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Osteodensimetric indicators of dogs' mandible during deciduous teeth change period

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Abstract. The data of bone mineralization range in dogs during the deciduous teeth change are presented in the article. Densitometry is a progressive and minimally invasive methods using in modern dentistry to determine bone mineral density. Five mongrel dogs at the age of 3 months were x-ray tested during the period of occlusion shifts per every 10 days for 3 months. It is found that a significant increase in bone density is registered in experimental animals during teething. It is established that the relative mineral density varies by 26.1% in the front teeth region, by 24.8% in canines' region and by 38.6% in the region between the second and third premolars in dogs. The average increase of the lower jaw bone mineral density has averaged about 26% due to permanent occlusion forming processes and skeletal growth in dogs.

1. Introduction

The process of changing deciduous teeth is extremely complex poorly understood and is under the control of genetic, environmental, infectious, traumatic and other factors in the body. A large group of dental-maxilla apparatus pathologies are diseases associated with disorders of the process of tooth replacement. At the same time, there are no system data on the mechanism of the change of teeth, which would allow judging the physiological status of the organism, as the actual eruption dates may differ from the rules under the influence of various factors [1,2]. It should be noted that most of the teeth are formed at time of birth; however, the dissimilar elements (cervical region and furrows) are not completely mineralized [3]. The process of teeth eruption starts with the bone resorption. Located over the occlusal surface regions are primarily resorbed due to next adjacent follicles [4]. There is an evidence of age mineralization of bone tissue, especially the formation of the skeleton in children, rate of bone resorption in various pathological processes in the humanitarian dentistry [5,6]. But we did not found such data in veterinary dental practice.

On this basis, we decided to perform osteodensitometry, which is an X-ray method of bone density quantitative measurement, to survey dogs' mandible during deciduous teeth change. Currently, this type of diagnosis is one of the most informative and safe methods of bone status assessing in modern dentistry [7]. The aim of this study was to identify indicators of bone density in dogs during the occlusion shifts period.

2. Materials and methods

Five clinically healthy mongrel dogs were grouped on the principle of analogues to October 2018. At the end of the experiment the animals age was 5.5 months and the average weight was 7.2 kg. Animals



were feed off ready balanced commercial diet, enriched mineral and vitamin complexes. X-ray examination of the mandible was carried out every 10 days for 3 months until the change of teeth. The study was conducted on the digital X-ray apparatus "errs 1" with an X-ray Toshiba D-124 tube. The X-ray data were analysed using the program Hi-Scene, which allows determining bone density in a single point in the digital photo. Each digital photo was previously converted into 8-bit image, which contained 256 brightness levels (or shades of grey), and each of them corresponded to a value of 1-pixel charge. Bone density in the region of the front teeth, canines and premolars of the mandible on each side was X-rays measured. Thus, 80 X-ray images of the lower jaws (figure 1 and 2) were analysed during the experiment.

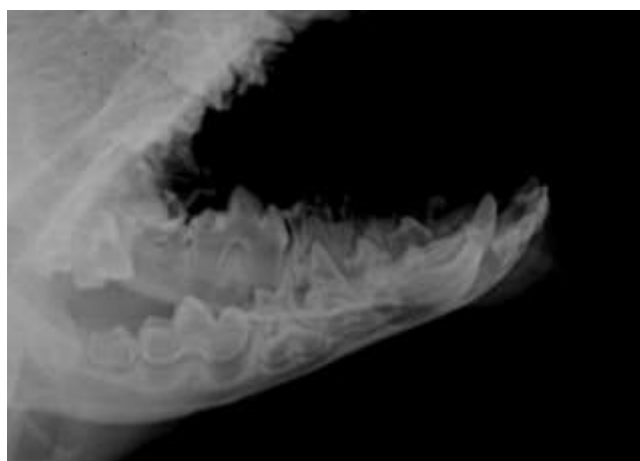


Figure 1. XRD pattern of the mandible on the right. X-ray test 4.

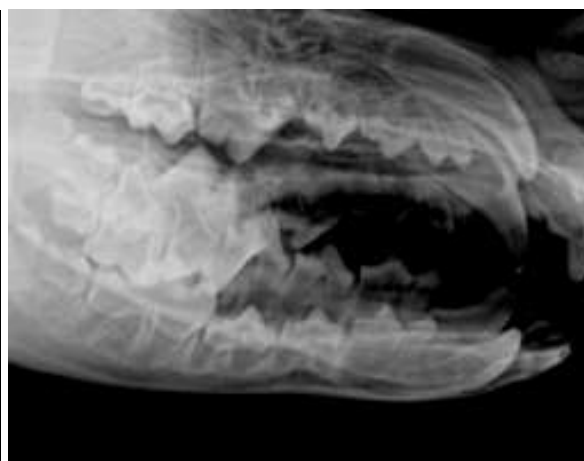


Figure 2. XRD pattern of the mandible on the right. X-ray test 7.

Statistical analysis was performed using Microsoft Excel package. Results were represented as the arithmetic mean (M) and standard deviation (m).

3. Results

Bone mineralization process is one of the most complex processes in the body, which is initiated by collagen molecules. According to an electron microscopy data, extracellular membrane-bound bodies, containing apatite crystals, phospholipids and active phosphatase, are located in the active mineralization region. It is necessary to maintain certain concentrations of calcium and inorganic phosphorus in plasma, saliva and periosteum for a bone mineralization process, including hard tooth tissue mineralization. The correct regulation of this process is provided by Parathyroid Hormone (PTH), calcitonin and vitamin D activity. Mechanical bone density determined by its mineral composition. In this case, densitometry allows quantifying the degree of bone mineralization.

Irreversible changes in osseous tissue lead to a distortion of linear growth and indicate a distortion of metabolic processes in the organism. The growth of bone tissue is provided by the processes of transformation and transposition, because of this factor, periosteal reconstruction and partial resorption occur. This type of bone growth is characterized of the facial region. This process is the most intensive during the physiological organism formation, then a process deceleration begins. During physiological formation period, organic matrix is mineralizing and increasing by 70%. The subsequent accumulation of mineral components can last several months. Mineral metabolism in bone tissue is regulated by osteoblasts. Their normal functioning and adaptation to various mechanical and metabolic processes is provided by transmembral proteins and skephic receptors. The basis of calcified bone is hydroxyapatite. It provides constant resorption and restoration of bone tissue. This process proceeds continuously.

Change of deciduous teeth in dog starts at the age of 3 months with front teeth group. At the age of 3-4 months, there is a change of premolars. At the age of 5-6 months, there is a change of canines.

Identical teeth change intervals were marked in experimental animals. Using the X-ray examination data, we have identified a relative mineral density of lower jaw bones in dogs during the occlusion shifts period. The results of the research are presented in tables 1 and 2.

Table 1. Bone mineral density of the left mandible branch ($M \pm m$, $p < 0.05$).

X-ray test No	The date of the X-ray control	Mineral density ($M \pm m$), px		
		Front teeth	Canines	2/3 premolars region
1	01/10/2018	232.6 $\pm$ 1.23	236.4 $\pm$ 1.32	277.6 $\pm$ 0.75
2	20/10/2018	239.5 $\pm$ 0.65	246.4 $\pm$ 2.01	301.0 $\pm$ 0.98
3	30/10/2018	255.2 $\pm$ 0.91	272.2 $\pm$ 1.21	319.7 $\pm$ 1.02
4	11/10/2018	270.3 $\pm$ 1.14	284.1 $\pm$ 1.02	336.5 $\pm$ 0.89
5	20/11/2018	294.9 $\pm$ 0.26	295.0 $\pm$ 1.27	352.9 $\pm$ 1.05
6	30/11/2018	299.2 $\pm$ 0.84	302.5 $\pm$ 0.65	379.3 $\pm$ 1.06
7	09/12/2018	316.4 $\pm$ 0.67	319.2 $\pm$ 0.72	387.7 $\pm$ 0.82
8	19/12/2018	316.7 $\pm$ 1.31	320.0 $\pm$ 0.25	389.9 $\pm$ 0.74

Table 2. Bone mineral density of the right mandible branch ($M \pm m$, $p < 0.05$).

X-ray test No	The date of the X-ray control	Mineral density ($M \pm m$), px		
		Front teeth	Canines	2/3 premolars region
1.	01/10/2018	233.3 $\pm$ 1.32	239.4 $\pm$ 0.87	280.5 $\pm$ 0.39
2.	20/10/2018	238.4 $\pm$ 0.55	248.0 $\pm$ 1.65	302.4 $\pm$ 0.48
3.	30/10/2018	252.7 $\pm$ 0.83	271.8 $\pm$ 0.86	317.4 $\pm$ 1.14
4	11/10/2018	272.4 $\pm$ 1.03	283.0 $\pm$ 0.72	337.5 $\pm$ 0.74
5	20/11/2018	292.8 $\pm$ 0.71	293.8 $\pm$ 0.94	353.8 $\pm$ 1.07
6.	30/11/2018	298.1 $\pm$ 1.01	300.7 $\pm$ 0.49	380.4 $\pm$ 0.35
7.	09/12/2018	315.7 $\pm$ 0.74	318.7 $\pm$ 0.41	386.2 $\pm$ 1.12
8	19/12/2018	315.2 $\pm$ 1.15	318.2 $\pm$ 1.03	388.7 $\pm$ 0.95

According to the presented in table 1 and 2 data, bone density of the lower jaw right and left branches did not have significant difference in dogs. But a significant difference in bone density was registered between different regions of the mandible. Indicator of bone density increased from the front teeth region to the premolars region by 19.4% or 20.2% in left or right mandible branches, respectively, at the beginning of the experiment and by 23.1% or 23.1%, respectively, by the end of the experiment. It is to be noted, that the bone tissue density in the canines' region was on average higher by 1-2% in comparison to the front teeth region, but bone tissue density in the 2/3 premolars region was much higher (more than 20%). This difference may be due to the difference in the thickness of the alveolar bone and the body of the mandible.

Since the animals were in the period of active growth, processes of bones formation respectively dominated in the body. As a result, the mandible growth and formation were intensive. This conclusion is confirmed by the gradual increase in bone density in each of the defined portions during the observation period. This phenomenon was the most noticeable in the 2/3 premolars region: the bone tissue density increased on average by 5-8% in this region. While this indicator increased with time only by 2-4% in the front teeth and canines' regions.

Besides, the tables 1 and 2 data suggest that the maximum bone density was detected at 7 X-ray test. The difference between 7 and 8 X-ray test data was not significant. By the end of the observation period, an increase in the relative bone mineral density increased by 0.2%, 0.3% and 0.6 % in the front teeth, canines and premolars regions, respectively. This was the result of a decrease in bone mineralization intensity by the end of the occlusion change. By this time the process of formation of permanent dentition is almost over.

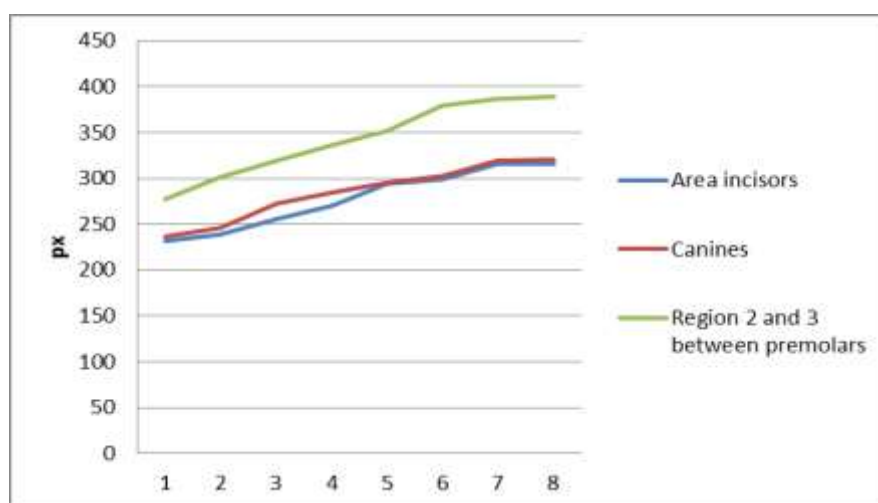


Figure 3. The dynamics of bone mineral density in the right mandible branch.

Since the beginning of the experiment to the end of the bone mineralization process, the bone density increased by 26.1% and 24.8% in front teeth and canines' regions respectively. The greatest degree of increase was found in the region between the second and third premolars. It amounted to 38.6%. Bone mineral density was changing in the test animals during the observation period, which is a natural phenomenon in the period of active growth processes.

4. Conclusion

Thus, the maximum degree of bone tissue mineralization in experimental animals was found in the 2/3 premolars region and premolars: it amounted to 389.9 ± 0.74 (left mandible branch) and 388.7 ± 0.95 (right mandible branch) px during 8 X-ray test. The minimum degree of bone tissue mineralization was marked in the front teeth region, it amounted to 232.6 ± 1.23 (the left mandible branch) and 233.3 ± 1.32 (right mandible branch) px during 1 X-ray test. Average increase of bone mineral density during follow-up was on average about 26%, which is associated with the processes of the formation of permanent occlusion in dogs. Considering the above, osteodensitometry can be recommended as a diagnostic method for monitoring the deciduous teeth change process.

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