DENTAL MEDICINE **ORIGINAL PAPERS**

CBCT ASSESSMENT OF MANDIBULAR BONE QUALITY AND QUANTITY IN PATIENTS WITH OSTEOPOROSIS

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CBCT ASSESSMENT OF MANDIBULAR BONE QUALITY AND QUANTITY IN PATIENTS WITH OSTEOPOROSIS (Abstract): Osteoporosis is characterized by weakened bones that put people at higher risk of fracture, especially in patients who have an advanced degree of damage and who follow or not treatment for osteoporosis. The **aim** of the study was to compare mandibular indices and mandibular bone density with the skeletal status investigated by osteodensitometry in patients with osteoporosis, with or without treatment. **Material and methods**: 40 patients with osteoporosis, divided into two equal groups, were evaluated by CBCT for the assessment of some mandibular indices that indicate the bone density at the cortical and cancellous bone level. The statistical analysis was performed with SPSS20.0, p=0.05. **Results**: For most of the evaluated parameters, higher values were recorded in the group of participants with osteoporosis but without treatment compared to the group of participants with osteoporosis, with treatment. The results showed a significant association between the mandibular cortical index and the type of treatment, with G1 patients presenting in a proportion of 25% the mandibular cortical index type 2, while G2 patients presented the mandibular cortical index type 2 in 58.33% of cases. In the case of G2 patients the cortical bone density values are significantly higher compared to the values corresponding to G1 patients. There are no significant differences in regard to cancellous bone density values between groups. **Conclusions:** The density of the mandibular bone is closely correlated with changes in the density and implicitly of the state of the skeleton of patients with osteoporosis, usually evaluated by bone osteodensitometry. The CBCT technique provides sufficient radiographic information that helps dentists and oral and maxillofacial surgeons to play an important role in the early diagnosis of mandibular osteoporosis. **Keywords:** CBCT, OSTEOPOROSIS, OSTEODENSITOMETRY.

Osteoporosis is characterized by weakened bones that put people at higher risk of fracture (1). Bone strength is a reflection of the fusion of bone quality and density are the two main characteristics. Bone density, which can be measured as grams of bone mineral per bone area, is thought to be responsible for 60-70% of bone strength. The rate of bone turnover, mineralization, material characteristics, microarchitecture (loss of horizontal struts, loss of connectivity), and geometry are all indicators of bone quality. Age-related bone loss creates deeper resorption cavities that concentrate mechanical stress that degrades bone quality and makes those areas more prone to fracture (2, 3).

Women are disproportionately affected by osteoporosis, which causes fractures that are related to it. The number of fractures and the proportion of women with osteoporosis will rise due to current demographic trends, despite decreases in hip fracture rates. Age, low BMD, and a history of fractures are just a few of the risk factors for fracture that have been identified. The identification of women at high risk should be made easier by targeting those with multiple risk factors (3).

The mandible is an active bone and is influenced by the force of the masticatory muscles. Therefore, reducing the number of teeth causes a gradual decrease in bone mass, (4) thus creating a thinner layer of cortical bone. The mandible can be affected by systemic diseases or various drugs in terms of bone quantity and quality. It is known that after a tooth extraction, alveolar bone resorption occurs, which can be accelerated by the presence of a systemic condition such as osteoporosis. The changes that can occur in the bone tissues of the skeleton and the mandible show numerous risk factors, such as: age, race, menopause, genetic factors, various medications and family history of a disease (5).

Several studies have been conducted in the last decade that demonstrate the presence of a link between the changes that can occur in the mandibular bone and the overall BMD status of the skeleton. Some writers (6) have clearly argued that there is a substantial relationship between mandibular cortical thickness or appearance and systemic osteoporosis. Other studies have discovered no such associations, and their confidence is low (7). The World Health Organization (WHO) classified osteoporosis only based on the T score, as a decrease in BMD of less than 2.5 standard deviations below the average of a young adult of the same sex (Osteopenia Score T -1 -2.5 SD, Osteoporosis Score T-2,5 SD).

The clinicians emphasized that radiomorphometric indices and the density of the jaw bones can be calculated on imaging studies, which can serve as a diagnostic criterion of skeletal BMD, allowing them to select patients with potential BMD changes (8, 9). These radiomorphometric indices, which included the upper and lower panoramic mandibular indexes, the chin index, and the cortical mandibular index, were assessed using orthopantomography to determine the quality of the mandibular bone. Few studies have employed these indices on CBCT images to assess mandibular bone (10).

The aim of the study was to compare mandibular indices and mandibular bone density investigated by osteodensitometry in patients with osteoporosis, with or without treatment.

MATERIAL AND METHODS

The study was carried out in the Medimagis Clinique of oral and Maxillo-Facial Radiology, Iasi. In this study, 40 patients with osteoporosis were included, who presented for CBCT investigations to plan the surgical treatment. Patients signed an informed consent prior to their inclusion in the study. The study was approved by the Research Ethics Committee of the "Grigore T. Popa" University of Medicine and Pharmacy, Iasi (No. 281/5.03.2023).

The inclusion criteria of patients in this study were: only women before menopause, aged between 40 and 80 years, diagnosed with osteoporosis and different classes of mandibular edentulousness. Exclusion criteria were local conditions affecting the mandible, postmenopausal status and other secondary causes of osteoporosis. The participants were equally divided into two groups: group 1 - participants with treatment for osteoporosis (G1), group 2 - participant without treatment for osteoporosis (G2).

All these patients presented clinical observation sheets, from which additional information was extracted regarding the status of the disease and its complications (hemoleucogram, CTX). An anthropometric assessment was also performed which included data on height, weight and abdominal circumference.

CBCT examination of the mandible

This research is part of a large study related to the radiological determination of bone characteristics in patients with general pathologies. This research is part of a large study related to the radiological determination of bone characteristics in patients with general pathologies. The working technique is described in detail in the study carried out by Nemtoi *et al.* (2019)(11). The Planmeca Promax 3D Mid (Planmeca OY, Helsinki, Finland) CBCT equipment was utilized to do the scan that was carried out with a FOV of 100x60 mm with the following exposure parameters: 85-90 kV, 11-12 mA, 12,02 seconds, voxel size of 200 mm, and 578 DAP (mGyxcm2). Romexis 4.4.0 software (Planmeca, Helsinki, Finland) was used to produce the initial and final reconstructions. CBCT reconstructions with a thickness of 1 mm and a distance of 1 mm were used to create sagittal and panoramic sections.

Mandibular bone analysis, quantitative and qualitative

Radiomorphometric indices tailored FOR CBCT images were utilized for quantitative and qualitative examination of the mandible according to Ledgerton's categorization (Ledgerton *et al*, 1999) the following indices were measured on CBCT images:

1) CBCT upper mandibular index, which represents the ratio between the thickness of the lower cortex and the distance from the level of the upper edge of the chin foramen to the lower edge of the mandible.

2) CBCT lower mandibular index, which represents the ratio between the lower cortical thickness and the distance from the lower edge of the chin foramen to the lower edge of the mandible.

3) The CBCT chin index, which represents the thickness of the lower cortex of the mandible, near the chin foramen.

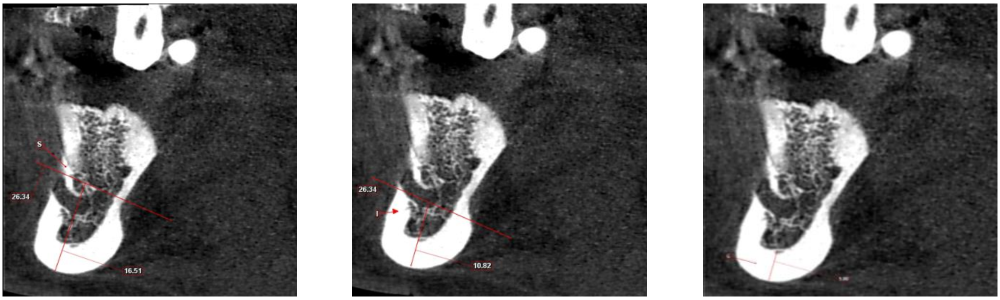
4) CBCT mandibular cortical index, which is classified as follows:

✓ Type 1: the endosteal margin of the basilar bone cortex appears smooth and regular.

✓ Type 2: the endosteal edge of the basilar bone cortex presents semilunar defects or 1-2 layers of cortical debris.

✓ Type 3: the endosteal margin shows numerous (> 3) cortical remnants and is obviously porous.

In addition, mean bone density was estimated for the regions of interest for qualitative analysis.

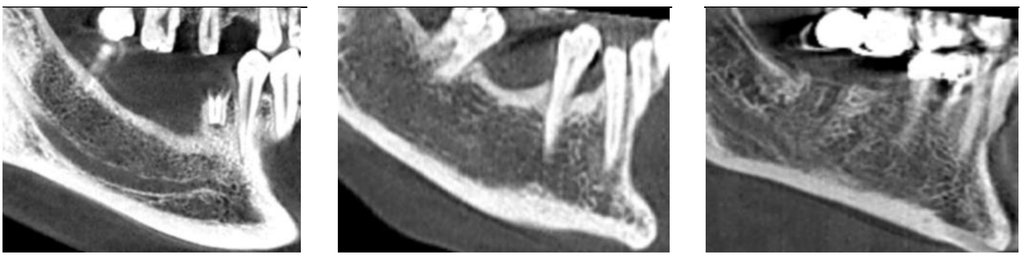


A B C

Fig. 1. CBCT aspect of measurements made on sagittal sections. A. The distance from the level of the upper border of the chin foramen (S) to the lower border of the mandible. B. The distance from the lower edge of the chin foramen (i) to the lower edge of the mandible. C. G represents the thickness of the lower cortex of the mandible, near the chin foramen (Medimagis collection)

These measures were taken from the sagittal (fig. 2) and panoramic (fig. 3) reconstructions produced by the CBCT examination.

A radiologist with long practice in oral and maxillofacial radiology used Romexis 4.4.0 software (Planmeca, Helsinki, Finland) to do all measurements.



A B C

Fig. 2. CBCT aspect of the mandibular cortex. A. Type 1: the endosteal margin of the basilar cortical bone appears smooth and regular. B. Type 2: the endosteal margin of the basilar bone cortex shows crescentic defects or 1 - 2 layers of cortical debris. C. Type 3: endosteal margin shows numerous (> 3) cortical debris and is obviously porous (Medimagis collection).

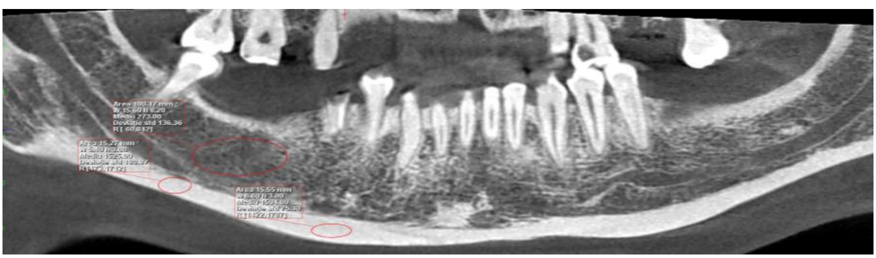


Fig. 3. CBCT evaluation of cortical and trabecular bone density in the regions of interest (Medimagis collection)

Statistical analysis

Data were analyzed with a statistical software package (*SPSS* version 20.0, SPSS Inc, Chicago, IL). Statistical tests were used to measure the differences between mandibular bone quality, bone mineral density at the level of the mandible: frequencies (%), average values, minimum and maximum values, ANOVA and Kruskal-Wallis test. Comparisons were made between groups. Statistical significance was established at p=0.05.

RESULTS

Both the right lower mandibular index (F=0.0018, p=0.892) and the left lower mandibular index (F=0.323, p=0.5729) show comparable values without significant differences in the case of G2 patients compared to G1 patients (tab. I).

TABLE I.

Statistical indicators for IMI $_{right}$ /$_{left}$ values. *vs*. groups

	Group	Av. IMI	Average -95%	Average +95%	SD	SE	Min	Max	Q25	Median	Q75
IMI right	G1	0.45	0.29	0.62	0.31	0.08	0.11	0.98	0.14	0.40	0.78
	G2	0.44	0.34	0.54	0.24	0.05	0.18	0.90	0.23	0.43	0.61
IMI left	G1	0.44	0.29	0.59	0.29	0.07	0.12	0.89	0.15	0.38	0.74
	G2	0.48	0.39	0.58	0.22	0.04	0.20	0.91	0.27	0.46	0.64

The study of the values of the right upper mandibular index and the left upper mandibular index demonstrated the absence of significant differences depending on the group, the average values being in the case of G2 patients of IMS right → 0.50±0.32 SD and IMS left → 0.53±0.31 SD, and in the case of G1 patients, the average values were IMS right → 0.57±0.27 SD and IMS left → 0.59±0.25 SD (tab. II).

TABLE II.

Statistical indicators for IMS $_{right / left}$ values *vs*. groups

	Groups	Av. IMS	Average -95%	Average +95%	SD	SE	Min	Max	Q25	Median	Q75
IMS right	G1	0.50	0.33	0.67	0.32	0.08	0.14	0.99	0.17	0.44	0.80
	G2	0.57	0.46	0.69	0.27	0.05	0.19	0.98	0.29	0.57	0.80
IMS left	G1	0.53	0.37	0.70	0.31	0.08	0.17	0.98	0.21	0.46	0.82
	G2	0.59	0.48	0.69	0.25	0.05	0.21	0.98	0.33	0.63	0.76

The analysis of the values of the right chin index according to the type of treatment, demonstrates significant values (F=6.67, higher for patients with G2 (2.47±0.8 SD) compared to patients with G1 (1.67±0.8 SD).

The values of the left chin index are significantly (F=6.95, p=0.0121, 95% CI) higher in patients with G2 (1.8±1.13 SD) compared to the values recorded in patients with G1 (2.58±0.75 SD) (tab. III).

The study of the degree of association between the mandibular cortical index and the type of treatment demonstrated the presence of a significant correlation, with G1 patients presenting in a proportion of 25% the mandibular cortical index type 2, while G2 patients presented the mandibular cortical index type 2 in 58.33% of cases (r=-0.298, χ^2=8.46, p=0.0145, 95% CI) (fig. 4, tab. IV).

TABLE III.
Statistical indicators for IMn $_{right/left}$ values *vs.* groups

	Groups	Av. IMn	Average -95%	Average +95%	SD	SE	Min	Max	Q25	Median	Q75
IMn right	G1	1.67	1.05	2.29	1.17	0.29	0.20	4.20	0.65	1.60	2.55
	G2	2.47	2.13	2.81	0.80	0.16	1.20	3.50	1.80	2.70	3.25
IMn left	G1	1.80	1.20	2.40	1.13	0.28	0.30	3.80	0.80	1.90	2.70
	G2	2.58	2.27	2.90	0.75	0.15	1.40	3.80	1.90	2.80	3.25

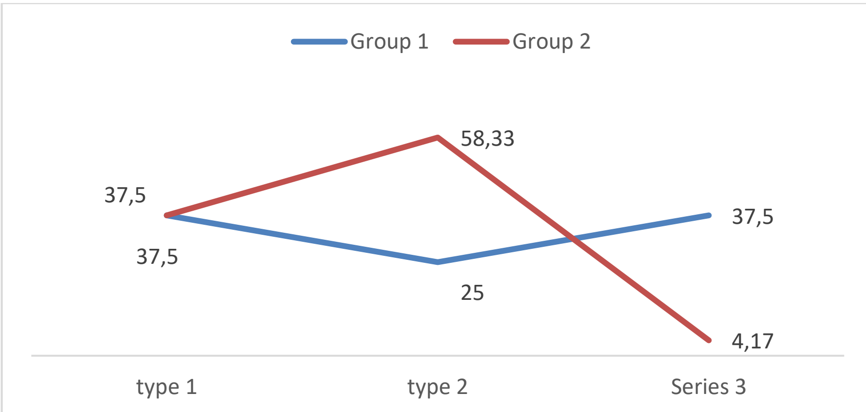


Fig. 4. Distribution of cases according to mandibular cortical index *vs.* groups

TABLE IV.
The estimated parameters in testing
the association of the mandibular cortical index *vs.* groups

df=2	Chi-square χ^2	p 95% CI
Pearson Chi-square - χ^2	8.465609	0.01451
M-L Chi-square	8.839532	0.01204
Correlation coefficient (Spearman Rank R)	-0.298507	0.23613

The analysis of the edentulous region according to type of treatment reveals the fact that in the case of G1patients the edentulous region is frequently found anteriorly, while in the case of G2 patients the edentulous region is found in the posterior region (fig. 5). These results demonstrate the significant association between type of osteoporosis treatment and the edentulous region (r=0.793, χ^2=8.83, p=0.00221, 95%CI) (tab. V).

The analysis highlighted the fact that in the case of G2 patients the cortical bone density values (704.38±352.1 SD) are significantly higher (F=4.38, p=0.0430, 95% CI) compared to the values corresponding to G1 patients (896.86±230.8 SD).

In the case of G2 patients, the cancellous bone density values (738.96±259 SD) do not show significant differences (F=3.607, p=0.065, 95% CI) compared to the values corresponding to G1 patients (562±359 SD). Since the distribution of values is not normal in this case, the results of the analysis considered the Kruskal-Wallis test, which is specific to these types of data (tab. VI).

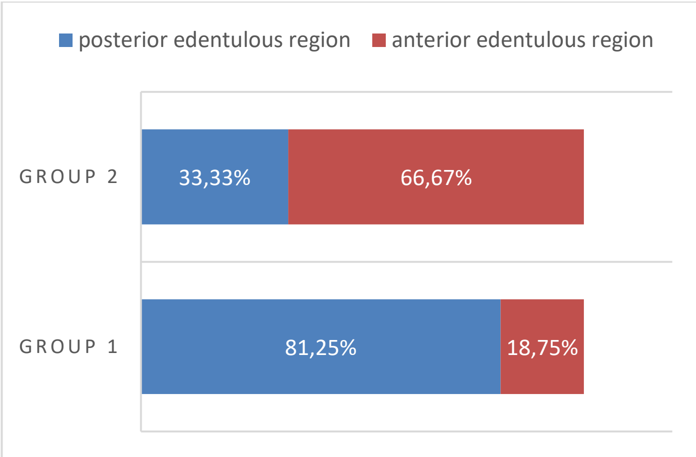


Fig. 5. Evaluation of the localization of mandibular edentation according to groups

TABLE V.

Estimated parameters in testing the association of mandibular bone density *vs.* groups

df=1	Chi-square χ^2	p 95% CI
Pearson Chi-square - χ^2	8.838763	0.00295
M-L Chi-square	9.356570	0.00222
Correlation coefficient (Spearman Rank R)	0.7931035	0.00221

TABLE VI.

The statistical indicators for the values of cortical bone density DOC (UH) and cancellous bone density (UH) *vs.* groups

	Groups	Value DOC/UH	Average -95%	Average +95%	SD	SE	Min	Max	Q25	Median	Q75
DOC	G1	704.38	516.74	892.01	352.12	88.03	234.00	1298.00	345.50	775.50	983.50
	G2	896.87	799.41	994.34	230.81	47.11	569.00	1298.00	716.00	967.00	1016.50
UH	G1	562.0	386.7	737.3	329.0	82.2	209.0	1267.0	234.0	499.5	856.0
	G2	739.0	629.6	848.3	259.0	52.9	430.0	1256.0	444.0	856.0	890.0

DISSCUSION

This study investigated the mandibular bone by applying two different radiological techniques whose results were compared. His aim was to assess the quality and quantity of mandibular bone in a population of treated and untreated patients with osteoporosis, as the quality and quantity of mandibular bone is of particular importance in certain dental treatments.

Bones differ in anatomical structure, with a different distribution of trabecular and cortical bone. Trabecular bone has a larger surface area and responds more rapidly to metabolic changes than cortical bone (12). The changes that can occur in the thickness of the mandibular cortex and the occurrence of systemic osteoporosis at the level of the skeleton have been studied by numerous researchers (6).

Preoperative CBCT measurements will give the practitioner useful information on bone quality and amount. Radiomorphometric indices developed for CBCT pictures were utilized for quantitative and qualitative examination of the mandible, and the findings obtained were significant for the study's goal.

In the case of G2 patients compared to G1 patients, the lower mandibular index reveals comparable values with no significant changes. The upper mandibular index showed no significant variations based on the group, with average values in all six groups.

The examination of the values of the right chin index based on treatment type reveals that patients with G2 had significantly greater values for both sides than patients with G1.

The findings revealed a substantial relationship between the mandibular cortex index and the kind of therapy, with G1 patients exhibiting the mandibular cortical index type 2 in 25% of instances and G2 patients exhibiting the mandibular cortical index type 2 in 58.33% of cases.

The examination of the edentulous region based on treatment type indicates that in the case of G1 patients, the edentulous region is usually located anteriorly, but in the case of G2 patients, the edentulous region is frequently found posteriorly. In our investigation, we discovered a strong relationship between the kind of osteoporosis therapy and the edentulous area.

Cortical bone density readings in G2 patients are substantially greater than values in G1 patients. There are no statistically significant differences in cancellous bone density values across groups.

The fact that the parameters obtained in the group of patients receiving osteoporosis therapy were lower than in the group of participants with osteoporosis but not receiving treatment may be explained through the lens of the kind of drug supplied and the course of osteoporosis. Several studies have been conducted to demonstrate the function of antiresorptive medicine in enhancing bone density

Thus, Bouxsein *et al.* (13) discovered increases in bone mineral density following raloxifene therapy, as well as a substantial reduction in fracture risk. According to Nils Heim *et al.*, (14) the impacts on bone density and microarchitecture are restricted to cortical bone and not cancellous bone. This is because bone remodeling is dependent on a balance of osteoclastic (bone-resorbing) and osteoblastic (bone-formation) activity. Antiresorptive drugs inhibit osteoclasts and reduce bone resorption by binding to active areas of bone remodeling. In the absence of therapy, bone density drops by 1.8% in the first 5 years after start, and the average N-telopeptide of cross-linked collagen type 1 is reduced by 70% below baseline, according to Bone *et al.*

The group sizes were one of the stud's limitations. More research with a bigger sample size, as well as an evaluation of the association between CBCT findings and BMD of other bone locations in osteoporosis patients, are required.

CONCLUSIONS

CBCT is a 3D type of imaging method used in dentistry. The CBCT approach gives adequate radiographic information to assist dentists and oral and maxillofacial surgeons in the early detection of mandibular osteoporosis. Furthermore, this study reveals that the density of mandibular bone is directly connected to changes in the density and, implicitly, the status of the skeleton in individuals with osteoporosis, as measured by bone osteodensitometry.

CONFLICT OF INTEREST AND FUNDING

The authors declare that there is no conflict of interest, and they received no specific funding regarding this scientific research.

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