# EXPERIENCE OF UNILATERAL AND BILATERAL TRANSPEDICULAR FIXATION IN DEGENERATIVE DISEASES OF THE LUMBAR SPINE

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## ABSTRACT

***The aim.*** *To study the effectiveness of using monosegmental fixation systems in surgeries involving resection of part of the facet joint in patients with posterolateral and foraminal hernias in the lumbar spine.*

***Materials and methods.*** *The study included 40 patients with degenerative diseases of the lumbar spine who underwent medial facet resection and the removal of posterolateral or foraminal disc hernia. Among them, 10 patients underwent unilateral single-level transpedicular fixation with interbody fusion using titanium cage (UTPF cage group), and the other 10 patients underwent unilateral monosegmental transpedicular fixation (UTPF group). The remaining 20 patients underwent bilateral transpedicular fixation (BTPF group). The amount of intraoperative blood loss, duration of surgery and length of hospital stay, as well as the frequency of perioperative complications in the groups were assessed. Visual analogue scale (VAS) pain score, Oswestry index and McNab score were assessed before and 6 and 12 months after surgery.*

***Results.*** *Intraoperative blood loss in the UTPF cage and UTPF groups was less than in the BTPF group, as was the duration of surgery; the differences were statistically significant ($p < 0.05$). Indicators of VAS score and Oswestry Quality of Life Index in the studied groups indicated the effectiveness of the technology.*

***Discussion.*** *Unilateral decompressive and stabilizing surgeries in patients with posterolateral and foraminal hernias of the lumbar spine can reduce the duration of the surgery, the volume of blood loss and the severity of pain in the postoperative period due to adequate decompression of the neurovascular formations of the spinal canal and stabilization of the spinal motion segment, which prevents the relapse of the disease and provides early rehabilitation of patients.*

***Conclusion.*** *Unilateral transpedicular fixation is acceptable and safe for lumbar degenerative diseases and improves the quality of life of the patients.*

***Key words:*** *unilateral transpedicular fixation, lumbar degenerative diseases, VAS score, Oswestry index*

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# ОПЫТ ОДНО- И ДВУХСТОРОННЕЙ ТРАНСПЕДИКУЛЯРНОЙ ФИКСАЦИИ ПРИ ДЕГЕНЕРАТИВНЫХ ЗАБОЛЕВАНИЯХ ПОЯСНИЧНОГО ОТДЕЛА ПОЗВОНОЧНИКА

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## РЕЗЮМЕ

***Цель исследования.*** *Изучить эффективность использования моносегментарных фиксирующих систем при операциях, сопровождающихся резекцией части дугоотростчатого сустава у пациентов заднебоковыми и фораминальными грыжами на поясничном отделе позвоночника.*

***Материалы и методы.*** *В исследовании участвовали 40 пациентов с дегенеративно-дистрофическими заболеваниями поясничного отдела позвоночника, которым выполнены резекция медиальной фасетки и удаление задне-боковой или фораминальной грыжи диска. Среди них 10 пациентам проведена монолатеральная одноуровневая фиксация транспедикулярными винтами с межтеловым спондилодезом титановым кейджем (ОТПФ-кейдж), а другим 10 – односторонняя моносегментарная транспедикулярная фиксация (ОТПФ). Оставшимся 20 пациентам выполнена двусторонняя транспедикулярная фиксация (ДТПФ). Проводилась оценка величины интраоперационной кровопотери, длительности операции и времени госпитализации, а также частота периоперационных осложнений в группах. Оценка боли по визуально-аналоговой шкале (ВАШ), степень ограничения жизнедеятельности на основании индекса Освестри и показателя Макнаб оценивались до и через 6 и 12 месяцев после операции.*

***Результаты.*** *Интраоперационная кровопотеря в группах с ОТПФ-кейджем и ОТПФ была меньше, чем в группе с ДТПФ, так же, как и продолжительность операции; различия были статистически значимыми ($p < 0,05$). Показатели ВАШ, индекс качества жизни Освестри в исследуемых группах свидетельствовали об эффективности технологии.*

***Обсуждение.*** *Односторонние декомпрессивно-стабилизирующие вмешательства у пациентов с заднебоковыми и фораминальными грыжами поясничного отдела позвоночника позволяют уменьшить продолжительность операции, объём кровопотери и выраженность болевого синдрома в послеоперационном периоде за счёт адекватной декомпрессии нервно-сосудистых образований позвоночного канала и стабилизации позвоночно-двигательного сегмента, что предотвращает рецидив заболевания и обеспечивает раннюю реабилитацию пациентов.*

***Вывод.*** *Односторонняя транспедикулярная фиксация допустима и безопасна при поясничных дегенеративных заболеваниях, способствует улучшению качества жизни пациентов.*

***Ключевые слова:*** *односторонняя транспедикулярная фиксация, поясничные дегенеративные заболевания, оценка по ВАШ, индекс Освестри*

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## INTRODUCTION

Over the last decades, significant progress has been observed in the treatment of degenerative-dystrophic spine diseases associated with the development of reasonable tactics and the introduction of new instrumental technologies into surgical practice. However, difficulties in the treatment of such patients remain, as clinical manifestations are caused not only by compression of the neural structures of the spinal canal, but also by the formation of instability in both the injured and adjacent spinal-motor segments [1–3].

The cornerstone component of the degenerative spine disease pathology appears to be changes in intervertebral discs and facet joints and, as a consequence, the development of segmental instability [4, 5], which in some cases is interpreted as "discogenic instability" [6, 7]. Violation of the biomechanics of the vertebral column is accompanied not only by linear but also angular displacement of vertebrae and, as a consequence, damage to the fibrous ring, ligamentous apparatus, and sometimes by disc herniation and the development of radicular and reflex-tonic syndromes [8, 9]. The outcome of changes in the vertebral-motor segments in the failure of the anterior and posterior support complexes, as well as the development of changes in the vertebral trabecular structures and degeneration of the disc tissue of the affected segment, appears to be natural.

Discectomy represents one of the common techniques for the surgical treatment of herniated discs in degenerative-dystrophic spine diseases. However, HIVD (Herniated intervertebral disc) excision by resection of a part of the facet joint without fixation of the spinal motion segment is accompanied by recurrence of pain and unsatisfactory treatment results both as a consequence of segmental instability and recurrence of the herniation in 7–18 % of cases [10–13].

Analysis of data from the current literature with meta-analysis of treatment results indicates the effectiveness of rigid transpedicular fixation, as well as interbody spondylodesis, for stabilization of the vertebral column [14–17]. At the same time, these surgical technologies also have disadvantages such as disconnection from the biomechanics of the vertebral-motor segment with the development of the "adjacent level" syndrome, which can be reduced by unilateral transpedicular stabilization [18–20]. Attention should also be paid to the high risks of instrumental spinal fixation in patients with ankylosing spondylitis, spondyloarthritis and osteoporosis. Surgical interventions with massive paravertebral trauma are also predictors associated with worsening treatment outcomes, causing pain recurrence and prolonged duration of rehabilitation treatment [21–23]. The domestic literature practically does not cover the aspects of using unilateral monosegmental fixations, whereas the technology is widely used abroad [18, 19].

## THE AIM OF THE STUDY

To study the effectiveness of using unilateral and bilateral monosegmental fixation systems during surgery with resection of part of the facet joint in patients with posterolateral and foraminal herniations in the lumbar spine.

## MATERIALS AND METHODS

Forty patients with degenerative and dystrophic spine pathology have undergone surgery at the Irkutsk Scientific Centre of Surgery and Traumatology. Among them, 10 patients underwent unilateral transpedicular fixation with titanium cage interbody spondylosis (UTPF-cage) after removal of radicular compression by medial facet resection, and the other 10 patients underwent only unilateral monosegmental transpedicular fixation (UTPF). A total of 20 patients underwent bilateral transpedicular fixation (BTPF). The clinical picture of the disease in patients was dominated by pain radicular syndrome in combination with vertebrogenic musculotonic syndrome. All patients underwent clinical neurological, neurophysiological, introscopic preoperative examination. The indications for surgery were ineffectiveness of nonsurgical treatment, persistent radicular pain syndrome. In most cases, the intervertebral hernia was located at the level of $L_{IV}$–$L_V$ in 26 (65 %), in 10 (25 %) – at the level of $L_V$–$S_I$, in 4 (10 %) – at the level of $L_{II}$–$L_{III}$. By sex and age, the patients were differentiated as follows: 16 (40 %) women, 24 (60 %) men; among them 30 (75 %) patients were of working age, from 38 to 65 years. Patients did not differ between groups in terms of sex, age, body mass index (BMI), and degree of intervertebral disc (IVD) degeneration (according to the C.W. Pfirrmann classification). The data are presented in Table 1.

The technology of HIVD excision was performed according to the generally accepted technique with resection of the medial facet and foraminotomy. Resection of a part of the facet joint allowed isolation of the spinal root, its displacement without gross traumatic effects and subsequent hernia excision. Unilateral transpedicular fixation was performed in 20 patients to stabilize the spinal motion segment. Among them, monolateral fixation using transpedicular screws with interbody spondylosis with a titanium cage was implemented in 10 patients (Fig. 1).

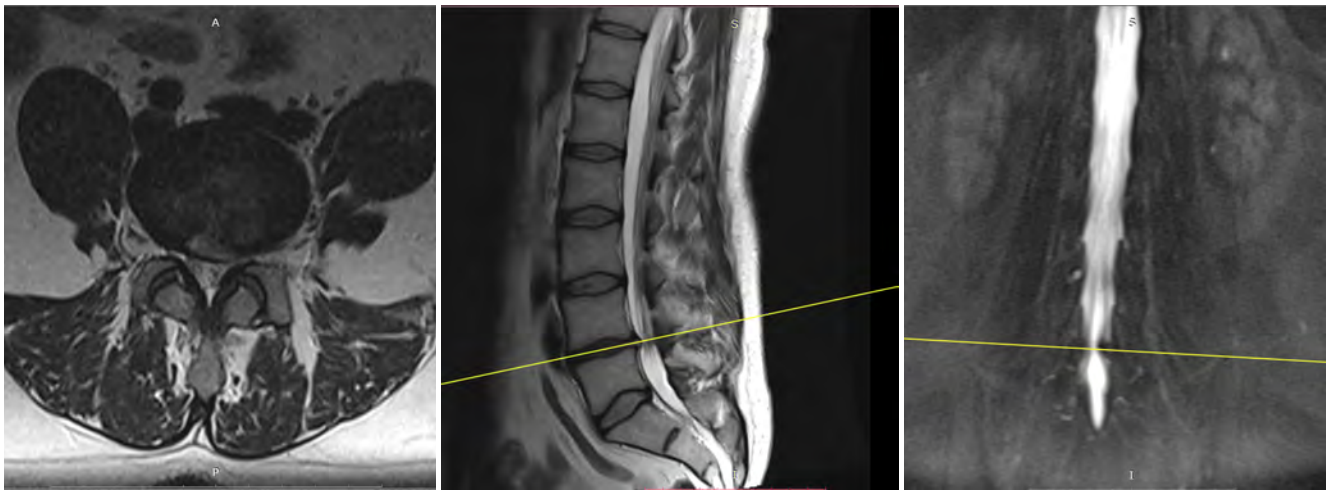
**Inclusion criteria:** presence of posterolateral or foraminal hernia with radicular compression; ineffectiveness of nonsurgical treatment for more than 3 months.

**Exclusion criteria:** obesity of the 2–3rd degree (BMI > 35 kg/m$^2$); spondylolisthesis of the II degree and above; lumbar degenerative scoliosis; infectious process in the acute phase; osteoporosis. Somatic and clinical manifestations in the groups had no statistically significant differences and were comparable. Patients signed informed consent. The study was authorized by the Ethical Committee of the Irkutsk Scientific Centre of Surgery and Traumatology (meeting minutes No. 9 dated December 08, 2021).

The results and patient satisfaction with treatment outcomes were assessed based on the visual analogue scale (VAS) of pain, the McNab scale, and the Russian version of the Oswestry index [24].

**TABLE 1**
**CHARACTERISTICS OF GROUPS**

| Indicators | | UTPF-cage (*n* = 10) | UTPF (*n* = 10) | BTPF (*n* = 20) |
|---|---|---|---|---|
| Sex: male/female | | 7/3 | 6/4 | –/8 |
| Age | | 49.22 ± 4.8 | 50.18 ± 2.8 | 50.33 ± 4.5 |
| BMI | | 29.1 ± 5.58 | 30.1 ± 3.23 | 30.5 ± 3.33 |
| Degrees of IVD degeneration (C.W. Pfirrmann classification) | II degree | 3 | 2 | 7 |
| | III degree | 7 | 8 | 11 |
| | IV degree | | | 2 |



***a***

***b***

***FIG. 1.***
***a*** *– MRI, $T_2$-weighted image, axial and sagittal sections: spondylarthrosis, left-sided $L_{IV}$–$L_V$ disc herniation;* ***b*** *– MSCT of the lumbar spine: transpedicular fixation of $L_{IV}$–$L_V$ on the left, interbody cage*

Statistical processing was performed using SPSS Statistics 10 program (IBM Corp., USA). Data are presented as mean and standard deviation, and differences between groups were analyzed using Pearson's $\chi^2$ test. Statistical significance was defined as $p < 0.05$.

## RESULTS

The results of surgical treatment were assessed based on the regression of vertebrogenic pain syndrome and neurological symptoms, restoration of static-dynamic function of the spine, indicators of the traumatic nature of surgery (duration, amount of blood loss), and patient satisfaction with the outcomes. The data are summarized in Table 2.

Analysis of surgical treatment revealed that intraoperative blood loss in the UTPF-cage and UTPF groups was less than that in the BTPF group, similarly to the duration of surgery. Pain regression and improved quality of life in the postoperative period were observed in all patients with a decrease in VAS score from 8.39 ± 0.3 to 2.39 ± 0.3 cm ($\chi^2 = 0.059$; $p < 0.05$), and the Oswestry index from 66 ± 0.35 to 31.7 ± 0.28 ($\chi^2 = 0.018$; $p < 0.05$). Relief of neurological symptoms (allodynia, paresthesias, weakness of foot extensors) was observed in 38 patients. All patients were intensively activated the day after surgery with mandatory lumbar fixation with a rigid orthopaedic corset. Postoperative re-

**TABLE 2**
**THE RESULTS OF SURGICAL TREATMENT**

| Indicators | | UTPF-cage ($n = 10$) | UTPF ($n = 10$) | BTPF ($n = 20$) | $p$ |
|---|---|---|---|---|---|
| Surgery time (min) | | 60 ± 1.9 | 56 ± 1.4 | 75 ± 1.7 | $p < 0.05$ |
| Blood loss (ml) | | 59.22 ± 2.8 | 57.18 ± 1.8 | 75.33 ± 2.5 | $p < 0.05$ |
| VAS | before the surgery | 8.35 ± 0.3 | 8.39 ± 0.2 | 8.45 ± 0.4 | $p > 0.05$ |
| | at discharge | 2.45 ± 0.3 | 2.35 ± 0.4 | 2.37 ± 0.4 | |
| | in 6 months. | 1.23 ± 0.33 | 1.22 ± 0.36 | 1.41 ± 0.26 | $p > 0.05$ |
| | in 12 months. | 0.90 ± 0.11 | 0.82 ± 0.15 | 0.92 ± 0.20 | |
| Oswestry Index | before the surgery | 66.3 ± 0.15 | 67.1 ± 0.25 | 64.6 ± 0.65 | |
| | at discharge | 31.7 ± 0.15 | 30.7 ± 0.15 | 32.7 ± 0.55 | |
| | in 6 months. | 18.1 ± 0.25 | 17.7 ± 0.15 | 19.7 ± 0.15 | $p > 0.05$ |
| | in 12 months. | 9.16 ± 1.26 | 9.26 ± 1.45 | 12.26 ± 1.35 | |
| McNab scale score at hospital discharge | perfect | 10 | 9 | 18 | |
| | good | – | 1 | 2 | $p > 0.05$ |
| | satisfactory | – | – | – | |
| McNab scale score in 6 months after discharge | perfect | 10 | 9 | 18 | |
| | good | – | 1 | 2 | $p > 0.05$ |
| | satisfactory | – | – | – | |
| McNab scale score in 12 months after discharge | perfect | 10 | 9 | 17 | |
| | good | – | 1 | 2 | $p > 0.05$ |
| | satisfactory | – | – | 1 | |

habilitation period in patients ranged from 1.5 to 2 months, and it was shorter in men. All patients retained their ability to work except 1 case. During the 12-month follow-up period after surgery, there was 1 case of increased pain in the lumbar spine against the background of progression of degenerative changes at the adjacent level during bilateral transpedicular stabilization. The patient was forced to change his place of employment. According to the control multispiral computed tomography, no implant failure was revealed. In summary, excellent and good results after discectomy for posterolateral and foraminal HIVD with single-level transpedicular fixation were achieved in all patients at 12-month follow-up.

## DISCUSSION

Posterior accesses to the spinal canal structures during discectomy followed by monolateral instrumental stabilization of the spinal segment, as well as classical transpedicular fixation techniques, contribute to fixation of the damaged spinal segment, but at the same time avoid excessive traumatization of soft tissues [25–28]. We are aware that at the stage of decompression of the neural formations of the spinal canal in patients with posterolateral and foraminal intervertebral hernias for neurolysis and mobilization of the radicular nerve, it is reasonable to perform resection of a part of the facet joint, which predetermines segment instability. Other risks of microsurgical HIVD excision include its recurrence into a formed fibrous ring defect, increased load on the arch joints, and pain exacerbation [29]. Prevention of disc hernia recurrence can be achieved through the use of a cage or a Barricaid intervertebral disc fibrous ring prosthesis [30], whereas stabilization of the supporting structures of the spinal motion segment (SMS) is achieved by unilateral unilevel transpedicular fixation combined with or without an interbody cage [31–33].

Improvement of the technology of surgical treatment of degenerative diseases of the lumbar spine allows us to formulate the main provisions that mitigate the risks of disease recurrence. First, surgical treatment of compression forms of degenerative spinal lesions should provide full decompression of the neurovascular formations of the spinal canal. Second, fixation of the damaged spinal-motor segment prevents recurrence of the disease and ensures early rehabilitation of patients. These provisions are related to both modern spine surgery techniques and the use of microsurgical techniques.

Our experience, as well as literature data about the use of unilateral and bilateral single-level fixation systems in patients with posterolateral and foraminal lumbar herniated discs, testify to their effectiveness. Reduction of traumatism and duration of surgery, as well as the blood loss extent, are the main predictors of the effectiveness of using unilateral monosegmental systems [26, 27].

The results of the study suggest that both unilateral and bilateral fixation techniques can be applied to prevent hernia recurrence and SMS instability, however, a reduction in the traumatic nature of the intervention is evidence in favour of monolateral systems. The issue needs further detailed and multicentre study and accumulation of clinical data in both foreign and domestic practice.

## CONCLUSIONS

Modern surgical techniques during surgery with resection of part of the facet joint in patients with posterolateral and foraminal herniations in the lumbar spine allow adequate decompression of the neural structures of the spinal canal and stabilization of the SMS.

Unilateral monosegmental instrumented fixation is an effective technique that allows achieving consolidation, early activation and social adaptation of patients.

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**Conflict of interest**

The authors declare the absence of apparent and potential conflicts of interest related to the publication of this article.

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