Morphodigital Study of the Mandibular Trabecular Bone in Panoramic Radiographs

Estudio Morfodigital del Trabeculado Óseo Mandibular en Radiografías Panorámicas

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SUMMARY: The aim of this study was to correlate the morphodigital characteristics of the trabecular mandibular bone, in this way, it is possible to observe osteoporosis clue in patients of both sex, using panoramic radiograph for analysis. The results of this study showed statistical difference between men and women considering the bone trabecular measures ($p < 0.05$), but it was not found statistical difference between the sides in each analyzed group ($p > 0.05$). Male group presented a more strongly trabecular and complex bone than the female group, this finding is important index to osteoporotic risk, being possible to affirm that the male bone is less probable to suffer a osteoporotic fracture.

KEY WORDS: Mandible; Bone; Digital image; Radiograph.

INTRODUCTION

Osteoporosis is a condition characterized by a loss in bone mineral density and micro-architectural deterioration in bone tissue leading to fractures (Concensus, 1991; Link *et al.*, 1999). Since the disease is preventable, diagnostic techniques are of major importance (Link *et al.*, 1999). The earliest suggestion of an association between osteoporosis and oral bone loss was made in 1960 (Groen *et al.*, 1960). The dentist is often the most regularly visited doctor in the elderly population, and dental radiographs are the most frequently used imaging modalities for these patients. Various studies have demonstrated that individuals with osteoporosis have altered morphology of the mandible (Hildebolt, 1997; White, 2002). Some qualitative and quantitative indexes, including the mandibular cortical index (MCI), mandibular cortical thickness, or panoramic mandibular index (Horner & Devlin, 1998) have also been used for panoramic radiographs to assess the bone quality and to observe the signs of resorption and osteoporosis (Klemetti & Kolmakow, 1997). Previous studies have reported significant correlations between BMD measurement and mandibular cortical thickness or panoramic mandibular index (Klemetti & Kolmakow, 1997; Horner & Devlin, 1998a,b; Benson *et al.*, 1991).

A number of mandibular indices based on panoramic radiographs, and image processing and analyzing techniques have been developed to allow quantification of mandibular bone mass and trabecular architecture in order to discriminate individuals with osteoporosis from those without osteoporosis. Cortical width (CW) (Taguchi *et al.*, 1995b), panoramic mandibular index (PMI) (Benson *et al.*, 1991), alveolar crest resorption degree (M/M) ratio (Taguchi *et al.*, 1995a), cortical index (CI) (Klemetti & Kolmakow, 1997) and fractal dimension (FD) (Pothuaud *et al.*, 1998; Southard *et al.*, 1996) are among them. In various studies, it has been shown that the decreased bone mineral density (BMD) affects the morphometric (Taguchi *et al.*, 1995a,b; Klemetti & Kolmakow, 1997; Kribbs *et al.*, 1989), densitometric (Horner & Devlin, 1998a,b) and architectural properties (White & Rudolph, 1999; Ruttimann *et al.* 1992; Law *et al.*, 1996) of mandibular bone in the osteoporotic patients on radiographs. When identified in the initial phase, more easy is the treatment process of this pathology. The trabecular and cortex mandibular bone study can evidence the initial signals of this disease, an example, is the panoramic radiograph exam.

The aim of this study was to correlate the morphodigital characteristics quality of the mandibular trabecular bone, in this way, being possible to observe osteoporosis clue in patients of both sex, using panoramic radiograph for analysis.

MATERIAL AND METHOD

It was used in this study fifty women (n=50) and fifty men (n=50), in each one, it was analyzed the right and left sides of the mandible, considering the mandibular trabecular bone portion. All the aspects of this work were approved by the Ethics Committee in Research.

The panoramic exams were obtained using an extrabuccal X-ray apparel, Orthopos, Siemens, standard at 62KVp, 16mA, and rotation time with 14.1 seconds, using radiograph films Kodak T-MAT G and ecran LANEX-Medium. The radiographic processing was performed manually, temperature/time, using dark camera and a GBX-II filter. After the final washing, the radiographs were dried and digitalized in a professional scanner, Epson, Expression 636, at 300 dpi. For the morphodigital study of the trabecular mandible bone, it was used a specific software for the image processing, as it was described by White *et al.* (2000) methodology. Three regions were studied, the anterior portion, ascendent ramus and the mandible body, and after it was made a mean of the values found in each region (Fig. 1 A-H).

Fig. 1. Sequence of the methodology used in the morphodigital image processing.

Data were submitted to statistical analysis, GLM ANOVA with Tukey test, 95% of significance level.

RESULTS

The results of this study showed statistical difference between men and women considering the bone trabecular

measures ($p < 0.05$), but it was not found statistical difference between the between the right and left sides in each analyzed group ($p > 0.05$). Male group showed a great number of trabeculas and architecture more complex and strongly than female group, in this way, the bone structure of man is less submitted to the risk of osteoporotic fractures (Fig. 2). This study revealed differences in the mandibular cortex width, being found the greatest values in the male group (Table I).

Fig. 2 A. Normal aspect of the mandibular bone structure. B. Osteoporotic mandible represented by the bone lost (square).

Table I. Means and standard deviations of the bone trabecular measures in the three regions of the mandible.

Groups	Mean (M)	Standard deviation (SD)
Male Group- right side ^a	2.95	0.76
Male Group- left side ^a	2.97	0.92
Female group- right side ^b	2.10	1.23
Female group- left side ^b	2.06	1.08

a,b- Different letters show statistical difference ($p < 0.05$).

DISCUSSION

The aim of this study was to correlate the morphodigital characteristics of the mandibular trabecular bone, in this way, being possible to observe osteoporosis clue in patients of both sex, using panoramic radiograph for analysis.

This article focused on the risk to have osteoporosis, because this pathology is a commonly situation found especially in women people. Post-menopausal women constitute more than 15% of the population in developed countries whereas this rate is 5-8% in less developed regions of the world (World Health Organization). By 2030, the world population of menopausal and post-menopausal women is expected to increase to 1.2 billion, with 47 million new cases each year (World Health Organization, 1996; Hill, 1996). Osteoporosis and fractures are more difficult and costly to treat than to prevent. Therefore, several health care interventions have been proposed to identify those people who may be at risk and who could benefit from preventive interventions (Espallargues *et al.*, 2001).

It was found in this study porosity in some radiograph images, especially in the female group. One of the most commonly studied parameters of mandibular bone in relation to osteoporosis is the porosity of the mandibular cortical bone. Some of the investigators have found an association between cortical index and osteoporosis (Klemetti & Kolmakow, 1997; Bollen *et al.*, 2000; White *et al.*, 2005; Nakamoto *et al.*, 2003; Taguchi *et al.*, 1996), but Drozdowska *et al.* reported that there was no relationship between osteoporosis and cortical bone. For the other parameters, some measurements must be performed and some calculations are necessary, and as it was stated before, the complexity of an index may increase its measurement error and decrease its repeatability. In this study, it was performed the cortical bone analysis, that represents a simple classification of the bone based on the appearance of the lower border of mandibular trabecular bone after the cortical bone removal, which it is according to Horner & Devlin (1998a,b) study.

The structure of the trabecular bone has been analyzed in relation to the possibility to have osteoporosis, being found a complex bone trabecular structure in the male group. While some authors stated that fractal dimension decreases in osteoporosis (Link *et al.*, 1998; Fazzalari & Parkinson, 1998) others reported an increase (Pothuau *et al.*; Ruttimann *et al.*). It was used in this study digitalized images of the panoramic radiographs. Each imaging modality may have its own non-linear artefacts such as sampling frequency and noise and this may have an affect on the results of fractal dimension (Geraets & van der Stelt, 2000). Geraets and van der Stelt have stated that most reports based on radiographs *in vivo* find an association between osteoporosis and increased values of fractal dimension (Pothuau *et al.*; Ruttimann *et al.*). Osteoporosis might not be affecting all bones at the same time with the same severity, thus it is important to correlate the data found in a specific study with another studies that used the same type of bone, in this case, the mandible bone.

The sample of this study was standardized, composed by young adults of both sexes, with similar characterizations. A standardized sample is important because many different factors, such as bone metabolism, skeletal mineral status, extraction of the teeth, surgical procedures, occlusal forces transmitted by dentures, and physical and muscular activity are involved in determining the rate of residual ridge resorption (Klemetti & Kolmakow, 1997). The structure of the mandibular bone differs significantly over the years and between the genders (Klemetti *et al.*, 1993), especially in postmenopausal women. Bras *et al.*, (1982) reported that the cortex and trabecular bone of the angle of the mandible was distinctly thinner on panoramic radiographs of postmenopausal women and patients with chronic kidney failure. Knezović-Zlatarić *et al.*, (2002) also reported that the age-related distribution of mandibular cortical index showed an age-related increase in the numbers of individuals with C3 cortex appearance, and a significantly higher incidence of women who had C3 cortexes in an older age group. On the other hand, Mohajery & Brooks (1992) could

not determine differences in the thickness of the angle of the mandible, sinus floor or lamina dura of the tooth sockets between healthy women and those with early osteoporosis.

It was possible to conclude in this study, that the male group presented a more strongly trabecular and complex bone than the female group, this finding is important index to

osteoporotic risk, being possible to affirm that the male bone is less probable to suffer a osteoporotic fracture. Thus, it is important to call the attention of all health professionals about the importance to identify the initial signals of the osteoporosis disease in their patients, in this way, this pathology will be treated in its initial phase and the clinical success will be probably reach.

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RESUMEN: El objetivo de este estudio fue correlacionar las características morfodigitales del trabeculado óseo mandibular para de esta manera, verificar indicios de señales de osteoporosis, utilizando para esto, radiografías panorámicas de pacientes de ambos sexos. Los resultados del estudio mostraron diferencias entre los grupos masculino y femenino, en la cuantificación de hueso trabecular mandibular ($p < 0.05$), pero no se encontraron diferencias entre los lados derecho e izquierdo en cada grupo analizado ($p > 0.05$). El grupo masculino presentó un patrón óseo trabecular más complejo y fuerte que el grupo femenino. Este hallazgo puede ser un importante indicador en cuanto a los riesgos de osteoporosis, por ejemplo, siendo posible afirmar que los huesos de los individuos del grupo masculino están menos sujetos a riesgo de fractura por osteoporosis.

PALABRAS CLAVE: Mandíbula; Hueso; Imagen digital; Radiografía

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