Original Research Paper

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Evaluation of Osteoporosis of Jaws Using Morphometric Indices in Panoramic Radiographs

Abstract:

Background & Objectives: Osteoporosis affects many elderly individuals and may not be identified until fracture-related symptoms manifest. Osteoporosis must be identified early in order to allow both therapy and prevention. In contrast to panoramic radiography, which is often utilized in dentistry, access to osteoporosis screening is frequently restricted. This emphasizes the part that dentists play in the early detection of this condition. With this context, the goal of the current study is to use digital panoramic radiographs to analyze the radiomorphometric indices of the mandible.

Materials and Methods: The study's sample included 100 panoramic radiographs, 50 of which were of men and 50 of women, all of whom were between the ages of 30-80. The data that were collected were statistically analyzed.

Results: Aging was associated with a decline in GI. Only among females above the age of 51 did MI exhibit a drop in mean values. PMI showed a dramatic decline after age 40. Age-related increases in C2 and C3 categories. In comparison to female patients, male patients had considerably higher measured values for mental foramen width, mandibular canal width, GI and MI. Most C3 cortical appearances were observed in females.

Conclusion: Older females had a decreased mandibular cortical thickness. This study demonstrated the value of mental foramen and mandibular canal width, GI, MI PMI, and MCI in identifying patients with osteoporosis or low skeletal bone mineral densities. Therefore, it is recommended that oral physicians take on a special role in patient screening for the assessment of osteoporosis.

Key-words: S.....

Introduction:

Osteoporosis is a disorder marked by a decrease in bone mineral density and micro-structural degradation in bone tissue, both of which increase the risk of fracture. One of the most prevalent diseases, osteoporosis affects primarily older adults and is thought to affect 75 million individuals worldwide. It makes bones more brittle and susceptible to fractures.[1] A major health issue that affects both industrialized and developing nations is osteoporosis. Around the world, it is linked to significant morbidity and socioeconomic burden. Osteoporosis is seen as a silent illness with severe social and financial costs. As a result, there has recently been an increase in interest in the diagnostic and oral symptoms of osteoporosis.[2] Riggs and Melton postulated that there are two distinct forms of involutional osteoporosis: postmenopausal (type 1) and senile (type 2) osteoporosis around the beginning of the 1980s. Both forms affect postmenopausal women, whereas type 2 osteoporosis affects men. Women go through an accelerated, temporary phase during menopause (which may lead to type 1 osteoporosis), which becomes more noticeable in the decade that follows and mostly affects trabecular bone.[3] Both trabecular and cortical bone are affected by the late, sluggish phase of

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postmenopausal women's bone loss, which is the slow, continuous phase of bone loss in elderly men. Senile osteoporosis was related to aging processes such osteoblast failure, but post menopausal osteoporosis was known to be brought on by an estrogen deficit.[4]

Because panoramic radiography has the capacity to provide a comprehensive image of the maxillofacial structures in everyday dentistry practice, it is regularly and frequently utilized as a diagnostic tool for the diagnosis of tooth and jaw anomalies. Osteoporosis is one of the systemic disorders that might present as a characteristic image on panoramic radiograph. This condition is known to cause cortical thinning and increased radiolucent trabecular regions. The amount and quality of jaw bone affect the success rate of dental treatment in osteoporotic individuals.[5] Beginning in the third decade of life, the density and porosity of human bones start to decline and increase, respectively. It is generally recognized that osteoporosis causes changes to the mandibular structure, particularly to the inferior border, as well as a decrease in jaw bone mass.[6,7] The mandibular cortical index (MCI), mandibular cortical width (MCW), panoramic mandibular index (PMI), gonial index (GI), and mental index (MI) are some of the mandibular cortical indices that have been developed to assess and quantify the quality of mandibular bone mass and to look for signs of resorption on panoramic radiographs to identify osteoporosis. However, no one morphometric indicator has the ability to reliably identify osteoporotic/osteopenic alterations. Determine the osteoporotic alterations in the jaw bones by measuring the mandibular canal's breadth and thickness as well as the margins of the mental foramen.[8]

Materials And Methods:

The study was conducted in the Department of Oral Medicine and Radiology, K. D. Dental College & Hospital, Mathura.

Study Subjects:

Adults from Mathura district of Uttar Pradesh, who were apparently healthy with no systemic diseases between the ages of 30 – 80 years, were included in this study. The subjects were explained of the procedure to be done in the study and consent was obtained. They comprised of 100 subjects divided into 5 groups (20 patients in each group) based on age. Subjects served as their own control. The ethical clearance for the study was obtained from our institution. Materials required for taking Digital Panoramic Radiographs. For the analyses, all the radiographs were taken using Carestream CS- 8100 (CARESTREAM, New York) Digital Panoramic Machine and projected in a LED 29" monitor screen with 2560× × 1080 pixels resolution and analyzed independently by a single examiner wearing a lead apron.

Study Sampling:

Random sampling

Criteria for Selection of Subjects:

Inclusion Criteria:

- Patients with no systemic diseases of both genders between the ages of 30- 80 years.
- Orthopantomograph with details of the patient.

Exclusion Criteria:

- *Patients with low bone mass or any systemic diseases.*
- *Patients with any drug history.*
- *Patients having any developmental anomaly of head and neck.*

Panoramic Radiograph Examination:

The entire procedure was explained to the patient and was positioned properly in the panoramic machine. Subjects were instructed to remove dental appliances, ear rings, necklaces, hairpins and any other metallic objects in the head and neck region. The antero- posterior position was achieved by having him/ her place the incisal edges of the maxillary and mandibular incisors into a notched positioning device (bite block). Subjects were positioned with their backs and spines as erect as possible and their neck extended. The same exposure parameters of 68 kV, 5 mA and 16 seconds were used throughout the study. The obtained image was displayed on the computer screen with aid of software. The 100 panoramic images were taken based on 5 age group of 30- 40 years, 41- 50 years, 51- 60 years, 61- 70 years and 71- 80 years. Each group comprised of 20 subjects of whom 10 were male and 10 were female. The parameters evaluated on panoramic radiographs for determination of osteoporosis included changes in mandibular canal width, mental foramen width bilaterally, mandibular cortical index, panoramic mandibular index, mental index and gonial index.

Figure1: (a) Placement of patient for radiograph, (b) Analyzing the radiograph using GIMPS software

Interpretation of Panoramic Radiograph:

The interpretation of digital panoramic radiograph was done using GIMPS 2.0 software. Using the digital ruler, the parameters were determined and measured bilaterally directly on the computer screen. The observer was allowed to use different enhancement tools, such as magnification, brightness, contrast, sharpening as well as softening filter provided by the software to modify images to increase the resolution up to the observer's optimum visible perception. The details of the parameters are as follows:

- By drawing a vertical line from the superior point of the canal's image at the ramus to the inferior border of the mandibular canal on both sides, the width of the canal was measured, and the mean value was recorded.

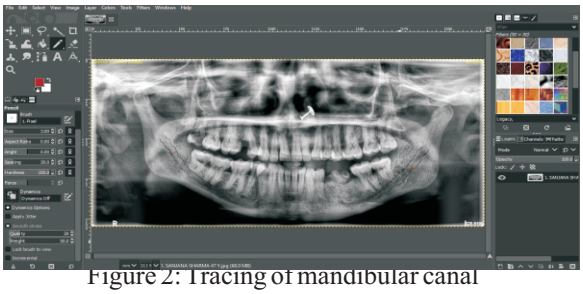

Figure 2: Tracing of mandibular canal

By connecting the lateral foramen borders horizontally, the width of the MENTAL FORAMEN was calculated. Both sides' average value was noted

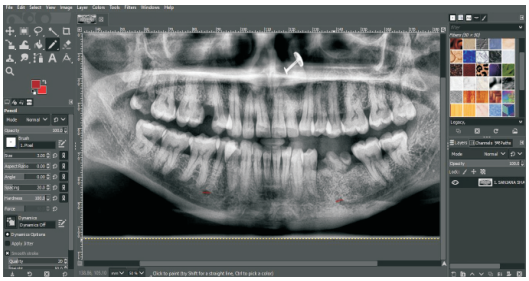

Figure 3: Tracing of mental foramen

- The cortical bone mineral density was assessed using the MANDIBULAR CORTICAL INDEX (MCI), also referred to as the "Klemetti Index". It is based on the way the mandibular lower boundary cortex looks away from the mental foramen. According to the following criteria, this approach divides the inferior cortex on either side of the jaw, distal to the mental foramen, into three groups:

➢ C 1: On both sides of the jaw, the endosteal edge of the cortex is uniform and acute.

➢ C 2: The endosteal margin has resorptive cavities with cortical residues one to three layers thick on one or both sides.

➢ C 3: The endosteal margin is porous and made up of thick cortical residues.[8]

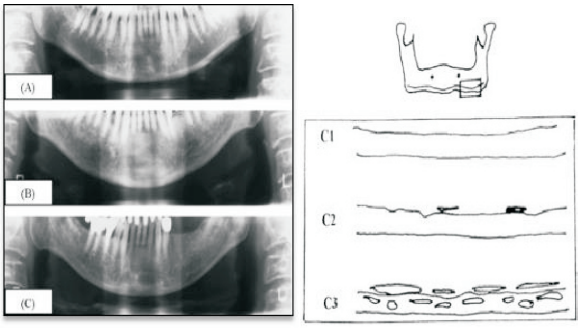

Figure 4: Types of mandibular cortex

- The relationship between the height below the inferior margin of the mental foramen and the residual ridge resorption is determined by the PANORAMIC MANDIBULAR INDEX (PMI). It is calculated by dividing the distance between the superior margin of the inferior mandibular cortex and the bottom of the jaw by the mandibular cortical thickness measured perpendicular to the bottom of the mandible at the middle of the mental foramen. Normal value- >0.3.[9]

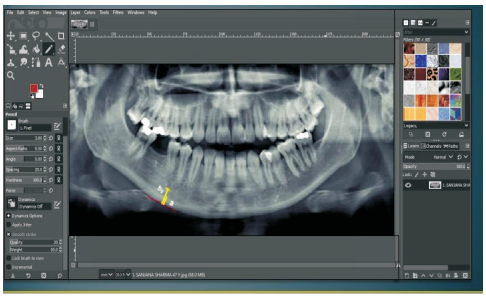

Figure 5: Tracing for PMI

- The reliability and reproducibility of cortical width measurements are assessed by the MENTAL INDEX (MI).At the center of the mental foramen; it is measured by drawing a line perpendicular to the bottom of the jaw. Value normally > 3.1mm.[9]

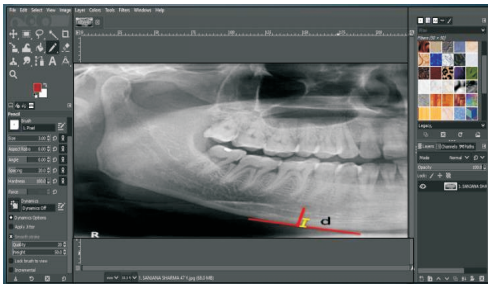

Figure 6: Tracing for MI

- The GONIAL INDEX (GI), which is measured on the bisectrix of the angle between the tangent lines to the

posterior border of the branch and the bottom of the jaw, establishes the mandibular cortical thickness. Value of >1.2 mm is typical.[10]

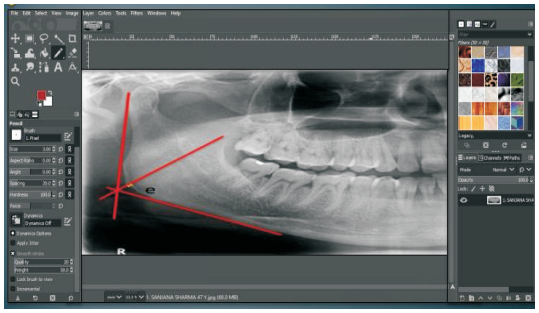

Figure 7: Tracing for gonial index

The data on the mandibular canal width, mental foramen width, and the radiomorphometric indices were compared with the sex and age of the individuals. Statistical analysis was carried out using the SPSS software v20.0 (IBM SPSS, Chicago, IL, USA). The quantitative data were presented using the mean

Results:

Table 1. Comparison of mean mandibular canal width (in mm)

Age Group (Years)	Minimum	Maximum	Mean	Std. Deviation	F value	p value
30-40	2.30	5.04	3.18	0.64	3.530	0.01*
41-50	1.97	4.17	3.02	0.49		
51-60	1.72	4.77	3.09	0.67		
61-70	2.07	3.79	2.76	0.49		
71-80	1.97	3.18	2.64	0.34		

*Statistically significant

1. The maximum mandibular canal width was in the age group of 30- 40 years.
2. The minimum mandibular canal width was in the age groups of 41- 50 years and 71- 80 years.
3. Mean±SD age for age group 30- 40 years was 3.18± 0.64, for age group 41- 50 years was 3.02± 0.49, for age group 51-60 yearswas 3.09± 0.67, for age group 61- 70 years was 2.76± 0.49 and for the age group 71- 80 years was 2.64± 0.34.
4. The difference was found to be statistically significant (p=0.01).

Table 2. Comparison of mean mental foramen width (in mm)

Age Group (Years)	Minimum	Maximum	Mean	Std. Deviation	F value	p value
30-40	2.12	4.44	2.98	0.73	3.462	0.01*
41-50	1.67	6.30	3.17	1.08		
51-60	1.62	4.70	2.66	0.79		
61-70	1.57	3.88	2.62	0.52		
71-80	1.35	2.92	2.39	0.45		

*Statistically significant

1. The maximum mental foramen width was in the age group of 41- 50 years.
2. The minimum mandibular canal width was in the age group of 71- 80 years.
3. Mean±SD age for age group 30- 40 years was 2.98± 0.73, for age group 41- 50 years was 3.17± 1.08, for age group 51-60 years was 2.66± 0.79, for age group 61- 70 years was 2.62± 0.52 and for the age group 71- 80 years was 2.39± 0.45.

Table 3. Comparison of mean panoramic mandibular index

Age Group (Years)	Minimum	Maximum	Mean	Std. Deviation	F value	p value
30-40	0.58	0.77	0.69	0.05	56.53	<0.01*
41-50	0.35	0.78	0.65	0.10		
51-60	0.27	0.68	0.50	0.11		
61-70	0.27	0.56	0.41	0.09		
71-80	0.19	0.47	0.35	0.07		

*Statistically significant

1. The maximum panoramic mandibular index was in the age group of 41- 50 years.
2. The minimum panoramic mandibular index was in the age group of 71- 80 years.
3. Mean±SD age for age group 30- 40 years was 0.69± 0.05, for age group 41- 50 years was 0.65± 0.10, for age group 51-60 years was 0.50± 0.11, for age group 61- 70 years was 0.41± 0.09 and for the age group 71- 80 years was 0.35± 0.07.
4. The difference was found to be statistically significant (p=0.01).

Table 4. Comparison of mean mental Index

Age Group (Years)	Minimum	Maximum	Mean	Std. Deviation	F value	p value
30-40	3.03	5.89	4.47	0.79	7.59	<0.01*
41-50	2.39	8.92	4.41	1.31		
51-60	3.19	5.67	4.22	0.67		
61-70	2.87	5.81	4.05	0.84		
71-80	2.00	4.60	3.10	0.75		

*Statistically significant

1. The maximum mental index was in the age group of 41- 50 years.
2. The minimum mental index was in the age group of 71- 80 years.
3. Mean±SD age for age group 30- 40 years was 4.47± 0.79, for age group 41- 50 years was 4.41± 1.31, for age group 51-60 years was 4.22± 0.67, for age group 61- 70 years was 4.05± 0.84 and for the age group 71- 80 years was 3.10± 0.075.
4. The difference was found to be statistically significant (p=0.01).

Table 5. Comparison of mean Gonial index

Age Group (Years)	Minimum	Maximum	Mean	Std. Deviation	F value	p value
30-40	1.00	2.32	1.60	0.34	2.879	0.02*
41-50	0.68	2.30	1.40	0.35		
51-60	0.90	1.74	1.28	0.24		
61-70	0.50	1.90	1.30	0.36		
71-80	0.48	1.87	1.38	0.39		

*Statistically significant

1. The maximum gonial index was in the age group of 30-40 years.
2. The minimum mental index was in the age group of 71-80 years.
3. Mean±SD age for age group 30- 40 years was 1.60± 0.34, for age group 41- 50 years was 1.40± 0.35, for age group 51-60 years was 1.28± 0.24, for age group 61- 70 years was 1.30± 0.36 and for the age group 71- 80 years was 1.38± 0.39.
4. The difference was found to be statistically significant (p=0.02).

Table 6. Mandibular cortical index

	C1		C2		C3	
Age Group (Years)	Frequency	Percent	Frequency	Percent	Frequency	Percent
30-40	12	60.0	8	40.0	0	0.0
41-50	1	5.0	18	90.0	1	5.0
51-60	0	0.0	18	90.0	2	10.0
61-70	0	0.0	16	80.0	4	20.0
71-80	0	0.0	13	65.0	7	35.0
Chi square value	58.64					
p value	<0.01*					

*Statistically significant

1. In Group 1 the percentage of C1 was 60 % and of C2 was 40%.
2. In Group 2 the percentage of C1 was 5%, of C2 was 90% and of C3 was 5%.
3. In Group 3 the percentage of C2 was 90% and of C3 was 10%.
4. In Group 4 the percentage of C2 was 80% and of C3 was 20%.
5. In Group 5 the percentage of C2 was 65% and of C3 was 35%.
6. The difference was found to be statistically significant (p<0.01).

Table 7.Correlation between age and various indices

		Age	Panoramic mandibular index	Mental Index	Gonial index
Panoramic mandibular index	**r value**	-.824**	1	.351**	.301**
	p value	.000		.000	.002
Mental Index	**r value**	-.469**	.351**	1	.191
	p value	.000	.000		.057
Gonial index	**r value**	-.225*	.301**	.191	1
	p value	.024	.002	.057	
	**. Correlation is significant at the 0.01 level (2-tailed).				
	*. Correlation is significant at the 0.05 level (2-tailed).				

1. The strength of correlation is significant when panoramic mandibular index is compared with age, mental index and gonial index.
2. The strength of correlation is significant when mental index is compared with age, panoramic mandibular index and non significant for gonial index.
3. The strength of correlation is significant when gonial index is compared with age and panoramic mandibular index.

Table 8. Comparison of mean of indices of different age groups according to gender

Parameters	Gender	Mean	Std. Deviation	t value	p value
Mandibular canal width	**M**	3.06	0.63	2.185	.031*
	F	2.82	0.48		
Mental foramen width	**M**	2.76	0.76	-.025	.980
	F	2.77	0.81		
Panoramic mandibular index	**M**	0.52	0.16	.000	1.000
	F	0.52	0.16		
Mental Index	**M**	4.20	1.06	1.528	.033*
	F	3.90	0.95		
Gonial index	**M**	1.43	0.36	1.125	.026*
	F	1.35	0.34		

*Statistically significant

1. The mandibular canal width when compared within all the age groups is more in males (3.06 ± 0.63) than in females (2.82 ± 0.48) which was statistically significant.
2. The mental foramen width when compared within all the age groups was found to more in females (2.77 ± 0.81) than in males (2.76 ± 0.76). However, it was not statistically significant.
3. The panoramic mandibular index when compared within all the age groups was found to be comparatively same in both males and females (0.52 ± 0.16) than in males (0.52 ± 0.16). However, it was not statistically significant.
4. The mental index when compared within all the age groups was found to more in males (4.20 ± 1.06) than in females (3.90 ± 0.95) which was statistically significant.
5. The gonial index when compared within all the age groups was found to be more in males (1.43 ± 0.36) than in females (1.35 ± 034) which was also statistically significant.

Observations:

There have been numerous studies on radiomorphometric mandibular indices, but very few comparative studies on younger populations. To ascertain whether osteoporotic bone alterations occurred sooner than they were actually detected, we also included younger people in our study. This investigation was carried out to see whether there was any association between the indices determined by panoramic radiography and the age and gender differences in osteoporosis susceptibility. In our study, a statistically significant (p value - 0.01) drop in the mean values of mandibular canal width was observed beginning at the age of 61. In our study, which was statistically significant (p value-0.01), we observed a dramatic drop in the mean values of mental foramen width starting from the age of 51 to 60 years. Starting at age 51, PMI's mean values had a sharp decline that was statistically significant (p value 0.01). PMI was higher among younger people. Additionally, in our study, the mean PMI was the same for both males and girls. Age and the PMI score displayed an inverse relationship. Age-related changes in the brain can account for it. In our study, the mean values of MI began to rapidly fall starting at age 51, which was statistically significant (p value 0.01). Age and MI revealed a

negative connection, and it was statistically significant that MI mean values were lower in females than in males. Females in the older age group had a statistically significant decreased MI value. Age and GI displayed a statistically significant negative connection. Females had significantly lower mean GI values than males, which was statistically significant ($p = 0.02$). In our study, a reduction in GI mean values was seen starting at age 51 and was statistically significant. In our investigation, it was shown that the GI exhibited a very progressive thinning with age and that the values were lower in females than in males. In our study, 73 out of 100 patients had MCI of the C2 kind, and 14 out of 100 had MCI of the C3 type, with the majority of these patients being older women. Males and females with younger ages tended to fall into the C1 category, but as people aged, they were more likely to fall into the C2 and C3 groups, and this difference was statistically significant.

Conclusion:

The present study was undertaken to assess and evaluate osteoporosis by using radiomorphometric indices in panoramic radiographs along with evaluation of influence of gender and age on the radiomorphometric indices in male and female patients between the ages of 30 to 80 years.

The study sample consisted of 100 patients and were divided into 5 groups; Group A (30-40 years), Group B (41- 50 years), Group C (51-60 years), Group D (61- 70 years) and Group E (71-80 years). Each group consisted to 10 males and 10 females and a total of 50 males and 50 females were included in the study.

After analysing the radiomorphometric indices on the digital panoramic radiographs, it was observed that age played a significant role in osteoporotic changes in the mandible. It was also observed that mental index and gonial index was significant as compared to other parameters.

Mean mandibular canal width was more in males than in females in all age groups. Average mean value for mandibular canal width was also more in males (3.05) than in females (2.80).

Mean mental foramen width was more in females as compared to males in all age groups. Average mean value for mental foramen width was relatively same in both the genders (2.76).

Mean panoramic mandibular index was relatively same in both genders in all age groups along with the average mean value (0.52).

The mean mental index was more in males than in females in all age groups. The average mean value was more in males (4.20) than in females (3.89).

The mean gonial index was more in males than in females in all age groups. The average mean value was also more in males (1.43) than in females (1.35).

In our study 73 patients showed C2 Type and 14 patients showed C3 Type of mandibular cortical index as the age increased. This suggested that as age advanced the risk of osteoporosis increases irrestive of the age. Although both men and women are affected, females lose bone mass at a rate higher than males, especially after menopause.

In conclusion, there is significant bone mass changes in the mandible that can be determined by radiomorphometric indices in panoramic radiographs as age advances specifically after 41 years of age in both genders but comparatively more in females. Thus it can be summarized that panoramic radiographs can play a vital role in estimating early osteoporosis in patients and thus prevent late high level risks caused.

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