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Haematological and Biochemical Parameters of Blood in Patients after BIOS of the Tibia using Bioinert and Biodegradable Implants based on Magnesium Alloy MA-10

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Nowadays, the search for new artificial materials to replace damaged tissues and organs is becoming increasingly important. Biodegradable materials occupy an honorable place among medical materials. Depending on the purpose, biodegradable implants should be gradually replaced by living tissue and function over a given period of time, as well as not have a negative impact on surrounding tissues and the body as a whole. Magnesium-based alloys are considered promising. Clinical studies of the dynamics of a number of key biochemical parameters that characterize the reactive response and regenerative processes in the body are of scientific and practical importance. The aim of the research was to study the laboratory - biochemical parameters of blood in patients after BIOS of the tibia using bioinert and biodegradable implants based on magnesium alloy MA-1036 patients with tibial fractures were operated in the traumatology department of MNCE “CH of Emergency and Urgent Medical Aid” in Zaporizhzhia. After closed repositioning, the tibial BIOS was performed using biodegradable alloy screws. Blood sampling for biochemical and cytological studies was performed before and in 2, 4 weeks, 2 and 4 months after surgery. Biodegradable magnesium alloy MA-10 (TU U 24.4-14307794-270: 2018) certified for use in medicine. The study of the total bilirubin dynamics in blood plasma showed that the maximum values of the indicator accompany the acute period of the pathological process. From the second week, slight fluctuations in á-amylase activity were detected, which is most likely due to the energetic support of the inflammatory process and the regeneration of damaged tissues. The use of magnesium alloy for the manufacture of screws showed stable enzyme activity for 4 weeks. In the group of patients who used magnesium alloy implants immediately after surgery, there was a significant (pdH0.05) increase in AST / ALT by 44%, compared with the initial value of the de Ritis coefficient, not by increasing the activity of AST, but by reducing activity ALT. The undulating dynamics of ESR, fibrinogen B and total bilirubin in the blood of patients of both groups reflects the stages of the reparative process. The bioinertness and expediency of using implants made of biodegradable magnesium alloy MA-10 in the dynamic BIOS for diaphyseal fractures of the tibia are substantiated.

Keywords: Biodegradation, Magnesium alloy, Inflammation, Blocking intramedullary osteosynthesis.

The use of artificial materials to replace damaged tissues and organs is becoming more and more relevant in modern conditions. The search and research of new biodegradable materials, their physico-chemical and toxicological characteristics, influence on osteogenesis, use in osteosynthesis continues. Depending on the purpose, biodegradable implants should be gradually replaced by living tissue and function within a given period of time, as well as not have a negative impact on the surrounding tissues and the body as a whole. Magnesium-based alloys are considered promising[1-6]. The need for complex laboratory examination of patients is due to the frequent presence of concomitant diseases: arterial hypertension, coronary heart disease, angina pectoris, obesity, diabetes and other[7].

Clinical studies of the dynamics of a number of key biochemical indicators characterizing the intensity of inflammatory reactions and the activation of regenerative processes in the body are of scientific and practical interest.

Aim of research was to study laboratory and biochemical parameters of blood in patients after BIOS of the tibia using bioinert and biodegradable implants based on magnesium alloy MA-10.

MATERIALS AND METHODS

In the orthopedic and trauma department with polytrauma beds of the Municipal Non-commercial Enterprise "City Hospital Of Emergency and Urgency Medical Aid" in Zaporizhzhia, an experimental study was performed in 36 patients with diaphyseal fractures of the tibia. According to the classification of AO / ASIF 42À - V. and 42À-Ñ2. There were 26 men and 10 women in the group. The average age of the patients was 48 years. Surgeries were performed within 2 to 14 days after the injury.

Cannulated intramedullary titanium rods were used as a fixator. After closed reposition, BIOS of the tibia was performed. D-5 mm titanium screws were used for distal locking. In the proximal part, in the oval (dynamic) hole, a D-5 mm screw was inserted, with complete threading made of titanium alloy.

In 21 patients, a screw D - 5 mm, H - 40 mm, made of titanium, was inserted into the static (round) hole.

In 15 patients, a screw D - 5 mm, H - 40 mm, made of magnesium alloy MA-10, was inserted into the static (round) hole. Numerous studies on animals have established that the products of bioresorption of the developed MA-10 alloy do not affect the organism of laboratory animals, no signs of intoxication and neurotoxic effects were found[16,4,18].

Biodegradable magnesium alloy MA-10 (TU U 24.4-14307794-270:2018) was certified for use in medicine. Certificate of conformity UA 101.MD.3.0521-21.00. Date of registration 03/11/2021. The certificate was issued by the Conformity Assessment Agency of the State Ukrainian Association "Politekhmed". Patent No. 123569 Ukraine.

Blood sampling for biochemical and cytological studies in both groups was carried out at the following intervals: before and after surgery, after 2 weeks, 4 weeks, 2 months and 4 months after surgery. Biochemical blood tests were carried out in the certified department of laboratory clinical diagnostics of MNCE "CH of Emergency and Urgent Medical Aid" in Zaporizhzhya using a biochemical analyzer FLEXOR E (Netherlands), photoelectric photometer Prestige. semi-automatic biochemical analyzer SOLAR PV1251 (Republic of Belarus). Biochemical indicators were determined using standard certified diagnostic kits and test systeMA: PrJSC "Reagent" (Ukraine), "Granum Laboratory" (Ukraine). Determination of the concentration of fibrinogen-monomer complexes in blood plasma (â-naphthol test) was carried out in accordance with the order of the Ministry of Health of Ukraine No. 417 dated November 15, 2002.

Statistical analysis of the obtained indicators was performed using the prograMA "STATISTICA for Windows 6.1" (StatSoft Inc., No. AXX R712D833214SAN5), "SPSS 16.0", "Microsoft Excel 2003". The Kolmogorov-Smirnov test was used to check the normality of the distribution in the groups. For each of the signs in the studied groups, the arithmetic mean value (M) and the error of the mean (m) were determined. To compare the mean values and identify the influence of certain factors under the conditions of normal distribution and in the case of equality of group variances in two independent samples, the Student's t-test was used. In all types of statistical analysis, the achieved level of significance (P) was calculated, the critical level of significance in this study was taken as equal to 0.05.

RESULTS AND DISCUSSION

In the course of the study, it was established that significant ($p \leq 0.05$) differences in enzyme activity indicators occur only before and immediately after surgery. Obviously, this can be explained by the stressogenic effect of the injury, and not the result of contact of the implant with body tissues (table 1). Starting from the second week, slight fluctuations in á-amylase activity were detected in both groups, which is most likely related to energy support of the inflammatory process and regeneration of damaged tissues.

The content of total protein in both groups significantly decreased only immediately after surgery, which is definitely related to blood loss. All subsequent periods of observation did not reveal deviations of this indicator from existing generally accepted norMA (table 1).

A study of the dynamics of total bilirubin content in blood plasma (table 1) showed that the maximum values of the indicator accompany the acute period of the pathological process.

Statistically significant ($p \leq 0.05$) differences between similar indicators of the two groups were found only in the initial values of total bilirubin in the blood plasma. A gradual decrease in the indicator occurred in both groups within two weeks after the operation (by 20% and 42%, respectively).

By the end of the 4th week after surgery, a repeated increase in total blood bilirubin was detected in both study groups (table 1). It can be assumed that this is due to an increase in the toxic load on the liver, taking into account the active destruction of damaged tissues during the reparative process. Statistical processing of the research results did not show significant ($p \leq 0.05$) differences between similar indicators of both groups (table 1).

When examining the level of glucose, it should be noted that there were no patients suffering from diabetes in the research. No significant fluctuations of the indicator were found in any of the groups. No statistically significant ($p \leq 0.05$) difference between similar indicators in the study groups was found (table 1).

The peak of creatinine in both groups usually falls on the acute period of the process. Statistical processing of the data of our study showed differences in the body's reaction to the nature of the material from which the implants are made (table 2). But during comparison of the increase in the concentration of creatinine in the blood plasma in the case of the use of biodegradable screws at all stages of observation, indicated in the table. 2 (respectively +21.8%, -6.3%, +6.4%, +15%, +4.3%) with similar indicators of the group where bioinert screws were used for BIOS (+50.3%, - 6.8%, -11.6%, -4.7%, -9.5%) revealed a significantly significant ($p \leq 0.05$) difference during the first two weeks of the postoperative period. The results of this study show a better reaction from the muscle mass to the biodegradable implant, which is expressed in a decrease in the intensity of inflammatory muscle destruction and an increase in energy production in the muscles.

The conducted studies revealed a slight decrease in the hematocrit index in both groups, which can be explained by blood loss either as a result of trauma or during surgery (table 2). During the first month after surgery, the indicator in both groups normalizes. At the same time, no reliably significant differences between the corresponding indicators in the groups were found (table 2).

Conducted laboratory tests of the patients' blood revealed a slight decrease in the indicator in both groups immediately after the surgery (table 2.). Subsequently, no deviations from the generally accepted reference values were found in both groups (table 2).

The leading role in the processes of implementation of inflammatory reactions is played by the liver, therefore the study of the activity of its aminotransferases is of scientific interest. The results of the study of the dynamics of aspartate aminotransferase (AST) activity are presented in table. 3.

A study of the dynamics of changes in enzyme activity in the first group of patients, who underwent BIOS with the use of biodegradable magnesium screws, showed that no significant

($p \leq 0.05$) differences between similar indicators of patients from the second group (a bioinert alloy was used for the manufacture of screws) were found in any of the stages of observation (table 3.).

Skeletal muscle injury causes muscle tissue hypoxia, and it is under these conditions that the malate-aspartate shunt promotes energy generation without significant oxygen consumption. When using bioinert screws for BIOS, AST activity gradually increased for 2 weeks (by 19% on average), and then a significant decrease in enzyme activity was observed, and after 2 months the

Table 1. Determination of biocorrosion products of implants' effect made of biodegradable and bioinert alloys on metabolic processes of the organism

Observation term	Total protein,g/l	Total bilirubin, mmol/l	α-amylase, g/(h*l)	Glucose, mmol/l
When using biodegradable magnesium screws				
Before surgery	73,95 ± 2,11	15,11 ± 1,33*	20,78 ± 1,74*	6,27 ± 0,27
After surgery	69,88 ± 1,91*	16,92 ± 0,65	17,87 ± 1,33*	6,08 ± 0,27*
In 2 weeks	73,08 ± 1,40	11,28 ± 0,54#	19,77 ± 1,00	5,18 ± 0,19#
In 4 weeks	72,85 ± 1,08	14,75 ± 0,89#	14,69 ± 1,39#	6,98 ± 0,32#
In 2 months	75,18 ± 1,02	12,37 ± 0,83	17,26 ± 1,00	5,17 ± 0,13#
In 4 months	74,77 ± 1,28	12,30 ±0,67	16,54± 0,81	5,63 ±0,18
When using bioinert screws				
Before surgery	70,90 ± 1,31	19,53 ± 1,22	15,69 ± 1,01	5,46 ± 0,27
After surgery	60,71 ± 1,03	18,51 ± 0,80	23,81 ± 1,20	4,91 ± 0,08
In 2 weeks	71,57 ± 0,90	11,33 ± 0,49	18,71 ± 0,73	4,94 ± 0,14
In 4 weeks	72,05 ± 0,80	14,78 ± 0,59	14,1 ± 0,68#	6,99 ± 0,30
In 2 months	73,52 ± 0,88	11,62 ± 0,62	16,24 ± 0,74	5,26 ± 0,12
In 4 months	74,67 ± 0,99	11,84 ± 0,50	15,52 ± 0,60	5,6 ± 0,16

Notes: * - the differences are significant compared to the group of patients who were operated on using screws made of bioinert material (ðd"0.05); # - differences are significant (ðd"0.05) compared to the previous observation period

Table 2. Determination of the effect of biocorrosion products of implants made of biodegradable and bioinert alloys on the energy supply system of exchange processes.

Observation term	Hematocrit, l/l	Hb, g/l	Creatinine, µmol/l
When using biodegradable magnesium screws			
Before surgery	0,42 ± 0,02	136 ± 3,33*	80,45 ± 3,80
After surgery	0,39 ± 0,01*	124,69 ± 4,53#	91,23 ± 4,39*
In 2 weeks	0,33 ± 0,01#	132,54 ± 2,63#	70,15 ± 2,04*#
In 4 weeks	0,46 ± 0,01*#	137,85 ± 5,09	79,69 ± 3,76#
In 2 months	0,46 ± 0,01	133,92 ± 4,33	86,12 ± 5,66
In 4 months	0,50 ± 0,01	139.1 ± 4,68	78,15 ± 2,74
When using bioinert screws			
Before surgery	0,43 ± 0,01	142,52 ± 3,53	87,86 ± 3,24
After surgery	0,31 ± 0,01#	133 ± 3,58#	132,05 ± 3,77#
In 2 weeks	0,32 ± 0,01	132,1 ± 1,88	81,90 ± 2,87#
In 4 weeks	0,46 ± 0,01#	135,81 ± 3,24	77,62 ± 2,58
In 2 months	0,46 ± 0,01	133,33 ± 2,83	83,76 ± 2,85
In 4 months	0,51 ± 0,01#	136,62 ± 3,15	79,48 ± 2,01

Notes: * - the differences are significant compared to the group of patients who were operated on using screws made of bioinert material (ðd"0.05); # - differences are significant (ðd"0.05) compared to the previous observation period indicator was already 30% lower than the initial value (table 3).

The use of screws made of MA-10 magnesium alloy showed stable enzyme activity for 4 weeks (Table 3). 2 months after the operation, a decrease in AST activity similar to the previous group was observed.

Probably, the increase in the activity of transaminases is connected either with the need to remove the products of glycolysis from organs that were in hypoxia, or with an increase in energy expenditure by the liver. In this context, an increase in the activity of transaminases does not indicate only cell lysis at all.

Table 3. Changes in the activity of liver transaminases and CRP synthesis when using biodegradable (magnesium) and bioinert screws for BIOS.

Observation term	AST, U/l	ALT, U/l	AST / ALT	CRP
When using biodegradable magnesium screws				
Before surgery	0,60± 0,04	0,40 ± 0,04	1,53 ± 0,08	- /+
After surgery	0,60 ± 0,05	0,34 ± 0,05	2,21 ± 0,29*#	++/+++
In 2 weeks	0,59 ± 0,03	0,55 ± 0,05*#	1,14 ± 0,08*#	- /+
In 4 weeks	0,6 ± 0,03	0,49 ± 0,03	1,25± 0,06	-
In 2 months	0,42 ± 0,04#	0,33 ± 0,04#	1,30 ± 0,05	- /+
In 4 months	0,78 ± 0,03#	0,71 ± 0,07#	1,15 ± 0,06	-
When using bioinert screws				
Before surgery	0,57 ± 0,05	0,5± 0,06	1,45 ± 0,26	- /+
After surgery	0,68 ± 0,04	0,45 ± 0,03	1,54 ± 0,07	++/+++
In 2 weeks	0,68 ± 0,04	0,44± 0,02	1,57± 0,09	+
In 4 weeks	0,66 ± 0,03	0,48 ± 0,02	1,39 ± 0,04	- /+
In 2 months	0,4± 0,02#	0,28 ± 0,02#	1,42 ± 0,05	- /+
In 4 months	0,83 ± 0,04#	0,68 ± 0,03#	1,24± 0,05#	- /+

Notes: * - the differences are significant compared to the group of patients who were operated on using screws made of bioinert material (ðd"0.05); # - differences are significant (ðd"0.05) compared to the previous observation period

Table 4. Determination of the effect of biocorrosion products of implants made of biodegradable and bioinert alloys on the hemostasis system after BIOS

Observation term	Fibrinogen, g/l	Fibrinogen (B)	ESR
When using biodegradable magnesium screws			
Before surgery	6,58 ± 0,84*	+/++	25,23 ± 2,99*
After surgery	7,24 ± 0,49*	++/+++	39,62 ± 4,45#
In 2 weeks	7,71 ± 0,61	- /+	26,15 ± 2,96#
In 4 weeks	7,23 ± 0,65	-	14,31 ± 1,83#
In 2 months	6,68 ± 0,84	+/++	19,62 ± 2,57
In 4 months	5,43 ± 0,39	- /+	8,69 ± 0,91#
When using bioinert screws			
Before surgery	4,33 ± 0,20	+/++	15,57 ± 2,78
After surgery	5,78 ± 0,31#	++/+++	30,81 ± 2,51#
In 2 weeks	7,97 ± 0,46#	+	27 ± 2,18
In 4 weeks	6,6 ± 0,4#	- /+	14,95 ± 1,27#
In 2 months	6,58± 0,58	+/++	21 ± 1,82#
In 4 months	5,17 ± 0,26#	- /+	9,81 ± 0,52#

Notes: * - the differences are significant compared to the group of patients who were operated on using screws made of bioinert material (ðd"0.05); # - differences are significant (ðd"0.05) compared to the previous observation period

The results of the study showed that during the first two weeks after the operation, the activity of ALT in both groups did not differ significantly ($p \leq 0.05$) from the initial activity of the enzyme and between similar indicators of both groups (table 3). Only on the 14th day, the activity of the enzyme in the first group turned out to be significantly higher (by 29%) than the similar indicator of the second group.

Later, a decrease in the activity of ALT was observed in both groups, and no significant difference in this indicator was found at the 2nd and 4th month of observation (table 3).

Determination of the dynamics of the De Ritis ratio in the group of patients with bioinert implants at all follow-up periods showed no significant deviation from the norm (table 3).

In the group of patients where magnesium alloy implants were used immediately after the operation, a significant ($p \leq 0.05$) increase in AST/ALT by 44% was observed, compared to the initial value of the De Ritis ratio, not due to an increase in AST activity, but due to a decrease of ALT activity (table 3). In the subsequent periods of observation, values of the indicator returned to normal.

Predictors of the development of the inflammatory-toxic stage, in addition to a sharp increase in the activity of aminotransferases, are also an increase in the content of C-reactive protein (CRP) in the blood[10,12].

The results of the study of this indicator (table 3) show that the peak falls on the acute postoperative period in both groups. However, among those operated with magnesium implants, the regression of CRP content in the blood plasma occurred more intensively, compared to the group where bioinert screws were used for BIOS.

The study of the dynamics of fibrinogen (table 4) showed that statistically significant differences in this indicator between the two groups were found only in the pre-operative period and immediately after BIOS. Thus, when using biodegradable magnesium screws, the indicator exceeded the similar value in the second group by 34.5%. Blood analysis of patients immediately after BIOS with the use of biodegradable implants showed an increase in the indicator by 10%, and with the use of bioinert - by 33.8%. Subsequently, the level of fibrinogen in patients from the 1st group remained stable for 2 months, and in the 2nd group, a significant ($p \leq 0.05$) increase in the indicator was noted until the end of the second week after surgery (by 37.9% compared to the previous value). One month after BIOS and until the end of the observation period, the level of fibrinogen gradually decreased in both groups. No significantly significant differences between the average value of the indicator in the groups were found (table 4).

Conducted laboratory studies of the qualitative determination of the content of fibrinogen B in the blood plasma showed the presence of two peaks of growth of the indicator - immediately after the operation and after 2 months. And although the trend is similar in both groups, the intensity of fibrinogen B formation prevailed in the group where BIOS was performed using bioinert implants (table 4). The second peak of growth of the indicator is probably associated with an increase in the motor activity of the operated and secondary traumatization of the tissues surrounding the implants. Although the inflammatory process of low intensity contributes to the acceleration of bone repositioning and regeneration of soft tissues.

The erythrocyte sedimentation rate (ESR) in blood plasma is directly proportional to the mass of erythrocytes, the difference in the density of erythrocytes and blood plasma, and is proportional to the viscosity of blood plasma. Aggregation and agglutination of erythrocytes, increasing the mass of sediment particles, accelerate sedimentation. The main factor affecting the formation of rouleaux of erythrocytes is the protein composition of blood plasma. All protein molecules reduce the zeta potential of erythrocytes (a negative charge that contributes to the mutual repulsion of erythrocytes and their maintenance in a suspended state), but asymmetric molecules — fibrinogen, immunoglobulins, and haptoglobin — have the greatest effect. The zeta potential of erythrocytes is also affected by other factors: blood plasma pH (acidosis reduces ESR, alkalosis increases it), ionic charge of blood plasma, lipids, blood viscosity, presence of anti-erythrocyte antibodies. Reference values of ESR: men 1-10 mm/h, women 2-15 mm/h[13, 14].

An increase in ESR is a reliable sign of the presence of inflammatory processes in the body. In the period of exacerbation during the progression of the inflammatory process, the ESR increases, in the period of recovery it decreases, but not as quickly as the decrease in the expressiveness of the leukocyte reaction. At the same time, accelerated ESR is not a specific indicator for a specific disease. However, often in the presence of pathology, its changes have diagnostic and prognostic significance and can be an indicator of the effectiveness of the therapy.

The results of the research (table 4) showed that the initial value of the indicator (before surgery) in the group where biodegradable implants were used exceeded the similar indicator of the other group by 38%. The rapid increase in the indicator in the postoperative period (by 57.1% in patients with biodegradable implants and by 97.5% in patients with bioinert implants) is associated with an active inflammatory process. During the next four weeks, there was a rapid regression of ESR in both groups. At the same time, ESR decreased by 63.9% in the first group, and by 51.5% in the second group (table 4). 2 months after BIOS, a slight increase in ESR was observed in both groups (table 4), which, together with an increase in the level of fibrinogen B, indicates a slight increase in the inflammatory process in the tissues. At the same time, no significant differences were found between similar indicators of both groups.

The speed of post-operative recovery of patients and the likelihood of developing complications depend on adequate microcirculation in damaged muscle and bone tissues. For this purpose, a number of biochemical indicators were investigated. Determination of á-amylase activity is necessary to exclude the possibility of a toxic effect of implant biocorrosion products on the work of the pancreas, since the vast majority of this blood enzyme is of pancreatic origin. According to the literature, an increase in the activity of á-amylase in blood serum more than twice can indicate damage to the pancreas[8]. Slight hyperamylasemia gives reason to suspect the pathology of the pancreas, but is sometimes observed in diseases of other organs[8, 9]. The largest changes in the value of the carbohydrate metabolism index were detected in both groups at the 4th week after the operation, which is probably related to the activation of the sympatho-adrenal system for energy support of the reparative process[8]. Creatinine is the final product of the breakdown of creatine, which plays an important role in the energy metabolism of muscle and other tissues. The concentration of creatinine in the blood depends on its formation and excretion. The formation of creatinine directly depends on the state of the muscle mass, and its excretion depends on glomerular filtration. According to literature data[8,9], normal levels of creatinine in the blood plasma of adults are: for women: 44-97 ìmol/l, for men: 62-115 ìmol/l.

Since muscle mass is quite stable for a certain person, the level of creatinine in the blood is also a fairly stable indicator. It increases with dehydration of the body, injury (damage) of muscles, damage to the kidneys, etc. In particular, the level of creatinine concentration in the blood plasma, in addition to the muscle mass of the individual, is influenced by gender, age, race, the nature of the diet (a large amount of protein in food increases the level of creatinine), and the presence of inflammatory reactions in the body. Hematocrit is the volume fraction of erythrocytes in whole blood, which depends on the number and volume of erythrocytes. The indicator is expressed as a percentage of the total volume of blood (then it is indicated in %) or in liters per liter (l/l) - then it is indicated as a decimal fraction (accurate to hundredths), which corresponds to the proportion of formed elements in 1 liter of blood . Normally, hematocrit in men is 0.41-0.53, and in women - 0.36-0.46. Our studies have not found any deviations of this indicator. Hemoglobin is a respiratory blood pigment that participates in the transport of oxygen and carbon dioxide, and additionally perforMA buffer functions (maintaining pH). Anemia can be a consequence of increased hemoglobin losses during various types of bleeding or hemolysis of erythrocytes. The cause of anemia can be a lack of iron, necessary for the synthesis of hemoglobin, or vitamins involved in the formation of erythrocytes (mainly B12, folic acid), as well as a violation of the formation of blood cells in specific hematological diseases. Anemia can occur secondary to various chronic somatic diseases. According to the literature, hemoglobin norMA (g/l): in women - 120-150; in men - 130-160[8, 9].

We did not detect any significant changes in the level of hemoglobin when using the new material, which indicates that it does not have hematotoxicity. We also established the absence of reliable changes in the activity of ALT and AST and the De Ritis ratio. The ratio of AST/ALT is called the De Ritis ratio. Normally, it is 1.33±0.42, in liver diseases it is lower than this value, and in heart diseases it is higher [10, 11]. The obtained results indicate the absence of hepatotoxicity of the new material for implantation[8].

The new material for implantation does not have a negative effect on the blood coagulation system and hemostasis, which is evidenced by the indicators of fibinogen and fibrinogen B in the studied groups of patients. It is known that magnesium in the body participates in metabolic processes, closely interacting with potassium, sodium and calcium, is an activator of many enzymatic reactions, participates in the synthesis of fatty acids, activation of amino acids, protein synthesis, phosphorylation of glucose and its derivatives by the glycolytic pathway, oxidative decarboxylation citrate[20]. Magnesium compounds are non-toxic, improve energy metabolism by affecting mitochondria[4,5,16,17].

CONLCUSION

1. Laboratory studies conducted using the blood of patients with tibial fractures as biomaterial and subsequent BIOS showed the absence of reliably significant deviations from the reference values of a number of general clinical indicators: á-amylase, total protein, glucose, hemoglobin, and hematocrit. Minor fluctuations are due to blood loss and the need for metabolic support of the reparative process.
2. According to the level of creatinine, a better reaction of the muscle tissue to the biodegradable implant was found, which indicates a decrease in the intensity of inflammatory muscle destruction and an increase in energy production during the reparative process.
3. The wave-like dynamics of total bilirubin in the blood of patients of both groups reflects the stages of the reparative process.
4. Determination of the activity of aspartate aminotransferase in the blood plasma of patients who underwent BIOS with the use of bioinert screws showed a slight increase in the activity of the enzyme during two weeks (on average by 19%), which is probably associated with inflammation of the injured muscle; the use of biodegradable screws was accompanied by stable enzyme activity for 4 weeks, which indicates a lower intensity of inflammation and the possibility of diverting glycolysis products from injured muscles that were in hypoxia.
5. Determination of the activity of alanine aminotransferase showed that during the first two weeks after the surgery, the activity in both groups did not differ significantly ($p \leq 0.05$) both from the initial activity of the enzyme and between similar indicators of both groups. Only on the 14th day, the activity of ALT in the first group was significantly higher (by 29%) than the similar indicator of the second group.
6. The wave-like dynamics of ESR, the content of fibrinogen B and total bilirubin in the blood of patients of both groups reflects the stages of the reparative process. The first peak falls on the acute postoperative period, and the second - 2 months after it. And although the trend is similar in both groups, the intensity of these pro-inflammatory markers prevailed in the group where BIOS was performed using bioinert implants. The second peak of the increase in the indicator is probably associated with an increase in the motor activity of the operated and secondary traumatization of the tissues surrounding the implant and an increase in the load on the liver.
7. The study of the dynamics of fibrinogen showed that statistically significant differences in this indicator between the two groups were found only in the preoperative period and immediately after BIOS.
8. The obtained laboratory and biochemical results confirmed the absence of undesirable reactions of bioinert implants on the body of patients and justify their wide use in clinical practice

Conflict of Interest

There is no conflict of interest.

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