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The use of laboratory criteria in the risk assessment of postoperative complications after transpedicular fixation of the lumbar spine

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Objective. To investigate the peculiarities of the development of postoperative complications after surgical treatment of degenerative diseases of the lumbar spine with transpedicular fixation of the vertebrae and their relationship with changes in preoperative laboratory parameters. *Methods.* A retrospective analysis of the biochemical examination data of 35 patients with degenerative diseases of the lumbar spine who underwent discectomy with transpedicular fixation was performed. In four groups of patients with postoperative complications: 10 patients — inflammation of the what fabrics around metal structures and 5 patients — instability of the metal structure. The results of the examination of 20 people without specified complications served as a comparison group. Comparison was made with a control group (20 practically healthy people). *Results.* Patients have a significant increase in serum ALT activity by 42.29 and AST by 63.55 %, by 38.37 % of the level of CS content, by 37.21 % of total glycoproteins compared to those in the control group. In patients with soft tissue inflammation around the serum instrument zone, the content of LDLP was recorded by 29.27 %, by 23.53 % of the UA, by 12.34 % of TP results higher by 32.01 % ALT activity and 83 %, 49 % AST, 54.96 % AIP activity, 31.40 % — AIP/AcP, 60.47 % — concentration of CS, 95.57 % — total glycoproteins than in persons in the control group. In the serum of patients with the development of instability of metal structures, 28.55 % was observed by activity of the ALT, AIP — by 38.47 %, AcP — by 48.84 %, less by 58.35 % of AIP/AcP, the CHOL content of 13 88 %, higher by 25.43 % of the LDLP content than such persons in the control group. Content of the P was lower by 31.51 % and the Ca/P ratio was higher by 38.95 %, the content of CS by 83.72 %, total glycoproteins — by 48.83 %. *Conclusions.* Comparative analysis of the results of preoperative clinical and laboratory examination of patients with degenerative spinal diseases with transpedicular fixation which is reflected in the deviations of their preoperative laboratory parameters from such persons with uncomplicated course of the postoperative period after similar surgery.

Мета. Дослідити особливості розвитку післяопераційних ускладнень після операції дегенеративних захворювань поперекового відділу хребта (ДЗПВХ) із транспедикулярною фіксацією хребців та їхній зв'язок із змінами передопераційних лабораторних показників. *Методи.* Проведено ретроспективний аналіз даних біохімічного обстеження 35-ти пацієнтів із ДЗПВХ після дискектомії з транспедикулярною фіксацією — у двох груп хворих, із післяопераційними ускладненнями: 10 осіб — запаленням м'яких тканин навколо металокопструкцій та 5 зі нестабільністю металокопструкції. Група порівняння — 20 осіб із неускладненим перебігом післяопераційного періоду. Порівняння проводили із контрольною групою (20 практично здорових людей). *Результати.* У пацієнтів без ускладнень виявлено достовірне збільшення в сироватці крові активності АЛТ й АСТ, а також рівня вмісту ХСТ і загальних глікопротеїнів порівняно з контрольною групою. У хворих із запаленням м'яких тканин навколо зони інструментації у сироватці крові зафіксовано нижчий вміст ліпопротеїнів низької щільності, сечової кислоти, результатів тимолової проби, але зростання активності АЛТ й АСТ, лужної фосфатази, ЛФ/КФ, концентрації ХСТ, загальних глікопротеїнів порівняно з контролем. У сироватці крові пацієнтів із розвитком нестабільності металевих копструкцій спостерігалося зростання АЛТ, лужної фосфатази, КФ та зменшення ЛФ/КФ, вмісту ХОЛ, збільшення вмісту ліпопротеїнів низької щільності порівняно з контролем. *Висновки.* Порівняльний аналіз результатів передопераційного клініко-лабораторного обстеження пацієнтів із ДЗПВХ із транспедикулярною фіксацією хребців із неускладненим та ускладненим перебігом післяопераційного періоду показав, що вірогідний розвиток ускладнень у післяопераційному періоді та їх особливості пов'язані зі змінами метаболізму пацієнтів, який відображається у відхиленнях їхніх передопераційних лабораторних показників від таких у осіб із неускладненим перебігом післяопераційного періоду після аналогічних оперативних втручань. *Ключові слова.* Транспедикулярна фіксація, дегенеративні захворювання хребта, ускладнення, біохімія, предикція.

Keywords. Transpedicular fixation, degenerative diseases of the spine, complications, biochemistry, prediction

Introduction

Lumbar discectomy is the most frequently performed surgical procedure for the treatment of patients with degenerative spine diseases [1]. One of the options for open surgical treatment of herniated intervertebral discs is the use of transpedicular fixation of adjacent vertebrae in the presence of additional instability of the operated segment, aseptic discitis, a decrease in the height of the segment or recurrence of the hernia [2].

The success rates of traditional open discectomy for herniated intervertebral discs of the lumbar spine range from 75 to 100 % [3]. Although open discectomy is an effective surgical treatment, it can also cause significant muscle damage [4]. Additional transpedicular fixation is used to avoid such adverse consequences of this intervention as epidural scarring [5] and destabilization of the spinal motor segment due to the necessary resection of structures, which, in most cases, leads to postdiscectomy syndrome [6, 7].

Possible complications of such decompressive-stabilizing operations are incorrect insertion of the screw, fracture or instability of one of the structural elements, development of an impairment at adjacent levels, neurological disorders [8]. The prevalence of infectious and specific complications ranges from 0.44 to 1.81 % [9].

Improper handling of transpedicular screws can cause the development of delayed infection at the place of attachment of the screw to the vertebral bone [10, 11]. At the same time, infection leads to loosening of the screw and pain [12]. During surgery, a fragment of adipose tissue or bone marrow can dislodge and block blood vessels of the lungs, causing pulmonary embolism [13–15].

The most serious complication of orthopedic surgery is deep vein thrombosis, which causes pulmonary thromboembolism [16–18].

It is very important to be able to predict the high probability of developing postoperative complications based on changes in biochemical parameters.

Purpose: to investigate the peculiarities of the development of postoperative complications after surgical treatment of degenerative diseases of the lumbar spine with transpedicular fixation of the vertebrae and their relationship with changes in preoperative laboratory parameters.

Material and methods

The research was conducted on the basis of the clinic of the State Establishment Professor M. I. Sytenko Institute of Pathology of the Spine

and Joints of the National Academy of Sciences of Ukraine (accreditation certificate (higher category) from 19.04.2021 to 18.04.2024 No. 015211 of the M3 series) in the department of laboratory diagnosis and immunology of the institute (certificate of compliance of the measurement system with the requirements of DSTU ISO 10012: 2005 from 14.03.2023 to 14.03.2026 No. 01-0017/2023).

The study is based on the results of a retrospective analysis of the biochemical examination data of 35 patients with degenerative diseases of the lumbar spine who underwent discectomy with transpedicular fixation of the vertebrae in the vertebrology clinic of the Institute in the period 2015–2023. The research plan was reviewed and approved at the meeting of the Bioethics Committee of the State Establishment Professor M. I. Sytenko Institute of Pathology of the Spine and Joints of the National Academy of Sciences of Ukraine (Protocol No. 215 of 19 April 2021).

The comparison was made in two groups of patients in which the following complications were observed in the postoperative period: Group I — inflammation of soft tissues around the instrumentation of the spine (10 patients); Group II — instability of transpedicular fixation (5 patients). The comparison group involved results of preoperative examination of 20 subjects in whom the postoperative period passed without the specified complications (Group III). The indicators of all three groups were also compared with the control group, which included 20 donors (practically healthy people).

In our study, we performed a pairwise comparison of the preoperative indicators of patients of Groups I and II with the data of the control group, as well as with the results of Group III individuals.

All patients had blood taken from the ulnar vein into a vacuum tube without anticoagulant for biochemical studies on an empty stomach 1–3 days before surgery and one day after surgery. To obtain serum after the formation of a clot, it was separated from the serum by centrifugation. The following were determined in blood serum: total protein; total bilirubin; glucose; urea; creatinine; total cholesterol (TC); low-density lipoprotein (LDL); uric acid; inorganic phosphorus; thymol test (TT); alanine aminotransferase (ALT) activity; aspartate aminotransferase (AST); alkaline phosphatase (AL); acid phosphatase (AP) according to the instructions for reagent kits. Calcium content was determined potentiometrically by the method using the AEK-01 electrolyte analyzer [19], the content of total chondroitin sulfates (CST) by reaction with rivanol (the Nemeth-Csoka

method as modified by L. I. Slutsky), total glycoproteins (according to the modified method of O. P. Shtenberg and Ya N. Dotsenko) [20]. The ratio of alkaline and acid phosphatase activity in blood serum (AL/AP) was calculated, showing the prevalence of anabolic (in case of increase) or catabolic processes (decrease) in bone tissue, and also indicating the activation of the initial stages of mineralization of new bone tissue. The degree of mineralization was determined (the ratio of calcium content in g/l to protein content), reflecting the activity of filling bone tissue with calcium at later stages of the mineralization process, in particular, newly formed bone. The ratio of the content of total calcium and inorganic phosphorus, characterizing the tendency to the development of osteoporosis, was also detected.

The obtained results were processed using MS Windows software, license package number 439108-251. The normality of the distribution was checked by the Kolmogorov-Smirnov method. Measurement results are given as root mean square \pm standard deviation ($M \pm m$). The Fisher-Student method was used for pairwise comparison of the results. The difference was considered statistically significant at $p < 0.05$ [21].

Results

Patients without postoperative complications even before operative treatment were found to have no significant differences with the data of the control group in terms of indicators of the general state of the body, namely: the content of glucose, protein, bilirubin, TC, urea, creatinine, total calcium and inorganic phosphorus in the blood serum, AL and AP activity, as well as TT results (Table). At the same time, they were shown to have a significant increase in ALT activity by 42.29 % and AST by 63.55 % in blood serum (Table). There was an increase of 38.37 % in the content of CST in the blood serum compared to that in the control group. A significant increase of 37.21 % in terms of the level of total glycoproteins in the blood serum of the control group was revealed (Table).

In patients with postoperative soft tissue inflammation around the instrumentation area, discrepancies were recorded for the following parameters: 9.67 % higher protein content in blood serum, 29.27 % lower LDL content and 32.01 % higher ALT activity and 83.49 % AST (Table). The level of AL/AP was significantly higher by 31.40 % than in the control group in the analyzed group of patients, probably due to a 45.96 % higher activity of AL. The level of uric acid in the blood serum of the group of patients with subsequent development of postoperative inflamma-

tory complications around the instrumentation area was significantly lower by 23.53 %. A significant increase of 60.47 % in the concentration of CST in blood serum was observed. The patients of the analyzed group had a 95.57 % increase in the level of total glycoproteins compared to the control group (Table). At the same time, the content of glucose, bilirubin, cholesterol, creatinine, urea, calcium, and inorganic phosphorus in the blood serum of the analyzed group of patients did not differ from the level of the corresponding indicators of the control group.

Most of the indicators of the general state of the body in the patients of the considered group did not have significant differences with those of Group III patients, in particular, the content of glucose, bilirubin, cholesterol, LDL, calcium, inorganic phosphorus, ALT and AST activity in the blood serum, as well as according to the results of thymol tests (Table). The protein content in Group I was 18.86 % significantly higher than that of patients without complications.

AL activity in blood serum of the Group I patients was 31.96 % higher, compared to Group III, accordingly, AL/AP was also 25.00 % higher. There was also a 18.98% lower level of mineralization, and a 14.75 % lower concentration of uric acid than in the family of Group III.

In parallel with the increased level of CST concentration in blood serum in Group I patients before surgery, a 15.97 % higher level was observed (Table). Total glycoproteins in the blood serum of the analyzed group were 42.37 % more than in this Group III (Table).

Patients with the development of transpedicular fixation instability showed a significant difference in serum glucose, protein, urea, creatinine, uric acid, thymol test results, and AST activity with such individuals of the control group. At the same time, in the analyzed group of patients, ALT activity was significantly higher by 28.55 %, LDL content by 25.43 %, and TC content was lower by 13.88 % than in the control group. A higher activity of AL and AP in blood serum was recorded by 38.47 and 48.84 %, respectively. At the same time, AL/AP in the analyzed group was significantly lower by 58.35 % than in the individuals of the control group (Table).

It should be added that the level of inorganic phosphorus was 31.51 % significantly lower than that of the control group and the value between the content of calcium and inorganic phosphorus was 38.95 % higher. The content of CST in the set of the II group was 83.72 %, and total glycoproteins — 48.83 % higher compared to those in the control group (table).

**Biochemical indicators of the general state of the body of patients
with postoperative complications after transpedicular fixation of vertebrae**

№	Indicator	Patients			
		control group (n=20)	without postoperative complications (n=20)	with subsequent inflammation of soft tissues (n=10)	with diagnosed structural instability (n=5)
1	2	3	4	5	6
1	Protein, g/l	78.10 ± 1,40	72.05 ± 1.65 -7.75 % ^{1,4)}	85.65 ± 1.21 +9.67 % ^{1,5)} +18.86 % ^{2,7)}	71.90 ± 1.73 -7.94 % ^{1,4)} -0.21 % ^{2,4)} -16.05 % ^{3,4)}
2	Glucose, mmol/l	5.10 ± 0.05	5.12 ± 0.24 +0.39 % ^{1,4)}	5.39 ± 0.21 +5.69 % ^{1,4)} +5.27 % ^{2,4)}	5.32 ± 0.33 +3.91 % ^{1,4)} +4.31 % ^{2,4)} -1.30 % ^{3,4)}
3	Urea, mmol/l	4.54 ± 0.21	4.69 ± 0.42 +3.320 % ^{1,4)}	4.72 ± 0.44 +3.96 % ^{1,4)} +0.69 % ^{2,4)}	4.68 ± 0.90 +3.08 % ^{1,4)} -0.21 % ^{2,4)} -0.85 % ^{3,4)}
4	Creatinine, µmol/l	86.80 ± 3.30	78.83 ± 4.65 -9.18 % ^{1,4)}	78.50 ± 6.85 -9.56 % ^{1,4)} -0.42 % ^{2,4)}	80.00 ± 5.14 -7.8 % ^{1,4)} +1.48 % ^{2,4)} +1.91 % ^{3,4)}
5	Uric acid, mmol/l	0.340 ± 0.010	0.305 ± 0.013 +11.48 % ^{1,5)}	0.260 ± 0.015 -23.53 % ^{1,5)} -14.75 % ^{2,5)}	0.320 ± 0.030 -5.88 % ^{1,4)} +4.92 % ^{2,4)} +23.08 % ^{3,5)}
6	Glycoproteins, mmol/l	0.43 ± 0.01	0.59 ± 0.04 +37.21 % ^{1,5)}	0.84 ± 0.05 +95.57 % ^{1,7)} +42.37 % ^{2,6)}	0.64 ± 0.04 +48.83 % ^{1,7)} +8.47 % ^{2,4)} -23.81 % ^{3,5)}
7	Bilirubin, µmol/l	12.60 ± 1.98	12.14 ± 2.16 -3.65 % ^{1,4)}	9.63 ± 1.18 -23.57 % ^{1,4)} -20.68 % ^{2,4)}	15.12 ± 2.69 +20.00 % ^{1,4)} +24.55 % ^{2,4)} +57.01 % ^{3,5)}
8	ALT activity, units/l	21.40 ± 1.40	30.45 ± 2.14 +42.29 % ^{1,5)}	28.25 ± 2.45 +32.01 % ^{1,5)} -7.22 % ^{2,4)}	27.51 ± 0.50 +28.55 % ^{1,5)} -10.51 % ^{2,4)} -2.62 % ^{3,4)}
9	AST activity, units/l	17.20 ± 1.20	28.13 ± 3.15 +63,55 % ^{1,5)}	31.56 ± 2.41 +83.49 % ^{1,5)} +12.19 % ^{2,4)}	22.67 ± 3.28 +31.80 % ^{1,5)} -19.41 % ^{2,4)} -28.17 % ^{3,5)}
10	Cholesterol, mmol/l	4.97 ± 0.20	4.18±0.34 % -15.90 % ^{1,4)}	4.17 ± 0.21 -16.10 % ^{1,4)} -0.24 % ^{2,4)}	4.28 ± 0.22 -13.88 % ^{1,5)} +2.39 % ^{2,4)} +2.64 % ^{3,4)}
11	Thymol test, U, S-H	3.08 ± 0.15	2.75 ± 0.15 -10.71 % ^{1,4)}	2.70 ± 0.26 -12.34 % ^{1,4)} -1.82 % ^{2,4)}	2.76 ± 0.25 -10.39 % ^{1,4)} +0.36% ^{2,4)} +2.22 % ^{3,4)}
12	Low-density lipoproteins, g/l	4.68 ± 0.19	5.76 ± 0.52 +23.08 % ^{1,5)}	6.05 ± 0.37 +29.27 % ^{1,5)} +5.03 % ^{2,4)}	5.87 ± 0.51 +25.43 % ^{1,5)} +1.91 % ^{2,4)} -2.98 % ^{3,4)}
13	Alkaline phosphatase activity, U/L	195.2 ± 1.9	215.2 ± 12.8 +10.25 % ^{1,4)}	284.9 ± 13.8 +45.96 % ^{1,5)} +31.96 % ^{2,5)}	121.0 ± 18.0 -38.47 % ^{1,5)} -43.77 % ^{2,5)} -57.84 % ^{3,5)}

Continuation of Table

1	2	3	4	5	6
14	Acid phosphatase activity, U/L	3.87 ± 0.09	4.06 ± 0.11 +4.95 % ^{1,4)}	4.30 ± 0.23 +11.11 % ^{1,4)} +5.91 % ^{2,4)}	5.76 ± 0.43 +48.84 % ^{1,7)} +41.87 % ^{2,7)} +33.95 % ^{3,7)}
15	Alkaline activity ratio and acid phosphatases	50.44 ± 1.41	53.01 ± 2.06 +5.10 % ^{1,4)}	66.26 ± 3.48 +31.40 % ^{1,5)} +25.00 % ^{2,5)}	21.01 ± 1.04 -58.35 % ^{1,5)} -60.40 % ^{2,7)} -68.29 % ^{3,7)}
16	Calcium, mmol/l	2.51 ± 0.04	2.46 ± 0.04 -1.99 % ^{1,4)}	2.38 ± 0.03 -5.18 % ^{1,4)} -3.52 % ^{2,4)}	2.39 ± 0.03 -4.78 % ^{1,4)} -2.85 % ^{2,4)} +0.42 % ^{3,4)}
17	Inorganic phosphorus, mmol/l	1.46 ± 0.12	1.52 ± 0.11 +4.11 % ^{1,4)}	1.57 ± 0.22 +7.53 % ^{1,4)} +3.29 % ^{2,4)}	1.00 ± 0.05 -31.51 % ^{1,5)} -34.21 % ^{2,6)} -36.31 % ^{3,6)}
18	Calcium and phosphorus content ratio	1.72 ± 0.15	1.62 ± 0.13 -5.80 % ^{1,4)}	1.52 ± 0.12 -11.63 % ^{1,4)} -6.17 % ^{2,4)}	2.39 ± 0.18 +38.95 % ^{1,5)} +47.53 % ^{2,5)} +57.24 % ^{3,7)}
19	Degree of mineralization	1.28 ± 0.06	1.37 ± 0.07 +7.03 % ^{1,4)}	1.11 ± 0.06 -13.28 % ^{1,4)} -18.98 % ^{2,6)}	1.33 ± 0.08 +3.9 % ^{1,4)} -2.92 % ^{2,4)} +19.82 % ^{3,5)}
20	Chondroitin sulfates, g/l	0.086 ± 0.004	0.119 ± 0.008 +38.37 % ^{1,5)}	0.138 ± 0.013 +60.47 % ^{1,7)} +15.97 % ^{2,5)}	0.158 ± 0.015 +83.72 % ^{1,7)} +32.77 % ^{2,5)} +14.49 % ^{3,4)}

Notes: ¹⁾ regarding the indicators of the control group; ²⁾ against indicators of patients without postoperative complications; ³⁾ to the indicators of patients with subsequent inflammation of soft tissues; ⁴⁾ $p > 0,05$; ⁵⁾ $p < 0,05$; ⁶⁾ $p < 0,01$; ⁷⁾ $p < 0,001$.

When comparing the indicators of patients of Group III, in the set of Group II, the activity of AL in blood serum was significantly lower by 43.77 % under the conditions of 41.87 % of the activity of AP, than that which remained without the development of complications. As a result, the value of AL/AP in blood serum of the population was reduced by 60.40 %. This was accompanied by a 34.21 % significantly lower level of inorganic phosphorus and a 47.53 % higher value of Ca/P in blood serum. 32.77 % higher CST content in blood serum.

When compared with indicators of patients with postoperative inflammation of soft tissues, in patients with the development of postoperative instability of transpedicular fixation, AST activity in blood serum was significantly lower by 28.17 % (Table). There was a 14.49 % higher level of CST in their blood serum, and a 23.08 % higher level of uric acid. In the patients of the considered group, a 57.84 % lower activity of AL in blood serum and a 33.95 % higher activity of AP were found (Table). Accordingly, a significantly lower value of AL/AP in blood

serum was observed by 68.29 %. Also, in Group II patients, a significantly lower concentration of inorganic phosphorus in blood serum was recorded by 36.31 % than in Group I patients. The degree of mineralization in Group II was recorded to be 19.82 % higher compared to that in the patients of Group I. A significantly higher value of Ca/P in blood serum of the analyzed group was observed by 57.24 %. The content of total glycoproteins in the blood serum of individuals of this group exceeded that of patients with the development of local inflammation around metal structures by 23.81 % (Table).

Discussion

All examined patients showed an absence of significant differences with the individuals of the control group according to the basic marker of protein metabolism — protein content, carbohydrate metabolism — glucose content in blood serum, as well as indicators of kidney function — urea and creatinine, which indicated a minor disturbance (failure) and these indicators were not informative for our study.

In all persons, regardless of the development of postoperative complications and their characteristics, signs of cytolysis of hepatocytes with increased activity of ALT and AST were observed, which was most likely caused by previous conservative treatment with the use of nonsteroidal anti-inflammatory, analgesic and other drugs. All patients also showed a moderate increase in the content of LDL, which is a sign of initial disturbances in lipid metabolism, in particular, from a sedentary lifestyle. Predictably, an increase in the level of total glycoproteins in the blood serum was observed, indicating an increase in the concentration of leukocyte fragments in the blood as a result of trauma and inflammation in the area of the surgical wound.

In Group III patients, in addition to general deviations, an increase in the content of uric acid in the blood serum was recorded. The study revealed an activation of the metabolism of connective tissue elements — a moderate increase in the content of CST in the blood serum. This corresponds to the normal course of the early stages of healing of bone and tendon elements of postoperative wounds. Metabolism of bone tissue was not significantly different from the individuals of the control group with no differences in the values of the relevant markers.

Group I patients were diagnosed with signs of activation of bone tissue remodeling with a predominance of its formation over lytic processes, as evidenced by an increase in AL/AP due to higher activity of AL [22, 23].

The protein content was significantly higher than that of patients without complications, which in these conditions can be explained mainly by an increase in the biosynthesis of acute phase proteins. Signs of a faster course of the early stages of bone tissue mineralization, which manifests itself with an increase in AL/AP, have been recorded. However, the final stages of bone mineralization were slowed, which was reflected in a lower degree of mineralization.

Before the intervention, Group II patients showed signs of imbalance in the metabolism of compounds of the lipid spectrum. This was reflected in a higher content of LDL in conditions of a low level of TC in the blood serum, compared to individuals of the control group. The most characteristic of patients with further development of instability of transpedicular fixation was a shift in the balance between the activity of osteoblasts and osteoclasts with a predominance of the activity of cells that destroy the mineral basis of the strength of bone tissue, as evidenced by a violation of the ratio between the activity of AL and AP in favor of the latter. A sign of the development

of osteoporotic processes, which was later reflected in the loosening and instability of the transpedicular fixation, can be considered to be significantly lower than in the control group, the level of P and, as a result, a higher value of the ratio between the content of Ca and P. This is a sign of the acceleration of the release of calcium from bone tissue and slowing down its recapture during the formation of new bone mineral loci [24]. The course of dystrophic processes in the connective tissue in patients with subsequent development of instability of transpedicular fixation can be indicated by a significantly higher level of CST in the blood serum than in the control group.

It was found that, compared to the indicators of people without complications of transpedicular fixation instability, the manifestations of osteoporosis were preceded by lower AL activity and higher AP in blood serum with a decrease as a resulting AL/AP. This was accompanied by a lower level of P, but a higher Ca/P in blood serum, which is also a sign of impaired bone mineralization. Taking into account the higher content of CST in blood serum, it can be assumed that the process of destruction of bone tissue occurred in the considered group of patients even before the surgical intervention, which subsequently led to the mobility of the screws [24].

In comparison with the data of Group I, in the analyzed group of patients there were signs of a decrease in the activity of the liver in the utilization of bilirubin, which is evidenced by the accumulation of the latter to a level that exceeded that of individuals from the comparison group. The lower activity of ALT in the blood serum of the subjects of the analyzed group indicates that the emphasis of changes in their indicators was shifted to markers of bone tissue remodeling. This is confirmed by the lower activity of AL and AL/AP with higher activity of AP than in patients with inflammatory complications of soft tissues, indicating a slowing down of the early stages of bone tissue calcification. Higher values of serum Ca content and the Ca/P ratio were also characteristic, in particular, due to the lower level of P. The greater activity of late stages of calcification of remodeled bone tissue was evidenced by the higher degree of mineralization than in the comparison group [20]. At the same time, the late stages of mineralization were less active.

Conclusions

A comparative analysis of the results of preoperative clinical and laboratory examination of patients with degenerative diseases of the spine with transpedicular fixation of vertebrae with uncompli-

cated and complicated postoperative period showed that the probable development of complications in the postoperative period and their features were associated with changes in the metabolism of patients, reflected in deviations of their preoperative laboratory indicators from those in persons with an uncomplicated course of the postoperative period after similar interventions.

All patients with degenerative diseases of the spine with transpedicular fixation of the vertebrae with an uncomplicated and complicated course of the postoperative period before the operation had biochemical signs of cytolysis of hepatocytes with an increase in the activity of alanine aminotransferase and aspartate aminotransferase with a simultaneous increase in the content of low-density lipoproteins, which is probably a companion of the body's natural reaction to conservative treatment that preceded surgery. Also, all patients showed an increase in the content of total glycoproteins in the blood serum, which may indicate an increase in the degree of inflammation and intoxication after surgery.

In patients with an uncomplicated postoperative period, in comparison with the control group, activation of the metabolism of connective tissue elements and an increase in the content of total chondroitin sulfates in blood serum were recorded. This corresponds to the normal course of the early stages of healing of bone and tendon elements of postoperative wounds. Metabolism of bone tissue was not significantly different from the control group due to the absence of differences in the values of the relevant markers. The content of total glycoproteins underwent minor changes and most often did not exceed the level of 0.55 mmol/l.

In patients with postoperative local inflammation of the soft tissues around the instrumentation area, an increase in serum total protein was observed. This is confirmed by a significant increase in the concentration of total glycoproteins above 0.80 mmol/l. This was accompanied by an acceleration of bone tissue remodeling with an increase in the activity of alkaline phosphatase (> 280 units/l) and an increase in the ratio between the activity of alkaline and acid phosphatases (> 65 units/l).

In the case of development of instability of transpedicular structures, the greatest changes in markers of bone tissue remodeling were recorded with a simultaneous decrease in the activity of alkaline phosphatase (< 130 units/l) and an increase in the activity of acid phosphatase (> 4.4 units/l). At the same time, the increase in the level of total glycoproteins was insignificant and amounted to more than 0.60 mmol/l.

Conflict of interest. The authors declare no conflict of interest.

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THE USE OF LABORATORY CRITERIA IN THE RISK ASSESSMENT OF POSTOPERATIVE COMPLICATIONS AFTER TRANSPEDICULAR FIXATION OF THE LUMBAR SPINE

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