



Evaluation of osteoporosis in diabetic individuals using digital intra oral periapical radiographs

Avaliação de osteoporose em indivíduos diabéticos utilizando radiografias periapicais digitais

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Abstract

Introduction: Osteoporosis is a major cause of fractures in middle aged individuals. There has been drastic increase in the number of osteoporotic patients over the past two decades. The relationship of osteoporosis and diabetes continues to be a topic of debate among research workers. Detection of osteoporosis is very important for oral diagnostics as it can bring changes in treatment plan and modifications in oral procedures. Current literature is directed at diagnosing this condition on dental radiographs. **Objectives:** The present study was aimed at detecting osteoporosis using digital dental radiographs of premolar and molar region using Adobe Photoshop CS2 software. **Materials and methods:** A total of 40 patients visiting the dental department who were already diagnosed with type II diabetes for minimum of 1 year

were selected randomly for the study. Digital intra oral periapical (IOPA) radiographs of lower premolar-molar region were obtained by paralleling technique. The images were then converted into bitmap file format and assessed using adobe Photoshop CS2 software. The number of trabeculae in a specified area were counted and compared with age and sex matched healthy individuals with normal glycemic control. **Results:** Mean number of trabeculae/mm² in normal individuals was 0.1987 ± 0.0244 , and in diabetic group 0.1737 ± 0.0279 . The difference was statistically significant ($p < 0.05$). **Conclusion:** This study confirmed that the number of trabeculae/mm² in diabetic individuals was less compared to that seen in normal individuals.

Keywords: Bone mineral density. Diabetes mellitus. Digital intraoral periapical radiographs. Osteoporosis.

Resumo

Introdução: A osteoporose é uma das principais causas de fraturas em indivíduos de meia idade. Houve aumento drástico no número de pacientes com osteoporose nas duas últimas décadas. A relação entre osteoporose e diabetes continua a ser um tema de debate entre os pesquisadores. A detecção da osteoporose é muito importante no diagnosticador bucal, uma vez que ela pode refletir em mudanças no plano de tratamento e modificações nos procedimentos bucais. O diagnóstico desta condição por meio de radiografias dentais tem sido discutido na literatura atual. **Objetivos:** O presente estudo teve como objetivo detectar a osteoporose utilizando radiografias digitais dentais da região de pré-molar e molar utilizando o software Adobe Photoshop CS2. **Materiais e métodos:** Um total de 40 pacientes que visitaram o departamento de odontologia e já previamente diagnosticados com diabetes tipo II no período mínimo de um ano foram selecionados aleatoriamente para o estudo. Radiografias digitais intra-orais periapicais orais da região inferior de pré-molar e molar foram obtidos pela técnica de paralelismo. As imagens foram então convertidas em formato de arquivo bitmap e avaliadas usando o software Adobe Photoshop CS2. O número de trabéculas em uma área específica foi contado e comparado com indivíduos saudáveis de mesma idade e sexo e controle glicêmico normal. **Resultados:** A média do número de trabéculas/mm² em indivíduos normais foi $0,1987 \pm 0,0244$, e de $0,1737 \pm 0,0279$ para o grupo diabético, sendo a diferença estatisticamente significativa ($p < 0,05$). **Conclusão:** Este estudo confirmou que o número de trabéculas/mm² em indivíduos diabéticos foi menor em comparação aos observados em indivíduos normais.

Palavras-chave: Densidade mineral óssea. Diabetes Mellitus. Radiografia digital periapical. Osteoporose.

Introduction

Osteoporosis is a systemic skeletal disease characterized by reduced bone mineral density and micro architectural deterioration of bone tissue, with a consequent increase in bone fragility and susceptibility to fracture. It is one of the most common diseases of modern society, affecting the old-and middle-aged individuals (1).

Diabetes mellitus (DM) refers to a group of common metabolic disorders that share the phenotype of hyperglycemia. The metabolic dysregulation associated with DM causes secondary pathophysiologic changes in multiple organ systems that impose a tremendous burden on the health care system (2). Diabetes affects bone mineral density through

obesity, hyperglycemia and advanced glycation end products. Albright and Reifenstein were first to report low mineral density and risk of fracture in diabetic subjects in 1948 (3). The relationship between diabetes and osteoporosis continues to be debated among the research workers. A recent meta-analysis showed that diabetic patients had higher hip bone mineral density (BMD) than non-Diabetic controls suggesting that BMD values may not reflect bone fragility in diabetic patients (4).

Bone density is determined by several modalities ranging from quantitative computed tomography (qCT) to dual energy x-ray absorptiometry (DEXA) or peripheral ultrasound measurement. Each modality has been shown to be independently predictive of fracture risk, yet each has its own limitations (5).

Determination of mandibular bone density is of paramount importance for the diagnosis, treatment planning and management of dental procedures such as osseointegrated implants, grafting or periodontal diseases (3). Decrease in bone mineral density indicates that there is increase in the intertrabecular distance and decrease in the number of trabeculae in a specified area (6).

All the above methods for detection of bone mineral densities are difficult perform in a routine dental setup. Hence the present study was aimed to detect osteoporosis in diabetic patients at an early stage by determining the number of trabeculae on digital IOPA radiographs and comparing it with normal healthy subjects.

Materials and methods

The current experimental study was performed in compliance with the relevant laws and our institutional guidelines. Ethical committee clearance was obtained. Informed consent was obtained from the patients who participated in the study. Study was performed over a period of 1 year between June 2008 to June 2009. A total of 40 patients (diagnosed as diabetes mellitus for at least one year) visiting dental OPD of our institution were enrolled at random in the study. Out of which only 21 met the required criteria and were included in the study. A total of 19 patients were excluded from the study. 7 female patients above 40 years were excluded as there would be chances of post menopausal osteoporosis. 5 patients had other systemic illness which would affect

the bone mineral density and contribute to osteoporosis. 2 Patients were excluded as premolar-molar were missing while 5 patients had severe periodontal disease in premolar-molar area. The study subjects were then compared with age and sex matched healthy individuals with normal glycemic control.

Digital IOPA image of mandibular premolar to molar region was made using the paralleling technique. The images were converted to bitmap file format from DICOM format. The images were then opened in Adobe Photoshop CS2 (Figure 1) and converted to life size by entering the actual dimension of digital sensor (26mm x 37mm) (Figure 1). Long axis of second premolar was marked as reference line which was turned parallel to the long axis of scale by using rotating canvas (Figure 2). Apart from this line 2 more vertical lines were marked on the image parallel to and at 5mm distance on either side of the long axis of the second premolar. Three horizontal lines were also drawn on the image; first line at the cementoenamel junction of 2nd premolar, second at 4mm below the first line and third horizontal line at the root tip (Figure 3). The region of interest was between points a, b, c and d as marked in the Figure 3. The images were filtered to remove Gaussian blur and smart sharpened by 30% for radius of 15 pixels from software (Figure 4). Both horizontal and vertical trabeculae (Figure 5) were counted in the region of interest and numbers of trabeculae/mm² were calculated in the specified area. The trabeculae which were angulated more than 45° to the horizontal plane were counted as vertical trabeculae. However the roots of the teeth were not included.

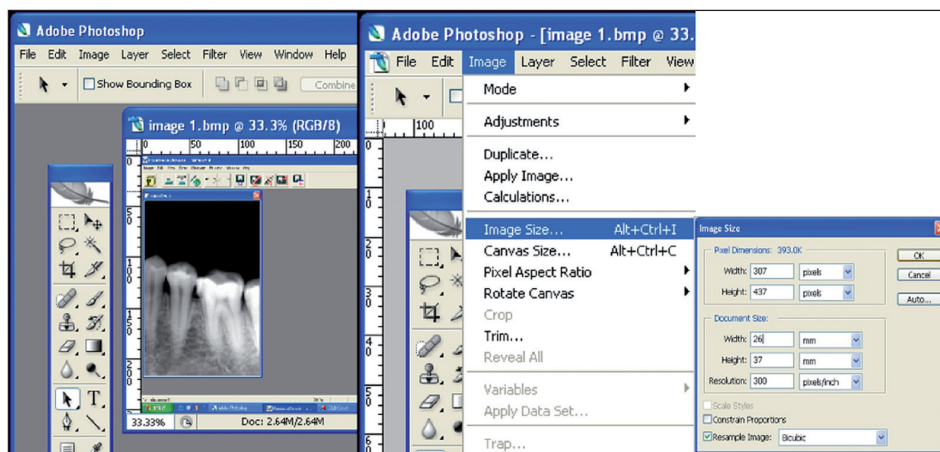


Figure 1 - Digital image is opened with Adobe Photoshop CS2 and is converted to life size image
Source: Research data.

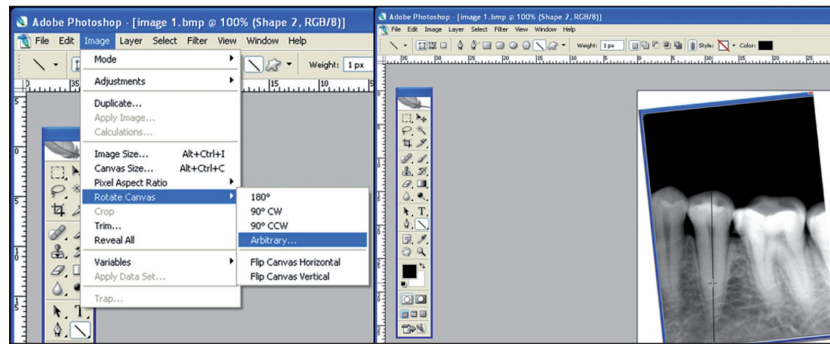


Figure 2 - Long axis of second premolar is made parallel with the long axis of scale
 Source: Research data.

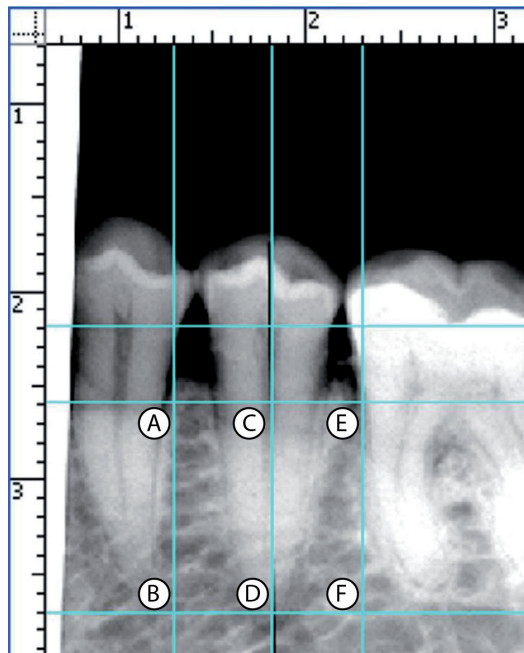


Figure 3 - Region of interest is Marked (abcd, cdef)
 Source: Research data.

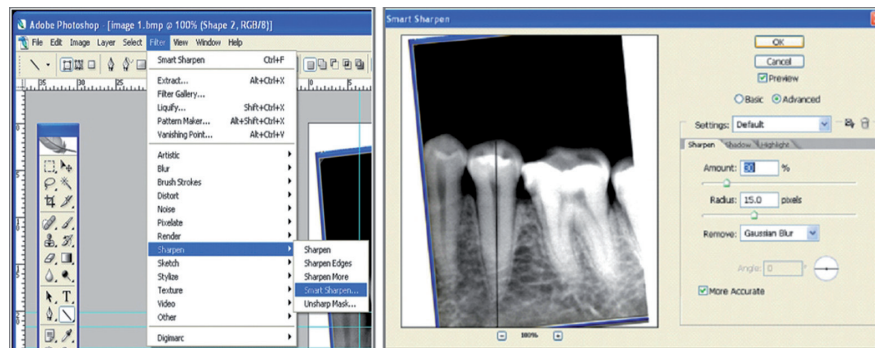


Figure 4 - Image is enhanced using filter and smart sharpen by amount of 30% in a radius of 15 pixel and removing Gaussian blurr
 Source: Research data.

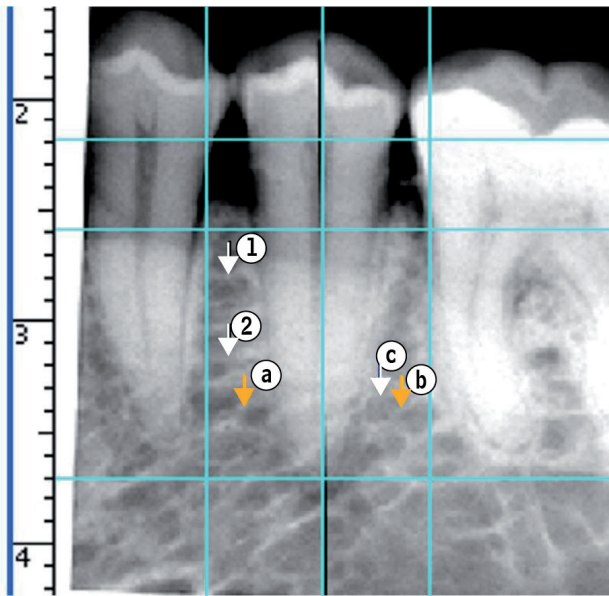


Figure 5 - Image is enhanced using filter and smart sharpen by amount of 30% in a radius of 15 pixel and removing Gaussian blurr

Source: Research data.

Statistical analysis

The data was entered on MS Excel (Microsoft office 2007 spreadsheet) and analysis was done (SPSS 9). Student's t test was performed to compare the data of normal and diabetic subjects. Also correlation between age, no. of trabeculae and duration of diabetes in diabetic group was assessed. The level of statistical significance was set at $p < 0.05$.

Results

The results are depicted in Table 1. Mean age in the healthy group was 52.9 ± 7.5 years while in the diabetic group was 50.3 ± 8.0 years. The mean number of trabeculae/mm² in normal subjects was

0.199 ± 0.024 where as in diabetic group it is 0.174 ± 0.028 . ($p = 0.0040$) thus depicting statistically significant difference between the two groups. There was no correlation between age and number of trabeculae/mm² with duration of diabetes.

Discussion

Osteoporosis is clinically a silent disease until a fracture occurs (7). Determination of mandibular bone density is of paramount importance for the diagnosis, treatment planning and management of dental procedures such as osseointegrated implants, grafting or periodontal diseases. The probability of bone loss in the mandible gains special importance with these procedures, where any systemic disease affecting the bone density is in question, such as diabetes mellitus (DM) (3).

The worldwide prevalence of diabetes mellitus has increased dramatically over the past couple of decades (2). The prevalence is similar in men and women throughout most age ranges (10.5% and 8.8% in individuals > 20 years) but is slightly greater in men >60 years (2). Worldwide estimates project that in 2030 the greatest number of individuals with diabetes will be 45–64 years of age (2). Diabetes could affect bone mineral density through obesity, hyperglycemia and advanced glycation end products (2). Based on these data it was proposed that altered bone metabolism in diabetics retards bone accumulation during growth, metabolic effects of poor glycemic control lead to increased bone resorption and bone loss, and low bone turnover affects the bone mass in such individuals (8). It has been shown that in diabetics with altered glycemic levels, serum osteocalcin levels were lower than that in normal individuals and once glycemic control has been achieved in these diabetic individuals, osteocalcin levels were improved (9). Hence it

Table 1 - Comparison of values of trabeculae/mm² non diabetic healthy individuals and diabetic individuals

	Healthy individuals		Diabetic		t-value	P
	Mean	Std.Dev.	Mean	Std.Dev.		
Age	52.9048	7.4960	50.3000	7.9611	1.0790	0.2872
N. of Trabeculae/mm ²	0.1987	0.0244	0.1737	0.0279	3.0598	0.0040

Source: Research data.

is concluded that the altered bone mass in diabetic individuals can be assessed by markers of bone formation and radiographic bone density.

Dental radiographs are relatively inexpensive and are regularly made for a large fraction of the adult population; therefore, they represent an enormous potential as a screening tool for osteoporosis. A considerable amount of work has been performed on methods of detecting individuals with low bone mass at an early stage (8-10). Some researchers have also considered that dental radiographs could have a role in the detection osteoporosis. A basic requirement for this would be, bone mass in the jaw relates significantly to that of other skeletal sites in which osteoporosis is a significant problem. In one of the studies (10) researchers tried to investigate the relationship between mandibular bone mineral density (BMD) and that of other skeletal sites commonly used for bone densitometry in the detection of osteoporosis. It was concluded that mandibular BMD assessed by DXA correlates significantly with the measurements of other important skeletal sites (11). In addition higher correlation coefficients and the greater sensitivity and specificity for the body of mandible (other sites being ramus, symphysis etc) suggests its use for any potential clinical application of dental radiographs in detection of osteoporosis (10). However monitoring the population by means of Dual X-ray Absorptiometry (DXA), which is currently the most accepted method for diagnosing osteoporosis, involves enormous costs and facilities. Thus in the present study we assessed number of trabeculae in the premolar-molar area which is an indirect indicator of bone mineral density for detecting osteoporosis at an early stage. Also one of the study maxillary and mandibular premolar areas were used to assess BMD and it was shown that maxillary and mandibular (IOPA) radiographs in premolar regions were equally good in predicting BMD (11). In previous studies it was shown that the characteristics of the radiographic trabecular pattern could be used to predict BMD values (12). Therefore in the present study digital IOPA of mandibular premolar-molar were used to assess the number of trabeculae as trabecular pattern is very clear in this region and there is minimum overlapping of structures.

Although intraoral radiographs are primarily made for dental diagnosis, they provide other useful information as well. Previous studies (10-12) have

shown that dental radiographs of mandibular and maxillary bone can also be used for the diagnosis of osteoporosis. Extensive morphological analysis of the trabecular pattern on dental radiographs in relation to osteoporosis has also been described. A study by Krakauer J.C. et al. showed that radial bone density did not differ significantly between patients with either type of diabetes but was significantly lower than in nondiabetic control subjects (8). This finding was in agreement with findings of the current study.

In our study we considered minimum duration of diabetes as one year and patients were on treatment for diabetes. There is still a controversy regarding correlation of glycemic control and alveolar bone loss in diabetic individual (13, 14). Therefore, further evaluation in this regard is required.

Conclusion

Limitation of the current study was that we did not assess the relationship of glycemic control to bone mineral density in diabetics. In addition the study did not compare the bone mineral density on IOPA with gold standard. There was a difference in trabecular density in diabetics and controls in the number of trabeculae in a specified area, which could be used as an indirect indicator in detection of early changes in the bone density and hence predict the possibility of osteoporosis. However, this premise needs to be further evaluated using a larger sample size and comparing this technique with gold standard, DXA, along with glycemic levels in such individuals. We suggest that every diabetic individual should be screened for osteoporosis using radiographs.

Acknowledgements

We express our sincere gratitude to SDM College of Dental Sciences and Hospital and Department of Oral Medicine and Radiology for providing the opportunity to conduct the study without any charges.

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Received: 07/14/2011

Recebido: 14/07/2011

Approved: 08/15/2011

Aprovado: 15/08/2011