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Assessment of efficacy of digital panoramic radiography as a diagnostic tool for evaluating general bone density

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ABSTRACT

Aim: To evaluate the efficacy of digital panoramic radiography as a diagnostic tool in detecting general skeletal bone density and to compare its accuracy with a DEXA scan.
Methodology: Seventy persons of age 50 years and above, scheduled to undergo DEXA scan and willing to participate in this study, were taken for panoramic radiography. Densitometric values were compared between DEXA scan and digital panoramic radiography, and collected data were subjected to statistical analysis.
Results: Statistical significant difference (P-value < 0.05) was found between normal and osteopenic/osteoporotic persons. No statistically significant difference (P-value > 0.05) in the values was observed between DEXA scan and digital panoramic radiography groups.
Conclusion: Based on the outcomes, it was concluded that general skeletal bone density could be favourably assessed in the mandible using densitometric analysis with digital panoramic radiography.

1. Introduction

Osteoporosis is a systemic skeletal disease characterized by decreased bone density and microstructurally weakened bone which increases the risk of their fracture.[1] Elderly patients with osteoporosis are therefore likely to have a reduced quality of life.[2] It is an easily preventable and treatable disease. Therefore sufficient importance has to be given for early identification and remediation of this condition.[3]

Among various types of diagnostic methods, DEXA (Dual Energy X-ray Absorptiometry), is considered as the gold standard fordetermining osteoporosis but the high cost associated with this advanced imaging technique and lack of availability of this equipment in most diagnostic centers limits its use by the general public.[4] Various authors have suggested the possibility of the use of panoramic radiographs as an effective alternative for assessment of osteoporosis by evaluation of jaw bone density.[5]

Panoramic radiographs are widely used to detect dental diseases and conditions. It is a cost-effective technique when compared to the other advanced imaging modalities.[6] There are various studies done on detecting osteoporosis by panoramic radiographs.[7] Till date, no studies have been carried out on comparing the DEXA scan with panoramic radiographs for assessing jaw bone density. The present study was done to evaluate the effectiveness of panoramic radiograph in the diagnosis of osteoporosis and to compare its efficacy with the traditional DEXA scan method.

2. Materials and Methods

The study has been carried out in the department of oral medicine and radiology under the collaboration with department of endocrinology. Ethical clearance was obtained from the Institutional Ethical Committee (IEC/NDCH/2019/P-16), and the study period was from December 2019 to February 2020.

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2.1. Participants

The present study comprised of 70 patients in the age range of 50 years and above, who were recruited into the study based on the following inclusion criteria: Adult patients scheduled to undergo DEXA scan, who were willing to participate in the study.

Exclusion criteria were bed ridden patients, pregnant ladies, liver disease patients, mentally retarded patients, terminally ill patients, patients with malignancies and other systemic diseases that would affect bone metabolism such as hyperparathyroidism, and paget's disease. Written informed consent was taken from all the participants, and then a DEXA scan was performed in the endocrinology department. After obtaining the results of DEXA scan, the subjects were classified as 1) Normal with T-score of >-1.0, 2) Osteopenic with T-score of -1 to -2.5 and 3) Osteoporotic with T-score of < -2.5. This standardized value was taken according to the World Health Organization (WHO) guidelines.[8] Digital panoramic radiographs were then taken for all the participants who had undergone the DEXA scan.

In digital panoramic radiographs, two areas of interest were recorded:

Area 1: Body of mandible just near the distal edge of the right mental foramen. Left side was chosen when right mental foramen was not visible.

Area 2: Linear distance from the outer cortical margin to the inner cortical margin of the inferior border of mandible with mental foramen as the reference point on the right side.

Density values at those regions from the DEXA scan and densitometric values at the selected area of interest from panoramic radiography were recorded in the Microsoft Excel spreadsheet 2013, and the data was subjected to statistical analysis. The statistical analysis was performed by using SPSS 17.0 version or Windows (Chicago, IL, USA).

2.2. Statistical analysis

The difference in the distribution of patients to the groups, based on the characteristics, was analyzed using a chi-square test. The normality of the data was tested using the Shapiro-Wilk test. The difference between the two groups was assessed using the paired t-test. The intergroup comparisons between the body of the mandible and inferior cortex were made using the Mann-Whitney U test. Whereas, the Wilcoxon signed-rank test was performed to compare the two related samples. The level of significance was set at 0.05.

3. Results

A total of 70 subjects (mean age of 54.7±6.2) were recruited into the study; of them, four were excluded as they were not further willing to participate in the study. Finally, 66 subjects were recruited into the study. Of them, 19 subjects were in the normal group as they had T-score of >-1.0, 26 subjects were in the osteopenic group, with a T-score of -1 to -2.5 and 21subjectswith T-score of <-2.5 were in the osteoporotic group. The intergroup comparison scores showed that there was a significant difference between the bone density of the three groups (normal, osteopenic and osteoporotic) at the body of the mandible just distal to mental foramen and at the inferior cortex (Table 1). Whereas, there was no significant difference between the values obtained from DEXA scan and panoramic radiograph at both the selected regions of interest in all the three groups which depicts a positive correlation between DEXA scan and panoramic radiograph (Table 2).

4. Discussion

Osteoporosis is a disease characterized by reduced bone mineral density and altered bone microstructure which leads to more bone fragility and predisposes to fracture.[1,9] It generally affects the older age group from the age of 50 years and above.[10] Post menopausal women are more affected when compared to males as a result of their lowering estrogen levels.[11,12] Owing to this compromised bone strength, most common sites of fracture is seen in the region of the distal radius and medullary bone.[13,14] Due to these debilitating effects, patients with osteoporosis might possess bad prognosis in terms of mortality, morbidity, and health care needs.[15]

Several techniques have been developed to determine the BMD, which include dual-energy X-ray absorptiometry (DXA and DEXA), quantitative computed tomography (QCT), qualitative ultrasound (QUS), single-photon absorptiometry (SPA), dual photon absorptiometry (DPA), DXR, and single-energy X-ray absorptiometry (SEXA).[16] Among these various methods, the DEXA scan was the most common tool for determining the minor changes in BMD because of its high precision T values.[17] The present study was performed to find a less expensive method to assess the bone mineral density and used CS software for windows that are easily available to assess BMD.

In dentistry, intraoral radiographs and panoramic radiographs are frequently taken to detect the dental abnormalities.[18] A study by Dutra et al. stated that reduced skeletal BMD has the potential to alter the shape of the mandible in osteoporotic patients.[19] Advantages of this panoramic radiograph are low cost and lesser radiation exposure when compared to DEXA scan. Hence, it can be used as an alternative diagnostic tool for identifying osteoporotic individuals.

Earlier studies indicated that there is no ideal region in the mandibular jaw to recognize the osteoporosis condition. Most of the studies have taken mandibular measurements in the area just distal to mental foramen as it has the lowest inter and intra anatomical variations in the form of

Table 1: Intergroup comparison of mandibular bone densityand inferior cortex in healthy, osteopenic and osteoporotic individuals

Group	Body of Mandible Distal to Mental foramen		Inferior Cortex	
	Mean±SD	P value*	Mean±SD	P value*
Normal	103.4±10.6	<0.001	111.5±10.3	<0.001
Osteopenic	83.7±6.8	(significant)	83.3±10.9	(significant)
Normal	103.4±10.6	<0.001	111.5±10.3	<0.001
Osteoporotic	61.3±4.4	(significant)	53.8±6.28	(significant)

Table 2: Comparison of DEXA scan and panoramic radiographin healthy, osteopenic and osteoporotic groups

Group	Variable	Minimum	Maximum	Mean±SD	P-value*
Normal	DEXA scan	-0.9	2	0.44±1.07	1.00
	Body of Mandible	91	127	103.4±10.6	
	DEXA scan	-0.9	2	0.44±1.07	0.54
	Inferior Cortex	95	125	111.5±10.3	
Osteopenic	DEXA scan	-2.5	-1	-1.83±0.44	0.70
	Body of Mandible	73	95	83.7±6.8	
	DEXA scan	-2.5	-1	-1.83±0.44	0.87
	Inferior Cortex	65	100	83.3±10.9	
Osteoporotic	DEXA scan	-4	-2.6	-3.17±0.39	0.70
	Body of Mandible	55	70	61.3±4.4	
	DEXA scan	-4	-2.6	-3.17±0.39	0.61
	Inferior Cortex	40	64	53.8±6.28	

size, shape, bone structure and function.[20] Similar to the previous studies, there is no significant difference observed between the SBMD values obtained from the DEXA scan and panoramic radiograph in all the groups. In contrary to the present study, Khojastehpour L et al.[21] had stated that significant difference existed between DEXA scan and panoramic radiograph in measuring the SBMD and FBMD values this might be due to the longer age group range which was employed in that study. Whereas in the present study, only SBMD values were taken into consideration, and the results stated that there is no significant difference in detecting the BMD values using DEXA scan and panoramic radiograph. Limitations of the present study were smaller size sample, and only SBMD values are taken for BMD values.

5. Conclusion

The findings of the present study suggest that both the DEXA scan and densitometric analysis of panoramic radiograph are equally effective for the assessment of osteoporosis. Panoramic radiography can be helpful as a cost-effective method to the clinician to diagnose osteoporosis.

6. Source of Funding

None.

7. Conflict of Interest

None.

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