Chronic Stress Impairs Structural Organization of Organic Matrix in Bone Tissue of Rat Periodontium

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Translated from *Byulleten' Eksperimental'noi Biologii i Meditsiny*, Vol. 135, No. 6, pp. 637-638, June, 2003
Original article submitted November 27, 2002

Chronic stress promoted disintegration of collagen and non-collagen proteins in the periodontal bone tissue, which depended on typological characteristics of animals. Stress-predisposed animals were characterized by most pronounced disturbances.

Key Words: *chronic stress; bone tissue; collagen; proteoglycans; chondroitin sulfates*

Bone tissue has a complex multilevel organization that determines its biomechanical properties. Collagen is the main component of the bone matrix (90%). Hydroxyapatite crystals are oriented along the longitudinal axis of collagen fibers. Organization of collagen fibers and the density of bone tissue depend on the interaction between proteoglycans and other extracellular macromolecules [4]. Proteoglycans, glycoproteins, and glycosaminoglycans bind collagen fibers with each together and form macromolecular aggregates. Polyanionic proteoglycans maintain the constant concentration of water in bone tissue and provide transport of metabolites and minerals [4].

Published data show that acute stress impairs osteogenesis, stimulates bone tissue resorption and, therefore, disturbs the imbalance between synthesis and disintegration of biopolymers [5].

Our previous studies showed that intensive resorption of periodontal bone tissue during chronic stress is associated with increased collagenolytic activity and stimulation of glycoprotein catabolism [5].

Here we studied changes in components of the mandibular organic matrix during chronic stress. We evaluated whether the changes in the organic matrix of bone tissue depend on the type of organism's reactivity.

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MATERIALS AND METHODS

Experiments were performed on 24 male Wistar rats weighing 150-200 g. Chronic stress (anxiety neurosis) was produced for 12 days [3]. Intact animals served as the control. The rats were divided into groups depending on their open-field behavior (method proposed by Hall) and results of factor analysis. Then the animals were divided into stress-resistant and stress-predisposed subgroups. Intact animals with the corresponding types of reactivity served as the control. The rats were euthanized by exsanguination under hexenal anesthesia (50 mg/kg). The contents of hydroxyproline, chondroitin sulfates, hexosamines, and tyrosine in the mandibles were measured. The results were analyzed by Student's *t* test.

RESULTS

Chronic stress 1.7-fold increased the content of hydroxyproline (collagen marker characterizing bone tissue resorption) in the mandibular organic matrix of stress-predisposed rats, which reflected intensification of collagen metabolism. In stress-resistant animals this parameter did not differ from the control (Table 1).

Under conditions of chronic stress the content of chondroitin sulfates (main type of glycosaminoglycans in bone tissue proteoglycans) increased by 25% only in periodontal bone tissue of stress-predisposed rats. We revealed no significant changes in the content of

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TABLE 1. Characteristics of Organic Matrix in Periodontal Bone Tissue in Rats during Chronic Stress (g/100 g dry tissue, *M*±*m*)

Parameter	Stress-predisposed animals		Stress-resistant animals	
	control (*n*=5)	stress (*n*=6)	control (*n*=6)	stress (*n*=6)
Hydroxyproline	2.97±0.21	5.02±0.31*	3.07±0.08	3.67±0.15
Hexosamines	0.233±0.053	0.180±0.082	0.246±0.063	0.190±0.054
Tyrosine	0.294±0.061	0.346±0.080	0.315±0.081	0.310±0.100
Chondroitin sulfates	0.109±0.008	0.137±0.007*	0.107±0.009	0.116±0.007

Note. *$p<0.05$ compared to the control.

chondroitin sulfates in the mandible of stress-resistant animals (Table 1).

Tyrosine concentration in bone tissue reflects the total content of non-collagen proteins. The contents of tyrosine and hexosamines in the bone tissue did not differ in rats of various groups (Table 1).

Previous studies showed that bone mineralization is accompanied by a decrease in the content of non-collagen proteins. Changes in the content of collagen and chondroitin sulfates in the bone tissue during chronic stress reflect deceleration of its maturation.

Changes in the bone tissue produced by stress are realized via different mechanisms. It should be emphasized that despite adaptation to chronic stress, the adrenal cortex remains most reactive, which determines increased level of corticosteroids [1]. Corticosteroids suppress synthesis of proteoglycans and collagen and modulate the state of connective tissue matrix.

The resistance to chronic stress is associated with changes in the metabolism of neurotransmitters in brain structures [2]. The data suggest that differences in the neurotransmitter balance and neurohumoral regulation of metabolic processes in the connective tissue determine typological characteristics of changes in the periodontal bone tissue during chronic stress.

Our results indicate that chronic stress suppresses maturation of bone tissue and promotes disintegration of collagen and proteoglycans in stress-predisposed animals.

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