INTRODUCTION

Osteoporosis is characterized by reduction in the amount of Bone Mineral Density (BMD) and consequent increase in fracture risk.\(^1\) A generalized reduction in bone mass which is less severe than that resulting from osteoporosis, caused by the resorption of bone at a rate that exceeds bone synthesis is referred to as osteopenia.\(^1\) It causes fragility fractures on minimal injury where otherwise a micro-fracture will not occur. The vertebral column, hip and wrist being the most common sites of such fractures.\(^2\) Patients may complain of non-specific musculoskeletal and bone pains, numbness, decrease in height and even deformity.\(^3\)

Osteoporosis is most commonly seen in females of old age as a result of lack of estrogen, labeled as menopausal osteoporosis.\(^4,5\) As the life expectancy is increasing the number of cases of osteoporosis are also expected to rise.\(^6\) A study conducted also claims that not only females of old age, but young Pakistani females are at an increased risk of developing osteoporosis.\(^7\) Increase in the number of reproductive years is protective against osteoporosis because of estrogen.\(^8\) The diagnosis of most of the osteoporotic females in our part of the world, where bone densitometry is not in reach of every female, is done when they come to the emergency with fracture femur neck. OPG are mainly done for evaluation of dental pain.\(^9\) These X-rays could easily be used for early detection of osteoporosis if dental and orthopedic community goes hand in hand.

Dental panoramic radiographs are used in different studies to observe mandibular cortical changes. Thin cortical width has been observed in low bone mineral density subjects.\(^10,11\) Many studies have evaluated Mental Index (MI), Mandibular Cortical Index (MCI) and Panoramic Mandibular Index (PMI) in radiographs for diagnosing osteoporosis in postmenopausal women.\(^12\) A few studies have seen parameters in older women as well.\(^13\) Recent studies show statistically significant results in values of MCI, PMI and Mandibular Cortical Width (MCW) on panoramic radiographs according to gender and dental status.\(^14\)

DXA scan is found to be superior to the Singh’s Index, which is a measure of trabecular pattern of bone, for diagnosis of osteoporosis.\(^15\) It uses the T-scoring system. T-score is the comparison of BMD of a subject...
to that of young adult reference population. According to World Health Organization T-score of -2.5 or below is defined as osteoporotic, T-score of -1.0 or greater is normal and T-score between -1.0 and -2.5 is osteopenia. Unavailability of solid epidemiological data regarding the prevalence of osteoporotic fractures in Pakistan is the major hindrance in planning programs for osteoporosis.

Different techniques are used for the assessment of bone mineral density. Worth mentioning are single or dual energy X-ray absorptiometry (SXA-DXA), single or dual photon absorptiometry (SPA-DPA), Quantitative Computerized Tomography (QCT), and Quantitative Ultrasound (QUS) which are expensive and may not be available at places. The purpose of this study was to establish an association between morphological changes in the angle of mandible on OPG and DXA scan of femoral neck and spine to see whether or not the OPG X-ray can be employed for early detection of osteoporosis.

**METHODOLOGY**

From December 2011 to July 2012 at Institute of Basic Medical Sciences (IBMS), Dow University of Health Sciences (DUHS), Karachi. Only females between 25 and 85 years were included in the study. Females with endocrine disorders, menorrhagia, oligomenorrhea, polycystic ovarian syndrome, chronic kidney disease, pregnant and lactating females and those on Oral Contraceptive Pills (OCP) and Hormone Replacement Therapy (HRT) were excluded. As excessive chewing activity enhances bone formation and mineralization, so people addicted to beetle nut and pan chewing were also excluded from the study. Data was collected irrespective of dental, nutritional and socio-economic status. Females with early menarche and late menopause were excluded as both elevate estrogen levels thereby improving bone quality and quantity. The sample size was calculated by open EPI sample size calculator with 5% margin of error and 95% confidence interval. Consecutive sampling technique was used.

Posters were designed to inform general population about osteoporosis and the purpose of DXA scan. These posters were pasted at different campuses of DUHS, and invited females to participate. All subjects interested to participate were asked to sign a consent form and invited females to participate. All subjects interested to participate were asked to sign a consent form and information sheet. Simultaneously, a proforma regarding subject’s history was filled by the researcher, on the basis of which they were divided into premenopausal (Group-I) and postmenopausal (Group-II). Group-I and Group-II included 85 and 89 females respectively. DXA scan was done at Dow Radiology. The females were then divided into normal (pre A, post A), osteopenic (pre B, post B) and osteoporotic (pre C, post C) groups on the basis of DXA scan. Group pre A and pre B include 37 females each while pre C included 11 patients. Group post A included 25, post B included 38 and post C included 26 females. Patients were then taken to Patel Hospital for OPG X-ray which was self financed by the researcher. OPG X-ray was preferred over a plain lateral X-ray as it gives an ear-to-ear exposure of mandible and accuracy in positioning of every subject is maintained.

OPG X-rays were then studied for angle of mandible (A) at Zoom factor x0.84. Measurements were taken bilaterally and the mean of the two was put to statistical analysis. In the present study intraobserver as well as interobserver analysis gave a difference of 0.5 mm. angle of mandible (A) was measured where the lines along the posterior and inferior border intersect using a software called K-Pacs-Lite. Kruskul Wallis test was applied in the groups where normality assumption was not fulfilled. One way analysis of variance (ANOVA) was applied to evaluate the significance between subgroups of Group-I and Group-II. For multiple comparisons in the subgroups of both groups Tukeys-B test was applied. Independent samples T-test was applied for intergroup comparison.

The results were expressed at 95% Confidence Interval and 5% margin of error. The p < 0.05 was considered statistically significant.

**RESULTS**

One hundred and seventy four females between the age of 25 to 85 years were randomly selected and divided into two groups, Group-I and Group-II. Group-I included 85 females while Group-II included 89 females. Comparisons made between subgroups of Group-I and subgroups of Group-II were to evaluate changes occurring as a result of osteoporosis. Similarly, in order to exclude age changes comparisons between Group-I and Group-II were made. The changes seen in angle of mandible were a measure of both osteoporosis and age. Comparison of means in Group-I came out to be insignificant with a p-value of 0.386 as shown in Table I. Comparison of means in Group-II came out to be significant with a p-value of 0.035 as shown in Table II (a). Multiple comparisons between subgroups of Group-II showed significant decrease in angle of mandible between Post normal (Post A) vs. Post osteopenic (Post B) groups. P-value of 0.028 was observed as shown in Table II (b). Figures 1 and 2 show normal and decreased angle of mandible respectively.

Intergroup comparison between Group-I and Group-II showed a significant decrease in angle of mandible between Pre-osteopenic (Pre B) vs. Post-osteopenic (Post B). P-value of 0.005 was observed as shown in Table III. Figure 1 shows the mean angle of mandible.
DISCUSSION

At birth the angle of mandible is obtuse (175°). By the end of the second year the angle becomes less obtuse (140°). In adult life the angle is between 110° and 120°. In older age group the alveolar margin is absorbed owing to the loss of teeth thus greatly decreasing the bone tissue. The angle once again increases to reach 140 degrees.\textsuperscript{19}

Dutra and colleagues proved that the angle of mandible shows no change as a measure of age, sex, dental status or even osteoporosis.\textsuperscript{20} Previously, studies conducted in old females who had no teeth, angle was found to be increased by some researchers\textsuperscript{21} while others showed inconsistent results.\textsuperscript{22} It was found that changes do occur in the angle of mandible (A) in majority of the groups but significant decrease was found in post normal vs. post osteopenic groups of Group-II. This suggests that the angle of mandible decreases because of reduced bone mass. A significant decrease in angle was also found in pre osteopenic vs. post osteopenic groups of Group-I vs. Group-II which signifies that as a result of aging process in the presence of reduced bone mass, the decrease in the angle of mandible takes place. Similar results were found by Cakur \textit{et al.} in 2011,\textsuperscript{23} when osteoporotic men were studied for angle of mandible. It has been found that genetics and ethnicity do play a strong role in describing the characteristics of angle of mandible.\textsuperscript{17} Angle of mandible could not be studied separately in a particular race or ethnic group in the current study because of certain limitations. The interplay between changes in mandible due to aging, tooth loss and osteoporosis needs to be further worked out.

There were certain limitations of the current study. The phenomenon of changes in osteoporosis was not studied in male population as the prevalence of osteoporosis is more in females compared to males. Reduction in number and height of alveolar ridges could not be studied because of limited resources. Trabecular bone separation could not be studied because of financial constraints. The hormonal levels were not included in the study and all participants were assumed to have normal estrogen levels. This being a well known fact that estrogen levels definitely effect the bone mass status, exclusion criteria of the study did not rule out abnormal hormonal levels. In addition to this, a bigger sample size could have allowed to conclude in prospect of prevalence of osteoporosis. The study still succeeds to show findings with respect to age in addition to low bone mass which could be looked forward by orthopedic community.

The goal of the study was to establish changes in mandible so that a simple screening tool could be developed to advise females for further bone assessment. The findings concluded that OPG X-rays could be used by orthopedic community to add this cost effective radiographic technique to their investigation list supporting financially compromised subjects of our community. However, clinical implementation of this
facility is still a question; further studies in this regard could help find a solution. One could look forward to clear out facts regarding maxilla, alveolar ridges, trabecular separation, cortical shape and RBD (Relative Bone Density) regarding age and osteoporosis.

CONCLUSION
As decrease in angle of mandible was observed at stage of osteopenia, it can be conveniently used for early detection of osteoporosis.

REFERENCES