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The influence of bone mineral density and body mass index on resorption of edentulous jaws

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SUMMARY

Objective. The aim of this study is to determine the relation of osteoporosis and body mass index to edentulous jaw bone resorption.

Material and methods. Study included 48 postmenopausal totally edentulous female patients, aged 50 to 84 years (average age 69.73), with period of at least 2 years after last tooth extraction. Bone mineral density was determined in the femoral neck and the lumbar area L2-L4 by dual energy x-ray absorptiometry (DEXA) using Lunar DEXA DPX-NT, GE Medical Systems hardware. Body mass index was calculated (BMI (kg/m^2)) using data from DEXA results. Lateral cephalogram (Pantomograph Trophycan C), and radiological measurement in the symphysis of the mandible was performed for each patient. Degree of the edentulous residual ridge resorption was determined clinically on diagnostic casts of anatomic impressions by classification of Kalk.

Results. There is no statistically significant difference between groups, comparing mandibular bone height changes (p=0.054) and various degrees of residual ridge resorption in maxilla (p=0.743) and mandible (p=0.752) with different bone mineral contents.

There is a statistically significant correlation between radiological mandibular measurement and body mass index (p=0.004). Statistically significant difference is also observed between various degrees of residual ridge resorption in maxilla (p=0.049) and mandible (p=0.027) and body mass index.

Conclusions. Resorption of edentulous jaw bone does not increase when bone mineral density decreases.

More severe manifestation of edentulous jaw bone resorption is observed in patients with diminished body mass index.

Keywords: residual ridge resorption, edentulous jaws, osteoporosis, body mass index.

INTRODUCTION

When making prostheses for completely edentulous patients, doctors often have to deal with insufficient bone quantity, which has occurred due to alveolar bone resorption. This is chronic, progressive and irreversible process but origin of it is still not clearly determined. However, many authors assure that anatomic (bone quantity, quality, shape), metabolic (sex, age, hormonal status, vitamin metabolism, systemic disorders, pathological and congenital conditions) and mechanic, which includes functional (force, directed on bone, frequency, intensity, duration and trajectory, muscle activity) and prosthetic (correspondence of dentures base to prosthetic field, dentures wearing habits, shape and number of replaceable teeth, interocluzal distance) aspects, have the main importance as causing factors. [1-4]

Although there is a hypothesis in the literature that systemic factors like osteoporosis have greater significance in jaw bone resorption [1, 5], determining the final speed and contour of resorption while impact of the local factors after last tooth extraction have already disappeared [6, 7], there are still

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Fig. 1. Mandibular radiological measurement Y1 in digital lateral cephalogramm

Fig. 2. Minimal degree of mandibular resorption: A - frontal plane; B - sagital plane; C - horizontal plane

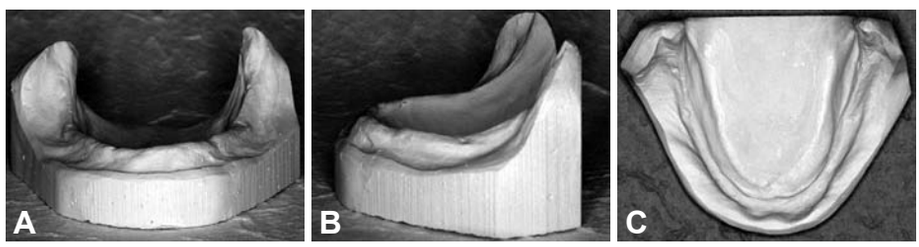

Fig. 3. Moderate degree of mandibular resorption: A – frontal plane; B – sagital plane; C – horizontal plane

Fig. 4. Severe degree of mandibular resorption: A – frontal plane; B – sagital plane; C – horizontal plane

controversial opinions if osteoporosis does [2, 6, 8] or does not [4, 9, 10] have an impact on edentulous jaw bone resorption.

Body mass index is also described in the literature as one of the atrophic jaw bone predisposing factors, emphasizing that not always patients with diminished bone mineral density have atrophic jaw bones or opposite. So it is possible that patients with finer body structure and anatomically smaller bones have more manifestation signs of jaw bone resorption than those with increased body mass index. [11-13]

The objective of this study is to determine the impact of bone mineral density and body mass index on resorption of edentulous jaws. The tasks of this study are to determine relationship between: radiological mandibular height measurement and osteoporosis; radiological mandibular height measurement and body mass index, clinically determined degree of edentulous residual ridge resorption and osteoporosis; clinically determined degree of edentulous residual ridge resorption and body mass index.

MATERIAL AND METHODS

The study was performed in the Institute of Stomatology of Riga Stradins University. 48 postmenopausal and completely edentulous female patients, aged 50 to 84 years (average age 69.73 years), (Table 1) participated in this study, i. e., all the patients who had come to the clinic of Dental Prosthodontics to have conventional complete dentures of both upper and lower jaw. All these patients had at least 2 years period after extraction of the last tooth and they agreed to take part in this study. Study protocol was rewieved and permission was obtained from the Ethics Commission of Riga Stradins University.

Bone mineral density was determined in both femoral necks and the lumbar area L2-L4 by dual energy x-ray absorptiometry (DEXA) using Lunar DEXA DPX-NT, GE Medical Systems hardware.

After collecting DEXA results, the worst finding from both was taken into account and patients were allocated into one of the 3 groups: normal bone mineral density, osteopenia or osteoporosis. Allocation of patients was done according to the World Health Organization T – score scale, which indicates the number of standard deviations above or below the mean for a healthy 30 year old adult patient of the same sex and ethnicity, where normal bone mineral density has ≥-1.0, osteopenia has -1.0 to -2.5, but osteoporosis has ≤-2.5 standard deviations [14].

Body mass index was calculated (BMI (kg/m^2)) using data about patients weight (kg) and height (m) from DEXA results.

To determine the residual ridge resorption of edentulous jaws, radiological and clinical examinations were done. For each patient digital lateral cephalogram (Pantomograph Trophycan C) was performed where radiological measurement (Y1) was measured in the symphysis of the mandible from the menton to the crest of the residual ridge by method of Tallgren (Figure 1) [15]. Degree of the edentulous residual ridge resorption was determined clinically as minimal, moderate or severe on diagnostic casts of anatomic impressions by classification of Kalk (Figures 2-4) [16].

Due to some imperfections of digital lateral cephalograms or visual inaccuracies of diagnostic casts, 8 women were excluded from the study, while 18 women were excluded because of missing DEXA results. Consequently in these groups where one of the interested parameters was bone mineral density 30 women were included, but where body mass index was one of the interested – 40 women were included.

Data was analyzed using descriptive and analytical statistical methods. Relation between variables was analyzed using Pearson correlation and two – way frequency tables. Statistical significance of the differences in the frequency distribution was tested by means of Pearson χ^2 test. Statistical significance of the mean differences between the measurements in groups was tested using t-test.

RESULTS

There was no statistically significant difference between groups (p=0.054), when comparing mandibular height changes by different bone mineral densities (Table 2).

Statistically significant correlation was observed (p=0.004) between radiological mandibular height measurement Y1 and body mass index (Table 3).

There was no statistically significant difference between different groups by degrees of edentulous

Table 1. Distribution of patients' age by different groups of bone mineral density

Groups according to BMD	Mean age	SD
Normal bone mineral density	69.45	8.14
Osteopenia	68.00	8.84
Osteoporosis	73.14	3.72

BMD – bone mineral density;
SD – standard deviations.

Table 2. Distribution of average results of radiological mandibular measurement Y1 into different groups of bone mineral density (p=0.054)

BMD	Number of patients	Mandibular measurement Y1 (mm)	SD
Normal bone mineral density	11	18.92	1.47
Osteopenia	12	21.71	3.66
Osteoporosis	7	20.63	4.24

BMD – bone mineral density;
SD – standard deviations.

Table 3. Correlation between radiological mandibular measurement Y1 and body mass index

		Y1
BMI	Pearson correlation	-0.449 (**)
	p value	0.004
	Number of patients	40

BMI – body mass index;
** – Correlation is significant with p value 0.01.

Table 4. Distribution of patients into groups by degree of mandibular residual ridge resorption and bone mineral density (p=0.752)

	Mandibular residual ridge resorption		
	Minimal	Moderate	Severe
Normal bone mineral density	1	4	6
Osteopenia	2	5	5
Osteoporosis	0	4	3

Table 5. Distribution of patients into groups by degree of maxillar residual ridge resorption and bone mineral density (p=0.743)

	Mandibular residual ridge resorption		
	Minimal	Moderate	Severe
Normal bone mineral density	1	4	6
Osteopenia	2	5	5
Osteoporosis	0	4	3

residual ridge resorption and osteoporosis neither in mandible (p=0.752) nor in maxilla (p=0.743), (Table 4 and 5).

Statistically significant difference was observed in mandible between moderate and severe (p=0.027), but in maxilla between minimal and severe (p=0.049) degrees of edentulous residual ridge resorption according to body mass index (Table 6 and 7).

DISCUSSION

Due to advanced socio–economic circumstances and medical technologies global trends in population ageing can be observed in industrially developed countries [17]. Consequently, the average age of inhabitants and also the number of those people who could suffer from total tooth loss and osteoporosis increases. Osteoporosis is a systemic skeletal disease characterized by low bone mass and structural deterioration of bone tissue, leading to bone fragility and an increased susceptibility to fractures [18, 19]. This is an actual society health problem, which influences the quality of life, morbidity and even mortality [14].

It is known that extraction of the last tooth activates the osteoclasts and in the period of first 6 to 24 months [3, 20] rapid residual ridge resorption can be observed, which later is replaced by slower but still progressive atrophy. As mentioned above, in literature there is an opinion that systemic factors have a greater importance in resorption of edentulous jaws and they are activated directly after the role of the local factors in postextraction period is diminished [1, 5]. That is why in our study were included only these patients, which had at least 2 years left after loss of the last tooth and which had no systemic diseases or disorders. All these factors determined the final amount of our research group.

Table 6. Differences between various degrees of mandibular residual ridge resorption (0 – minimal; 1 – moderate; 2 – severe) according to body mass index

	Degree of mandibular residual ridge resorption		
	0/1	**1/2**	**0/2**
BMI	p=0.202	p=0.027	p=0.982

BMI – body mass index.

Table 7. Differences between various degrees of maxillar residual ridge resorption (0 – minimal; 1 – moderate; 2 – severe) according to body mass index

	Degree of maxillar residual ridge resorption		
	0/1	**1/2**	**0/2**
BMI	p=0.248	p=0.145	p=0.049

BMI – body mass index.

There are very different results of the studies, where relationship between jaw bone resorption and bone mineral density was considered. That could be explained by different diagnostic methods used in studies to determine bone mineral density, i.e., dual energy x-ray absorbtiometry [4, 7, 10, 21], visual analysis of the radiographs [22, 23], confirmation of osteoporotic fractures [9, 24], and also to determine edentulous residual ridge resorption, i.e, clinical classification by the degree of alveolar bone atrophy [7, 23], ratio of radiological measurements in the area of mental foramen [4, 8, 9, 22, 24], comparing the field of the jaw bones in definite time period [6], measurements of computed tomography in the area of symphysis [21], and other radiological measurements in different areas of the mandible [10].

In similar studies, e.g., Klemetti and Vainio research, which included 128 edentulous, postmenopausal female patients, determination of osteoporosis was done using DEXA but resorption of mandible – defining degrees of atrophy in frontal region between mental foramens and distally from them. As a result they found statistically significant correlation between mandibular resorption in distal areas and osteoporosis [7]. The study by Soikkonen and Ainamo included 92 edentulous female patients, aged 75 to 85 years, and determination of osteoporosis was done using visual analysis of radiographs but degrees of resorption were defined visually in orthopantomogramms in regions, where the most severe resorption was observed. As a result statistically significant difference was found between minimal and moderate according to bone mineral density [23]. Statistically significant difference was not found between osteoporosis and different edentulous residual ridge resorption degrees in the study by Von Wowern and Kollerup, which included 12 edentulous, postmenopausal female patients, The osteoporosis in this study was determined by confirming osteoporotic fracture in medical history but fields of resorption were calculated in lateral cephalogramms [6].

To ensure accurate measurements of bone mineral density in our study dual energy x–ray absorptiometry was used in both femoral necks and the lumbar area (L2-L4), which nowadays is accepted as the "gold standard" for diagnosis of osteoporosis because of better precision, greater functionality and lower radiation dose [25].

To determine resorption of edentulous jaws in our study for all the patients digital lateral cepha-

logram was performed, where the height was measured in the symphysis of the mandible. Likewise in other studies there are measurements in lateral cephalograms [6], and in orthopantomograms [7, 23], using different reference points, like, midline of the jaw or mental foramen region. There is a study that confirms that there is no statistically significant difference between radiological mandibular height measurement in its midline in digital orthopantomogram or in lateral cephalogram [26]. Some authors affirm that the midline region morphology of both jaws can be better analyzed in lateral cephalogram than in orthopantomogram [27].

As we accept that in case of osteoporosis the first signs of resorption could be observed in residual ridge, in our research besides lateral cephalograms, where we measured the total mandibular height, we also included diagnostic casts of anatomic impressions to determine specific degree of residual ridge resorption. For all that evaluation of diagnostic casts was done based on particular anatomical checkpoints, we still cannot exclude possible subjectivity of this method. There are data in the published literature that osteoporosis provokes specific bucolingual alveolar bone resorption, leading to "knife edge" type configuration [28], which could be precisely analyzed in three dimensional x-ray examination.

Although many studies confirm connection between different degrees of edentulous residual ridge resorption and osteoporosis [6, 7, 23], in our study such relevance could not be found. We could assume that the time period of 2 years after loss of the last tooth has not been sufficient yet to observe the impact of systemic factors on resorption of edentulous jaw bones. It is possible that determinative action of osteoporosis is only in initial stage.

Despite lots of attempts to prove connection between residual ridge resorption and osteoporosis, doctors often deal with such situation, when patient with severe jaw bone atrophy has normal bone mineral density or opposite. That has forwarded the scientists to find other interconnections in development of residual ridge resorption [11-13, 29, 30] and as one of the interest, also in our study, is body mass index. For example, Lindsay assures that people with massive bones and changed estrogen metabolism because of increased fat accumulation has less manifestation signs of residual ridge resorption than those who have diminished body mass index [31]. Although Kazovic with colleges in their study, where 31 edentulous female patients were included, did not find statistically significant correlation between body mass index and the speed and progress of residual ridge resorption [13]. In study of Klemetti and his colleges, were 128 edentulous female patients were included, statistically significant correlation was found between increased body mass index and higher residual ridges [11]. Knezovic and his colleges in their study, which included 96 edentulous female patients, found statistically significant difference between different radiological mandibular height measurements according to body mass index [12]. In our study we also found statistically significant correlation between body mass index and resorption of edentulous residual ridges, which was evaluated by radiological measurements and clinical appraisal of diagnostic casts.

CONCLUSIONS

Resorption of edentulous jaw bone does not increase radiologically or clinically when bone mineral density decreases.

More severe manifestation of edentulous residual ridge resorption is observed radiologically and clinically in patients with diminished body mass index.

Long term observation of specific patient group should be done to evaluate the impact of osteoporosis on intensity of edentulous residual ridge resorption.

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