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ЕЖЕМЕСЯЧНЫЙ НАУЧНЫЙ ЖУРНАЛ

Медицинские новости Грузии

საქართველოს სამედიცინო სიახლენი

GEORGIAN MEDICAL NEWS

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GMN: Georgian Medical News is peer-reviewed, published monthly journal committed to promoting the science and art of medicine and the betterment of public health, published by the GMN Editorial Board since 1994. GMN carries original scientific articles on medicine, biology and pharmacy, which are of experimental, theoretical and practical character; publishes original research, reviews, commentaries, editorials, essays, medical news, and correspondence in English and Russian.

GMN is indexed in MEDLINE, SCOPUS, PubMed and VINITI Russian Academy of Sciences. The full text content is available through EBSCO databases.

GMN: Медицинские новости Грузии - ежемесячный рецензируемый научный журнал, издаётся Редакционной коллегией с 1994 года на русском и английском языках в целях поддержки медицинской науки и улучшения здравоохранения. В журнале публикуются оригинальные научные статьи в области медицины, биологии и фармации, статьи обзорного характера, научные сообщения, новости медицины и здравоохранения. Журнал индексируется в MEDLINE, отражён в базе данных SCOPUS, PubMed и ВИНИТИ РАН. Полнотекстовые статьи журнала доступны через БД EBSCO.

GMN: Georgian Medical News – საქართველოს სამედიცინო სიახლენი – არის ყოველთვიური სამეცნიერო სამედიცინო რეცენზირებადი ჟურნალი, გამოიცემა 1994 წლიდან, წარმოადგენს სარედაქციო კოლეგიისა და აშშ-ის მეცნიერების, განათლების, ინდუსტრიის, ხელოვნებისა და ბუნებისმეტყველების საერთაშორისო აკადემიის ერთობლივ გამოცემას. GMN-ში რუსულ და ინგლისურ ენებზე ქვეყნდება ექსპერიმენტული, თეორიული და პრაქტიკული ხასიათის ორიგინალური სამეცნიერო სტატიები მედიცინის, ბიოლოგიისა და ფარმაციის სფეროში, მიმოხილვითი ხასიათის სტატიები.

ჟურნალი ინდექსირებულია MEDLINE-ის საერთაშორისო სისტემაში, ასახულია SCOPUS-ის, PubMed-ის და ВИНИТИ РАН-ის მონაცემთა ბაზებში. სტატიების სრული ტექსტი ხელმისაწვდომია EBSCO-ს მონაცემთა ბაზებიდან.

WEBSITE

www.geomednews.com

К СВЕДЕНИЮ АВТОРОВ!

При направлении статьи в редакцию необходимо соблюдать следующие правила:

1. Статья должна быть представлена в двух экземплярах, на русском или английском языках, напечатанная через **полтора интервала на одной стороне стандартного листа с шириной левого поля в три сантиметра**. Используемый компьютерный шрифт для текста на русском и английском языках - **Times New Roman** (**Кириллица**), для текста на грузинском языке следует использовать **AcadNusx.** Размер шрифта - **12**. К рукописи, напечатанной на компьютере, должен быть приложен CD со статьей.

2. Размер статьи должен быть не менее десяти и не более двадцати страниц машинописи, включая указатель литературы и резюме на английском, русском и грузинском языках.

3. В статье должны быть освещены актуальность данного материала, методы и результаты исследования и их обсуждение.

При представлении в печать научных экспериментальных работ авторы должны указывать вид и количество экспериментальных животных, применявшиеся методы обезболивания и усыпления (в ходе острых опытов).

4. К статье должны быть приложены краткое (на полстраницы) резюме на английском, русском и грузинском языках (включающее следующие разделы: цель исследования, материал и методы, результаты и заключение) и список ключевых слов (key words).

5. Таблицы необходимо представлять в печатной форме. Фотокопии не принимаются. **Все цифровые, итоговые и процентные данные в таблицах должны соответствовать таковым в тексте статьи**. Таблицы и графики должны быть озаглавлены.

6. Фотографии должны быть контрастными, фотокопии с рентгенограмм - в позитивном изображении. Рисунки, чертежи и диаграммы следует озаглавить, пронумеровать и вставить в соответствующее место текста **в tiff формате**.

В подписях к микрофотографиям следует указывать степень увеличения через окуляр или объектив и метод окраски или импрегнации срезов.

7. Фамилии отечественных авторов приводятся в оригинальной транскрипции.

8. При оформлении и направлении статей в журнал МНГ просим авторов соблюдать правила, изложенные в «Единых требованиях к рукописям, представляемым в биомедицинские журналы», принятых Международным комитетом редакторов медицинских журналов - http://www.spinesurgery.ru/files/publish.pdf и http://www.nlm.nih.gov/bsd/uniform_requirements.html
В конце каждой оригинальной статьи приводится библиографический список. В список литературы включаются все материалы, на которые имеются ссылки в тексте. Список составляется в алфавитном порядке и нумеруется. Литературный источник приводится на языке оригинала. В списке литературы сначала приводятся работы, написанные знаками грузинского алфавита, затем кириллицей и латиницей. Ссылки на цитируемые работы в тексте статьи даются в квадратных скобках в виде номера, соответствующего номеру данной работы в списке литературы. Большинство цитированных источников должны быть за последние 5-7 лет.

9. Для получения права на публикацию статья должна иметь от руководителя работы или учреждения визу и сопроводительное отношение, написанные или напечатанные на бланке и заверенные подписью и печатью.

10. В конце статьи должны быть подписи всех авторов, полностью приведены их фамилии, имена и отчества, указаны служебный и домашний номера телефонов и адреса или иные координаты. Количество авторов (соавторов) не должно превышать пяти человек.

11. Редакция оставляет за собой право сокращать и исправлять статьи. Корректура авторам не высылается, вся работа и сверка проводится по авторскому оригиналу.

12. Недопустимо направление в редакцию работ, представленных к печати в иных издательствах или опубликованных в других изданиях.

При нарушении указанных правил статьи не рассматриваются.

REQUIREMENTS

Please note, materials submitted to the Editorial Office Staff are supposed to meet the following requirements:

1. Articles must be provided with a double copy, in English or Russian languages and typed or compu-ter-printed on a single side of standard typing paper, with the left margin of **3** centimeters width, and **1.5** spacing between the lines, typeface - **Times New Roman** (**Cyrillic**), print size - **12** (referring to Georgian and Russian materials). With computer-printed texts please enclose a CD carrying the same file titled with Latin symbols.

2. Size of the article, including index and resume in English, Russian and Georgian languages must be at least 10 pages and not exceed the limit of 20 pages of typed or computer-printed text.

3. Submitted material must include a coverage of a topical subject, research methods, results, and review.

Authors of the scientific-research works must indicate the number of experimental biological species drawn in, list the employed methods of anesthetization and soporific means used during acute tests.

4. Articles must have a short (half page) abstract in English, Russian and Georgian (including the following sections: aim of study, material and methods, results and conclusions) and a list of key words.

5. Tables must be presented in an original typed or computer-printed form, instead of a photocopied version. **Numbers, totals, percentile data on the tables must coincide with those in the texts of the articles.** Tables and graphs must be headed.

6. Photographs are required to be contrasted and must be submitted with doubles. Please number each photograph with a pencil on its back, indicate author's name, title of the article (short version), and mark out its top and bottom parts. Drawings must be accurate, drafts and diagrams drawn in Indian ink (or black ink). Photocopies of the X-ray photographs must be presented in a positive image in **tiff format**.

Accurately numbered subtitles for each illustration must be listed on a separate sheet of paper. In the subtitles for the microphotographs please indicate the ocular and objective lens magnification power, method of coloring or impregnation of the microscopic sections (preparations).

7. Please indicate last names, first and middle initials of the native authors, present names and initials of the foreign authors in the transcription of the original language, enclose in parenthesis corresponding number under which the author is listed in the reference materials.

8. Please follow guidance offered to authors by The International Committee of Medical Journal Editors guidance in its Uniform Requirements for Manuscripts Submitted to Biomedical Journals publication available online at: http://www.nlm.nih.gov/bsd/uniform_requirements.html
http://www.icmje.org/urm_full.pdf
In GMN style for each work cited in the text, a bibliographic reference is given, and this is located at the end of the article under the title "References". All references cited in the text must be listed. The list of references should be arranged alphabetically and then numbered. References are numbered in the text [numbers in square brackets] and in the reference list and numbers are repeated throughout the text as needed. The bibliographic description is given in the language of publication (citations in Georgian script are followed by Cyrillic and Latin).

9. To obtain the rights of publication articles must be accompanied by a visa from the project instructor or the establishment, where the work has been performed, and a reference letter, both written or typed on a special signed form, certified by a stamp or a seal.

10. Articles must be signed by all of the authors at the end, and they must be provided with a list of full names, office and home phone numbers and addresses or other non-office locations where the authors could be reached. The number of the authors (co-authors) must not exceed the limit of 5 people.

11. Editorial Staff reserves the rights to cut down in size and correct the articles. Proof-sheets are not sent out to the authors. The entire editorial and collation work is performed according to the author's original text.

12. Sending in the works that have already been assigned to the press by other Editorial Staffs or have been printed by other publishers is not permissible.

Articles that Fail to Meet the Aforementioned Requirements are not Assigned to be Reviewed.

ავტორთა საყურადღებოდ!

რედაქციაში სტატიის წარმოდგენისას საჭიროა დავიცვათ შემდეგი წესები:

1. სტატია უნდა წარმოადგინოთ 2 ცალად, რუსულ ან ინგლისურ ენებზე,დაბეჭდილი სტანდარტული ფურცლის 1 გვერდზე, 3 სმ სიგანის მარცხენა ველისა და სტრიქონებს შორის 1,5 ინტერვალის დაცვით. გამოყენებული კომპიუტერული შრიფტი რუსულ და ინგლისურენოვან ტექსტებში - **Times New Roman (Кириллица)**, ხოლო ქართულენოვან ტექსტში საჭიროა გამოვიყენოთ **AcadNusx.** შრიფტის ზომა – 12. სტატიას თან უნდა ახლდეს CD სტატიით.

2. სტატიის მოცულობა არ უნდა შეადგენდეს 10 გვერდზე ნაკლებს და 20 გვერდზე მეტს ლიტერატურის სიის და რეზიუმეების (ინგლისურ, რუსულ და ქართულ ენებზე) ჩათვლით.

3. სტატიაში საჭიროა გაშუქდეს: საკითხის აქტუალობა; კვლევის მიზანი; საკვლევი მასალა და გამოყენებული მეთოდები; მიღებული შედეგები და მათი განსჯა. ექსპერიმენტული ხასიათის სტატიების წარმოდგენისას ავტორებმა უნდა მიუთითონ საექსპერიმენტო ცხოველების სახეობა და რაოდენობა; გაუტკივარებისა და დაძინების მეთოდები (მწვავე ცდების პირობებში).

4. სტატიას თან უნდა ახლდეს რეზიუმე ინგლისურ, რუსულ და ქართულ ენებზე არანაკლებ ნახევარი გვერდის მოცულობისა (სათაურის, ავტორების, დაწესებულების მითითებით და უნდა შეიცავდეს შემდეგ განყოფილებებს: მიზანი, მასალა და მეთოდები, შედეგები და დასკვნები; ტექსტუალური ნაწილი არ უნდა იყოს 15 სტრიქონზე ნაკლები) და საკვანძო სიტყვების ჩამონათვალი (key words).

5. ცხრილები საჭიროა წარმოადგინოთ ნაბეჭდი სახით. ყველა ციფრული, შემაჯამებელი და პროცენტული მონაცემები უნდა შეესაბამებოდეს ტექსტში მოყვანილს.

6. ფოტოსურათები უნდა იყოს კონტრასტული; სურათები, ნახაზები, დიაგრამები - დასათაურებული, დანომრილი და სათანადო ადგილას ჩასმული. რენტგენოგრამების ფოტოასლები წარმოადგინეთ პოზიტიური გამოსახულებით **tiff** ფორმატში. მიკროფოტოსურათების წარწერებში საჭიროა მიუთითოთ ოკულარის ან ობიექტივის საშუალებით გადიდების ხარისხი, ანათალების შეღებვის ან იმპრეგნაციის მეთოდი და აღნიშნოთ სურათის ზედა და ქვედა ნაწილები.

7. სამამულო ავტორების გვარები სტატიაში აღინიშნება ინიციალების თანდართვით, უცხოურისა – უცხოური ტრანსკრიპციით.

8. სტატიას თან უნდა ახლდეს ავტორის მიერ გამოყენებული სამამულო და უცხოური შრომების ბიბლიოგრაფიული სია (ბოლო 5-8 წლის სიღრმით). ანბანური წყობით წარმოდგენილ ბიბლიოგრაფიულ სიაში მიუთითეთ ჯერ სამამულო, შემდეგ უცხოელი ავტორები (გვარი, ინიციალები, სტატიის სათაური, ჟურნალის დასახელება, გამოცემის ადგილი, წელი, ჟურნალის №, პირველი და ბოლო გვერდები). მონოგრაფიის შემთხვევაში მიუთითეთ გამოცემის წელი, ადგილი და გვერდების საერთო რაოდენობა. ტექსტში კვადრატულ ფჩხილებში უნდა მიუთითოთ ავტორის შესაბამისი N ლიტერატურის სიის მიხედვით. მიზანშეწონილია, რომ ციტირებული წყაროების უმეტესი ნაწილი იყოს 5-6 წლის სიღრმის.

9. სტატიას თან უნდა ახლდეს: ა) დაწესებულების ან სამეცნიერო ხელმძღვანელის წარდგინება, დამოწმებული ხელმოწერითა და ბეჭდით; ბ) დარგის სპეციალისტის დამოწმებული რეცენზია, რომელშიც მითითებული იქნება საკითხის აქტუალობა, მასალის საკმაობა, მეთოდის სანდოობა, შედეგების სამეცნიერო-პრაქტიკული მნიშვნელობა.

10. სტატიის ბოლოს საჭიროა ყველა ავტორის ხელმოწერა, რომელთა რაოდენობა არ უნდა აღემატებოდეს 5-ს.

11. რედაქცია იტოვებს უფლებას შეასწოროს სტატია. ტექსტზე მუშაობა და შეჯერება ხდება საავტორო ორიგინალის მიხედვით.

12. დაუშვებელია რედაქციაში ისეთი სტატიის წარდგენა, რომელიც დასაბეჭდად წარდგენილი იყო სხვა რედაქციაში ან გამოქვეყნებული იყო სხვა გამოცემებში.

აღნიშნული წესების დარღვევის შემთხვევაში სტატიები არ განიხილება.

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CLINICAL AND IMAGING OUTCOMES OF XLIF SURGERY FOR LUMBAR SPINAL STENOSIS

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Abstract.

Background: To evaluate the treatment outcomes of lateral interbody bone graft surgery and posterior percutaneous screws for lumbar spinal stenosis

Methods: This is a cross-sectional descriptive study. There were 27 patients with 30 segments of surgery diagnosed with lumbar spinal stenosis that were surgically treated with the XLIF method. Clinical outcomes measured included VAS scores for lower back pain and leg pain, ODI, and JOA scores. Magnetic resonance imaging of the lumbar spine after surgery was used to evaluate indirect decompression. X-ray or CT scan to evaluate bone fusion after 6 months of surgery. Differences were determined by independent T-test.

Results: There were 27 patients with 30 segments of surgery. They were 12 males and 15 females with an average age of 58.81±8.1. There was significant improvement in VAS for lower back pain from 7.11±1.31 to 3.67±1.3, VAS for leg pain from 6.81±2.19 to 1.59±1.89, ODI from 26.41±8.95 to 13.69±8.34, and JOA score from 7.63±2.87 to 13.5±1.73. A-P diameter increased 134%, lateral diameter increased 120%, lateral recess depth increased 166%, disc height increased 126%, foraminal height increased 124%, spinal canal area increased 30%. The p-values were all <0.001. The average hospital stay was 6.79±3.01 days. Complications included 1 pedicle screw malformation, 1 ALL avulsion fracture, 1 abdominal herniation, 1 venous damage, 1 failure.

Conclusion: XLIF surgery presents a favorable option for patients with lumbar spinal stenosis. This is a minimally invasive surgical method that reduces pain, reduces bleeding, and is effective in indirectly decompressing the spinal canal both clinal and imaging.

Key words. Clinical, imaging, lumbar stenosis, lateral approach surgery, percutaneous screws.

Abbreviations. XLIF: Extreme Lateral Interbody Fusion; VAS: Visual Analogue Score; ODI: Oswestry Disability Index; JOA: Japanese Orthopedic Association; MRI: Magnetic Resonance Imaging.

Introduction.

Lumbar interbody fusion (LIF) has been recognized as an effective method for patients with refractory low back pain due to a variety of degenerative lumbar spinal disorders, including lumbar stenosis diseases and spondylolisthesis [1].

Extreme lateral interbody fusion (XLIF) surgery is defined as minimally invasive lateral, retroperitoneal surgery to the anterior spinal column with reduced injury to muscles and adjacent structures by manual dissection of the retroperitoneal space. We conducted initial guidance of the psoas muscle to the surface of the psoas muscle, use of the intraoperative neurophysiology monitoring when passing through the psoas muscle, extension of the retraction system and direct observation of the surgical field, placement of a large interbody instrument to open maximum intervertebral and orthopedic space expansion. XLIF is indirect decompression surgery and thus restoring disc and foraminal height resulting in symptomatic relief is its main advantage over more invasive decompression and interbody fusion surgeries. Indeed, XLIF surgery can reduce post-operative pain, entry wounds, tissue trauma, operating, recovery and mobility times resulting in shorter hospital stays.

We conducted research on the topic " **Clinical and imaging outcomes of XLIF surgery for lumbar spinal stenosis**" with the aim of:

Evaluating the clinical and imaging effectiveness of lateral interbody bone graft surgery and posterior percutaneous screws to treat lumbar stenosis.

Materials and Methods.

Patient selection: Our study recruited 27 patients with 30 segments surgery who were treated with the XLIF method from 2019 to April 2024. Ethical approval was received from the institution's review board (IRB approval number 853/GCN-HĐĐĐNCYSH-ĐHYHN)

The indications for XLIF include patients with lumbar spinal stenosis, except for patients with paralysis or severe leg pain at rest, the absence of a free disc fragment on MRI, bony lateral recess, deformities of both lower extremities, diseases that greatly affect diagnosis (spinal tuberculosis, spinal arachnoiditis, etc.), or patients were previously performed lumbar spinal surgery or patients with no clinical manifestations or enable to follow-up post-surgery.

Research Methods: We conducted a cross-sectional descriptive study during the mentioned period time. The demographic and clinical data were retrieved from medical chart reviews. Clinical presentations and imaging investigation were collected before, during and after surgery.

During the operation, we collected several indexes including intraoperative monitoring of surgery time, amount of blood loss, amount of blood transfusion, and accuracy of screws and cages. Treatment outcomes were evaluated at 1 month and 6 months after the surgery. The outcome measures included the VAS for lower leg pain and back pain, the ODI for disability, and the JOA scores for functional recovery. All patients had plain anteroposterior (AP) and lateral x-rays, dynamic flexion-extension lateral x-rays before the surgery, at 1 month and 6 months after surgery. All patients had a lumbar spine magnetic resonance imaging study before the surgery, and some of them had lumbar spine MRI after surgery. We measure the anterior and posterior diameter of the spinal canal, lateral diameter, lateral recess depth, spinal canal area, disc height, foraminal height pre-operation and post-operation on PACS software [2].

CT or X ray of the lumbar spine was arranged at 6 months after the surgery to evaluate the bone fusion status. Reconstruction images on the sagittal and coronal planes were used to evaluate the formation of bridging bone. Fusion results were classified from grade I to grade IV using the Bridwell interbody fusion grading system [3]. Grade I or grade II fusion was defined as successful fusion. Evaluation of the success or failure of decompression surgery based on postoperative clinical symptoms. Indirect decompression surgery is considered to have failed when direct decompression surgery is required afterward.

Independent T-tests were used to compare the continuous variables between groups. Chi-square test was used to compare categorical variables between groups. A p-value of < 0.05 was considered statistically significant. The data was processed using SPSS 20.0 software.

Results.

This study included 12 males and 15 females with an average age of 58.81 years (range 36–74 years). These patients received 30 segments of XLIF, including 1-segment fusion in 24 patients, 2-segment fusion in 3 patients. L4–5 was the most frequently involved level, followed by L3–4, and L2–3. The average follow-up period was 17.8 months (range, 1–62 months). The average hospital stay was 6.79 days (range, 3–14 days). No patient required a blood transfusion. After surgery, the VAS for lower back pain had improved from 7.11±1.31to 3.67±1.3, and VAS for leg pain improved from 6.81±2.19 to 1.59±1.89. After one month the ODI had improved from 26.41±8.95 to 13.69±8.34. The JOA score had improved from 7.63±2.87 to 13.5±1.73. All these improvements were statistically significant from baseline with $p < 0.001$. Complications included 1 pedicle screw malformation (3.7%), 1 ALL avulsion fracture (3.7%), and 1 abdominal herniation (3.7%), 1 failure, 1 venous damage (3.7%). Reoperation was required in 2 patients for posterior decompression and adjusting the pedicle screw. There was no pedicle screw loosening or posterior cage migration. The demographic data and clinical outcomes were summarized in Tables 1 and 2.

Table 1. *Demographic data.*

Variable	Value
Sex	
Male	12(44.4)
Female	15 (55.6)
Age (years)	58.81±8.1
Lumbar stenosis	27 (100)
Segments of XLIF	
1-segment	24 (88.9)
2-segment	3 (11.1)
Level distribution (n=21)	
L23	1 (3.3)
L34	6 (20)
L45	23(76.7)
Blood loss (ml)	46.8±94.13 (10-500)
Time surgery (minutes)	132.22±37.45
Length of hospital stay (days)	6.79±3.01
Time follow-up (months)	17.8 (1–62)
Clinical sign	
Lumbar back pain	96.3%
Radiculopathy	78.8%
Neurogenic claudication	85.2%
Complications	
Pedicle screw malformation	1 (3.7)
ALL avulsions fracture.	1 (3.7)
Abdominal herniation	1 (3.7)
Venous damage	1(3.7)
Failure	1 (3.7)
Fusion results by Bridwell grading (n=14)	
Grade 1	6 (43)
Grade 2	8 (57)

Values are presented as a number (%) or mean (range).
ALL, Anterior longitudinal ligament.

Table 2. *Summary of clinical outcomes.*

Variable (n=27)	Preoperative	Postoperative	P-value
VAS for back pain	7.11±1.31	3.67±1.3	<0.001
VAS for leg pain	6.81±2.19	1.59±1.89	<0.001
ODI	26.41±8.95	13.69±8.34	<0.001
JOA score	7.63±2.87	13.5±1.73	<0.001

Values are presented as mean± standard deviation or a number (%)
VAS, visual analogue scale; ODI, Oswestry Disability Index; JOA, Japanese Orthopedic Association.

Thirteen patients with 14 fusion segments underwent CT or XQ scan evaluation six months after surgery. Based on the Bridwell grading system, the fusion results were grade I in 6 segments (43%), grade II in 8 segments (57%). Successful fusion was achieved in 14 segments (100%).

21 segments of surgery underwent MRI after surgery to evaluate the size of the spinal canal. In those 21 segments of surgery, the anterior and posterior diameter increased from 7.73±2.24 mm to 10.32±3.00mm, 134% of pre-operation , the lateral diameter increased from 13.56±2.97mm to 16.32±2.86mm, 120% of pre-operation lateral recess depth increased from 1.95±1.39 mm to 3.26±0.93 mm, 166% of pre-operation, spinal canal area increased from 86.17±34.54 mm^2 to 112.19±44.53 mm^2, 130% of pre-operation, disc height increased from 9.06±2.23 mm to 11.40±1.94 mm, 126% of pre-operation, foraminal height increased from 16.27±4.03 mm to 20.24±2.76 mm, 124% of pre-operation.

Discussion.

Indirect decompression through eXtreme Lateral Lumbar Interbody Fusion has been shown to achieve similar or better outcomes with regards to pain and disability relief compared to direct approaches [4].

In our research group, there were 27 cases of lumbar spinal stenosis (Table 1). The main clinical symptoms are back pain accounting for 96.3%, radiculopathy accounting for 78.8% and neurogenic claudication 85.2% (Table 1).

There were 24 cases of 1-segment XLIF surgery, 3 cases of 2-segments XLIF surgery (Table 1). The average surgery time was 132.22±37.45 minutes, the average blood loss was

46.8±94.13 ml, there was 1 case of 500ml blood loss due to damage to the iliac vein. There were no cases requiring blood transfusion during or after surgery, the average hospital stay was 6.8±2.93 days (Table 1). There was 1 segment at L23, 6 segments at L34, 23 segments at L45.

Assessing the VAS score after surgery, the back VAS score decreased from 7.11±1.31 to 3.67±1.3 after surgery (P<0.001) (Table 2). The leg VAS decreased from 6.81±2.19 to 1.59±1.89 after surgery (p<0.001) (Table 2). Rogers et al. [5] studied XLIF surgery for 63 patients with grade II spondylolisthesis, with an average follow-up period of 12 months. The results showed that the most common surgical level was L4-5 (97%), 84% of patients were female, average age was 66. The majority of patients (71%) had undergone previous lumbar spine surgery. The average amount of blood loss decreased by 1.4g (after surgery compared to before surgery), the average hospital stay was 1.2 days. 2 cases (3.4%) of complications were: 1 case of intestinal obstruction after surgery, 1 case of screw fracture 14 months after a traffic accident. There was no nerve damage or infection. VAS score improved 75% (8.7 to 2.2), disc height increased 96% (4.6mm to 9.0mm), slippage improvement was 11.1mm to 3.6mm. Most patients had complete bone union with an improved Lenke score of 1.1 after 12 months. 89% of patients described being satisfied or very satisfied with the results.

X-ray examination after surgery showed that 1 case had pedicle screw malformation (Figure 3). The patient showed signs of nerve root compression. Postoperative X-ray showed pedicle screw malformation. After 2 days, the patient had surgery to reset the screw, and all in cases the cage was placed in the correct position (Table 2).

There was one case (3,7%) of failure after indirect decompression surgery, however, after direct posterior decompression surgery, there was no compression and after a period of rehabilitation, the patient recovered well. Oliveira et al. [6] reported that 9.5% of patients had insufficient relief of nerve compression symptoms and required additional direct posterior decompression. The causes of failure included cage subsidence, loss of sagittal alignment correction, and persistent central and foraminal stenosis.

Rentenberger et al. [7] reported an 18.8% reoperation rate due to neurological symptoms, pain, or radiculopathy. Kim et al. [8] showed that the rate of additional posterior decompression after XLIF was 60% while Park et al. [9] reported that the rate posterior decompression after indirect decompression and instrumentation was as high as 72.1% in patients with leg pain that improved ≤ 50% after the index procedure. A few reports have provided clear guidance for selecting appropriate patients for indirect decompression. Lim et al. [10] proposed the prerequisite of preoperative postural pain status to guide patient selection for indirect decompression with XLIF. The ability to achieve a pain-free position, such as sitting or lying, was a clinical predictor of successful XLIF for patients with lumbar spinal stenosis. Gabel et al. [11] suggested an algorithmic approach to predict success of indirect decompression with LLIF. Patients who achieved pain relief at rest and lacked facet fusion, free disc fragments, facet cysts, osteoporosis, and severe spinal stenosis were unlikely to require revision surgery for direct decompression. In the study by Wicharn Yingsakmongkol and colleagues in 2022 [12], the success rate of indirect lateral decompression surgery was 93.3%. The author also commented that patient selection for surgery plays an important role in the success of the surgery. The author selected patients with pain relief when walking, standing, and when resting. The height of the intervertebral disc increased by at least 1mm when in a lying position, no muscle weakness greater than grade IV, and no posterior compression such as a cyst, joint facet and no migrated disc herniation. Do not select patients with congenital spinal stenosis or short spinal pedicles, do not select patients with bone spurs compressing the lateral recess, do not select patients with radicular pain without Improved bending position. The author also commented that during surgery, a disc height of at least 10mm will increase the likelihood of success. In the study of Sertac Kirnaz et al. [13], they showed that one of the causes of failure of decompression is bony lateral recess stenosis. The author also suggests direct decompression for severe cases of lateral recess stenosis.

Timothy Y. Wang et al. [14] also concluded that bony lateral recess stenosis is an important factor of failure in indirect decompression surgery. Of 45 patients (age 65.6 ± 10.5 years; 14 male) involving 101 spinal levels included in this study, 13 (29%) failed indirect decompression.

There was 1 case (5%) of abdominal wall hernia after surgery requiring abdominal wall restoration surgery (Table 2), 1 case of ALL avulsion fracture, 1 case of pedicle screw malformation which required reoperation to adjust the pedicle screw. There were no cases of dural damage, major blood vessel damage or post-operative infection.

In our research group, 21 segments surgery floors had postoperative magnetic resonance imaging to evaluate the size of the spinal canal, disc height, lateral recess depth and foraminal height after surgery (Figure 4). In those 21 segments of surgery, the anterior and posterior diameter increased from 134% of pre-operation, the lateral diameter increased 120% of pre-operation lateral recess depth increased 166% of pre-operation, spinal canal area increased 130% of pre-operation, disc height increased from 126% of pre-operation, foraminal height increased 124% of pre-operation (Figures 1 and 2). In Hiroaki Nakashima's study the thecal sac increased 189% [15].

In Wicharn Yingsakmongkol's study [12], it was shown that in the successful group the disc height increased from 8.08 mm to 12.195 mm, in the failed patient group the disc height increased from 7.47 mm up to 9.39 mm, foraminal height in the success group increased from 17.05 mm to 19.7 mm, in the failed group increased from 16.58 mm to 18 mm.

In our study, there were 14 surgical stages that were followed for more than 6 months, with X-rays or CT scan, showing that the bone fusion rate of grade 1 was 43%, grade 2 was 57% (Figure 5). This is also the advantage of XLIF surgery when placing a larger cage. In Kanthika Wasinpongwanich's study, comparing the bone fusion rate of XLIF with TLIF, it showed that after 1 year, the bone fusion g rate of XLIF was better (72.7% compared to 83.07%), however after 2 years, the rate was not difference [16].

Rodgers et al. [17] compared the complications of 60 patients aged 80 years or older undergoing interbody fusion (20

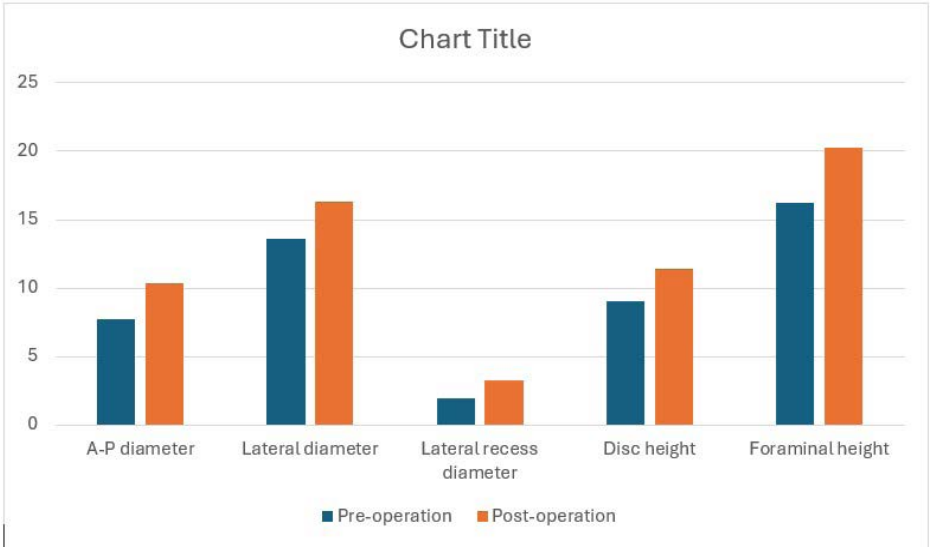

Figure 1. *Change MRI in spinal diameter before and after surgery.*

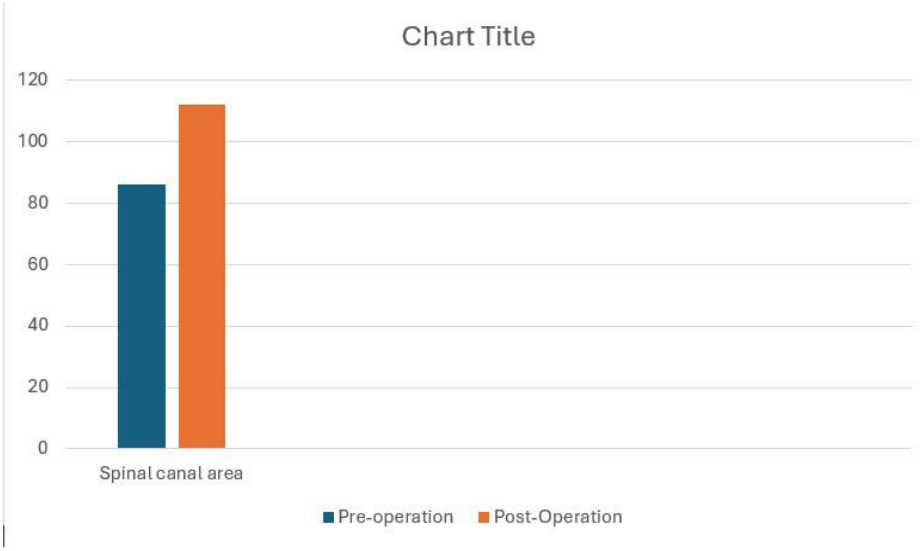

Figure 2. *Change MRI in spinal canal area after surgery.*

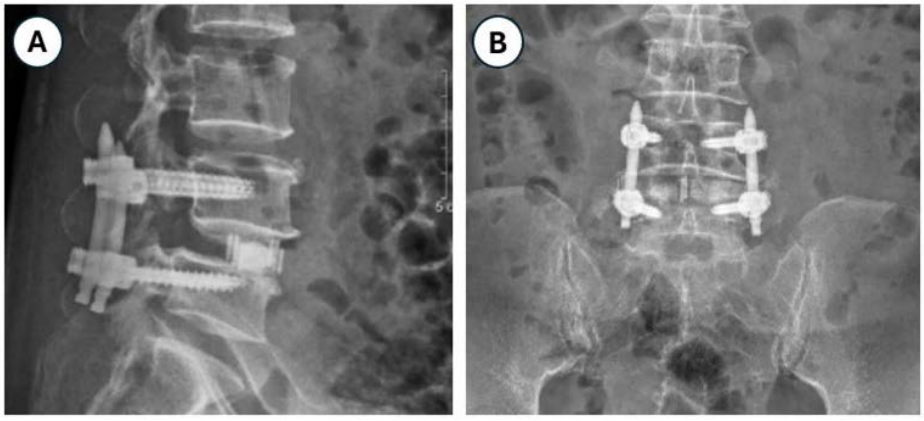

Figure 3. *X ray after surgery to evaluate the accuracy of screws and cage.*

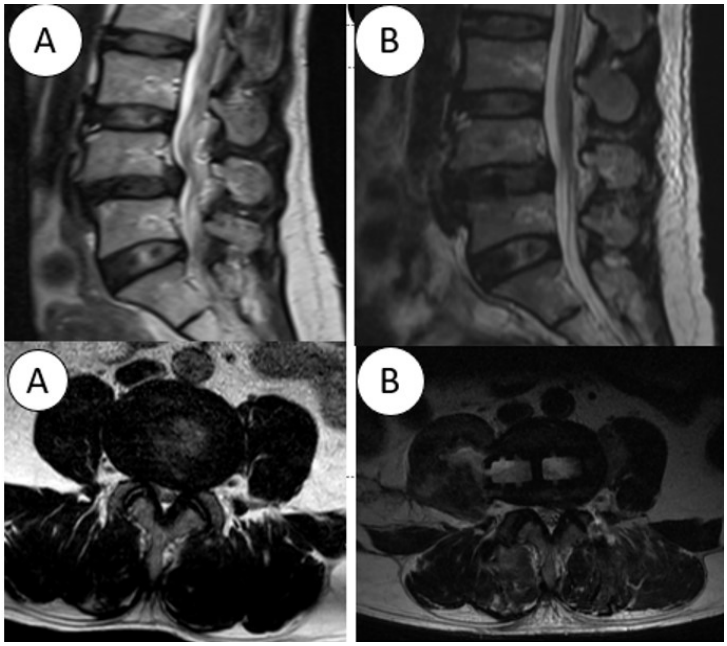

Figure 4. *MRI before (A) and after (B) surgery.*

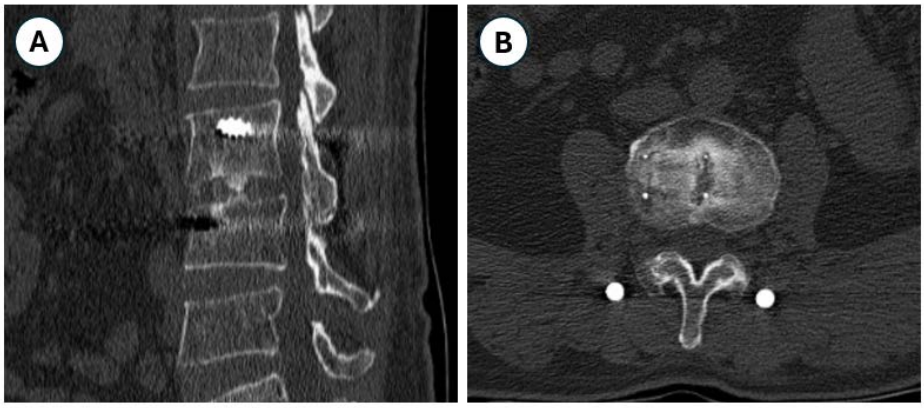

Figure 5. *The lumbar spine CT scanner 6 months post-surgery evaluated the bone fusion grade (A-B).*

PLIF patients and 40 XLIF patients). The average number of PLIF treatment floors was 2.6 while the average number of XLIF treatment floors was 1.6. When comparing, the author commented that the blood loss rates of PLIF and XLIF were 2.7g and 1.4g respectively, blood transfusion rates were 70% and 0%, complications were 60% vs 7.5%, The length of hospital stays was 5.3 days versus 1.3 days, the reoperation rate was 15% versus 5%, and the 6-month mortality rate was 30% versus 2.5%. In a separate study of XLIF the authors compared patients with BMI below and above 30 (obesity threshold). The author also concluded that there were similarities in hospital stay, blood loss, and complications (the author did not mention any cases of infection in either group). From there, the author concluded that the risk of patients with high age and BMI in traditional surgery had changed in XLIF [18] surgery.

Conclusion.

Treatment of spinal stenosis with XLIF surgery through the retroperitoneal psoas muscle is a minimally invasive method. This is an indirect decompression method for spinal stenosis. The level of improvement in clinical symptoms and imaging shows the effectiveness of the method. This method helps patients recover quickly after surgery, has little blood loss. However, patient selection plays an important role in the success of surgery.

Declaration of patient consent.

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published, and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Ethical policy and institutional review board statement.

Ethical approval for this study was provided by the Institutional Ethical Committee/Institutional Review Board.

Data availability statement.

All collected data is available for this study. Data will be provided upon request.

Authors' contributions.

Conceptualization or design of the work: HKD, TCN, VN, HDD; Data acquisition: TMH; Analysis or interpretation: TMH, Writing or manuscript revision: TMH. All authors reviewed and approved the final draft of the manuscript, and all take responsibility of the content of the publication.

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Nil.

Conflicts of interest.

There are no conflicts of interest.

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