New mandibular indices in cone beam computed tomography to identify low bone mineral density in postmenopausal women

Sâmila Gonçalves Barra, DDS, MSc,[a] Isadora Pereira Gomes, DDS,[b]
Tânia Mara Pimenta Amaral, DDS, MSc, PhD,[c] Cláudia Borges Brasileiro, DDS, MSc, PhD,[c]
Lucas Guimarães Abreu, DDS, MSc, PhD,[d] and Ricardo Alves Mesquita, DDS, MSc, PhD[e]

Objective. The aim of this study was to evaluate new radiomorphometric indices in cone beam computed tomography (CBCT) for assessing bone mineral density (BMD) status in postmenopausal women.

Study Design. Mandibular inferior cortical bone thickness was evaluated in 48 postmenopausal women in cross-sectional images at 4 sites: (1) symphysis (S): cross-sectional image equidistant from the centers of the right and left mental foramina (MF); (2) anterior (A): 10 mm anterior to the MF; (3) molar (M): 10 mm posterior to the MF; and (4) posterior (P): 25 mm posterior to the MF. Participants underwent dual-energy x-ray absorptiometry and were divided into normal, osteopenia, and osteoporosis groups. In the study, *t* tests with Bonferroni correction were conducted. Statistical significance was set at $P < .017$. Receiver operator characteristic (ROC) analyses were performed.

Results. Mean S index was significantly lower in osteoporosis than in osteopenia ($P = .005$). Mean M index was significantly lower in osteopenia ($P < .001$) and osteoporosis ($P = .001$) than in normal individuals. Mean P index was significantly lower in osteoporosis than in normal patients ($P = .008$). ROC values ranged between 0.643 and 0.740. Cortical thicknesses separating normal from abnormal varied from 1.73 mm to 3.37 mm.

Conclusions. M and P indices in CBCT may be useful for identifying low BMD in postmenopausal women. (Oral Surg Oral Med Oral Pathol Oral Radiol 2021;131:347−355)

Osteopenia and osteoporosis are conditions characterized by reduction in bone mass, increasing the risk of bone fractures. They mainly affect postmenopausal women, in whom a marked reduction in bone mineral density (BMD) is common. The mechanism through which BMD is reduced in these diseases has not been fully elucidated, but it is known that changes in hormone levels may affect bone remodeling rates.[1,2] Dual-energy x-ray absorptiometry (DXA) is regarded as the gold standard for BMD measurement.[1] DXA is a simple and noninvasive method, but the high cost makes the application of this tool unfeasible for routine examination.[3-5]

Radiomorphometry consists of bone evaluation by means of quantitative and qualitative measures in imaging examinations.[6] Previous studies have investigated the relationship of these indices in panoramic radiography and cone beam computed tomography (CBCT) to BMD values obtained by DXA. Radiomorphometric indices have been demonstrated to be predictive tools for osteopenia and osteoporosis in many studies.[4,5,7-22] These radiographic examinations, commonly used in dental practice, are substantially cost effective.

Most studies of BMD status have used measurements of radiomorphometric indices in the mental foramen (MF) region of panoramic radiographic images.[4,7,9-22] The same region has been evaluated by means of quantitative indices in studies with CBCT, which provides images of anatomic structures without overlap, magnification, or distortion and allows 3-dimensional examination of the craniofacial architecture.[5,8,20,21] According to the literature, the MF region is not modified by the influence of chewing muscles, and the identification of the MF is fixed, even in the presence of bone resorption in the alveolar bone. These characteristics make the MF region the standard area for BMD evaluation.[4] However, because osteopenia and osteoporosis are systemic conditions, changes in BMD may possibly be detected in other regions of the mandible.

[a]PhD student in Dentistry, Department of Oral Pathology and Surgery, School of Dentistry, Universidade Federal de Minas Gerais, Pampulha, Belo Horizonte/Minas Gerais, Brazil.
[b]MSc student in Dentistry, Department of Oral Pathology and Surgery, School of Dentistry, Universidade Federal de Minas Gerais.
[c]Adjunct Professor, Department of Oral Radiology, School of Dentistry, Universidade Federal de Minas Gerais.
[d]Adjunct Professor, Department of Pediatric Dentistry and Orthodontics, School of Dentistry, Universidade Federal de Minas Gerais.
[e]Professor, Department of Oral Pathology and Surgery, School of Dentistry, Universidade Federal de Minas Gerais, Pampulha, 31270-010 Belo Horizonte/Minas Gerais, Brazil.
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Statement of Clinical Relevance

Osteopenia and osteoporosis are systemic diseases characterized by decreased bone mineral density (BMD). New radiomorphometric indices in mandibular cone beam computed tomography may be useful in the identification of BMD in postmenopausal women.

Evaluations of quantitative indices in CBCT of other areas beyond the mental foramen region have not been published. The acquisition of CBCT images may be performed for diagnosis and treatment planning in various regions of interest to the health care provider in oral and maxillofacial radiology. Therefore, a study investigating BMD in areas other than the MF region in CBCT is worthwhile.

This study aimed to determine the potential use of 4 new radiomorphometric indices distributed across the mandible in CBCT examinations for assessment of BMD in postmenopausal women. The null hypothesis stated that the 4 new indices would have no significant correlation with BMD. We hypothesized that significant correlations would be found and the radiomorphometric indices may, therefore, be used to identify women with low BMD.

MATERIALS AND METHODS

Participants, setting, period of recruitment, and ethical issues

The study included postmenopausal women who had been referred to the Oral and Maxillofacial Radiology Service of the School of Dentistry, Federal University of Minas Gerais, Belo Horizonte, Brazil, with request for CBCT of the mandible to assess the bone for dental implant placement. The age of the women selected was between 51 and 83 years. The recruitment of participants occurred randomly between 2014 and 2016. The analyses of the present study were performed in 2018. Participants signed an informed consent form and answered a questionnaire regarding their general health. Exclusion criteria were a history of ovariectomy, metabolic bone disease, hyperparathyroidism, hypoparathyroidism, diabetes, osteomalacia, or kidney disease; use of medications that might have affected bone metabolism; hormone replacement therapy and diet supplementation with calcium and vitamin D because of the possible influence on bone metabolism. Patients with missing data and those who had undergone CBCT examination wherein assessment of the area was unfeasible were also excluded.

A total of 58 postmenopausal women had undergone imaging tests and 10 were excluded for the reasons listed in the exclusion criteria. Thus, 48 individuals participated in the study. The mean age of the 48 participants was 61.4 ± 8.2 years.

This study was approved by the Institutional Ethics Committee of the Federal University of Minas Gerais (35869714.5.0000.5149).

BMD assessment

Patients who agreed to participate in the study had already undergone DXA for BMD assessment. These postmenopausal women had undergone BMD assessment with the use of the Hologic Discovery DXA System (Hologic Inc., Bedford, MA). Patients were submitted to the positioning and analysis procedures recommended by the International Society for Clinical Densitometry.[23] Room temperature was maintained at 20°C to 23°C. Quality assurance procedures described in the manufacturer's manual were performed on a daily-operation basis. Clothes and other removable artifacts were fully removed before each examination.

The lumbar spine (L1-L4) and proximal femur (neck and total) regions were examined in all patients. To be accepted for the analyses, the lumbar acquisitions had to have at least 2 readable vertebrae and the proximal femur had to have the femoral neck and the total femur regions of interest (ROIs) correctly exposed, with their reading boxes correctly placed. Proximal femur internal rotation was obtained with the aid of a positioning device that accompanies the densitometer. A leg cushion device was used to attenuate lumbar spine lordosis. A single operator performed and analyzed all examinations.

The eligible vertebrae within L1−L4 were analyzed for lumbar spine evaluation. The lowest ROI T-score between the neck and the total femur was considered for assessment of the proximal femur. The lowest T-score between the lumbar spine and the proximal femur was used for the diagnosis. The BMD absolute values in grams per centimeter squared (g/cm^2) were compared to determine the BMD-monitored differences among the examinations of each patient. Least significant change with 95% statistical significance at an absolute variation of 0.022 (L1−L4) and 0.033 (total femur) in g/cm^2 was calculated according to the precision assessment procedures recommended by the International Society for Clinical Densitometry.[23] BMD was calculated by using the enCORE program (version 14.1) (GE Healthcare, Madison, WI). This system was used to review and reanalyze each acquisition and was included in the final data analyses.

On the basis of the DXA scores and World Health Organization (WHO) criteria,[1] participants were assigned to 3 groups according to the score obtained: (1) normal individuals (T-score ≥ -1); (2) individuals with osteopenia ($-1 >$ T-score > -2.5); and (3) individuals with osteoporosis (T-score ≤ -2.5).

Sample size calculation

Sample size calculation was performed with the Power and Sample Size program (PS, version 3.0, Nashville, TN). Sample size was based on a previous study,[21] in which a comparison was made between postmenopausal women with osteoporosis and those without osteoporosis with respect to the computed tomography mandibular index

(CTMI). Assessment of the CTMI in that study was carried out with CBCT. Mean values and standard deviations (SDs) were provided. The difference in mean CTMI between the postmenopausal women with osteoporosis and those without osteoporosis was 0.68 (SD 0.67). Considering a type I error of 5% and a study power of 80%, 16 individuals in each group would be necessary to reject the null hypothesis that there is no difference between the groups. Therefore, the sample of our study was composed of 48 participants: 16 normal postmenopausal women; 16 postmenopausal women with osteopenia; and 16 postmenopausal women with osteoporosis, whose BMD status was determined by DXA and which served as the gold standard against which the radiomorphometric index classifications were evaluated.

CBCT image acquisition

CBCT images were acquired with a KODAK 9000 C 3-D system (Kodak Dental Systems, Carestream Health, Atlanta, GA). This instrument had a 0.076 mm voxel size, field of view of 50 mm in diameter × 37 mm in height, 72 kVp tube voltage, 10 mA tube current, and a scanning time of 32.4 seconds. CS Imaging v. 7.0.3 (Carestream Health, Atlanta, GA) was used for image access. The CBCT examinations were saved in the DICOM (Digital Imaging and Communications in Medicine) format in the Trophy DICOM 6.3.0.0 (Carestream Dental, Atlanta, GA) database. The DICOM files were processed by using Imaging Studio 3.2 (Anne Solutions, São Paulo, SP, Brazil). The CBCT examination results were evaluated, and the measurements were defined by using the Implant Viewer program version 3.5 (Anne Solutions, São Paulo, SP, Brazil). Analyses of all images were carried out on a single 15-inch LG monitor (LG Electronics, Taubaté, Brazil) in a room with dimmed lighting. The time elapsed between DXA assessment and the acquisition of CBCT images was less than 15 days.

Radiomorphometric indices in CBCT

The radiomorphometric indices were measured in CBCT cross-sectional images of the mandible by using slice thicknesses of 1 mm with 1 mm interslice intervals. A line parallel to the base of the mandibular cortical bone and a line parallel to the border between the medullary bone and the cortical bone were drawn. The measurement of the index was defined as the length of a perpendicular line connecting these 2 lines. The following indices were calculated:

Symphysis index (S): Representing the thickness in millimeters of the inferior cortex of the mandible in the cross-sectional image equidistant from the centers of the right and left MF (Figure 1A).

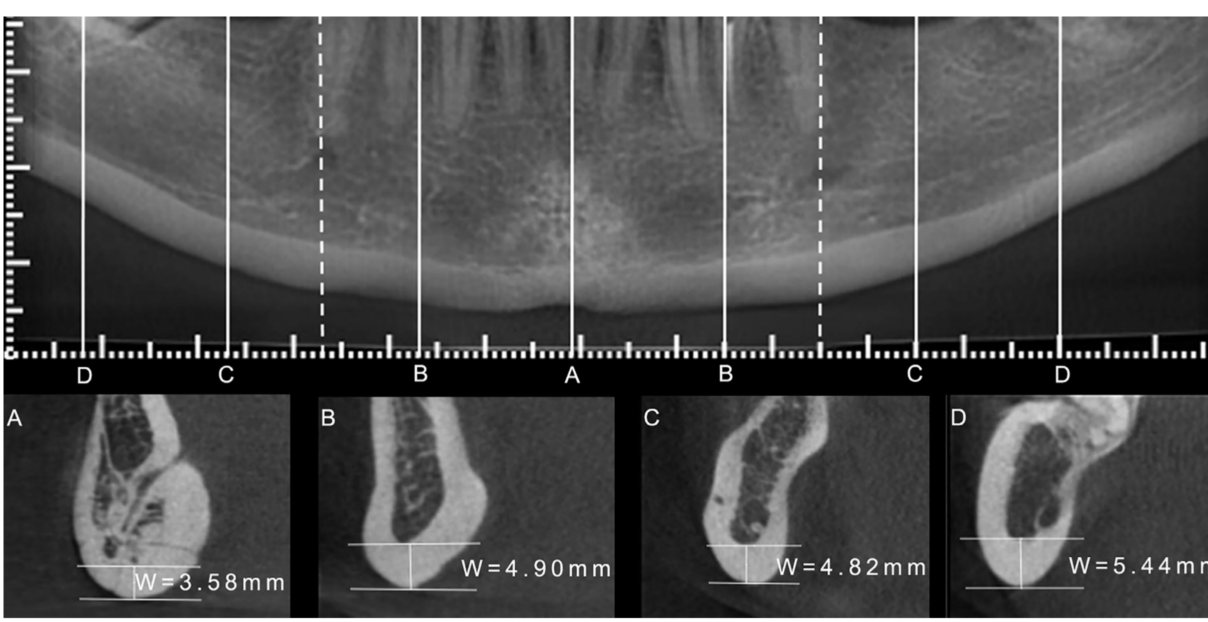

Fig. 1. Radiomorphometric index measurements. The vertical lines in the panoramic reconstruction represent the sites of measurements of the indices. The dotted lines represent the mental foramen on each side. **A,** Symphysis *(S)*: Representing the thickness of the inferior cortex of the mandible in the cross-sectional image equidistant from the centers of the right and left mental foramina. **B,** Anterior *(A)*: Representing the thickness of the inferior cortex of the mandible in the cross-sectional image 10 mm anterior to the cross-sectional image through the mental foramen. **C,** Molar *(M)*: Representing the thickness of the inferior cortex of the mandible in the cross-sectional image 10 mm posterior to the cross-sectional image of the mental foramen. **D,** Posterior *(P)*: Representing the thickness of the inferior cortex of the mandible in the cross-sectional image 25 mm posterior to the cross-sectional image through the mental foramen.

Anterior index (A): Representing the thickness in millimeters of the inferior cortex of the mandible in the cross-sectional image 10 mm anterior to the cross-sectional image through the MF (Figure 1B).

Molar index (M): Representing the thickness in millimeters of the inferior cortex of the mandible in the cross-sectional image 10 mm posterior to the cross-sectional image through the MF (Figure 1C).

Posterior index (P): Representing the thickness in millimeters of the inferior cortex of the mandible in the cross-sectional image 25 mm posterior to the cross-sectional image through the MF (Figure 1D).

Measurements were made on both sides of the mandible and the mean value of the 2 measurements represented the value of the index for statistical analysis.

Examiner training and calculation of the error method

A researcher who was unaware of the patients' BMD status assessed the radiomorphometric indices. This examiner, who was trained by an oral and maxillofacial radiologist with greater than 10 years of experience in analyzing dental examinations, performed the measurements. The training consisted of the study of 18 CBCT examinations of women who were not included in the study. These CBCT examination results were selected from records available at the service and included 6 CBCTs of normal individuals, 6 of individuals with osteopenia, and 6 individuals with osteoporosis. The examiner and the oral and maxillofacial radiologist were blinded to the BMD conditions of these 18 patients, and interexaminer agreement was determined. The 18 images were re-evaluated 15 days later to determine intraexaminer agreement. Intraclass correlation coefficient values for measurements of inter- and intra-examiner agreements were greater than 0.80.

Before the start of the study, the error method was also evaluated for the examiner who would perform the measurements. Systematic error was assessed by means of the paired t test, and random error was determined by using the Dahlberg formula.[24] The results of the paired t tests yielded $P > .05$, indicating no systematic error. The random error results ranged between 0.005 and 0.050 mm.

Statistical analysis

The Statistical Package for the Social Sciences version 17.0 (SPSS for Windows, SPSS Inc., Chicago, IL) was used for data analysis, and descriptive statistics were performed. Three pair-wise comparisons of indices were carried out: (1) comparison between normal individuals and individuals with osteopenia, (2) between normal individuals and individuals with osteoporosis, and (3) between individuals with osteopenia and individuals with osteoporosis. The Student t test was employed. Bonferroni's correction was applied to avoid a type I error of incorrectly rejecting the null hypothesis because of the use of 3 pair-wise comparisons. The α level of 0.05 was divided by 3, and the statistical significance for each pair-wise comparison was, therefore, set at $P < .017$.

For the pair-wise comparisons of indices with statistically significant differences between groups, receiver operator characteristic (ROC) analyses were carried out with the MedCalc software (MedCalc Software BVBA, Ostend, Flanders, Belgium). The area under the ROC curve (AUC), 95% confidence interval (CI), sensitivity, and specificity were calculated. The Youden index was used to determine the index test value of measured cortical thickness which, when used as the threshold discriminator or cutoff point between the 2 groups, yielded the best combination of sensitivity and specificity.

RESULTS

Table I lists the mean values in millimeters of the 4 radiomorphometric indices in the 3 BMD groups and the significance levels of the difference in mean values for the 3 pair-wise comparisons. There was no statistically significant difference in mean values of the S index between normal

Table I. Mean values (with standard deviations) in millimeters of the radiometric indices for the normal, osteopenia, and osteoporosis groups

Indices	*Normal (Mean ± SD)*	*Osteopenia (Mean ± SD)*	*Osteoporosis (Mean ± SD)*	*Normal × Osteopenia (P value)*	*Normal × Osteoporosis (P value)*	
				Osteopenia × Osteoporosis (P value)		
S	3.69 ± 1.47	3.85 ± 1.34	2.57 ± 1.06	.746	.019	.005*
A	4.24 ± 0.84	3.72 ± 0.47	3.62 ± 0.56	.037	.019	.590
M	4.11 ± 0.75	3.22 ± 0.36	3.24 ± 0.62	< .001*	.001*	.914
P	3.73 ± 0.73	3.08 ± 0.90	2.99 ± 0.76	.031	.008*	.760

*Statistically significant difference in the Student t test with Bonferroni's correction at $P < .017$.*A,* anterior index; *M,* molar index; *P,* posterior index; *S,* symphysis index.

individuals and those with osteopenia (P = .746) or between normal individuals and those with osteoporosis (P = .019). However, the mean S index was significantly lower in the osteoporosis group than in the osteopenia group (P = .005). There was no statistically significant difference in mean A index values between any of the groups ($P \geq .019$). The mean M index was significantly lower in individuals with osteopenia ($P < .001$) and those with osteoporosis (P = .001) than in normal individuals, but there was no significant difference between the osteopenia and osteoporosis groups (P = 0.914). The mean values of the P index were significantly lower in osteoporotic individuals than in normal individuals (P = .008). No significant difference with respect to the mean P index was observed between individuals with osteopenia and normal individuals (P = .031) or between the osteopenia and osteoporosis groups (P =.760).

ROC analyses for pair-wise comparisons between groups that had significantly different mean index values are illustrated in Figure 2. The AUC values, 95% CI, sensitivity, specificity, Youden index, and cutoff points of cortical thickness established to separate the 2 groups based on the radiomorphometric values are listed in Table II. The comparison of the S index between individuals osteopenia and those with osteoporosis yielded an AUC of 0.680 (see Figure 2A), with a cutoff cortical thickness of 1.73 mm distinguishing osteopenia from osteoporosis. For the comparison of the M index between normal individuals and those with osteopenia, the AUC was 0.643 (see Figure 2B) when the cutoff point between the 2 groups was 3.37 mm. For the comparison of the M index between normal individuals and those with osteoporosis, the AUC was 0.740 (see Figure 2C) when the cutoff point was 2.64 mm. Comparison of the P index between the normal and osteoporosis groups resulted in an AUC value of 0.693 (see Figure 2D) with a cutoff point of 2.84 mm.

Sensitivity ranged between 50% for the comparison of the S index between individuals with osteopenia and osteoporosis and 93.7% for the comparison of M index values between normal individuals and those with osteopenia. The specificity ranged from 37.5% for the comparison of the M index between normal individuals and those with osteopenia to 87.5% for the comparison of the S index between the osteoporosis and osteopenia groups.

DISCUSSION

This study examined the potential use of different radiomorphometric indices in CBCT examinations of the mandible for evaluation of BMD in postmenopausal women. The results demonstrated that M and P indices are promising tools in CBCT of the mandible for the assessment of BMD in postmenopausal women. These indices exhibited significant differences among patients with normal BMD and those with osteopenia and/or osteoporosis.

The most commonly used quantitative indices for the determination of low BMD in the MF region are the panoramic mandibular index (PMI)[4,9] and the mental index (MI), also known as the mandibular cortical width (MCW).[10] The PMI was presented by Benson et al.[4] as the ratio between the thickness of the inferior cortex in the mental region and the distance from the MF to the inferior border of the mandible. Individuals with reduced BMD have PMI values lower than 0.3.[11,12] The MI[9] or MCW[10] is the mean of the widths of the inferior cortex in the region below the 2 MFs. Values of the MCW used as a basis for referral of patients have been published. One study reported values less than 3 mm[13] and other studies reported values less than 4 mm.[14,15] Therefore, the literature indicates that MCW values lower than 4 mm would suggest the need for referral of individuals for BMD measurement. An adapted version of these measures has greatly contributed to the quantitative indices used in CBCT.[5,8,20,21] The new indices in CBCT proposed in this study are very similar to the MCW used in panoramic radiographs, but in different locations in the mandible. Similar to the radiomorphometric indices in panoramic radiographs, the CBCT indices had lower values in patients with low BMD compared with healthy individuals.[5,8,20,21]

The MF region is not only an anatomic region that can be easily identified on dental radiographs but also a region that is not susceptible to the impact of chewing forces in masticatory muscles because no muscle has its origin or insertion in this area.[4] The distance between the MF and the inferior border of the mandible is relatively constant, even with the presence of bone resorption above the MF. Therefore, the distance between the MF and the inferior border of the mandible is a suitable measurement in the identification of individuals with low BMD.[9-15]

Anatomic areas other than the MF have been used to evaluate BMD on panoramic radiographs, including the angle of the mandible and the region posterior to the MF.[7,12,25,26] However, with respect to the usefulness of such areas, the results have been unsatisfactory, possibly because of the limitations of the panoramic image.[9,22] Panoramic radiography is a 2-dimensional examination with inherent shortcomings, such as overlap, distortion, and magnification of the images. These limitations make the identification of anatomic structures difficult, hampering the determination of the accuracy of radiomorphometric index measurements.[4,7] CBCT allows 3-dimensional examination of anatomic structures by means of detailed and high-quality reformatted radiographic images, without the drawbacks of panoramic radiographs.[8,20] Moreover, CBCT has the advantage of exposure protocols with a smaller field of view, which can result in a lower dose of radiation to patients.

Koh and Kim[20] performed the first study using CBCT to evaluate mandibular measurements for the detection of BMD in postmenopausal women.

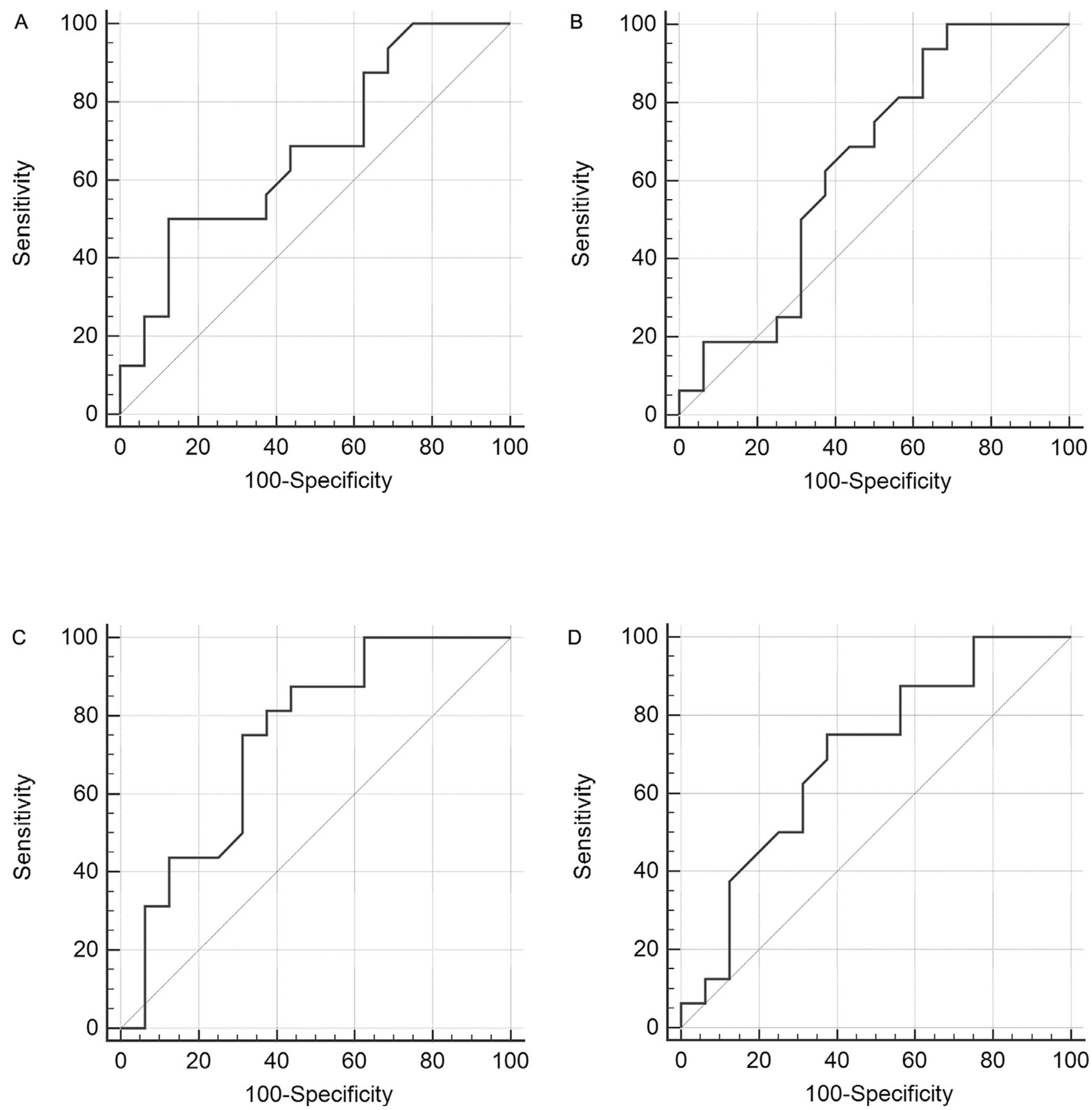

Fig. 2. Receiver operator characteristic (ROC) analyses for the pair-wise comparisons of indices with statistically significant difference. **A,** Comparison of the S index between individuals with osteopenia and osteoporosis . **B,** Comparison of the M index between normal individuals and those with osteopenia. **C,** Comparison of the M index between normal individuals and those with osteoporosis. **D,** Comparison of the P index between normal individuals and those with osteoporosis.

Table II. Assessment of the area under the curve, 95% confidence interval, sensitivity, specificity, Youden index, and the cutoff points

	Area under the curve	*95% confidence interval*	*Sensitivity*	*Specificity*	*Youden index*	*Cutoff point (mm)*
S Index (Osteopenia × Osteoporosis)	0.680	0.492−0.833	50.0%	87.5%	0.375	1.73
M Index (Normal × Osteopenia)	0.643	0.454−0.803	93.7%	37.5%	0.312	3.37
M Index (Normal × Osteoporosis)	0.740	0.555−0.878	75.0%	68.7%	0.437	2.64
***P* Index** (Normal × Osteoporosis)	0.693	0.506−0.843	75.0%	62.5%	0.375	2.84

M, molar; *mm,* millimeters; *P,* posterior; *S,* symphysis.

Subsequently, other investigators evaluated the same region of the MF in CBCT images.[5,8,21] Our study evaluated different regions in the mandible, including 10 mm anterior, 10 mm posterior, and 25 mm posterior to the foramen, in an attempt to determine if these other sites can provide reliable results to identify low BMD in postmenopausal women. Therefore, with the validation of these new indices, the screening of patients for low BMD is feasible, even when the assessment of the MF region on the examination is hampered or impossible. Koh and Kim evaluated 2 groups of postmenopausal women who were of similar age, as were the participants in our study. One group consisted of women with normal BMD, and the other group was composed of women with osteoporosis. The CTMI, which corresponds to the width of the mandibular cortex in the MF region, was calculated. In our study, however, the width of the mandibular cortex was evaluated in 4 new regions. Koh and Kim obtained lower mean values in individuals with decreased BMD (2.33 mm) compared with mean values for individuals in the normal group (3.22 mm) but no statistically significant differences were observed.[20] A comparison of the CTMI in the region of the MF between individuals with normal BMD and individuals with osteoporosis was also conducted in the study by Mostafa et al.[21] The mean values of CTMI in the osteoporosis group (3.75 mm) were significantly lower than those in the normal BMD group (4.43 mm). Unlike in the research of Koh and Kim and of Mostafa et al.,[20,21] women with low BMD who participated in our study were divided into 2 groups—that is, the osteopenia and osteoporosis groups. Significant differences were seen between the normal group and the osteoporosis group in the M and P indices and between the normal group and the osteopenia group with the M index. For the S or A indices, no significant differences between the normal group and the osteoporosis and/or the osteopenia groups were observed.

Brasileiro et al.[5] and Gungor et al.[8] measured radiomorphometric indices on cross-sectional CBCT images bilaterally in the region of the MF and also distributed the participants of their studies across 3 groups: normal BMD, osteopenia, and osteoporosis groups. Brasileiro et al.[5] found significant differences between the normal and osteopenia groups, between the osteopenia and osteoporosis groups, and between the normal and osteoporosis groups. Gungor et al.[8] found lower CTMI values in the osteoporosis group (2.76 mm) in comparison with the osteopenia (3.42 mm) and normal (3.62 mm) groups. However, the difference between the normal BMD and osteopenia groups was not statistically significant. Unlike the present investigation, Gungor et al.[8] did not report whether their study had been performed only with postmenopausal women and whether there were discrepancies between the normal BMD group and the osteopenia and osteoporosis groups. Thus, the findings of Gungor et al.[8] may not have reflected the changes caused by osteoporosis because other factors, such as increased age, have been significantly correlated with a lower mandibular thickness.[16,20]

In the present study, there were no significant differences between the groups for the mean A index values ($P \geq .019$). There were no significant differences in the S index values between the normal group and the osteopenia group or between the normal group and the osteoporosis group ($P \geq .019$). There was a significant difference in the S index between the osteopenia and osteoporosis groups. However, for this last comparison, the sensitivity was low (50%), indicating a higher number of false-negative results, but the specificity was high (87.5%), indicating the occurrence of a small number of false-positive results. The anterior region of the mandible consists of bone with greater density compared with the posterior region of the mandible.[27] In the groups of individuals with low BMD, reduction in the mandibular cortical thickness in the area was observed, and the identification and examination of the superior cortex of the mandible were easier; this was helpful in measuring the index. In contrast, in groups of individuals with normal BMD, the mandibular cortical thickness did not change, and the identification and measurement of the S index were more difficult because of problems in assessing the superior cortex of the mandible in a region with high bone density.

The comparison of the mean values of the M index between the normal and osteopenia groups showed high sensitivity (93.7%), reflecting the possibility of few false-negative results, but low specificity (37.5%), indicating the likelihood of a high number of false-positive results, when the cutoff point between these groups was set at a cortical thickness of 3.37 mm. Mean values of the M and P indices were significantly lower in the osteoporosis group than in the normal group, corroborating the results of previous studies with CBCT.[5,8,20,21] In these 2 comparisons, the indices also showed satisfactory values of sensitivity (75% for both) and specificity (68.7% and 62.5%, respectively) and the best values in relation to AUC (0.740 and 0.693, respectively). These values were calculated on the basis of cutoff points of cortical thickness that were very similar: 2.64 mm for the M index and 2.84 mm for the P index. This shows that the indices posterior to the MF provided better results for the identification of patients with low BMD compared with the indices anterior to the MF. This can be explained by the fact that the posterior regions are subject to a higher impact of masticatory forces[4] and are, therefore, more susceptible to bone changes and demonstrate the greatest impact of osteoporosis.

This study was conducted with a limited number of individuals from a specific population. Therefore, we should recognize that this may have led to a biased sample,[28] overestimating test performance.[29] Further studies in different populations and with larger sample sizes are needed. Our study has demonstrated that new quantitative CBCT indices in the mandible in the regions posterior to the MF proved to be effective in the identification of postmenopausal women with low BMD. When examining CBCT scans of postmenopausal women, oral health care providers should be aware of changes in bone density in the mandible. This tool and the cutoff points provided herein may be useful in determining referral of affected individuals for specific tests and treatment for osteopenia or osteoporosis.

CONCLUSIONS

Within the limitations of this study in terms of sample size, the M and P indices seem to enable distinction of patients with osteopenia or osteoporosis from those with normal BMD when using a mandibular cortical bone thickness of 3.37 mm to separate normal individuals from patients with osteopenia in the M index and values of 2.64 mm for the M index and 2.84 mm for the P index as the dividing point between normal individuals and patients with osteoporosis. If the MF region is not visualized on a CBCT scan, values for these indices below the cutoff points may prompt the dentist to refer patients for investigations to ensure a more accurate diagnosis and timely medical treatment.

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Reprint requests:

Sâmila Gonçalves Barra
Department of Oral Pathology and Surgery
School of Dentistry, Universidade Federal de Minas Gerais
Faculdade de Odontologia
sala 3202-D
Av. Antônio Carlos 6627
Pampulha − 31270- 010, Belo Horizonte
Minas Gerais − Brazil.
samilagbarra@gmail.com