Original Article

A Retrospective CBCT Survey on Severity and Pattern of Alveolar Bone Loss Among a Selected Sample in the City of Sulaimani, Kurdistan Region of Iraq

Ayob O. Mohammed[1], Faraedon M. Zardawi[2], Sarhang S. Gul[2]*

Abstract

Objective: To evaluate the prevalence, distribution, and pattern of bone loss by using Cone beam Computed Tomography in relation to age and sex.

Methods: The severity and pattern of bone loss were evaluated on four sites of teeth. The severity and pattern were measured on proximal aspects, estimated by measuring the distance from the cementoenamel junction to the remaining alveolar bone crest subtract 2mm. Furcation defect was determined and recorded as presence and absence, and the sample was divided into seven age groups from (18 – 70 years).

Results: 212 well-defined CBCT for 76 males, 136 females with a mean population age of 40.4 ±13.3. Height of bone inspected on 20620 sites; the study sample included 781 missing teeth with a mean of 3.68 ±4.53. The total population bone loss prevalence was 7.6 %, with a mean amount of 1.54 ± 1.48 mm. The highest frequency of bone loss was at distal surfaces and mesial surfaces for lower-mid sextant with higher frequency for horizontal rather than vertical patterns. A highly significant difference in the severity of bone loss was recorded between younger and older age groups. The highest amount of bone loss was for the buccal aspects of mandibular left sextant followed by mid and right sextant, 4.27± mm, 3.92± mm and 3.75± mm respectively, with no significant differences between male and female (P>0.05) (1.65±1.57 mm and 1.48±1.44 mm).

Conclusions: CBCT can be utilized as a helpful radiographic tool to interpret the amount, pattern, and distribution of periodontal bone loss and detection of furcation defects.

Keywords: *Prevalence, Alveolar bone loss, Cone beam computed tomography.*

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1. *Kurdistan Board for Medical Specialties, Shorish Teaching Dental Center, Sulaimani, Iraq.*
2. *Department of Periodontics, College of Dentistry, University of Sulaimani, Sulaimani, Iraq.*

** Corresponding author: ayubosman82@gmail.com.*

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Introduction

Periodontitis is a chronic immuno-inflammatory disease of the periodontium. The disruption of the balance between host and microbiota interactions is key to the onset and progression of the disease[1]. Therefore, the diagnosis of periodontal disease mainly depends on clinical signs and symptoms. However, clinical parameters applied for the diagnosis of periodontal diseases cannot determine the amount and shape of alveolar bone loss. Therefore, radiographs are valuable diagnostic tools adjuncts to clinical examination to provide additional insight and knowledge about the periodontal condition and progression of periodontal diseases[2].

The radiographic image plays an important role in periodontal diagnosis because radiographs determine the severity and pattern of alveolar bone loss[2]. Alveolar bone loss is an important radiographic feature utilized to interpret the severity and pattern of alveolar bone loss during periodontitis that could be used together with clinical attachment loss (CAL) measurement for the diagnosis of periodontitis. Both Radiographic features and CAL determine the stage and grade of periodontitis according to the periodontal diseases classification system of 2017[3].

Alveolar bone loss can be determined routinely by bitewing, periapical and panoramic radiography, although the extraoral technique is the most widely used for a dental examination. However, periodontal abnormalities can be interpreted with intraoral bitewing and periapical radiographs with better details. Each technique has advantages and disadvantages, for instance. Regarding radiation dose, patients' comfort, and cost, the panoramic technique can be chosen but with a less detailed view[4,5]. Further limitations are masking the labial and lingual cortical plate by the high density of the tooth structure and evaluating bone craters, lamina dura. In addition, periodontal bone level is limited by geometric factors and superimpositions of adjacent anatomical structures. Subsequently, two-dimensional radiography often underestimates the actual amount of alveolar bone destruction[6,7]. These limitations can be eliminated by using a three-dimensional imaging system, CBCT imaging technique is based on a cone-shaped X-ray beam centered on a two-dimensional (2D) detector that performs one rotation around the object, producing a series of 2D images. These images are reconstructed in 3D using a modification of the original cone-beam algorithm developed by Feldkamp et al. in 1984[8]. Despite these advantages of CBCT and benefits that can be accomplished to diagnose periodontitis[9,10], the potential x-ray hazard should be considered. Therefore, its application should be confined to necessity; furthermore, the waiting time and cost required for CBCT should be considered. Searching online databases showed only a few studies conducted on the prevalence and intraoral distribution of infrabony lesions.

The rationale behind this study was to highlight the significance of using CBCT in the diagnosis of periodontitis at an early stage. The currently applied two-dimensional radiograph has some limitations such as over- lapping and lack of accuracy that cannot accurately identify the amount and pattern of bone loss. Further, CBCT can be applied with a margin of error and showing the architecture of bone loss in three dimensions that could be helpful to make better diagnosis and treatment plans. Moreover, No study was conducted to determine prevalence, severity, and patterns of bone loss by using CBCT in the Kurdistan region of Iraq previously.

Thus, this study aimes To evaluate the prevalence, distribution, and pattern of bone loss by using CBCT in relation to age and sex.

Patients and methods

Study sample

A retrospective CBCT survey was conducted on the radiographic database of two private dental centers in Sulaymaniyah in the Kurdistan Region of Iraq, with an inclusive period from January 2017 to October 2020. Two hundred twelve well-defined CBCTs were selected out of 260 CBCTs. The radiographic records were for patients their ages ranged from 18 to >70 years. Ethical approval was obtained to conduct this study by submitting the study protocol to the ethical and scientific committee of the Kurdistan Board for Medical Specialties (NO=628 on 13.9.2020). First, the radiographic interpretation was carried out then the records were divided into seven groups (G1, G2, G3, G4, G5, G6, G7) according to the age of the patients whom CBCT captured for them as follow:

G1 (18-20) , G2 (21-30), G3 (31-40), G4 (41-50), while G5 (51-60), G6 (61-70) s and G7 >70 years. Furthermore, the study sample was further divided and analyzed according to the Jaw sextants and gender.

Cone Beam Computed Tomography views were obtained using (Sirona GALILEOS comfort) model

2016,98kv,25mAs, Field of view GALILEOS Compact (12 x 15 x 15) cm³ with 3D Resolution (isotropic voxel size) 0.3 mm. A digital method of estimating alveolar bone height on CBCT images was employed using constant anatomic landmarks as reference points-CEJ and alveolar bone crest. The severity of bone loss was estimated by measuring the distance from the cementoenamel junction to the crest of the remaining alveolar bone minus 2mm at sites with a reduced normal level of interseptal bone.

The severity and pattern of bone loss were evaluated on four sites around each tooth in the radiographic images (mesial, distal, buccal, and lingual); in multi-rooted teeth, radiographic furcation defect was examined by identifying the furcation involvement (present or absent). Measurement of interproximal areas was carried out in a tangential view, and interpretation of the furcation area was made in an axial view. At the same time, buccal and Lingual or palatal bone loss was determined in a cross-sectional view (Figure 1). The pattern of bone loss was determined and recorded as vertical, horizontal, and furcation bone loss. Further, descriptive variables including; age, sex, number of extracted teeth, and number of sites examined were also recorded.

Images captured for patients aged less than 18 years, unclear, distorted CBCT because of overlapping and unclear anatomical landmarks such as blared CEJ, AC, or tooth apex were excluded from the total sample. Furthermore, CBCT for local areas other than full upper and lower arches was also excluded and not considered during interpretation.

Statistical analysis

The Shapiro-Wilk test was used to test the normality of the data. ANOVA test was carried out to determine the compares (significant differences) between the seven age groups. Pairwise comparison between groups was performed with Post hoc statically test LSD in table 2. P≤ 0.05 was regarded as statistically significant, t-test used for male and female compares in figure 4. Data analysis was conducted using the statistical software package IBMSPSS (Statistical Package for the Social Sciences version 21.0, Chicago IL, USA).

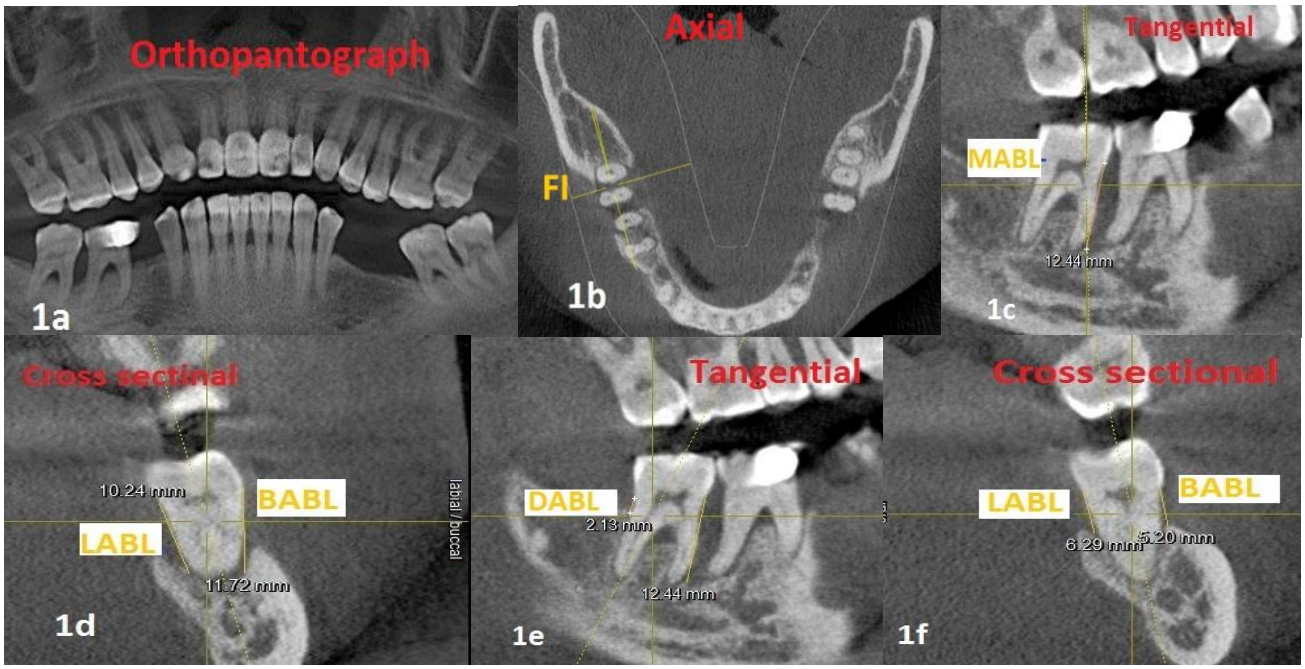

Figure 1: 1a- OPG view of a patient with periodontitis revealing different level of bone loss. 1b CBCT, axial view showing furcation involvement, 1c- CBCT,is the tangential view showing amount of bone loss on the mesial root (12.44 mm), 1d- CBCT, is the cross sectional view showing amount of bone loss on the buccal and lingual root (11.72mm,10.24mm respectively), 1e- CBCT, is the tangential view showing amount of bone loss on the distal root (2.13mm). 1f- CBCT, is the cross-sectional view showing amount of bone loss on the buccal and lingual root (5.20 mm, 6.29 mm) respectively.

Results

The retrospective radiographic study was carried out on 212 well-defined out of 260 CBCT radiographs composed of seventy-six males and 136 females with a mean population age of 40.4 ±13.3. Height of bone level was inspected on 20620 sites; the study sample included 781 missing teeth with a mean of 3.68 ±4.5.

Interpretation of the valid CBCTs employed in the study revealed that a mean of 1.54 ± 1.48 mm of total populations has a bone loss. The prevalence of total population bone loss was = 7.6%, in which 90% had horizontal bone loss, and 9.8% had vertical bone loss. Furthermore, the interpretation revealed that the highest frequency of bone loss was found to be on the distal surface for the mandibular mid sextant, 506 (40.7%) sites followed by mesial aspect of the same sextant then buccal and lingual surfaces, 504 (40.5%), 263(21.1%) and 203(16.3%) respectively. Horizontal bone loss was more frequent than the vertical bone loss in general. The highest prevalence of horizontal bone loss was recorded at mandibular mid sextant followed by maxillary mid sextant, 475 (37.3%) 141 (11.8%) respectively. At the same time, vertical bone loss at these two sextants was less frequent than each other, 32 (2.5%) and 13 (1%), respectively. However, the highest vertical and furcation bone loss were recorded for mandibular left and mandibular right sextants, 18 (1.4%) *vs.* 16 (1.3%) and 8 (0.7%) *vs.* 5 (0.4%), respectively, as shown in table 1.

Highly significant differences in the severity of bone loss were recorded between the younger age groups and older age groups but not between youngers and youngers or between older with each other, for example; a comparison of the severity of bone loss between G2 (21-30) and the other higher age groups G3 (31-40), G4 (41-50), G5 (51-60), G6 (61-70), and G7>70. Statistically, there was no significant difference between G3 (31-40) and the next age group G4(41-50), P=0.7, whereas there was highly significant differences with the other four higher age groups, G4 (41-50), G5 (51-60), G6 (61-70) and G7 >70 and P<0.05 (Table 2).

Figure 2 and figure 3 shows the mean amount of bone loss on each surface of the teeth in all sextants in both maxillary and mandibular jaw, respectively, the highest amount of bone loss found on the buccal surfaces of the teeth in almost all sextants except at the maxillary left sextant, in which buccal bone loss was less than other surfaces of the sextant. Generally, the buccal surfaces of the mandibular three sextants, mandibular left 4.27 mm, mandibular mid 3.92 mm, and mandibular right 3.75 mm, showed the highest amount of bone loss compared to the corresponding maxillary three sextants, upper left, 2.65 mm, maxillary mid 3.03 mm and upper right 2,23 mm respectively. Therefore, a mean of 1.54 ± 1.48 mm bone loss was recorded as a total bone loss among the whole sample examined in this study.

Furthermore, the amount of bone loss among the seven age groups recorded a gradual increase in bone loss with increased age; the amount of bone loss recorded a direct proportion with increased age groups, as shown in Figure 4.

Although males' CBCT slightly higher mean of bone loss than females on all surfaces of the six sextants (1.65 ± 1.57) mm VS (1.48±1.44) mm respectively, however, the difference doesn't reach a significant level statistically (p = 0.52), as shown in Figure 5.

Table 1: Frequency and percentage of bone loss and furcation involvement according to sites at each sextant (Total sites =20620).

Site and Type of BL	Upper Right (701)	Upper Mid (1192) N (%)	Upper Left (682) N (%)	Lower Left (668) N (%)	Lower Mid (1242) N (%)	Lower Right (670) N (%)
Distal	43 (6.1)	154 (12.9)	71 (10.4)	112 (16.2)	506 (40.7)	91 (13.5)
Buccal (Labial)	13 (1.8)	59 (4.9)	12 (1.7)	35 (5.2)	263 (21.1)	23 (3.4)
Lingual(Palatal)	15 (2.1)	47 (3.9)	11 (1.6)	29 (4.3)	203 (16.3)	18 (2.6)
Mesial	50 (7.1)	153 (12.8)	69 (10.1)	104 (15.5)	504 (40.5)	95 (14.1)
Horizontal bone loss	40 (3.1)	141 (11.8)	61 (4.8)	88 (6.9)	475 (37.3)	76 (6)
Vertical bone loss	7 (0.6)	13 (1)	10 (0.8)	18 (1.4)	32 (2.5)	16 (1.3)
Furcation involvement	3 (0.9)	-	2 (0.2)	8 (0.7)	-	5 (0.4)

Table 2: Comparison of severity of bone loss between the study age groups.

Age groups	G2(21-30)	G3(31-40)	G4(41-50)	G5(51-60)	G6(61-70)	G7(>70)
G1(18 -20)	0.79	0.9	0.38	**0.027**	**0.006**	**0.038**
G2(21-30)		0.7	**0.04**	**0.0001**	**0.0001**	**0.01**
G3(31-40)			**0.07**	**0.0002**	**0.0001**	**0.018**
G4(41-50)				**0.02**	**0.002**	0.07
G5(51-60)					0.36	0.37
G6(61-70)						0.67

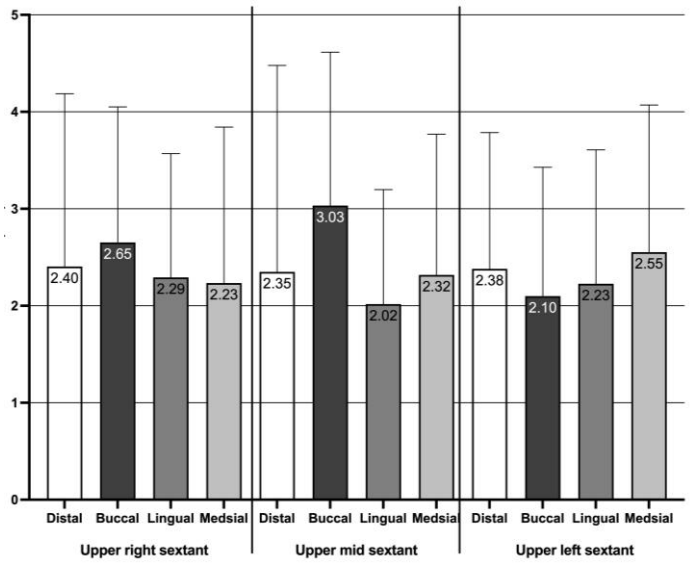

Figure 2: (median and interquartile range): Amount of bone loss in mm according to sites at each sextant for the upper teeth.

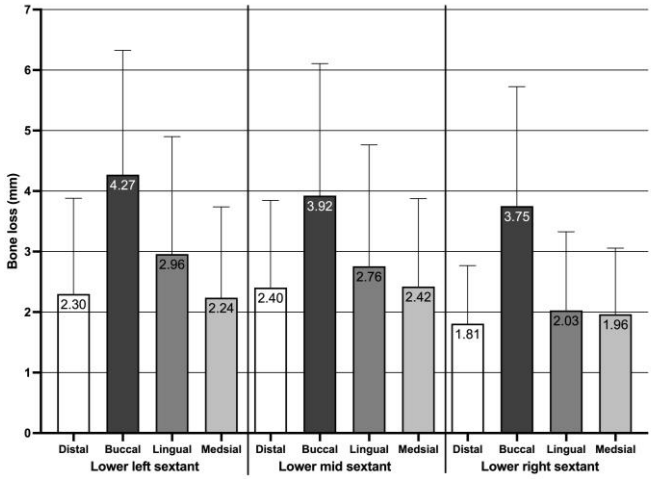

Figure 3: (median and inerquartile range) Amount of bone in mm according to site at each sextant for the lower teeth.

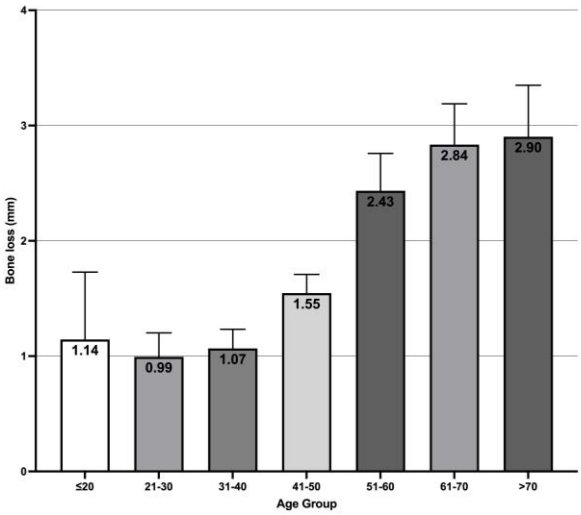

Figure 4: Distribution of the mount of bone loss in mm according to age groups.

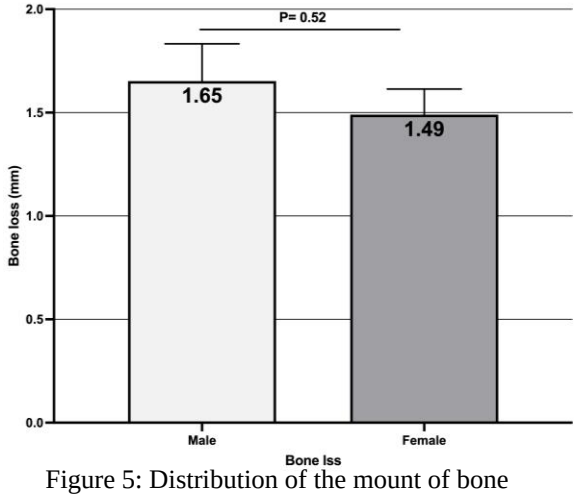

Figure 5: Distribution of the mount of bone loss in mm according to male and female.

Discussions

The diagnosis and treatment of periodontal disease require consideration of severity (such as the amount of bone loss) as well as the extent (the percentage or number of affected sites) of the disease[11] and further details regarding an osseous defect in periodontitis that could be scanned and detected more obviously on CBCT images than Orthopantomography images as the former is a 3D image, which can be interpreted at different planes thus providing further details than 2D images and overcome the problems of superimposition of higher density of the teeth structures. This will mask the facial and lingual alveolar bone plate and any osseous defects on these aspects of the tooth, as shown in Figures 1a, 1b, 1c, 1d, 1e, and 1f. A more accurate evaluation of alveolar bone height in relation to the cemento-enamel junction is the primary benefit of radiologic examination in periodontal diagnosis.

Interpretation of the images also revealed that the highest frequency and prevalence of bone loss was found on the distal surface of the mandibular mid sextant; this result was consistent with a previous study[12]. This could be explained by an early eruption of the teeth as mandibular incisors are the first permanent teeth that erupt in the oral cavity and perhaps longer exposure of these teeth to local factors than other teeth. At the same time, a labial bone loss could be attributed to labial muscle or frenum pull or could be due to malalignment of the teeth and the presence of bone dehiscence at the lower jaw[12].

The current study revealed bone loss as a site-specific phenomenon. Certain sites around the teeth exhibited a higher bone loss than others; a similar result was also detected by Fukuda et al.[12]. Thus, patients may show various degrees of alveolar bone loss at different sites around the same tooth.

The greatest amount of alveolar bone loss was detected at the buccal aspect of the mandibular left sextant, followed by the labial aspect of the mandibular mid sextant and buccal aspect of the mandibular right sextant. This finding was consistent with the result of a study by Sarajilić et al., and disagree with the finding of Kasaj et al., that detected a mean depth of 6.0 mm mean angular bony defects with the greatest mean depth in the anterior maxillary area[14]. This finding could more likely be due to early eruption of first molar and incisors and consequently longer exposure of these teeth to detrimental occlusal and plaque-associated factors. Perhaps the position of the incisors within the alveolar bone at this region may leave thin labial bone, which leads to labial dehiscence. At the same time, furcation factors of the molar teeth may be responsible for buccal bone loss on the mandibular molars[15,16].

Successful periodontal therapy is based not only on recognizing the amount of bone loss but also on identifying the pattern of alveolar bone loss to plan the appropriate treatment procedure and, further, determine the prognosis of each tooth[17].

Assessment of intrabony defects, maxillary trifurcations, buccal and lingual bone loss, and interdental craters on 2D radiographs. However, due to the limitations of clinical examination and periapical radiographs to detect 3D defect architecture, accurate imaging of the morphology of the remaining bone and a 3D architecture of the osseous defect is an essential

determinant for making an appropriate diagnosis and treatment planning, thus taking the right decision on the periodontal treatment option and determination of prognosis[18].

Furthermore, the current study scanned the morphology of the osseous defect, and the outcome revealed a significantly higher frequency of horizontal bone loss than vertical. Among the total sites scanned in this study, 881 sites have been detected with horizontal osseous defects against only 96 vertical defects. Our result was consistent with a similar study by Ozean et al., that also determined a higher frequency of horizontal bone loss than vertical[18]. Furthermore, the highest prevalence of vertical bone loss was detected in the mandibular left and mandibular right sextants, as seen in Table 1.

The prevalence of furcation defect is not constant among dentition[19,20], as other similar studies detected a higher prevalence of furcation bone loss in the maxillary molars[21], which was not consistent with the outcome of the current study.

The CBCT images in this study presented an age-dependent determinant of alveolar bone loss. There was an incremental increase in the amount of bone loss with increasing age. Statistically, it was highly significant when the younger age groups compared to older age groups shown in Table 2. This outcome was similar to the findings of the previous studies by Nielson et al.[11] and Zhao et al.[22]. Males slightly recorded a higher prevalence of alveolar bone loss than females but didn't reach a significant level. This result is similar to the outcome of a recent study by Helmi et al., which detected a higher risk of alveolar bone loss and development of periodontitis[23].

Nowadays, imaging procedures and software facilities are commonly applied to diagnose and accurately measure alveolar bone loss due to periodontitis. However, in two-dimensional images, the buccal and palatal alveolar plate is overlapped and hidden by the high density of the tooth structures, thus obscures any buccal and palatal bone loss; this can be achieved by low radiation dose and high spatial resolution, three-dimensional image[24].

CBCT can scan and detect early stages of periodontal disease osseous defects, thereby playing an important role in applying all the primary preventive measures. In addition, it gives a clear understanding of the morphology of alveolar bone loss in chronic periodontitis patients, which helps design appropriate regenerative periodontal therapy. Future studies should be conducted correlating CBCT with clinical examination to determine the accuracy of CBCT in evaluating the prevalence, amount, and distribution of osseous defects in periodontitis[25].

One of the most deterministic factors to evaluate treatment procedures is making a definite diagnosis of the defect morphology and classification. Currently, it is acknowledged that lower radiation dose used in CBCT, imaging with 3D techniques is becoming more widely applicable for routine periodontal imaging to design the appropriate treatment planning in hazardous teeth with complex bone loss morphology. CBCT can provide comprehensive information about the remaining alveolar bone structures and morphology. The significant point for conducting this study was a self-argument to have an overlook at a group of archived CBCT in a Private dental center to find out how to utilize these images appropriately to get a better insight into these images for definite diagnosis and treatment planning of periodontal disease.

Conclusions

Based on the results of this retrospective CBCT analysis, the outcome of this survey concludes that the greatest prevalence and frequency of alveolar bone loss was detected on the distal aspects of the mid sextant 506 (40.7%) sites. In contrast, the highest amount of Alveolar bone loss was detected on the mandibular left sextant 4.27mm (on the buccal surface). Furthermore, the amount and level of alveolar bone loss found to be age-dependent that increased with increasing ages, and no statistically significant differences were detected between males and females although males recorded a slightly higher amount of alveolar bone loss in CBCT samples examined in this study, Horizontal bone loss (90%) was more frequent than vertical bone loss 9.8% in general and the highest prevalence of horizontal bone loss was recorded at mandibular mid sextant.

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