Clinical and Laboratorial Research in Dentistry

Correlation between MCI/Sapori screening tools and DXA results and between MCI/Sapori and Frax tool for estimating fracture risk

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ABSTRACT | *Background*: Peripheral Dual-energy X-ray absorptiometry (DXA) can be applied to identify low bone mineral density (BMD) patients, however, DXA is not sufficiently available in many countries. Thus, the use of simpler and cheaper screening tools than DXA to detect low BMD become indispensable. *Objectives*: The objective of this study was to correlate São Paulo osteoporosis risk index (Sapori) and mandibular cortical index (MCI) screening tools with the femur DXA results of patients in our sample of Brazilian women. A secondary objective was to assess which of these screening tools better correlates with the results of the Frax tool. *Material and Methods*: Exams of women who had undergone panoramic radiographic examination at the beginning of dental treatment and peripheral DXA for screening osteoporosis from 2010 to 2014 were included. The MCI was evaluated, and Sapori and Frax were calculated with their available online software tools. Spearman correlation was performed to analyse the level of correlation between femur T-scores (and MCI and Sapori values, as well to perform the level of correlation between Frax and MCI and Sapori values. *Results*: The spearman correlation comparing the numerical T-score values and the categorical values of MCI (rs=-0.274), and of Sapori (rs=-0.470), showed a statistically significant inverse correlation for both equations ($p<0.01$). The Spearman equation comparing the values obtained with Frax and MCI did not show a statistically signifcant correlation ($p>0.01$). But the equation comparing the values obtained with Frax and Sapori showed a positive, moderate and statistically significant correlation between them (rs=0.460). *Conclusion*: MCI is not a reliable screening tool to identify women with low BMD or Osteoporosis, whereas more optimistic results were observed for the Sapori.

DESCRIPTORS | Osteoporosis; Panoramic Radiography; Bone Mineral Density; Brazil; Software Tools.

RESUMO | **Correlação entre as ferramentas de triagem ICM/Sapori com os resultados obtidos por Dexa e entre ICM/Sapori com a ferramenta Frax para avaliar o risco de fratura** • A Absorciometria bifotónica de raios X (Dexa) pode ser aplicada para identificar uma baixa densidade mineral óssea (DMO) em pacientes. No entanto, o exame de Dexa não está disponível em muitos países. Assim, o uso de ferramentas de triagem mais simples e mais baratas para detectar uma baixa DMO torna-se indispensável. Objetivos: O objetivo deste estudo foi correlacionar o índice de triagem de osteoporose de São Paulo (Sapori) e o índice cortical mandibular (MCI) com os resultados obtidos pelo Dexa de fêmur de pacientes em uma amostra de mulheres brasileiras. Como objetivo secundário, avaliar qual dessas ferramentas de triagem se correlaciona melhor com os resultados obtidos pela ferramenta Frax. Material e Métodos: Foram incluídos exames de mulheres que foram submetidas a exames radiográficos do tipo panorâmico no início de seus tratamentos odontológicos, e a exames de Dexa periférica para rastreamento de osteoporose entre 2010 a 2014. O ICM foi avaliado e o Sapori e o Frax foram calculados através de suas ferramentas de *software* disponíveis. A Correlação de Spearman foi realizada para analisar o nível de correlação entre os valores de T-score obtidos do fêmur com os valores de ICM e Sapori, bem como para a correlação entre Frax e ICM e Sapori. Resultados: A Correlação de Spearman comparando os valores numéricos de T e os valores categóricos de ICM (rs=-0,274) e de Sapori (rs=-0,470) mostraram uma correlação inversa e estatisticamente significante para ambas as equações ($p<0,01$) e a equação de Spearman comparando os valores obtidos com Frax e ICM não apresentaram correlação estatisticamente significante ($p>0,01$), mas a equação comparando os valores obtidos com Frax e Sapori mostrou uma correlação positiva, moderada e estatisticamente significante (rs=0,460). Conclusão: O ICM não é uma ferramenta confiável para identificar mulheres com baixa DMO ou Osteoporose; resultados mais otimistas foram observados para a ferramenta Sapori.

DESCRITORES | Osteoporose; Radiografia Panorâmica; Densidade Óssea; Brasil; Doenças Ósseas Metabólicas.

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INTRODUCTION

One of the greatest challenges for society is to diagnose individuals with a predisposition to have low bone mineral density (BMD) or at increased risk of osteoporotic fractures. It has been frequently observed that the majority of the population is not correctly diagnosed or treated for low BMD.[1,2]

The primary method to measure BMD and diagnosis osteoporosis is dual X-ray absorptiometry (DXA).[3] Peripheral DXA can be applied to identify low BMD patients[4] as well. However, DXA is not sufficiently available[5] in many countries specially in some developing countries as Brazil[6]. Thus, the prevention of osteoporotic fractures by early diagnosis is often neglected[7]. In these countries, the use of simpler and cheaper screening tools than DXA to detect low BMD is indispensable.

In Dentistry, many researchers advocate that panoramic radiographs can be applied to screen patients with low BMD and, for instance, may need a DXA exam for confirmation.[8-11] Mandible BMD reduction and shape modification can be evaluated by radiomorphometric indices on panoramic radiographs, such as the Mandibular Cortical Index (MCI),[8,9,12,13] indicating changes of the skeletal bone density. The major advantages of panoramic radiograph are the low cost and low radiation patient exposure, and its is an examination that is always requested at the beginning of treatment.[14,15]

Several screening tools for low BMD have been developed in different countries aiming to detect individuals at significant risk of bone fractures or with a low BMD.[16] Due to the fact that osteoporosis affects mainly postmenopausal women,[17] different screening tolls have been developed in Europe, Asia and America.

These abovementioned screening tools considerate manifold risk factors for low BMD, such as ethnicity, age, weight, smoking, diet, physical activity, actual/past drug intake and/or the presence of metabolic diseases that may affect the bone metabolism. Their primarily objective is to integrate the risk factors into a single risk estimation software for the presence of low BMD or fracture risk.[18]

Frax tool for instance, might be calculated for men and women and it is easily used for the calculation of 10-year probability of a major osteoporotic fracture. The Frax software has been constructed considering the differences of nine different population based cohorts from around the world (North America, Europe, Asia and Australia).[19]

A Brazilian screening tool was also developed and published in 2012.[16] The São Paulo Osteoporosis Risk Index (Sapori) was created to identify women at higher low BMD risk.[16] Brazilian population is very mixed and heterogeneous, primarily due to past mass immigration, with unique ethnic characteristics.[20]

Many researchers have compared different low BMD screening tools with distinct populations.[21-25] A total of 39 tools for low BMD and fracture risk detection was identified and their diagnostic performance was evaluated,[26] but only 9 have external validation.[26] However, to our knowledge, Sapori hasn't been further studied or compared to other low BMD screening tools since its publication. Moreover, Brazilian physician's familiarity with the use of SAPORI or other screening tools are currently unknown. The objective of this study is to correlate the Sapori and MCI screening tools with the femur DXA results of the patients in our sample of Brazilian women. And thus, to evaluate which of these tools are more reliably correlated with the results of densitometry. A secondary objective is to assess which of these screening tools (Sapori or MCI) better correlates with the results of Frax tool, that it is a fracture risk assessment tool that shows the percentage of fracture risk in 10 years.[27]

MATERIALS AND METHODS

Study participants inclusion and exclusion criteria

Exams of women who had undergone panoramic radiographic examination at the beginning of

dental treatment and peripheral DXA for screening osteoporosis from 2010 to 2014 were included. Patients filled out a form with personal information (such as age, weight and height), lifestyle habits (alcohol, exercises, tobacco use) and complete medical history (for example: menopause, medication intake, comorbidities).

The exclusion criteria were considered: presence of metabolic diseases or history of medication intake affecting bone metabolism as well as tobacco or alcohol chronic use patients.

Dual x-ray absorptiometry

Bone densitometry measurements were carried out with peripheral DXA (pDexa, Norland, Norland Medical Systems, Inc., White Plains, NY, USA). The radiation dose was less than 0.03 mSv for each examination. Patients were diagnosed as normal or with low BMD/osteoporotic based on femur BMD values according to World Health Organization (WHO) criteria as normal (T score > -1.0), osteopenic/low BMD (T score, -1.0 to -2.5) and osteoporotic (T-score ≤ -2.5 SD).[28]

Panoramic radiographs

All digital panoramic radiographic images were taken using the same device (Kodak 8000, Eastman Kodak Company, Rochester, United States of America) and analysed using the same software (ImageJ, National Institute of Health, Bethesda, MD, USA). Radiographs with technical failures or pathological alterations (such as cystic lesions or tumors) in the mandibular cortical area were not included.

Mandibular cortical index

The MCI was evaluated by the appearance of the cortical bone at mandibular endosteal margin below the mentual foramen to second inferior molar region, using Klemetti et al. (1994)[9] classification in both sides of mandible (right and left). The appearance of the endosteal margin in inferior mandibular cortex was classified as follows:

C1 = normal, with well-defined endosteal margin without porosity or lacunar resorption (oval-shaped radiolucency near and above the margin or in the margin);

C2 = moderately eroded, when presenting lacunar resorption or endosteal linear cortical residues; multiple lacunar resorptions;

C3 = severely eroded, when clear lacunae or linear cortical residues or erosions were observed. Endosteal margin is not poorly evident.

Three observers with expertise in oral radiology made all panoramic radiomorphometric measurements within a consensus.

Frax® Tool analysis

The Frax model of Brazil is one of the 27 Frax models freely available. It is an online calculator based on clinical risk factors. Frax calculates a person's 10-year probability of a major osteoporotic fracture with or without the use of BMD values. For this study, the BMD values of patients were not included. Only one observer familiarized to the use of the tool did the analysis in the software for all women included in the study.

Sapori online tool

Only one observer made all the analysis with Sapori software for all patients included in this study. The interpretation of Sapori software is as follows: patients that had resultant values greater or equal to zero are indicated to undergo densitometry.

Statistical analysis

Spearman correlation was performed to analyse the level of correlation between femur T-scores and MCI values, as well to correlate femur T-scores and Sapori values.

For statistical correlation reasons, the values obtained by the Sapori software were categorized.

If the value was greater than or equal to zero, the patient was considered "sick". However, if the result was lower than zero the patient was considered healthy. The objective was to evaluate which of these tools is more reliable or closer to the femur DXA results.

And as a secondary objective, Spearman correlation was performed to analyse the level of correlation between Frax values and MCI values, as well to analyse the level of correlation between Frax values and Sapori values. In this way, it was possible to identify which of these screening tools – MCI or Sapori – better correlates with Frax tool that predicts the percentage of fracture risk in 10 years.

All statistical analyses were performed at a level of significance of 5%, using IBM SPSS Statistics 17, SPSS®, Inc, Chicago, IL.

RESULTS

The spearman correlation comparing the numerical T-score values and the categorical values of MCI and of Sapori, showed a statistically significant inverse correlation for both equations ($p<0.01$). However for the correlation between femur T-scores and MCI values the inverse correlation was weak ($rs=-0.274$), and for the correlation between T-scores and Sapori values, the inverse correlation was moderate ($rs=-0.470$).

The Spearman equation comparing the values obtained with Frax and MCI did not show a statistically significant correlation ($p>0.01$). Nonetheless, the equation comparing the values obtained with Frax and Sapori showed a positive, moderate and statistically significant correlation between them ($rs=0.460$) (Table 1).

Table 1 | Results of the statistical test correlating the screening tools and the values of femur T-scores.

Spearman Correlation				
	T-score x MCI	T-score x Sapori	Frax x MCI	Frax x Sapori
- Coefficient * - P value	rs = -0,274* p < 0.01	rs = -0.470* p < 0.01	rs = -0.107* p > 0.01	rs = 0,460* p < 0.01
Interpretation of the results	Inverse and weak correlation	Inverse and moderate correlation	Not statistically significant	Positive and moderate correlation

* rs = spearman correlation coefficient

DISCUSSION

Brazil is a very heterogeneous country, which implies different ethnicities and, consequently, different risk factors for low BMD and Osteoporosis. Moreover the access to DXA examination, that is essential for the final diagnosis of low BMD or osteoporosis, is still sparse for the population. The poor availability is due to high costs to patients, misinformation and for the fact that Osteoporosis is a disorder that evolves silently over time; constituting these abovementioned barriers for the feasibility to such testing in the country.[29]

Despite all difficulties of a developing country, there are some screening tools such as Sapori software and MCI that are simple, fast and valid tools for identifying women at higher risk for low BMD or osteoporotic disease.[16]

Notwithstanding, few studies have evaluated the reliability of these tools as indicators for the densitometry examination. In other words, few studies have tested their correlation with the results obtained with DXA, specially because Sapori is a designed tool to be used just for the Brazilian population.[16,30]

In this study, instead of performing Kappa test between observers, three observers with expertise in oral radiology made all MCI analysis within a consensus. And as Frax and Sapori are mathematical tools that automatically calculate the risk of fracture or low BMD, one single expertise in manipulating these software was responsible to enter each patients' risk factors in the available online software.

Spearman correlations showed that MCI is not a reliable screening tool to identify women with low BMD or Osteoporosis in this study – when correlated with femur t-scores a weak correlation was found between them, and when compared to the values obtained with Frax tool non-significant results were obtained. The lack or absence of statistical significance might be due to the sample size of this study or due to the fact that MCI it is a subjective examination. Others studies comparing MCI and DXA results have obtained better results.[8,31] A study evaluating 228 postmenopausal women concluded that T and Z-score values were significantly correlated with MCI (r=0.428, p=0.001 and r=0.356, p=0.22),[8] whereas in this study 96 women were evaluated and T-score value was weakly correlated with MCI values (rs=-0.274, p=0.007).

The results herein showed more optimistic results for the Sapori tool: a moderate correlation between Sapori and DXA and between Sapori and Frax values was obtained. Perhaps the moderate correlations found in both equations are because Sapori is mathematical software that operates through data of patient's risk factors as well as Frax tool. In other words, it is an objective examination that takes into consideration several risk factors of the same patient and not only one image of a specific region of the patient. Nevertheless, further researches with larger samples should be done to confirm the results obtained herein.

CONCLUSION

The results showed that MCI is not a reliable screening tool to identify women with low BMD or Osteoporosis, whereas more optimistic results were observed for Sapori tool.

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