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MORPHOMETRIC ANALYSIS OF MANDIBULAR BONE STRUCTURE IN ORTHOPANTOMOGRAMS OF PATIENTS WITH PERIODONTAL DISEASES

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ABSTRACT

Panoramic radiographs of eleven patients with juvenile periodontitis and of 30 patients with chronic periodontitis and those of age- and sex-matched healthy subjects were evaluated using the quantitative morphometric method with special emphasis on mandibular trabecular pattern and alveolar bone loss. The diagnosis of juvenile periodontitis and chronic periodontitis was settled by clinical and radiological examinations, and the possibility of any systemic disease was excluded by extensive laboratory tests.

Morphometrically measured volume densities of trabecles (Vt) increased at the expense of medullary space (Vm) in patients with severe chronic periodontitis and juvenile periodontitis. Changes in females were more obvious than in males. The results are discussed in terms of the known histopathological changes found in bone i.e. osteolysis-malacia and osteoporosis. The present results suggest that alterations in mandibular trabecular pattern, whether systemic or local might reflect factors contributing to periodontal diseases.

INTRODUCTION

A variety of metabolic diseases, age and many drugs influence the mineral content of bone (Stanbury and Lumb 1966, Nordin 1971, Karjalainen and Alhava 1977). Jaws are also affected, but it is still unknown, whether changes in bone metabolism due to generalized bone diseases predispose or accentuate the alveolar bone loss in periodontal diseases.

Bone diseases are characterized by either osteoporosis or osteomalacia (Nordin 1971). The diagnostic value of radiographs in assessing these bone changes accurately has been a controversial issue for a long time (Nordin et al. 1962, Choen et al. 1970, Ward and Manson 1973, Karjalainen and Alhava 1977). It has been shown that 30 - 50 % of bone mineral must be lost to become visible in radiographs (Agus and Goldberg 1972, Shapiro 1972). On the other hand, alterations in bone trabecular pattern in connection with age and renal diseases have been described (Virtama and Mähönen 1960, Smith 1969, Syrjänen and Lampainen 1983).

The hypothesis of a relationship between the degree of osteoporosis and the degree of structural bone disturbance in periodontal diseases has been investigated by few. In these studies, no correlation could be found between the rate of alveolar bone loss and the bone mineral content, however (Ward and Manson 1973, von Wowern and Stoltze 1977).

As far as the authors are aware, no previous reports are available on relationships of mandibular bone structure to periodontal diseases. The purpose of this study was to analyze with quantitative morphometric method, the mandibular trabecular pattern in panoramic radiographs of patients with juvenile periodontitis and chronic periodontitis.

MATERIAL AND METHODS

The material consisted of 30 patients with chronic periodontitis and 11 patients with juvenile periodontitis. Both groups were supplemented by age- and sex-matched control subjects with normal periodontal condition.

The diagnosis of chronic periodontitis was settled by clinical and radiological examination based on estimates of the generalized alveolar bone loss. Juvenile periodontitis was defined as a disease of the periodontium occuring in adolescents and characterized by a rapid bone loss and pocket formation involving more than one tooth of the permanent dentition.

The possibility of any systemic disease in subjects studied was excluded by laboratory tests. The groups of patients studied, their mean age, and sex distribution are seen in Table 1.

All patients were subjected to the routine panoramic radiography. The films were evaluated using the quantitative morphometric method with special emphasis on the bone marrow space and on the trabecular pattern. A transparent pointed grid (point to point distance 2 mm in all direction) was

Table 1. Female/male ratio, mean ages for both sexes in the two groups of patients with periodontal diseases.

Group of subjects	No. of subjects	Female: male	Age of female (yrs)	Age of male (yrs)
Patients with chronic periodontitis	30	12 : 18	35.2 +- 3.7	35.9 +- 4.3
Patients with juvenile periodontitis	11	6 : 5	26.0 +- 12.2	33.8 +- 14.4

Test- and control subjects were paired according to age and sex for both groups, separately.

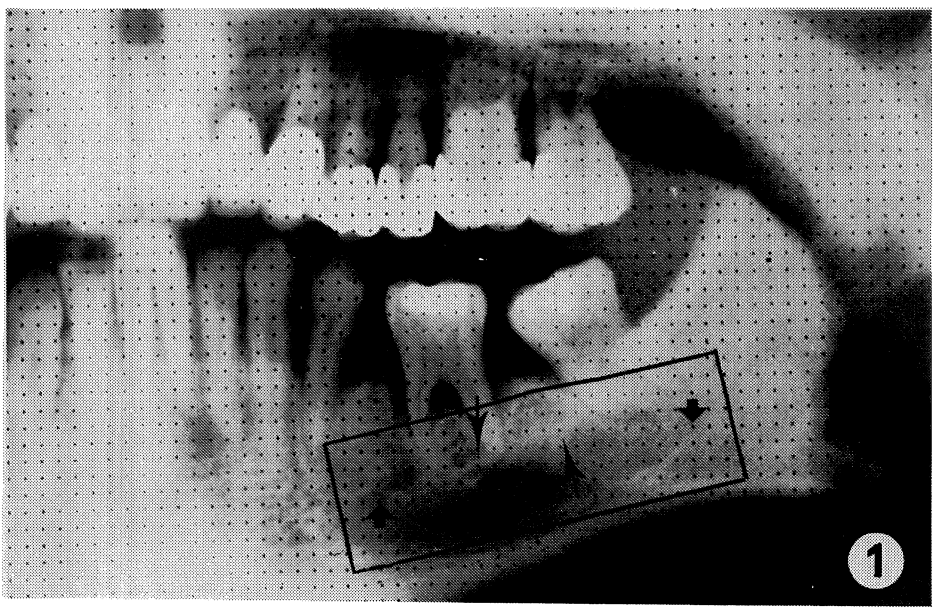

Fig. 1. A transparent pointed grid applied on the panoramic film. The points falling on the trabecular spices, Vt, (slender arrows) and on medullary space, Vm, (thick arrows) are separately counted, and their volume densities calculated. Measurements were done on both the left and the right mandibular sites (the evaluated area encircled). This panoramic view of a 35-year-old shows rapid alveolar bone loss and pocket formation (d.36) in connection with juvenile periodontitis. The determined values of the volume densities were: Vt 47.3 and Vm 52.7. The mean percentage of alveolar bone loss was 51.6.

applied. Figure 1 shows the grid set on a radiograph, as well as the areas evaluated.

The points falling on the trabecles and on the medullary space were separately counted. The number of points falling on the above two compartments (Pi) divided by the total number of points (Pt) calculated was called the volume density (Vi); Vi = Pi : Pt. The volume densities of the trabecles (Vt) and of the bone marrow space (Vm) were calculated.

Alveolar bone loss was estimated by using the method of Schei et al. (1959). The transparent measuring device was used to determine the percentage of alveolar bone loss (Fig. 2).

The distance from cementoenamel junction to alveolar crest was measured for each tooth and divided by the total length of the root to calculate the percentage of bone loss.

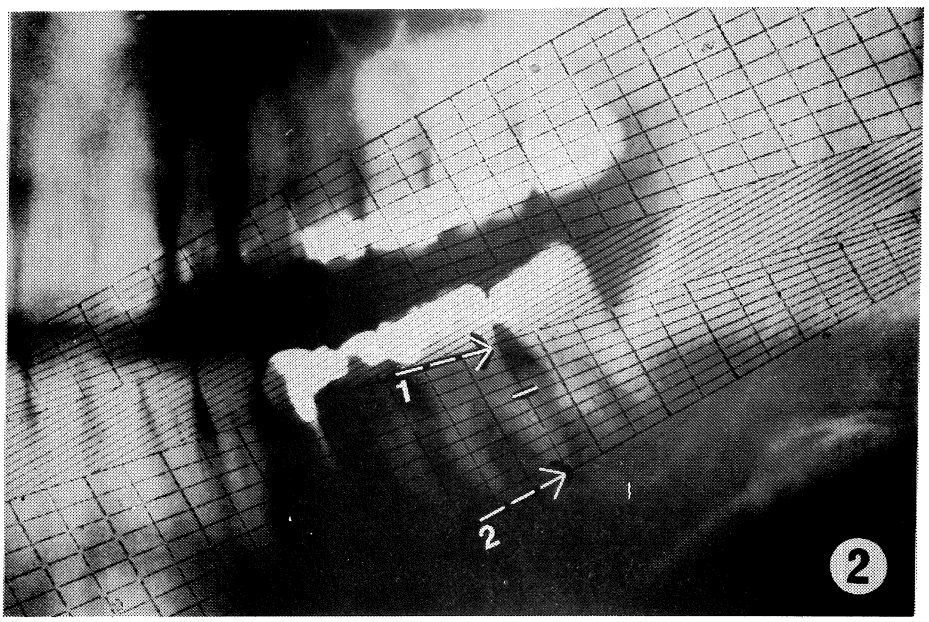

Fig. 2. A transparent measuring device is applied on the panoramic film of 38 year-old female with chronic periodontitis. The device was used to determine the alveolar bone loss as follows: the line 1 was settled on cementoenamel junction, so that the line 2 was on the apex of the tooth (distance between line 1 and line 2 is 100 %). The short white line (border of alveolar bone) shows the percentage of alveolar bone loss of the tooth (4/10 i.e. 40 %).
Morphometrically measured volume densities were: Vt 37.8 and Vm 62.2. The mean percentage of alveolar bone loss was 30.9.

Table 2. Quantitative morphometric analysis of the panoramic radiographs.

Group	Volume density of trabeculate (%) (M+-SD)		Volume density of medullary spaces (%) (M+-SD)		Mean number of points counted
	Men	Women	Men	Women	(M+-SD)
Chronic periodontitis	39.4+- 9.8*	39.8+-11.7*	60.4+-11.2*	60.2+-12.2	891+-116
Controls	34.6+- 2.6	33.9+- 4.0	65.4+- 2.6	66.1+- 4.0	953+-120
Juvenile periodontitis	37.9+- 8.6	40.8+- 6.1**	62.1+- 8.6	59.2+- 6.1**	560+-101
Controls	33.5+- 7.7	30.5+- 7.0	66.4+- 7.8	69.5+- 7.0	948+-160

* = $p < 0.05$, ** = $p < 0.01$

RESULTS

The results of the quantitative morphometric analysis of the panoramic radiographs are depicted in Table 2.

The mean number of Pt counted per one film varied from 560 to 948. In patients with both juvenile periodontitis and chronic periodontitis the volume density of trabecles (Vt) increased significantly at the expense of the medullary space (Vm) when compared with the values of controls. The changes were more obvious in women than in men especially in patients with juvenile periodontitis.

Table 3 shows the degree of alveolar bone loss. In both patient groups with periodontal diseases the mean percentages of bone loss were significantly higher when compared with those of the controls ($p < 0.001$). Alveolar bone loss in women was greater than in men in both diseased groups studied.

DISCUSSION

Experimental studies concerning the relation between an induced osteoporosis and a progressive loss of alveolar bone are contradictory (Henrikson 1968, Svanberg et al. 1973). Only two clinical investigations exist on the relationship between sceletal mineral content and the degree of alveolar bone loss in connection with periodontal diseases. No correlation could be found between these two parameters, however (Ward and Manson 1973, von Wowern and Soltze 1977). In earlier investigations, changes in cancellous bone have been shown to occur

Table 3. Mean percentages of alveolar bone loss detected in dentition.

Group	Bone loss in women (M+-SD,%)	Bone loss in men (M+-SD,%)	Both sexes together (M+-SD,%)
Chronic periodontitis	20.3+-5.3***	19.6+-7.8***	19.9+-6.9***
Controls	5.2+-2.9	5.3+-2.0	5.2+-2.5
Juvenile periodontitis	20.3+-8.1***	27.9+-25.9***	23.7+-17.8***
Controls	5.2+-2.9	5.3+- 2.0	5.2+- 2.5

*** = p <0.001

more rapidly than in compact bone (Johnston et al. 1968, Karjalainen and Alhava 1977). Alterations in mandibular trabecular pattern are also more sensitive than changes in mandibular compacta or lamina dura (Brynolf 1978, Syrjänen and Lampainen 1983).

In the present study where trabecular pattern, per se, was estimated, a significant increase in volume densities of trabecles was noticed in patients with both periodontal diseases when compared with those of controls. This increase in trabecular proportion might be explained by bone remodelling (Belanger 1965, Brown at al. 1966, Henrikson 1968). Under normal conditions, the volume of tubular cancellous bone is maintained unchanged by the equilibrium between bone apposition on the surface of the tubules and the deep seated osteolysis. When increased resorption is induced, the immediate response to the accelerated osteolysis is an accelerated apposition, appearing in radiographs as a widening the individual trabecles. Later, when surface appositon can no longer keep pace with osteolysis an inevitable thinning of the individual trabecles is noticed. Then the radiographic appearance is that a delicate finely meshed trabecular pattern with increased over all grayness.

The end result is a confluence of such expanding tubules with only remnants of bone left in the replacing fibrous tissue, which appear as radiolucency in a radiograph. These gradual changes in trabecular structure can also be seen in radiographs of patients with renal diseases, or in experimentally induced osteoporosis (Choen et al. 1970, Svanberg et al. 1973, Kelly et al. 1980, Syrjänen and Lampainen 1983). This

suggestion is supported by the measurements of alveolar bone with absorptiometry, where in addition to marginal alveolar bone loss, also intraosseal changes have been shown (Hausmann et al. 1982).

Another explanation to the increased volume densities in the periodontal groups could be the occlusal interferences often reported as contributory factors for the periodontal diseases. Elevation in bone mineral content can be also induced by increased physical stress (Karjalainen and Alhava 1977, Brynolf 1978). However, changes in trabecular densities were more obvious in women than men speaking in favour of osteolysis rather than occlusal influence. The physiological reduction in bone volume starts earlier in females (at age about 35 - 45 years) than in males (about 45 - 65 years).

As a conclusion, in patients with juvenile periodontitis or with severe chronic periodontitis alterations in mandibular trabecular pattern could be shown which might be explained by mild osteolysis. However, further studies with more extensive patient groups and using methods like absorptiometry and serological studies are essential to fully elucidate the nature of changes.

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