly used method of surgical corridor assessment is measuring the distance from the lateral edge of the aorta or the left-sided common iliac artery to the medial edge of the left-sided psoas muscle.[9-11] However, several authors proposed that the limitation of the lateral approach to the lumbar spine lies between the proximity of the lumbar plexus and the major vessels.[9-11,14]

The width of the surgical corridor at the L4–5 intervertebral disc level, which was measured using the preoperative MR images, was reported in the literature to be 8.92–12.1 mm.[14,21,22] A width of at least 10 mm is widely acknowledged as the minimum requirement for the OLIF procedure, particularly for novice surgeons.[17,18] During surgical dissection, the surgeon could create adequate surgical access to the targeted intervertebral disc space by retracting the surrounding structures away from the surgical corridor.[15,19] In a cadaveric study conducted by Davis et al.,[15] it was found that retraction of the psoas muscle can increase accessibility to the lumbar spine by approximately 6.9–9.45 mm. The psoas muscle retraction could increase the surgical corridor's width at the L4–5 level by an average of 58.97%, or approximately 9.45 mm.[15] Molinares et al.[14] discovered an adequate surgical corridor of access to the L4–5 discs in up to 91% of the studied MR images. Razzouk et al.[23] measured the corridor at the L4–5 level and observed corridors less than 10 mm in 18% of the studied sample. Several authors suggested that the surgeon should consider alternative fusion techniques in less than 10 mm of the oblique corridor.[17,18]

Tao et al.[22] have described the trajectory width from the main artery to the lumbar plexus as 24.36 ± 7.87 mm on the L4–5 level. However, during the surgical approach, the arterial structures could be more easily and safely mobilized than the venous structures, which are usually firmly attached to the spine and surrounding area and less resistant to stretching than the arterial structures.[20] It was also reported that the venous structure is also enlarged when lying in the decubitus position.[24] Therefore, there is a greater risk of venous injury during surgery than to the arterial structures. The surgeon should be aware of this risk and perform a meticulous dissection and gentle retraction of the surrounding structures to safely expand the oblique surgical corridor.

According to all our knowledge, our study described a new radiographic method to evaluate the approachable oblique corridor by measuring the distance between the vein and the lumbar plexus. A limited surgical corridor of less than 1 cm was observed in 34.45% of our entire study population using conventional measurement. In contrast, when employing an ESc, only 2.35% of the population exhibited a limited surgical corridor. This idea is confirmed by a number of successful OLIF L4–5 cases in patients with a limited surgical corridor categorized with the conventional measurement. In our study, 33.83% of patients who were diagnosed with lumbar degenerative diseases were defined as having a limited surgical corridor (the corridor's width being smaller than 1 cm) at the L4–5 level, as determined by conventional measurement. The other 39.10% exhibited a corridor's width ranging from 1 to 2 cm (moderate corridor), which was potentially necessitating vascular manipulation and psoas retraction during surgical dissection to access the L4–5 intervertebral disc. However, only 3.01% of this population were categorized as having an ESc smaller than 1 cm in width. In theory, having no surgical corridor might not be suitable for OLIF surgery.[13,14,16] Nevertheless, from the authors' experiences of performing the OLIF procedure for more than 5 years (WL and WS), the thorough anatomical understanding accompanied by meticulous dissection and gentle retraction of the surrounding structures could provide safe surgical access to the targeted disc and adequate working space in the oblique corridor. For surgeons who early adopt the OLIF procedure in their practice, it is recommended to begin with cases that offer a spacious surgical corridor. Collaborating with a highly-experienced spine surgeon or an access surgeon is also advocated.

Intraoperatively, every surgical step is essential, and surgeons should carefully perform the procedure to ensure procedural safety, even for patients that have an adequate oblique corridor on the preoperative MR images. The process begins with the proper skin incision, aimed at establishing an adequate surgical passage to the targeted intervertebral disc space without subjecting the surrounding structures to extensive retraction, particularly the venous structures. Avoidance of direct venous retraction is crucial to minimize the risk of substantial bleeding resulting from potential vascular injury.[25] If any degree of the venous structures' manipulation becomes necessary, meticulous attention is required to retract the veins while avoiding attempting to mobilize them from the underlying structures. The venous structures should not be directly manipulated; instead, they may be mobilized indirectly by gently shifting the surrounding loose soft tissue attached to them.[26] In the event of vascular wall disruption, adequate exposure of the bleeding site, bleeding control, and seeking assistance are the pivotal steps. Firm compression of the bleeding vessels against the firm surface of the surgical field, such as the vertebral body, can temporarily halt the bleeding. Frequent release of the compression to check for cessation of bleeding may exacerbate the situation and result in increased blood loss. Endeavoring to perform vascular repair independently could lead to complications due to the surgeon's heightened state of anxiety and lack of experience. It is advisable for a vascular surgeon or even the assistant surgeon to manage the situation, as they might be better equipped to handle it than the primary surgeon.[25]

Aggressive manipulation of the surrounding structures could cause complications ranging from a minor one to a life-threatening condition. The incidence of anterior thigh symptoms was reported at a rate of 1.3%–13.5% after the OLIF procedure.[26,27] The amount of psoas muscle retraction is also reported to be associated with the anterior thigh symptom in OLIF at the L4–5 level.[28] Aggressive and prolonged retraction may cause more severe postoperative anterior thigh symptoms. Care should be taken during the psoas muscle manipulation in order to expose the targeted intervertebral disc. The rate of vascular injury in OLIF was reported to be 0.3%–3.9%. Major vascular injuries could cause a lethal complication; an intraoperative fatal injury to the great vessel in a lateral transpsoas approach has been reported.[25] However, segmental vessel injuries were more common during the OLIF procedure.[26,27,29,30] Awareness of the potential vascular injury during the operation, combined with surgical skill in vascular control, could minimize the risk of these complications during the operation.

https://doi.org/10.14245/ns.2346678.339

This study had several limitations. The distances measured in the MR images might not represent actual distances achievable during the OLIF surgery. The discrepancy may arise from several factors that are not accounted for in the preoperative radiographic evaluation. For instance, the images are typically taken with the patient in a supine position, which may not accurately represent the anatomical conditions encountered during lateral position surgery. Additionally, variations in the psoas muscle morphology, a factor not studied in this research, might impact corridor measurements and the surgical approach. Intraoperative measurement of the corridor should be conducted to validate this measurement method. Furthermore, it's important to note that the authors exclusively focused on the L4–5 level. Lastly, data regarding the duration of psoas muscle retraction during the procedure were lacking.

CONCLUSION

Our study introduced a new preoperative method for evaluating the OLIF surgical corridor. Through the utilization of the ESc, approximately 2.35% of the patients were categorized as having a limited surgical corridor. In contrast, 97.65% of the patients had an accessible corridor that could be successfully operated by experienced spine surgeons who employ meticulous surgical dissection and thorough understanding of the anatomical structures. The expanded oblique surgical corridor may represent true accessibility to the disc space for the OLIF procedure, particularly at the L4–5 level.

NOTES

Conflict of Interest: The authors have nothing to disclose.

Funding/Support: This research received grant from Ratchadapiseksompotch Fund, Graduate Affairs, Faculty of Medicine, Chulalongkorn University (Grant number GA66/039).

Acknowledgments: The authors thank Thanachaporn Kittipibul, MD, and Clinical Spine Research Center, Chulalongkorn University for supporting this study.

Author Contribution: Conceptualization: WL; Data curation: NP, WY, WS; Formal analysis: PP, NP, VK; Methodology: TT, NP, VK; Project administration: WL, WY, WS; Writing - original draft: WL, PP; Writing - review & editing: TT.

ORCID

Worawat Limthongkul: 0000-0002-0116-8791
Pakawas Praisarnti: 0000-0003-0220-4608
Teerachat Tanasansomboon: 0000-0002-2448-2118
Natavut Prasertkul: 0009-0002-0179-4060
Vit Kotheeranurak: 0000-0002-9593-429X
Wicharn Yingsakmongkol: 0000-0002-8784-7604
Weerasak Singhatanadgige: 0000-0001-7166-1381

REFERENCES

1. Youssef JA, McAfee PC, Patty CA, et al. Minimally invasive surgery: lateral approach interbody fusion: results and review. Spine (Phila Pa 1976) 2010;35(26 Suppl):S302-11.
2. Lang G, Perrech M, Navarro-Ramirez R, et al. Potential and limitations of neural decompression in extreme lateral interbody fusion-a systematic review. World Neurosurg 2017;101: 99-113.
3. Limthongkul W, Tanasansomboon T, Yingsakmongkol W, et al. Indirect decompression effect to central canal and ligamentum flavum after extreme lateral lumbar interbody fusion and oblique lumbar interbody fusion. Spine (Phila Pa 1976) 2020;45:E1077-84.
4. Kim H, Chang BS, Chang SY. Pearls and pitfalls of oblique lateral interbody fusion: a comprehensive narrative review. Neurospine 2022;19:163-76.
5. Yingsakmongkol W, Jitpakdee K, Kerr S, et al. Successful criteria for indirect decompression with lateral lumbar interbody fusion. Neurospine 2022;19:805-15.
6. Park SJ, Hwang JM, Cho DC, et al. Indirect decompression using oblique lumbar interbody fusion revision surgery following previous posterior decompression: comparison of clinical and radiologic outcomes between direct and indirect decompression revision surgery. Neurospine 2022;19: 544-54.
7. Lee YS, Lee DH, Cho DC, et al. The change of spinal canal according to oblique lumbar interbody fusion in degenerative spondylolisthesis: a prospective observational study. Neurospine 2022;19:492-500.
8. Gagliardi MJ, Guiroy AJ, Camino-Willhuber G, et al. Is indirect decompression and fusion more effective than direct decompression and fusion for treating degenerative lumbar spinal stenosis with instability? A systematic review and meta-analysis. Global Spine J 2023;13:499-511.
9. Moro T, Kikuchi S, Konno S, et al. An anatomic study of the lumbar plexus with respect to retroperitoneal endoscopic surgery. Spine (Phila Pa 1976) 2003;28:423-8.
10. Benglis DM, Vanni S, Levi AD. An anatomical study of the lumbosacral plexus as related to the minimally invasive trans-

psoas approach to the lumbar spine. J Neurosurg Spine 2009;10:139-44.
11. Uribe JS, Arredondo N, Dakwar E, et al. Defining the safe working zones using the minimally invasive lateral retroperitoneal transpsoas approach: an anatomical study. J Neurosurg Spine 2010;13:260-6.
12. Woods KR, Billys JB, Hynes RA. Technical description of oblique lateral interbody fusion at L1-L5 (OLIF25) and at L5-S1 (OLIF51) and evaluation of complication and fusion rates. Spine J 2017;17:545-53.
13. Garg B, Mehta N, Vijayakumar V, et al. Defining a safe working zone for lateral lumbar interbody fusion: a radiographic, cross-sectional study. Eur Spine J 2021;30:164-72.
14. Molinares DM, Davis TT, Fung DA. Retroperitoneal oblique corridor to the L2-S1 intervertebral discs: an MRI study. J Neurosurg Spine 2016;24:248-55.
15. Davis TT, Hynes RA, Fung DA, et al. Retroperitoneal oblique corridor to the L2-S1 intervertebral discs in the lateral position: an anatomic study. J Neurosurg Spine 2014;21:785-93.
16. Ng JP, Kaliya-Perumal AK, Tandon AA, et al. The oblique corridor at L4–5: a radiographic-anatomical study into the feasibility for lateral interbody fusion. Spine (Phila Pa 1976) 2020;45:E552-9.
17. Liu L, Liang Y, Zhang H, et al. Imaging anatomical research on the operative windows of oblique lumbar interbody fusion. PLoS One 2016;11:e0163452.
18. Quillo-Olvera J, Lin GX, Jo HJ, et al. Complications on minimally invasive oblique lumbar interbody fusion at L2-L5 levels: a review of the literature and surgical strategies. Ann Transl Med 2018;6:101.
19. Deng D, Liao X, Wu R, et al. Surgical safe zones for oblique lumbar interbody fusion of L1-5: a cadaveric study. Clin Anat 2022;35:178-85.
20. Weiner BK, Walker M, Fraser RD. Vascular anatomy anterior to lumbosacral transitional vertebrae and implications for anterior lumbar interbody fusion. Spine J 2001;1:442-4.
21. Julian Li JX, Mobbs RJ, Phan K. Morphometric MRI imaging study of the corridor for the oblique lumbar interbody fusion technique at L1-L5. World Neurosurg 2018;111:E678-85.
22. Tao Y, Huang C, Li F, et al. Magnetic resonance imaging study of oblique corridor and trajectory to L1-L5 intervertebral disks in lateral position. World Neurosurg 2020;134:E616-23.
23. Razzouk J, Ramos O, Mehta S, et al. CT-based analysis of oblique lateral interbody fusion from L1 to L5: location of incision, feasibility of safe corridor approach, and influencing factors. Eur Spine J 2023;32:1947-52.
24. Gandhi SV, Dugan R, Farber SH, et al. Anatomical positional changes in the lateral lumbar interbody fusion. Eur Spine J 2022;31:2220-6.
25. Assina R, Majmundar NJ, Herschman Y, et al. First report of major vascular injury due to lateral transpsoas approach leading to fatality. J Neurosurg Spine 2014;21:794-8.
26. Tannoury T, Kempegowda H, Haddadi K, et al. Complications associated with minimally invasive anterior to the psoas (ATP) fusion of the lumbosacral spine. Spine (Phila Pa 1976) 2019;44:E1122-9.
27. Abe K, Orita S, Mannoji C, et al. Perioperative complications in 155 patients who underwent oblique lateral interbody fusion surgery: perspectives and indications from a retrospective, multicenter survey. Spine (Phila Pa 1976) 2017;42:55-62.
28. Chang SY, Lee WS, Mok S, et al. Anterior thigh pain following minimally invasive oblique lateral interbody fusion: multivariate analysis from a prospective case series. Clin Orthop Surg 2022;14:401-9.
29. Mehren C, Mayer HM, Zandanell C, et al. The oblique anterolateral approach to the lumbar spine provides access to the lumbar spine with few early complications. Clin Orthop Relat Res 2016;474:2020-7.
30. Fujibayashi S, Kawakami N, Asazuma T, et al. Complications associated with lateral interbody fusion: nationwide survey of 2998 cases during the first 2 years of its use in Japan. Spine (Phila Pa 1976) 2017;42:1478-84.

https://doi.org/10.14245/ns.2346678.339