

## CLINICAL EFFICACY OF FACET FIXATION IN COMBINATION WITH LATERAL INTERBODY FUSION IN THE TREATMENT OF PATIENTS WITH DEGENERATIVE SEGMENTAL INSTABILITY OF THE LUMBAR SPINE

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### ABSTRACT

To improve the treatment results of patients with degenerative segmental instability of the lumbar spine, a new facet fixation technology is introduced in combination with the lateral interbody fusion. This method is carried out by implanting the interbody cage through a lateral retroperitoneal approach followed by bilateral implantation of titanium cages into facet joint spaces, which are fixed by additional fixing screws.

The purpose of present study was to perform the analysis of the clinical efficacy of minimally invasive technology – facet fixation in combination with lateral interbody fusion in patients with degenerative segmental instability of the lumbar spine.

The study included 18 patients with clinical and radiological manifestations of abnormal segmental mobility, who had indications for decompressive-stabilizing intervention. In all patients the level of pain by visual analogue scale, life quality by Oswestry disability index, duration of surgery, patients' satisfaction with treatment outcomes by Macnab scale, as well as the occurrence of complications were assessed. Dynamic observation and comprehensive evaluation of the treatment results were conducted at an average in 6 months after surgery.

Thus, facet fixation method with “facet Wedge” implant in combination with lateral retroperitoneal interbody fusion can be successfully used in the treatment of patients with degenerative segmental instability of the lumbar spine. Application of the new method allows to achieve positive clinical outcomes in the postoperative period, to provide efficient stabilization of the operated segment, which in all cases was confirmed by radiographic data. The technology of facet fixation is quite simple and can significantly reduce pain and improve the life quality of patients in the immediate and late post-operative periods. Further researches on the efficacy of abovementioned less traumatic posterior fixation, as well as comparative analysis with the known analogues are needed.

**KEYWORDS:** lumbar spine, degenerative segmental instability, facet fixation, lateral interbody fusion

### INTRODUCTION

The dominant cause of temporary disability and primary disability in middle age group individuals is

low back pain [Minaeva N, 2001]. While studying vertebrogenic syndrome causes, it was revealed, that the major part of vertebral-spinal pathology is associated with degenerative intervertebral disc lesions [Wilmink J, 1999; Byvaltsev V et al., 2011b], thereby, in more than 50% of cases, diagnosed patients have radiological signs of segmental instability [Resnick D et al., 2008; Konovalov H et al., 2009].

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Currently, the main method for surgical correction of clinically significant abnormal segmental mobility of the lumbar spine is transpedicular fixation with the installation of interbody cages from posterior approach [Pellise F et al., 2007; Van den Hauwe L, 2009].

Many authors show the significant damage of muscular-ligamentous apparatus around the operated area, contributing to the formation of rough scar-adhesion changes and expressed postoperative pain in classical open transpedicular fixation [Blumenthal S, Gill K, 1993; Marchi L et al., 2012; Son S et al., 2012; Byvaltsev V et al., 2015]. Striving for better results of decompressive-stabilizing interventions in patients with degenerative segmental instability of the lumbar spine has led to the development of an optimal method for decompression of neural structures and effective stabilization of the operated segment with minimal trauma to surrounding tissues.

Since 2015, the Neurosurgery Center of Road Clinical Hospital at Irkutsk-Passenger station JSC "Russian Railways" applies a new method of fusion, which consists in fixing of facet joints with "facet Wedge" implant (Synthes, Switzerland) and installing interbody cage "Oracle" (Synthes, Switzerland) from lateral access.

Lack of information about the clinical efficacy of facet fixation with "facet Wedge" implant combined with lateral retroperitoneal interbody fusion was a motivating point for this research project.

The purpose of present study was to perform the analysis of the clinical efficacy of minimally invasive facet fixation technology in combination with lateral interbody fusion in patients with degenerative segmental instability of the lumbar spine.

#### MATERIAL AND METHODS

Retrospective analysis of the prospectively collected data of 18 patients with symptomatic degenerative segmental instability of the lumbar spine (vertebrae linear broadcast more than 4 mm, vertebral sagittal angulation of more than 10°) treated at the Neurosurgery Center of Road Clinical Hospital JSC "Russian Railways", over the period from January to August 2015.

The evaluation of clinical efficacy was performed on the basis of the most important parameters for this category of patients: severity of pain, life quality as-

sociated with the problem of back pain, satisfaction with treatment and presence of complications. Also the technical features of the surgery were investigated – surgery duration, blood loss, hospitalization length and activation time. Values of parameters before the surgery, at discharge and follow-up examination were also studied in 4-7 months after the intervention. The pain intensity was assessed by visual analogue scale, the level of life quality for patients with problems in the back – by the special questionnaire Oswestry (Oswestry disability index) [Byvaltsev V et al., 2011a], subjective satisfaction with the results of surgical treatment by Macnab scale [Macnab D et al., 1987]. In order to assess the viability of forming bone block (direct and lateral spondylography), the dynamics of radiographic parameters and neuroimaging data of magnetic resonance imaging were also studied with the use of Siemens Magnetom Essenza 1.5 T scanner (Siemens, Germany) and multi-slice (4 spirals) computed tomography Bright Speed Edge (General Electric, USA).

Surgical interventions were performed under intravenous anesthesia with artificial lung ventilation. Procedural steps were performed under fluoroscopic control of the C-arm (Philips, Netherlands). Patients were activated in the first days after the procedure. All patients were operated with original instruments and by one surgical team without social and economic interest as a result of the surgical interventions.

Statistical analysis of the study results was performed by using Microsoft Excel and Statistica 8.0 software packages. To assess the significance of differences of the sampled population, the criteria for nonparametric statistics were used. The level of  $p < 0.05$  was considered as the lower confidence level. The data are presented in median and interquartile range as Me (25%; 75%).

#### RESULTS

The ratio of males and females among operated patients was 2:1, with median age of 34 (27; 46) years. Localization of the affected segment in study groups was as follows: in 6 patients the destruction was detected in L<sub>II</sub>-L<sub>III</sub> segment, in 8 patients – in L<sub>III</sub>-L<sub>IV</sub>, in 3 – in L<sub>IV</sub>-L<sub>V</sub> and in 1 patient – in L<sub>V</sub>-L<sub>VI</sub> segment.

Intra- and postoperative technical characteristics of interventions are shown in table.

**Table**  
Characteristics of patients by operational criteria

Parameters	Study group of patients (n=18) (Me 25%-75%)
Surgery duration (min)	135 (95; 140)
Extent of blood loss (ml)	80 (70; 140)
Activation time (days)	2 (1; 2)
Hospitalization terms (days)	10 (9; 11)

Assessment of pain according to visual analogue scale showed a significant decrease in its intensity after surgery ( $p_w < 0.001$ ) both in the early postoperative period (at discharge) and in the long-term period (at the average in 6 months after surgery) (Fig. 1).

While analyzing Oswestry index values a significant positive dynamics of functional state has been established after surgery in comparison with preoperative values ( $p_w < 0.001$ ) during the whole observation period (Fig. 2).

The analysis of treatment results at the average in 6 months after surgery showed mostly excellent and good postoperative outcomes by Macnab scale. Poor outcomes were not observed (Fig. 3).

According to the results of all performed interventions, 1 (5%) complication as a sign of intermuscular hematoma infection was recorded. Extending the local and systemic antibiotic therapy contributed to a favorable healing of surgical wounds without increasing the length of hospitalization.

During the catamnesis observations (at the average during 6 months) on the control spondylograms of patients, no dislocation and migration of the implants, as well as signs of segmental instability have been identified. Clinical example of bilateral facet fixation in combination with lateral retroperitoneal interbody fusion is shown in figure 4.

**DISCUSSION**

In modern operational vertebrology for the treatment of patients with degenerative spinal segmental instability of the lumbar spine, it is urgent to improve the results of surgical interventions aimed at decreasing the adverse effects by reducing traumas and effective elimination of pathologi-

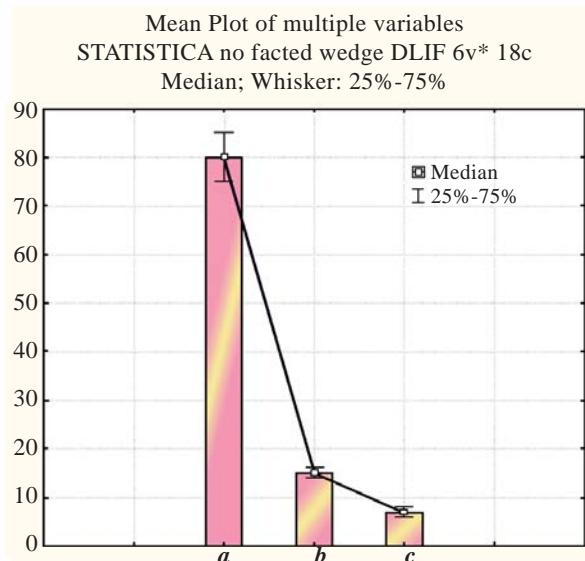


FIGURE 1. Dynamics of the level of pain according to visual analogue scale in the study group of patients before (a) and after (b) surgery within 4-7 months (c).

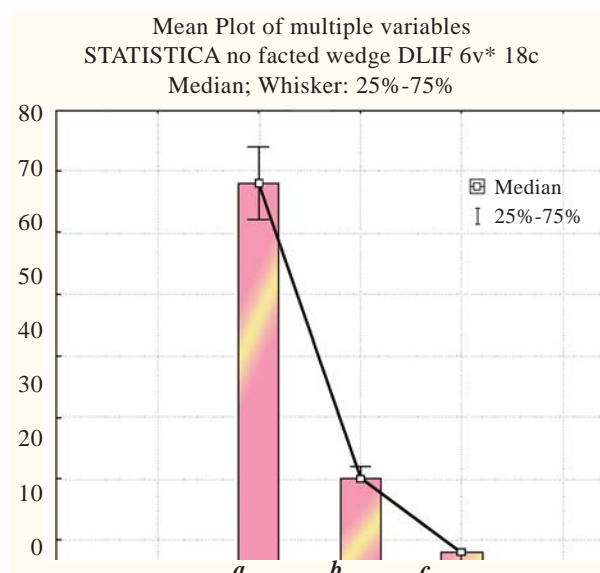


FIGURE 2. Dynamics of the functional state of study group patients according to Oswestry Disability Index before (a) and after (b) surgery within 4-7 months (c).

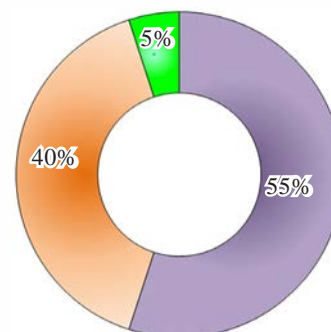
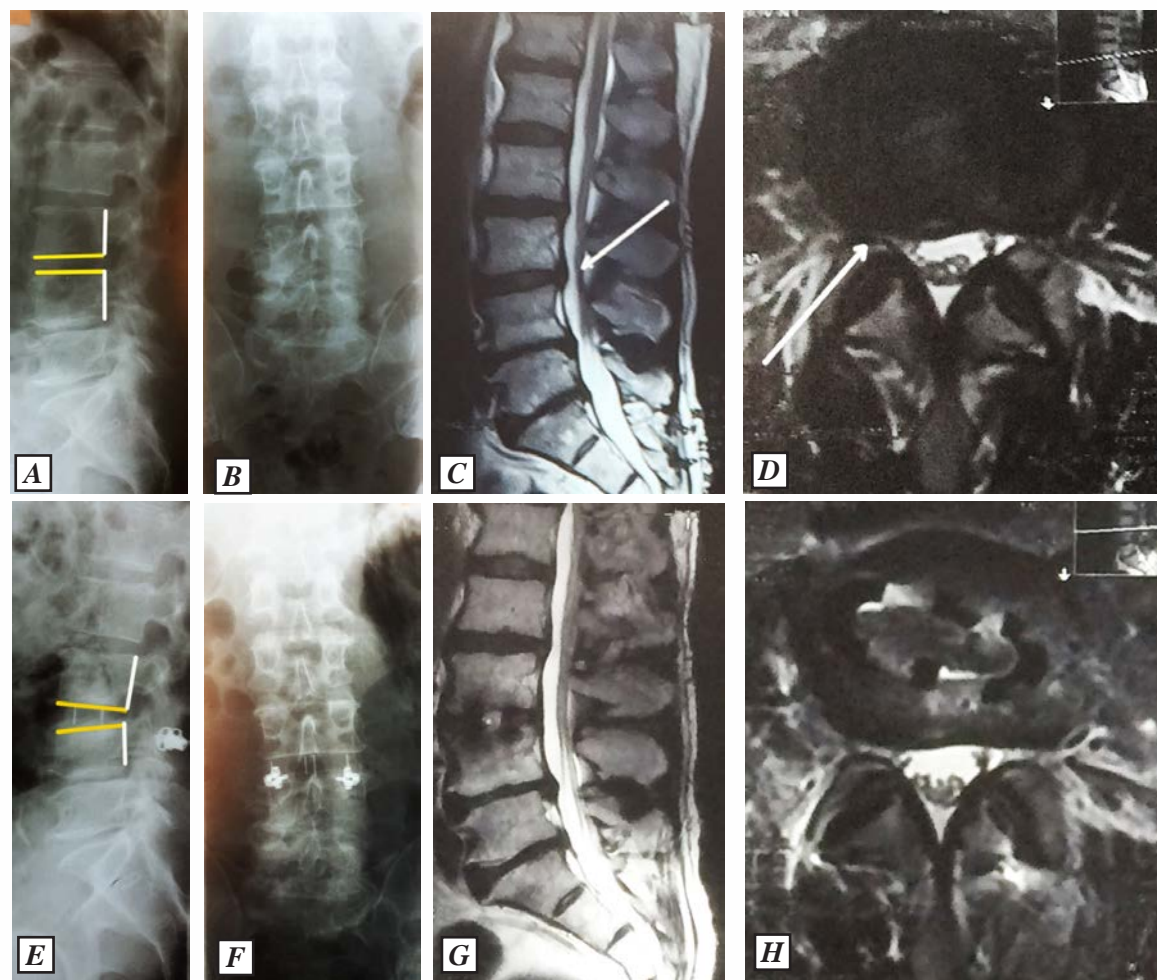


FIGURE 3. Subjective satisfaction with the operation according to Macnab scale in the study group [Macnab D et al., 1987]



**FIGURE 4.** Patient Z., 56 years old. Right-sided paraforaminal disc herniation  $L_{III}$ - $L_{IV}$  with degenerative segmental instability: Lumbar spondylography before surgery (A,B) – antespindilolistez  $L_{III}$  vertebra of I stage, flattening the lumbar lordosis ( $28^\circ$ ); MRI of the lumbar spine (C,D) prior to surgery (intervertebral disc disease is shown by arrow). Lumbar spondylography in 6 months after surgery (E,F) – segments are stable, lumbar lordosis restored ( $42^\circ$ ), signs of the migration of construction elements have not been identified; MRI of the lumbar spine (G,H) in 6 months after surgery – the position of the right construction elements, data for compression of neural structures are not obtained

cal vertebral mobility [Fritsch E et al., 1996; Byvaltsev V et al., 2015].

Thus, the method of percutaneous transpedicular fixation was developed for the replacement of traditional open method of transpedicular fixation, which has been considered as “a gold standard” of segmental instability treatment for a long time and has been characterized by significant intraoperative trauma of muscular-ligamentous apparatus [Son S et al., 2012]. The abovementioned method helped to improve the results of surgical interventions due to less damage of paravertebral muscles. Meanwhile, carrying out percutaneous vertebral screws through the leg of vertebra creates high risks of intracanal injuries at its malposition, and prolongs the compression of the surrounding soft

tissue and contributes to the development of muscle atrophy and wound infection [Masferrer R et al., 1998; Moore K et al., 2002].

Trying to reduce the risks of complications and minimize surgical traumas served as a stimulus to the emergence of facet fixation method and its modifications [Magerl F, 1984]. Researchers confirmed the relative simplicity of application, low traumatic method and considerably low risks of damage of the spinal canal contents compared to transpedicular fixation [Abumi K et al., 1990; Hafer T et al., 1994]. The method of lateral interbody fusion being a modification of the ventral retroperitoneal approach [Ozgun B et al., 2006], reduces the risk of intracanal scar-adhesion changes and has destabilizing effect of the operation com-

pared to the posterior approach [Moore K et al., 2002; Parker S et al., 2011].

The analysis of specialized literature revealed insufficient information about both lateral interbody fusion and facet fixation for the treatment of patients with segmental instability of the lumbosacral spine [Voyadzis J, Anaizi A, 2013; Rhee J et al., 2015]. In the Pubmed database and the Russian literature, the authors have not found any clinical studies revealing the clinical efficacy of facet fixation with “facet Wedge” cage.

According to F. Magerl (1984), clinical efficacy of lateral interbody fusion and facet fixation in the treatment of patients with degenerative diseases of the lumbar spine was measured by the dynamics of pain. Thus, J. Rhee and co-authors showed a reduction of pain according to visual analogue scale after the operation in back (from  $74 \pm 30$  to  $19 \pm 24$ ) and foot (from  $70 \pm 29$  to  $20 \pm 30$ ) ( $p < 0.0001$ ). One postoperative complication of pulmonary artery embolism was revealed in the postoperative period, unrelated to the surgical interventions [Rhee J et al., 2015]. In the study conducted in 2013 the authors indicate the reduction of pain in back from an average of  $89 \text{ mm}$  to  $9 \text{ mm}$  and in foot from  $80 \text{ mm}$  to  $9 \text{ mm}$ , without adverse postoperative outcomes [Voyadzis J, Anaizi A, 2013].

In present study no fundamental differences were established in the clinical results with the

data presented in the literature. After surgery patients had statistically significant improvement in functional state in the long-term period, which is stated by the minimum number of points by Oswestry disability index and low level of pain by visual analogue scale.

Facet fixation method with “facet Wedge” implant in combination with lateral retroperitoneal interbody fusion in patients with degenerative segmental instability of the lumbar spine allows achieving favorable clinical results and efficient stabilization of the operated segment at low intraoperative injury. All of the abovementioned statements contribute to the safe and early activation of patients, reducing the risk of intra- and post-operative complications, rapid and complete social and labor rehabilitation of patients.

The work presents the experience of facet fixation in combination with lateral retroperitoneal intervertebral fusion for the treatment of patients with degenerative segmental instability of the lumbar spine. The technology of facet fixation is quite simple and can significantly reduce pain and improve the life quality of patients in the immediate and late post-operative periods. Further researches on the efficacy of abovementioned less traumatic posterior fixation, as well as comparative analysis with the known analogues are needed.

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## REFERENCES

1. Abumi K, Panjabi MM, Kramer KM, Durancieu J, Oxland T, Crisco JJ. Biomechanical evaluation of lumbar spinal stability after graded facetectomies. *Spine (Phila Pa 1976)*. 1990; 15(11): 1142-1147.
2. Blumenthal S, Gill K. Complications of the Wiltse Pedicle Screw Fixation System. *Spine (Phila Pa 1976)*. 1993; 18(13): 1867-1871.
3. Byvaltsev VA, Kalinin AA, Belykh EG, Sorokovikov VA, Shepelev VV. [Optimization of treatment results of patients with segmental instability of the lumbar spine while using minimally invasive technique of fusion] [Published in Russian]. *Voprosy neirokhirurgii imeni N.N.Burdenko*. 2015; 3: 45-54.
4. Byvaltsev VA, Sorokovikov VA, Belykh EG, Arsenteva NI. [The use of scales and questionnaires in spine] [Published in Russian]. *Zhurnal nevrologii i psikiatrii imeni S.S. Korsakova*. 2011a; 9(III): 51-56.
5. Byvaltsev VA, Sorokovikov VA, Kalinin AA, Egorov AV, Belykh EG, Panasenko SY. [Comparative analysis of the results decompression and simultaneous decompressive-stabilizing operations in the treatment of disco-radicular conflict lumbosacral spine] [Published in Russian]. *Bulletin of the East-Siberian Scientific Center of the Siberian Branch of the Russian Academy of Medical Sciences*. 2011b; 1(80): 38-43.

6. *Fritsch EW, Heisel J, Rupp S.* The failed back surgery syndrome: reasons, intraoperative findings, and long-term results: a report of 182 operative treatments. *Spine (Phila Pa 1976)*. 1996; 21(5): 626-633.
7. *Hafer TR, O'Brien M, Dryer JW, Nucci R, Zipnick R, Leone DJ.* The role of the lumbar facet joints in spinal stability: identification of alternative paths of loading. *Spine (Phila Pa 1976)*. 1994; 19(23): 2667-2670.
8. *Konovalov HA, Shevelev IN, Kornienko VN, Nazarenko AG.* [Clinical and diagnostic evaluation of the severity of the degenerative lesions of the lumbosacral spine] [Published in Russian]. *Annals of clinical and experimental neurology*. 2009; 1: 16-21.
9. *Macnab D, Fitzsimmons G, Casserly C.* Development of the Life Roles Inventory – Values Scale. *Canadian Journal of Counselling*. 1987; 21: 86-98.
10. *Magerl FP.* Stabilization of the lower thoracic and lumbar spine with external skeletal fixation. *Clin Orthop Relat Res*. 1984; 189: 125-141.
11. *Marchi L, Abdala N, Oliveira L, Amaral R, Coutinho E, Pimenta L.* Stand-alone lateral interbody fusion for the treatment of low-grade degenerative spondylolisthesis. *Scientific-WorldJournal*. 2012; 2012:456346.
12. *Masferrer R, Gomez CH, Karahalios DG, Sonntag VK.* Efficacy of pedicle screw fixation in the treatment of spinal instability and failed back surgery: a 5-year review. *J Neurosurg*. 1998; 89(3): 371-377.
13. *Minaeva NG.* [Initiative pain in the lower back] [Published in Russian]. World Health Organization. Department for management of non-communicable diseases. *Neurology journal*. 2001; 6(3): 53-57.
14. *Moore KR, Pinto MR, Butler LM.* Degenerative disc disease treated with combined anterior and posterior arthrodesis and posterior instrumentation. *Spine (Phila Pa 1976)*. 2002; 27(15): 1680-1686.
15. *Ozgun BM, Aryan HE, Pimenta L, Taylor WR.* Extreme lateral interbody fusion (XLIF): a novel surgical technique for anterior lumbar interbody fusion. *Spine J*. 2006; 6(4): 435-443.
16. *Parker SL, Adogwa O, Witham TF, Aaronson OS, Cheng J, McGirt MJ.* Postoperative infection after minimally invasive versus open transforaminal lumbar interbody fusion (TLIF): literature review and post analysis. *Minim Invasive Neurosurg*. 2011; 54(1): 33-37.
17. *Pellise F, Hernandez A, Vidal X, Minguell J, Martínez C, Villanueva C.* Radiologic assessment of all unfused lumbar segments 7.5 years after instrumented posterior spinal fusion. *Spine (Phila Pa 1976)*. 2007; 32(5): 574-579.
18. *Resnick DK, Haidjr RW, Wang JC.* Surgical management of low back pain. New York: Thieme. 2008. 210p.
19. *Rhee JW, Petteys RJ, Anaizi AN, Sandhu FA, Voyadzis JM.* Prospective evaluation of 1-year outcomes in single-level percutaneous lumbar transfacet screw fixation in the lateral decubitus position following lateral transposinterbody fusion. *Eur Spine J*. 2015; 24(11): 2546-2554.
20. *Son S, Lee SG, Park CW, Kim WK.* Minimally invasive multilevel percutaneous pedicle screw fixation for lumbar spinal diseases. *Korean J Spine*. 2012; 9(4): 352-357.
21. *Van den Hauwe L.* Facet joint degeneration. *Eur Radiol*. 2009; 19(1): 19.
22. *Voyadzis JM, Anaizi AN.* Minimally invasive lumbar transfacet screw fixation in the lateral decubitus position after extreme lateral interbody fusion: a technique and feasibility study. *J Spinal Disord Tech*. 2013; 26(2): 98-106.
23. *Wilmink JT.* MR imaging of the spine: trauma and degenerative disease. *Eur Radiol*. 1999; 9(7): 1259-1266.