

## **Densitometric evaluation of bone regenerate in the experimental process of distractive osteogenesis by means of the Ilizarov method**

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The paper deals with the densitometric, histological and X-ray microanalyses undertaken in order to examine the mineralization process of bone regenerate during the distractive bone osteogenesis. Testing was carried out on 20 sheep on Merynos breed whose tibiae were elongated by means of distractive osteogenesis according to the Ilizarov method. Various methods of bone cross-cutting, i.e., open and closed corticotomy, were employed.

*Keywords: bone regenerate, digitized X-ray densitometry, the Ilizarov method, distractive osteogenesis*

### **1. Introduction**

One of the major problems related to distractive bone osteogenesis lies in possibly objective assessment of the regenerated bone quality as regards both its histological quality and its mechanical resistance [1, 3, 6]. Densitometric testing of bone density by means of various picture recording techniques, i.e. X-ray photography, DEXA, USG, CT, is becoming a more and more frequently used method of estimating physiologic as well as pathologic states of bone tissue [5, 7, 8].

### **2. Material and method**

The aim of this paper was to evaluate biological quality of a new bone regenerate during distractive osteogenesis. The goal has been achieved by means of densitometric testing of bone tissue optical density in relation to histological research results as well as electron microscopy. Testing was carried out on 20 sheep of Merynos breed whose tibiae were elongated by means of distractive osteogenesis according to the Ilizarov method. Various methods of bone cross-cutting, i.e. open and closed corticotomy [2, 4, 9], were employed. The rate of elongation amounted to 1 mm per day.

The assessment of the new regenerated bone taking place in 3, 7, 9, 12 and 14 weeks after corticotomy was carried out on the basis of:

- X-ray testing and computer processing of digitized X-ray densitometry,
- histological examination,
- X-ray microanalysis examining the mineralization process.

Using X-ray visualisation process three zones ( Z1, Z2, Z3) of the new bone regenerate during distractive osteogenesis were established. In these zones the changes of optical bone density were measured.

### 3. Results

Up to the 10th week of the mineralization process the lowest bone tissue density was found in the middle part of the new bone regenerate. The new bone tissue forming itself in the range of distraction assumed the shape of several cones with their bases facing the bones after corticotomy and their tops pointing to the middle part of the regenerated bone (Figs. 1, 2). During that time a decrease in the density of both bone parts near the place of corticotomy in the vicinity of the distractive slot was recorded. From the morphological point of view we noticed that up to the 5th week the initial stage of the new bone regenerate organisation took place. Between the 5th and the 10th weeks a bone with thick fibres was formed and only from the 14th week the thick-fibred bone tissue began its remodelling into mechanically valuable laminar bone.

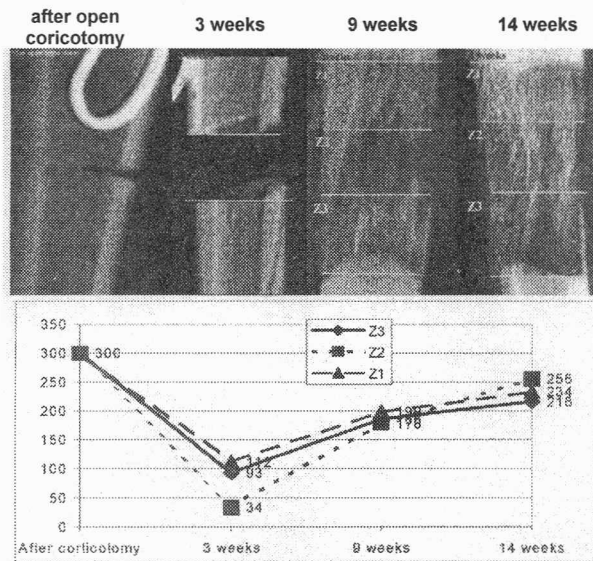


Fig.1. Open corticotomy by the Ilizarov method. Formation of the bone regenerate from the moment of corticotomy to the 16<sup>th</sup> week after operation.

A – X-ray visualisation, B – changes of the bone density in the zones 1, 2, 3

As far as the densitometric evaluation is concerned, homogeneous distribution of the regenerated bone density was found from the 14th to 16th weeks after the corticot-

omy. These observations substantiate the X-ray microanalysis results which revealed that up to the 14th week calcium and phosphorus saturations were similar (Fig. 3), which resulted

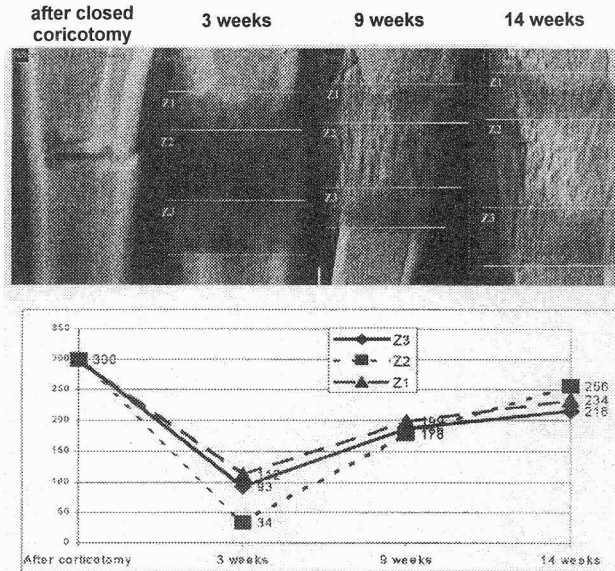


Fig. 2. Closed corticotomy. Formation of the bone regenerate from the moment of corticotomy to the 16th week after operation.

A – X-ray visualisation, B – changes of the bone density in the zones 1, 2, 3

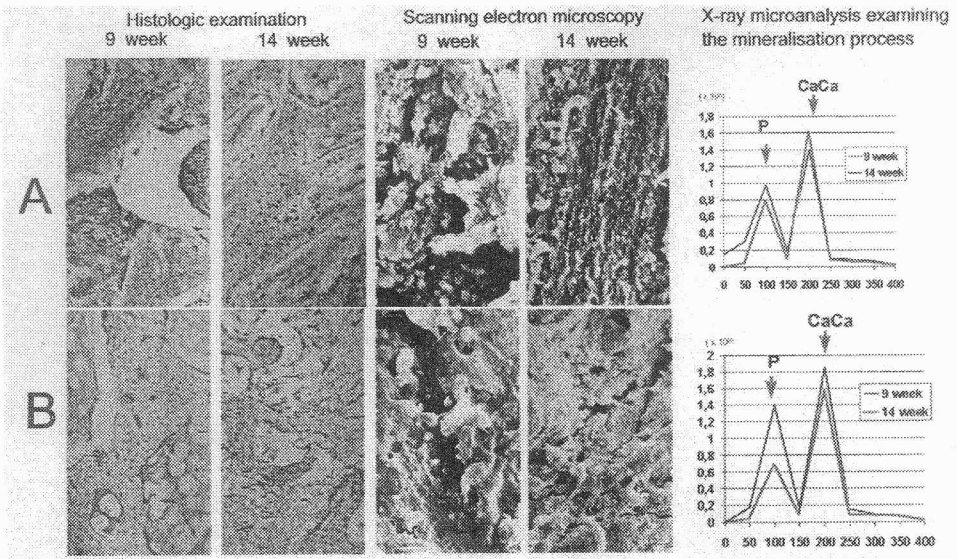


Fig. 3. The assessment of the bone regenerate in the 9<sup>th</sup> and 14<sup>th</sup> weeks after open corticotomy (A) and closed corticotomy (B) – histologic, scanning electron microscopy and X-ray microanalyses examining the mineralisation process

in a low mechanical resistance of the regenerated bone to forces occurring in a bone during normal bone loading.

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The research has been supported by the State Committee for Scientific Research (KBN) within the framework of grant No. 7T07C00116.