

METHODS

Effect of the Nature of Damage on Regional Changes in Some Parameters of the Endocrine System

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Forty-five patients with open and closed diaphyseal fractures of the shin are observed during a 10-day period after trauma. Serum contents of thyroxine, triiodothyronine, thyroxine-binding globulin, and cortisol are determined in radioimmune assay. Blood is taken from *v. femoralis* of intact and fractured legs. Statistical mathematical models of changes in each parameter are obtained. A similarity between the groups is revealed, which is probably due to the identical direction of local processes leading to fracture consolidation. The regional changes in the studied parameters depend on the nature of damage.

Key Words: thyroid hormones; thyroxine-binding globulin; cortisol; diaphyseal fractures; adaptation

Previously, we showed that the response of bone tissue to trauma depends on the distance from the site of fracture [1-3]. It is also known that the specific features of adaptational transformation of the organism are determined by the nature of the external stimulus [5,7]. However, the effect of the type of injury on regional changes in endocrine regulation has not been studied. Our objective was to assess the effect of the nature of the fracture (open or closed) on the level of thyroid hormones, their transport protein, and cortisol in the blood taken from the femoral veins of the fractured and intact legs.

MATERIALS AND METHODS

Forty-five patients aged 16-58 years were observed. Twenty-five patients had uncomplicated closed dia-

physeal fractures of both shin bones and received conservative treatment and 20 patients had open fractures of the same localization. In the latter group primary wound toilet was performed and the extension apparatus was applied not later than 6 h after trauma. The patients received infusion and antibacterial therapy. There were no complications during the postoperative period.

The patients were examined from day 1 to day 10 on a sliding schedule, i.e., 1-4 observations were performed every day. Blood was collected from *v. femoralis* of the intact and fractured legs after an overnight fast, at 09:00 h following a 30-min rest in the horizontal position. The method of venipuncture was based on the technique for puncture of a peripheral artery [8]. The blood was centrifuged, and the serum was divided into aliquots and frozen at -25°C. The contents of total thyroxine (T_4), total triiodothyronine (T_3), thyroxine-binding globulin (TBG), and cortisol were determined in serum duplicates in a radioimmunoassay using standard commercial kits manufac-

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TABLE 1. Statistical Modeling of the Dynamics of Serum Levels of T_3 , T_4 , TBG, and Cortisol in Intact and Injured Legs in Patients with Closed or Open Fracture

| Parameter | Intact legs | | | | Fractured legs | | | |
|------------------------|-------------|----------|------------|------------|----------------|----------|------------|------------|
| | day 1 | σ | time, days | changes, % | day 1 | σ | time, days | changes, % |
| <i>Closed fracture</i> | | | | | | | | |
| T_3 , nmol/liter | 1.11 | 0.22 | 1-10 | -6 | 1.03 | 0.16 | 1-10 | -2 |
| T_4 , nmol/liter | 105.94 | 21.71 | 1-10 | +13 | 101.22 | 16.74 | 1-10 | +17 |
| TBG, μ g/ml | 16.58 | 2.16 | 1-10 | +2 | 16.01 | 1.90 | 1-10 | +5 |
| Cortisol | 763.22 | 253.49 | 1-6 | +10 | 685.48 | 220.06 | 1-5 | +11 |
| | | | 7-10 | -9 | | | 6-10 | -10 |
| <i>Open fracture</i> | | | | | | | | |
| T_3 , nmol/liter | 1.28 | 0.12 | 1-10 | -20 | 1.28 | 0.16 | 1-10 | -24 |
| T_4 , nmol/liter | 111.18 | 37.75 | 1-5 | -7 | 70.21 | 20.03 | 1-10 | +74 |
| | | | 6-10 | +6 | | | | |
| TBG, μ g/ml | 14.68 | 5.93 | 1-10 | +43 | 16.64 | 4.31 | 1-10 | +13 |
| Cortisol | 617.99 | 157.67 | 1-10 | +53 | 592.78 | 156.23 | 1-10 | +34 |

Note. σ is the half-width of the confidence corridor (at $p < 0.05$) expressed for each compound in its units of measurement; increase (+) and decrease (-) of the levels.

tured at the Institute of Bioorganic Chemistry (Belarus Academy of Sciences).

All the obtained time sequences were smoothed by the method of least squares using third-degree splines [4] to obtain statistical mathematical models of changes in the concentration of each compound in the intact and fractured legs. The parameters of the models were $P=0.005$ (T_4), $P=0.001$ (T_3), $P=0.0005$ (TBG), and $P=0.005$ (cortisol). The dynamics of changes in the levels of the studied compounds were compared using the Sobolev metric [6], which reflects not only the difference in the contents but also the rate and acceleration of their changes on each day of observation.

RESULTS

Table 1 gives the characteristics of statistical models of the studied parameters. It can be seen that in the intact and fractured legs the deviations of these parameters are the same with the exception of T_4 in open fracture. Comparing the dynamics of the level of each compound in the femoral vein of patients with closed fractures, we discovered changes over the entire period of observation. In open fracture, changes in T_3 and TBG were detected over the entire period of observation, in in T_4 from day 1 to day 4, and in cortisol after 3 days.

In the comparable leg of compared patients, the changes in the levels of TBG and thyroid hormones (except T_4 in the intact leg) were of the same direction. In patients with open fractures, the cortisol content in both the intact and damaged leg increased up to day 10, while in patients with closed fractures it increased up to day 5-6 and then decreased. It is noteworthy that in patients with open fractures the

changes in all the parameters (except T_4 in intact legs) were more pronounced. The differences in the dynamics of T_3 and TBG in intact legs were observed over the entire observation period, while the cortisol and T_4 levels changed only during the first 8 and 7 days, respectively. In the injured leg, these changes were documented over the entire observation period for thyroid hormones and TBG and from day 3 to day 6 for cortisol.

Our results indicate that after trauma the regional changes in the studied parameters of the endocrine system are determined by the nature of the damage. Presumably the similarities between the groups are due to the same direction of local processes leading to consolidation of fractures. In our opinion, the differences observed in this study point to variations in the manifestation of the time-space organization of the biological system, making for the same result in terms of the adaptative reaction.

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