Effect of Personal Habits on Bone Mineral Density among adults using Orthopantomogram Indices as a Screening tool for Osteoporosis

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Abstract

Background: Effect of tobacco, areca nut, and alcohol consumption (vices) on orthopantomogram (OPG) indices. **Aims:** To assess the relationship between vices on OPG indices in Indian adult males aged 20–60 years. **Subjects and Methods:** This study was conducted on 172 males with a mean age of 34.2 ± 1 years. OPG was used for measuring mandibular indices and correlated with the history of the presence of vices. **Statistical Analysis Used:** Data were presented as mean ± SE or frequency (%). Point biserial correlation was used to assess the correlation between OPG indices and vices. Analysis of covariance was used to analyze the differences in age-adjusted OPG indices between males who had vices against males who had no vice. **Results:** Overall, 21.5% of the males had at least one vice. A significant decrease in antegonial index (AI) values ($P < 0.05$) was found between tobacco and alcohol consumption. There was a significant decrease in the values of the gonial index (GI) and AI, having at least one vice ($P < 0.05$). A higher percentage of participants who had at least one adverse habit had low OPG indices score than participants who had no such habits. **Conclusions:** Orthopantomogram indices specifically AI were negatively affected in males who had vices.

Keywords: *Antegonial index, bone mineral density, Orthopantamograph indices, osteoporosis, screening tool*

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Introduction

Osteoporosis in men is now recognized as an increasingly important public health issue.[1] Several risk factors have been identified as contributing to the development of osteoporosis.[2] "A study from Delhi estimated the prevalence of osteoporosis as 24.6% in men above 50 years of age."[3] Another study by "Sharma *et al*. has reported a prevalence of 8.5% at the femoral neck region."[4] Despite being a well-known cause for morbidity and mortality in males, data on osteoporosis in Indian men are scant.

Smoking has been demonstrated as a well-established risk factor for osteoporosis and bone fractures and hence is a part of the Fracture Risk Assessment Tool.[5] In India, "14% of the population above the age of 15 years smokes tobacco."[6] "Recent evidence demonstrates that tobacco smoking causes an imbalance in the mechanisms of bone turnover, leading to lower bone weight and bone mineral density (BMD) making bone at risk for

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osteoporosis and fractures."[7-9] Consumption/chewing of betel nut has also been associated with osteoporosis.[10] Treatment with areca nut/betel nut extract could affect the serum levels of osteoprotegerin, decreasing the receptor activator of NF κb ligand/osteoprotegerin ratio.[10]

Further, alcohol consumption has also long been recognized as a risk factor for osteoporosis; excessive alcohol intake reportedly reduces BMD.[11] Yet, some studies have reported that drinking increases the BMD, thus resulting in much controversy.[12]

There is increasing evidence in support of osteoporotic manifestation within the mandible raising the potential of routine dental radiographs in the form of orthopantomograms (OPG) and periapical X-rays in performing the dual role of dental investigation as well as opportunistic screening for osteoporosis.[13] Several methods have been studied including mandibular cortical thickness/width, panoramic mandibular index (PMI), mandibular index, gonial thickness, and antegonial index (AI) as well as simple visual inspection.[13,14] There is evidence that all these methods may be correlated with skeletal BMD and thus could potentially be used to screen for osteoporosis.[14]

Taken together, osteoporosis is an important public health issue in Indian men. OPGs are often performed as a dental procedure and there is a lacuna in the literature with regard to the effect of various adverse habits and osteoporosis as judged by dental X rays in the Indian population; hence, the current study was undertaken. Study objectives were (1) to assess relationship between consumption of areca nut, tobacco, and alcohol with OPG indices in men aged 20–60 years of age and (2) to study the association of various adverse habits with osteopenia/osteoporosis as judged by OPG indices (as per available published literature) in Indian men aged 20–60 years.

Subjects and Methods

In this cross-sectional study, apparently healthy adult men (n = 172), aged 20–60 years, attending routine health checks from hospitals were randomly selected. The sample size calculated considering 10% dropout was 172 male subjects in the age range of 20–60 years.[15,16] Sample size was derived using the formula "n = N * X by (X + N – 1), where, X = $Z_{\alpha/2}^2$ *p* (1 − p)/MOE^2, and $Z_{\alpha/2}$ is the critical value of the normal distribution at α by 2." (e.g., confidence level: 95%, α: 0.05, critical value: 1.96, MOE-margin of error, p-sample proportion, and N-population size). Written informed consent was obtained from participants. Written informed consent was obtained from participants. "This study protocol was reviewed and approved by the Institutional Ethics Committee; approval number was SDCH/IEC/2017-18/OUT/61.

Inclusion criteria

Dentulous male subjects within the age group of 20–60 years with a minimum of 20 teeth present.

Exclusion criteria

Participants with root piece, impacted teeth, history of orthodontic treatment, serious systemic debilitating conditions such as malignancy, mental disorders, or any pathological disorder of mandible.

Personal habits history

A pretested structured questionnaire was used to collect data of the prevalence of habits such as chewing tobacco, betel nut, smoking, and alcohol consumption.

Digital panoramic radiographs

The examiner was trained by an experienced dental professional from the Department of Oral Radiology, to ensure uniform evaluation and consistent interpretations. Then, dental OPG was performed for all participants. Each scan was obtained using a Planmeca Promax 3d Mid Proface (Finland) cone beam computed tomography unit. The exposure settings were in the range of 90 kV and 11.2 mA. Images were saved as digital imaging and communications in medicine images. Images were accessed in the software viewer (Romexis version; 4.2.0 R 10/13/15). Orthopantomographic indices mental index (MI), PMI, gonion index (GI), and AI were calculated as below.

1. MI: "It is measured on the line perpendicular to the bottom of mandible at middle of the mental foramen"[17,18]
2. PMI: "It is a ratio of mandibular cortical thickness to the distance between mental foramen and inferior mandibular cortex"[17,18]
3. Gonion index (GI): "Thickness of mandibular cortex is measured on the bisecting angle between the tangents at the posterior border and the bottom of the mandible"[17,18]
4. AI: "Cortical width in the anterior region to gonion on anterior border of the ramus and below to inferior border of mandible."[17,18]

Statistical methods

Data were analyzed using SPSS version 25 for Windows (version 25, 2017, IBM Corporation, Armonk, New York, and United State). Data were presented as Mean ± SE or frequency (%). Point biserial correlation was used to assess the correlation between orthopantomogram indices and habits/vices. One-way analysis of covariance was used to analyze the difference in various age-adjusted orthopantomogram indices

between males who had vices against males who had no vices. "Z scores were calculated for indices using the reference data given by Pal and Amrutesh."[19] "The formula used for calculating Z score was:

$$Z\ score = \frac{Value\ of\ participant - Mean}{SD}$$

Based on the Z score, participants were classified as Normal BMD (Z score >-1), osteopenia (Z score − 2.5 to − 1), and osteoporosis (Z score <−2.5). $P < 0.05$ was considered to be statistically significant."[20]

Results

Data collected on 172 adult males on orthopantomograph (OPG) and their correlation with various vices are presented in the current study. Mean age of participants was 34.2 ± 1 years. The prevalence of vices was as follows: Smoking in 7.6% of males, tobacco consumption in 8.7% males, betel nut consumption in 5.8% males, and alcohol consumption 14.5% males. Overall, 21.5% of the males had 1 or more vices as shown in Table 1.

Correlation of orthopantomogram indices with vices was performed. Significant negative correlation of AI with tobacco and alcohol consumption ($P < 0.05$) indicating that males who consumed tobacco or alcohol had a lower AI as compared to those who did not consume tobacco or alcohol. Furthermore, when vices were clubbed together, it was found that there was a significant negative correlation of both gonion index and AI with having vices, indicating that having vices negatively affected gonion and antegonial indices ($P < 0.05$) as shown in Table 2.

Age was significantly higher in males who had various vices in comparison to males who did not have vices ($P < 0.05$). As age may negatively impact orthopantomogram indices,[21,22] hence, to further evaluate the relationship of vices with orthopantomogram indices, age-adjusted orthopantomographic indices were compared in males having vices against novices as shown in Table 3. The age-adjusted AI was significantly lower in males who smoked, consumed tobacco, and consumed alcohol as compared to males who did not smoke, consume tobacco, or consume alcohol ($P < 0.05$). A marginal difference in the age-adjusted gonion index was also found between males who consumed tobacco as against those who did not consume tobacco ($P = 0.053$). Also, when vices were clubbed together as shown in Table 2 age-adjusted gonion and AI were significantly lower in males who had 1 or more habits as against males who had no vices ($P < 0.05$). No other significant differences were observed ($P > 0.05$) as shown in Table 3.

Table 1: Anthropometry, orthopantomogram indices, and prevalence of vices

Characteristic	Mean±SE/*n* (%)
Age (years)	34.2±1.0
Height (cm)	168.9±0.5
Weight (kg)	71.3±1.0
BMI (kg/m2)	24.9±0.3
MI (mm)	3.67±0.05
PMI (mm)	0.28±0.004
GI (mm)	1.21±0.04
AI (mm)	2.68±0.048
Vices (*n*=172)	
Smoking	13 (7.6)
Tobacco	15 (8.7)
Betel nut	10 (5.8)
Alcohol	25 (14.5)
Has 1 or more vices	37 (21.5)

SE=Standard error, BMI=Body mass index, MI=Mental index, PMI=Panoramic mandibular index, GI=Gonion index, AI=Antegonial index

Table 2: Correlation of orthopantomogram indices with vices

	MI	PMI	GI	AI
Smoking	−0.03	−0.03	−0.06	−0.13
Tobacco	0.02	0.05	−0.12	−0.16*
Betel nut	−0.03	0.04	−0.06	−0.09
Alcohol	0.05	−0.01	−0.14	−0.16*
Have 1 or more vices	0.02	0.004	−0.19*	−0.19*

*P<0.05. Data presented as point-biserial correlation value. MI=Mental index, PMI=Panoramic mandibular index, GI=Gonion index, AI=Antegonial index

The prevalence of osteopenia and osteoporosis using MI, PMI, and AI Z scores calculated in comparison to Reference value by Amrutesh and Pal.[20] Using Amrutesh and Pal Reference value, 26.2% participants had osteopenia using MI Z score, 50.6% had osteopenia using PMI Z score and 40.1% had osteopenia using AI Z score. None of the participants had osteoporosis using MI Z score, whereas 1.7% had osteoporosis using PMI Z score and 14% osteoporosis using AI Z score as shown in Figure 1.

Discussion

In the current study, overall, 21.5% of study participants had one or more vices. The scores of gonial and antegonial indices were lower among participants with tobacco, alcohol, or betel nut consumption; these differences remained after adjustment for age. The decreased scores for OPG indices indicate decreased mandibular bone thickness; finally, 1.7% of study participants had osteoporosis using PMI Z score and 14% using the AI Z score.

Table 3: Age-adjusted orthopantomogram indices

OPG indices score (mm)	No smoking (*n*=159)	Smoking (*n*=13)	*P*
Mental Index, mm	3.68±0.09	3.64±0.15	0.79
Panoramic Mandibular index, mm	0.28±0.004	0.28±0.01	0.71
Gonion index, mm	1.17±0.04	1.08±0.13	0.49
Antegonial index, mm	2.65±0.05	2.32±0.15	0.04
	No tobacco (*n*=157)	**Tobacco (*n*=15)**	***P***
Mental Index, mm	3.67±0.05	3.74±0.13	0.61
Panoramic Mandibular index, mm	0.28±0.004	0.29±0.01	0.35
Gonion index, mm	1.19±0.04	0.96±0.11	0.05
Antegonial index, mm	2.66±0.05	2.37±0.13	0.03
	No betel nut (*n*=162)	**Betel nut (*n*=10)**	***P***
Mental Index, mm	3.68±0.05	3.62±0.16	0.72
Panoramic Mandibular index, mm	0.28±0.004	0.29±0.01	0.49
Gonion index, mm	1.18±0.04	1.00±0.14	0.25
Antegonial index, mm	2.63±0.05	2.45±0.17	0.32
	No Alcohol (*n*=147)	**Alcohol (*n*=25)**	***P***
Mental Index, mm	3.67±0.05	3.71±0.11	0.15
Panoramic Mandibular index, mm	0.28±0.004	0.27±0.008	0.60
Gonion index, mm	1.19±0.04	1.009±0.09	0.06
Antegonial index, mm	2.67±0.05	2.39±0.11	0.02
	Had no habits/ vices (n=135)	**Had 1 or more habits/ vices (n=37)**	***P***
Mental Index, mm	3.67±0.05	3.68±0.09	0.97
Panoramic Mandibular index, mm	0.28±0.004	0.28±0.007	0.87
Gonion index, mm	1.23±0.05	0.97±0.07	0.004
Antegonial index, mm	2.69±0.05	2.41±0.09	0.006

Our findings are in alignment with previous studies which show overall prevalence of drinking and smoking was 8.8% (8.1–9.5) and 53.1% (51.5–54.6), respectively, and drinking and smoking both was 6.9% (6.3–7.6).[23] In another study, nationally representative data were used with a high response rate among the general population. "The prevalence of smoking was 24.6%, smokeless tobacco use was 29.1%, and both smoked and smokeless tobacco use was 8.4%."[24]

Smokers were found to be 3.45 times more prone to develop osteoporosis at an early age compared to controls.[25] It has been found that BMD is decreased in smokers as per the data obtained from the previous study out of total number n = 211 of cigarette smokers, n = 26 (12%) were osteoporotic.[25] "Many studies have provided evidence that smoking affects the balance of the naturally occurring processes of osteoblastic

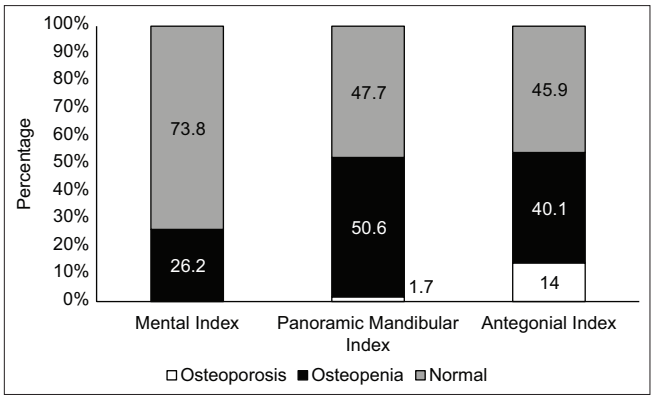

Figure 1: prevalence of osteoporosis in participants

and osteoclastic activities, resulting in low BMD."[26] Exposure to smokeless tobacco products also reportedly inhibits osteoblastic activity.[27] Tobacco has been found to have a detrimental effect on BMD which is reflected in radiomorphometric indices of Mandibular Cortical Index, MI, and PMI.[28]

Although betel quid is considered the fourth most psychoactive substance worldwide, in a previous study, "it was found to be most popular among the study population and the highest cause of osteoporosis."[29] Several *in vitro* studies have suggested that areca nut extracts inhibit immune reactions and affect osteoblast viability.[30] Possible effects of ripe areca nut extracts are on viability and gene expression of alkaline phosphatase (and Osteoprotegerin) in human osteoblasts.[31]

In contrast to the findings of the current study, the previous studies show a positive relationship between consumption of alcohol and BMD in men. "The reproducibility of these effects across different bone sites, and the consistency of these findings with other published studies of total alcohol intake suggest that alcohol intake, particularly from beer and wine, may protect bone health."[32] "Several other potential factors that may result in misclassification have recently been highlighted for epidemiologic analyses with alcohol including the pattern and frequency of alcohol consumption."[33] Osteoporotic damage due to alcohol consumption appears to be related to the amount and duration of alcohol consumption.[33] Although the damage from previous alcohol use cannot be undone, reports suggest that patients need to stop drinking to prevent further bone damage.[33,34]

Osteoporosis is often not diagnosed because it is asymptomatic and thus goes unnoticed. The current gold standard for diagnosing osteoporosis is BMD using Dual-energy X-ray absorptiometry DXA examination. However, "this diagnostic modality is very expensive,

and availability is limited and for these reasons, cannot be accessed by a vast section of the Indian elderly population."[21] Dentists use radiographs extensively in their daily practice to diagnose oral diseases. Recent research has centred on whether radiographic changes in the jaws could be used as an accurate early diagnostic tool for osteoporosis. This radiographic method is cost effective and easily available. In the present study, Z scores of MI, PMI, and AI were used to find out Reference value for osteopenia and osteoporosis similar to Amrutesh and Pal (2013).[20] Using the Reference value, least number of participants (26.2%) had osteopenia and none osteoporosis using MI Z score, whereas most of the participants (50.6%) had osteopenia and 1.7% had osteoporosis using PMI Z score 40.1% had osteopenia and 14% osteoporosis based on Z scores of AI. A number of mandibular cortical indices have been developed to allow quantification of mandibular bone mass and identification of osteopenia.[20]

The current study was conducted among males aged 20–60 years of age, as vices are more common among males in this age group. As OPG is a routine diagnostic procedure in the dental office, dental professionals can serve as the first to detect changes in the mandible followed by appropriate referrals. A history related to the consumption of smoking, alcohol, and betel nut can be considered as a risk factor for the development of osteoporosis and hence screening using OPG indices can be done.

However, our study has several limitations, we studied only male subjects. Smoking, alcohol consumption, betel nut consumption, and tobacco chewing are habits that women in India often indulge in and hence, there is a need to conduct a similar study in women. Further, we have not reported on osteoporosis as judged by DXA. Furthermore, longitudinal studies to explore relationship between vices and mandibular indices and osteoporosis and critical.

Our study suggests that vices such as tobacco chewing and smoking, alcohol, and betel/areca nut consumption are associated with decreased score of OPG indices and therefore a higher likelihood of osteoporosis. Dental professionals may help to screen patients with undetected osteoporosis, especially in those with habits such as smoking; further research needs to be conducted with the goal of screening individuals who are at risk for osteoporosis and then refer them appropriately.

Conclusions

Our study suggests that vices such as tobacco chewing and smoking, alcohol, and betel/areca nut consumption are associated with decreased score of OPG indices and therefore a higher likelihood of osteoporosis. Dental professionals may help to screen patients with undetected osteoporosis, especially in those with habits. Further research needs to be conducted with the goal of screening individuals who are at risk for osteoporosis and then refer them appropriately.

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Conflicts of interest

There are no conflicts of interest.

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