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**CHANGES IN BONE MINERAL DENSITY AND INDEX OF
MINERALIZATION DURING COMBINED INJURIES OF MANDIBULE
AND FEMUR ON THE BACKGROUND OF HYPOKINETIC
OSTEOPOROSIS**

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Summary: One of the factors of polytrauma pathogenesis is the reduction of bone mineral density that is observed within 30 days of posttraumatic period and values of bone mineralization index. The indicated deviations on the background of hypokinetic osteoporosis are an oscillatory in nature with a moderate violation on the 10-th day, significant improvement on the 20-th day and pronounced deterioration on the 30-th day that indicates negative impact of osteoporosis on the course of polytrauma, which promotes the development of disorders in late posttraumatic period.

Key words: hypokinetic osteoporosis, polytrauma, bone mineral density, post-traumatic period.

INTRODUCTION

A characteristic feature of modern urban society is the low mobility and high physical injuries [1, 2]. Inactive way of life promotes dysfunctional (hypokinetic) osteoporosis and creates a favorable background for the emergence of skeletal bones lesions even under the influence of low-traumatic factors. In healthy young adults aged 18-25 years, mainly in the period when forming of the bone mass is finished, the bone mineral density violation is determined [3]. In the available literature an insufficient attention is paid to hypokinetic osteoporosis and its role in the pathogenesis of trauma and bone remodeling that leads to increased study of pathogenic mechanism of formation of these pathological processes and searching of a reasonable ways of correction that is based on pathogenesis. Thus, the aim of research was to determine characteristics of bone mineral density and index of mineralization in the dynamics of polytrauma in animals with hypokinetic osteoporosis.

MATERIALS AND METHODS

Experiments were done on 42 nonlinear white male rats with weight 180-200 g in groups of 6 animals. In the first series of experiments hypokinetic osteoporosis was caused after Z. Kundurovich (1989) by imposing on the animal's body gypsum cuff [4]. After 2 months the cuff was removed and polytrauma was modeled in animals using specially developed method by injuring two bone segments: femur and lower jaw. In the second series of experiments a similarly injury was done to animals without osteoporosis. The control group is consisted of intact animals. Injuries to animals were carried out under thiopental sodium anesthesia ($40 \text{ mg} \cdot \text{kg}^{-1}$). The study was held on 10-th, 20-th and 30-th day after injury. Under anesthesia the animals were sacrificed by total bleeding from the heart; in the blood serum and in the homogenate of intact half of the mandible the

content of calcium was determined [5]. Bone mineral density (BMD) was calculated on the basis of weight of the free from soft tissues intact femur and its volume was determined by the amount of displaced water from it [1]. Index of mineralization was established by the ratio of activity of acid and alkaline phosphatases for semi-automatic biochemical analyzer “Humalazer 2000” using sets of reagents firms “Human” (Germany). Statistical analysis was performed using digital data variation statistics using Student criterion.

RESULTS AND DISCUSSION.

As the table shows, during trauma in animals without osteoporosis on 10-30 days was observed significantly lower BMD - an average of 7,29 % ($p < 0,05$) than in control. Animals that previously were modeled with hypokinetic osteoporosis BMD on 10-th day of experiment was reduced more – by 13,6 % ($p < 0,001$). At this observation period differences in BMD in respect to group without osteoporosis were statistically significant. On 20-th day in animals with osteoporosis a significant increase in the studied parameters compared to the previous period was noted ($p_1 > 0,05$), but on 30-th day this indicator decreased, reaching the level of the tenth day and was statistically significantly lower than in animals without osteoporosis ($p < 0,01$).

Table

Features of bone mineral density in the course of polytrauma and hypokinetic osteoporosis ($M \pm m$)

| Seria | Control | The terms of research, day | | |
|---|-------------------|----------------------------|--|---|
| | | 10 | 20 | 30 |
| Mineral bone density, $g \cdot cm^{-3}$ | | | | |
| Without osteoporosis | $1,600 \pm 0,032$ | $1,382 \pm 0,021^{***}$ | $1,465 \pm 0,012^{**}$ $p_1 < 0,05$ | $1,402 \pm 0,028^{***}$ $p_1 > 0,05$ $p_2 < 0,10$ |
| Osteoporosis | | $1,460 \pm 0,036^*$ | $1,487 \pm 0,027^*$ $p_1 > 0,05$ | $1,503 \pm 0,013^*$ $p_1 > 0,05$ $p_2 > 0,05$ |
| p | | $< 0,10$ | $> 0,05$ | $< 0,01$ |
| Index of mineralization, conventional units | | | | |

| | | | | |
|----------------------|-----------|---------------------------|--|---|
| Without osteoporosis | 161,9±8,2 | 60,35±6,60 ^{***} | 47,74±4,00 ^{***} p ₁₀ >0,05 | 76,96±6,47 ^{***} p ₁₀ <0,10 p ₂₀ <0,01 |
| Osteoporosis | | 13,70±1,33 ^{***} | 19,76±2,65 ^{***} p ₁₀ <0,01 | 11,23±0,58 ^{***} p ₁₀ >0,05 p ₂₀ <0,01 |
| p | | <0,001 | <0,001 | <0,001 |

Notes:

- * – significance of differences regarding the control group (* – p<0,05; ** – p<0,01; *** – p<0,001).
- p – significance of differences between series 1 i 2.
- p₁ – significance of differences regarding indices on the 10-th day of observation.
- p₂ – significance of indices' differences regarding indices on the 20-th day of observation.

Index of mineralization on the background of polytrauma is decreased in relation to the control group. Animals with osteoporosis on 10-th day of experiment had lower values than the control group – up to 62,7 %, on 20-th day - 70,5 %; on 30-th day of experiment an index was increased and became statistically significantly greater than on 20-th day (61,2 %, p₂<0,05), but remained on 52,5 % lower than control (p<0,001). Animals with hypokinetic osteoporosis had such index of mineralization that was significantly lower than the control and ranged from 11,23 to 19,76 conventional units (p<0,001). Noteworthy is increasing in value of the index on the 20-th day (44,2 % in relation to the tenth day, p₁<0,01) and significantly reduced on the 30-th day (by 43,2 % with respect to the previous observation period, p₂<0,05). Comparing the value of this index between experimental groups it was found that in animals with hypokinetic osteoporosis it was statistically significantly lower in all periods of observation after polytrauma (p<0,001).

Thus, in all periods of observation, there is a decline in BMD, which is most pronounced on the 10-th day of post-traumatic period. We can assume that during

the acute response to injury a violation of basic mineral content of bone tissue is observed with significant leaching of calcium, leading to a substantial decrease in the index of mineralization of bone that is manifested at least 30 days of post-traumatic period. Thus, in the pathogenesis of traumatic disease a certain place has development of secondary osteoporosis with reduced calcium content in bone tissue and the occurrence of severe hypercalcaemia.

On the background of hypokinetic osteoporosis a violation of the studied parameters has oscillatory character with a decrease by the 10-th day, increasing by the 20-th day and more expressed violation by the 30-th day. Herewith reaction of animals with osteoporosis by the 10-th day is less pronounced than in animals with osteoporosis. Thus, osteoporosis significantly modifies the response of animals to injury with marked increase in bone mineralization by the 20-th day, which occurs, in our opinion, due to the implementation of a continuum of responses aimed at normalization of BMD, which was limited due to physical inactivity of animals by imposing of gypsum cuff. In addition, at this time, according to some authors, there is a significant improvement of polytrauma course [4]. On the 30-th day there is a deterioration of BMD, indicating a certain role of osteoporosis in the formation of polytrauma phase course with deterioration of condition of the injured body in the later periods of post-traumatic period.

CONCLUSIONS:

1. One of the factors of the pathogenesis of polytrauma is a reduction of bone mineral density, resulting in increasing of its content in the blood serum, its reduction in the homogenate of bone tissue and bone dry residue that is observed for 30 days of post-traumatic period.

2. Violation of bone mineral density on the background of hypokinetic osteoporosis is oscillatory in nature with moderate violation by 10-th day, a significant improvement on 20-th day and expressed deterioration by 30-th day, indicating a negative effect of osteoporosis on the course of polytrauma, contributing to the development of disorders in late posttraumatic period.

3. Polytrauma that is caused by simultaneous fracture of the femur and mandible is accompanied by increased activity of acid phosphatase in the homogenate of bone on the background of simultaneous decrease in the activity of alkaline phosphatase, calcium content and bone mineralization index values. After 30 days an improvement of the studied parameters is observed.

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