AL-AZHAR
Journal of Dentistry

The Official Publication of The Faculty of Dental Medicine For Girls, Al-Azhar University Cairo, Egypt.

Print ISSN 2974-4156 • Online ISSN 2974-4164

AZJD, Vol. 10, No. 2, April (2023) — PP. 461:469

Correlation Between Clinical and Radiographic Evaluation Using Custom-made Newly Developed Software Program as A Guide for Accurate Diagnosis of Periodontal Diseases

Eman M. Hassan[1]*, Naglaa S. El-kilani [2], Halaa H. Hazza[3]

Codex : 2-09/23.04

azhardentj@azhar.edu.eg

http://adjg.journals.ekb.eg

DOI: 10.21608/adjg.2023.105625.1456

Oral Medicine & Surgical Sciences
(Oral Medicine, Oral & Maxillofacial Surgery, Oral Pathology, Oral Biology)

ABSTRACT

Purpose: to correlate between clinical and radiographic findings using custom–made newly developed software program that guide clinicians, for accurate diagnosis. This is based on clinical and radiographic data from 3D volumetric rendering of cone beam computed tomography. This has been done based on the new classification of periodontal diseases (of 2018). **Materials and methods:** A randomized clinical study was performed on hundred and fifty patients with periodontal diseases of both gender with age range (30-60) years old. Periodontal clinical parameters were taken. Radiographic analysis using CBCT and 3D volumetric rendering was done. **Results**: There is a moderate positive correlation between Clinical data (clinical attachment loss CAL and probing depth PD) and linear measurements (Mesial and distal bone loss). Moreover, there was positive correlation between Clinical data (CAL and Max PD) and volumetric measurements (Mesial and distal bone loss area) and between linear measurements (mesial and distal bone loss) and volumetric measurements (mesial and distal bone loss area). This correlation was statistically highly significant at the 0.01 level (P0.01 < & confidence 99 %). **Conclusion**: There is moderate positive correlation between clinical and radiographic data that is statistically highly significant at the 0.01 level (P0.01 < & confidence 99 %).

KEYWORDS

Periodontal Diseases,
Cone Beam Computed Tomography,
Volumetric Rendering.

INTRODUCTION

Periodontitis is a multifactorial inflammatory disease that causes the tooth-supporting apparatus to gradually deteriorate that is linked to dysbiotic plaque biofilms. Periodontal tissue support is lost, as evidenced

1. Assistant Lecturer of Oral Medicine, Periodontology, Oral Diagnosis and Dental Radiology Department., Faculty of Dental Medicine for Girls, Al-Azhar University, Cairo, Egypt.
2. Professor of Oral Medicine, Periodontology, Oral Diagnosis and Dental Radiology, Head of Oral Medicine, Periodontology, Oral Diagnosis and Dental Radiology Department, Faculty of Dental Medicine for Girls, Al-Azhar University, Cairo, Egypt.
3. Professor of Oral Medicine, Periodontology, Oral Diagnosis and Dental Radiology, Al-Azhar University, Cairo, Egypt.

* Corresponding author email: em12hassan@gmail.com, eman aly.26@azhar.edu.eg

by loss of clinical attachment (CAL), radiographic evidence of alveolar bone loss, gingival bleeding and the formation of periodontal pockets are the most common symptoms [1].

Periodontitis is a disease affecting health of the general public which is a serious issue because of its great occurrence, as well as the fact that it can induce tooth loss and impairment, impair chewing function and aesthetics, generate social disparity, and lower life quality. Periodontitis is responsible for a large percentage of edentulism and masticatory problems, costs a lot of money to treat, and has a possible negative impact on overall health. In (1999) classification, periodontitis is divided into chronic periodontitis, aggressive periodontitis, periodontitis as a manifestation of systemic disease, necrotizing periodontal disorders, and periodontal abscesses [2].

Workgroup (2017) set out to review the 1999 periodontal disease classification system, include new epidemiological knowledge, pathogenesis and etiology that has accumulated since the current classification was established, and suggested a new classification system that includes case definitions. For this reason, five position papers were commissioned, written, peer-reviewed, and accepted. Periodontitis classification has been changed several times in the previous 30 years to fit it with new scientific information [3].

The workshop (2017) agreed that three types of periodontitis can be identified, based on current pathophysiology knowledge: periodontitis as a manifestation of systemic disease, necrotizing periodontitis, and the types of periodontitis that have previously been defined as "chronic" and "aggressive," which have now been combined into one category, "periodontitis". The workshop came to an agreement on a periodontitis classification system. Moreover, defined by a staging and grading system with several dimensions that may be adjusted gradually as new information becomes available [4-10].

Staging is divided into four groups (stages 1–4) and is established by taking into consideration a variety of issues such as probing depth, Loss of attachment, the presence and extent of angular bony deformities, as well as involvement of the furcation, movement of the teeth, and Periodontitis-related tooth loss. There are three categories of progression risk (grade A–low risk, grade B–moderate risk, and grade C–high risk) [3]. For the diagnosis, treatment planning, and prognosis of bone loss, A precise assessment of the bone status is required. Guidelines for determining the height of alveolar bone and a vertical bone defect screening come from gingival tissue information combined with diagnostic imaging [11- 14].

Cone beam computed tomography (CBCT) has a detection and classification sensitivity of 80–100% of artificially created bone defects, while intraoral radiographs have a sensitivity of 63–67%, according to study comparing the use of 2D images and three-dimensional (3D) volumetric images for bone defects created artificially [12]. For the reasons stated above, CBCT was used in this investigation to assess the quantity of bone resorption around the teeth in all quadrants using 3D volumetric rendering as a tool for periodontal disease diagnosis.

A crucial graphics and visualization approach is called volume rendering. A rendered volume can be used to show not only the model's surfaces, but also the fine details contained therein. We used the Direct Volume Rendering (DVR) approach for 3D visualization to achieve our goal. It aids in the creation of an interactive 3D model that can be changed to show surfaces of various intensities [14]. This aids in the creation of accurate photographs of the part under consideration [15] Thus the aim of the current study is to correlate between clinical and radiographic findings using custom–made newly developed software program that guide clinicians, for accurate diagnosis. This is based on clinical and radiographic data from 3D volumetric rendering of cone beam computed tomography. This has been done based on a new periodontal disease classification (of 2018).

MATERIALS AND METHODS

Study design and ethical approval:

This randomized clinical study was performed on hundred and fifty patients with periodontal diseases of both gender with age range (30-60) years old. They were selected from Oral Medicine, Periodontology, Diagnosis and Radiology Department, Faculty of Dental Medicine for Girls Al Azhar University. Research Ethics Committee approval with code **(REC-ME-21-06)** was obtained from Faculty of Dental Medicine for Girls, Al-Azhar University. Priors to any intervention all subjects were informed about the study procedures and benefits of their participation in the study. Each patient signed a written consent form, denoting their convenience about the schedule research program design.

Sample calculation

Sample size calculation has been done according to the following equation [16]**:** 4P*Q/d2.P= prevalence f b- Q = 100- P c- D= allowable error (15% of P) d.

Subject selection:

The patients have been divided equally into the following five groups with reference to new classification of periodontal disease [10]**:** **Group I**: 30 patients with healthy periodontium. **Group II**: 30 patients with periodontitis diagnosed as stage I. **Group III**: 30 patients with periodontitis diagnosed as stage II. **Group IV**: 30 patients with periodontitis diagnosed as stage III. **Group V**: 30 patients with periodontitis diagnosed as stage IV. The new classification for periodontal and peri implant disorders was used to examine all of the patients. and conditions [3] which were assessed radiographically**.**

Clinical parameters:

The following clinical parameters will be measured and recorded :

a) Bleeding index [17] : The tooth has been evaluated at four sites (buccal, lingual, mesial and distal).

b) Probing pocket depth: Six measurements per tooth was made using the University of Michigan 'O' periodontal probe, with Williams's markings [7].

c) Clinical attachment level[5]: recorded from the cemento-enamel junction to the bottom of the pocket**. (Fig 1)**

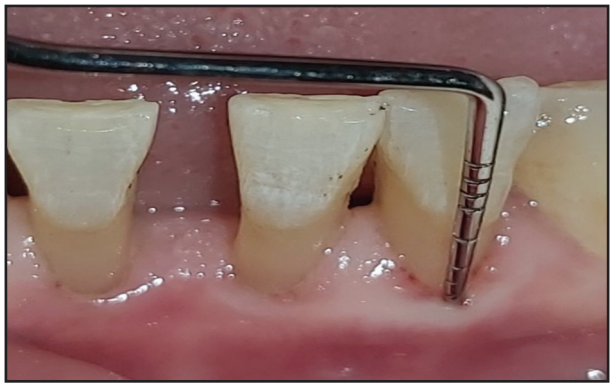

Figure (1) Clinical photograph showing 6mm clinical atachment loss

Radiographic evaluation:

Radiographic evaluation was done for each patient using cone beam computed tomography (planmecca Romexis 3D software program).). Radiographic examination for a specific area, segment, quadrant or whole arch will be done according the amount of bone loss (localized or generalized) using the low radiation mode offered by the CBCT machine. Periodontal bone defects have been measured from C.E.J to the alveolar crest (AC) in a horizontal defects and from C.E.J to the bottom of the defect in the vertical defects**.** **Measured** from the sagittal view, at both the mesial and distal sites of the most affected tooth **(Fig.2)**.

a) At Six points around the most affected tooth from cross sectional view Mesio buccal (MB), Mid Buccal (Mid B), Disto Buccal (DB), Disto Lingual (DL), Mid Lingual (Mid L) and Disto Lingual (DL)**.**

b) Angle of the defect also measured if vertical bone defect is present.

c) Percent or radiographic bone loss around the most affected tooth.

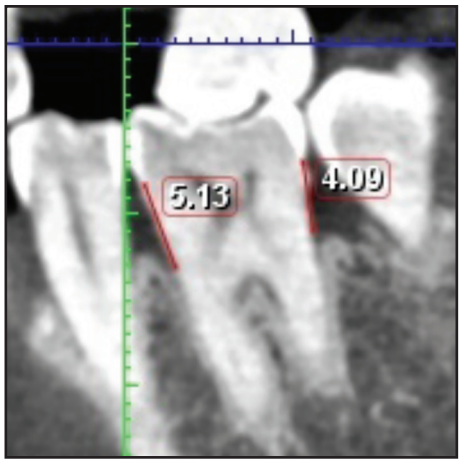

Figure (2) Stage IV: Marginal bone loss mesial and distal to the tooth.

3d volumetric rendering:

3d volumetric rendering images for measurement of alveolar bone loss was done around the tooth at six points per tooth using third party software. All patients in the study received oral hygiene instructions, scaling and root planning and required periodontal therapy.

Statistical analysis:

- The results were statistically analyzed using one-way ANOVA and a post hoc test.
- Pearson Correlation coefficient test was applied to study the correlation between Clinical data and Radiographic data, Pearson correlation is a statical test used to measure the strength and direction of linear relationship between two variables, its value always range between -1(strong negative relationship) and +1 (strong positive relationship) and the test criteria can be classified according to **Likert** scale as the following:

r = 0	No correlation
0.00 <r 0.25 <	Weak correlation
0.25 ≤r 0.75 <	Moderate correlation
0.75 ≤r 1.00 <	Strong correlation
r = 1	Complete correlation

- $p < 0.05$ was considered statistically significant (95% significance level) and Shapiro Wilk test was used for testing the normality of data.
- Statistical evaluation was performed using the SPSS statistical package (version 25, IBM Co. USA).

1- Clinical data and Linear measurements

The result of the Pearson correlation test between Clinical data (Cal and Max PD) and linear measurements (Mesial and distal bone loss) is tabulated in Table 1. From the results we could conclude the following:

- There was a moderate positive correlation between Clinical attachment loss (CAL) and Mesial Bone Loss (r = 0.683). This correlation was statistically highly significant at the 0.01 level (P0.01 < & confidence 99 %).
- There was a moderate (close to being strong) positive correlation between Clinical attachment loss and Distal Bone Loss (r = 0.740). This correlation was statistically highly significant at the 0.01 level (P > 0.01& confidence 99 %).
- There was a moderate positive correlation between Maximum probing depth (Max PD) and Mesial Bone Loss (r = 0.532). This correlation was statistically highly significant at the 0.01 level (P0.01 < & confidence 99 %).
- There was a moderate positive correlation between Maximum probing depth (Max PD) and Distal Bone Loss (r = 0.579). This correlation was statistically highly significant at the 0.01 level (P0.01 < & confidence 99 %).

Table (1): *Correlation between clinical variables (Cal and Max PD) and linear measurements (Mesial and distal bone loss).*

	Mesial Bone Loss	Distal Bone Loss
Clinical attachment loss (CAL)	0.683** 0.000HS Moderate positive	0.740** 0.000HS Moderate positive
Maximum probing depth (Max PD)	0.532** 0.000HS Moderate positive	0.579** 0.000HS Moderate positive

- ** *Pearson Correlation value*

-HS *Highly significant (Correlation is significant at the 0.01 level).*

2- Clinical data and Volumetric measurements

The result of the Pearson correlation test between Clinical data (Cal and Max PD) and Volumetric measurements (Mesial and distal bone loss area) was tabulated in Table 2. From the results we can conclude the following:

- There was a moderate positive correlation between Clinical attachment loss (CAL) and Mesial Bone Loss Area (r = 0.606), and this correlation was statistically highly significant at the 0.01 level (P0.01 < & confidence 99 %).
- There was a moderate positive correlation between Clinical attachment loss and Distal Bone Loss Area (r = 0.532), and this correlation was statistically highly significant at the 0.01 level (P > 0.01& confidence 99 %).
- There was a moderate positive correlation between Maximum probing depth (Max PD) and Mesial Bone Loss Area (r = 0.419), and this correlation was statistically highly significant at the 0.01 level (P0.01 < & confidence 99 %).
- There was a moderate positive correlation between Maximum probing depth (Max PD) and Distal Bone Loss Area (r = 0.418), and this correlation was statistically highly significant at the 0.01 level (P0.01 < & confidence 99 %).

Therefore, we can briefly say that there is a clear moderate positive correlation between Clinical data (Cal and Max PD) and Volumetric measurements (Mesial and distal bone loss Area).

Table (2)*: Correlation between clinical variables (Cal and Max PD) and Volumetric measurements (Mesial and distal bone loss Area).*

	Mesial Bone Loss Area	Distal Bone Loss Area
Clinical attachment loss (CAL)	0.606** 0.000HS Moderate positive	0.532** 0.000HS Moderate positive
Maximum probing depth (Max PD)	0.419** 0.000HS Moderate positive	0.418** 0.000HS Moderate positive

- ** *Pearson Correlation value*

-HS *Highly significant (Correlation is significant at the 0.01 level).*

3- Volumetric measurements and Linear measurements

The result of the Pearson correlation test between linear measurements (Mesial and distal bone loss) and Volumetric measurements (Mesial and distal bone loss area) was tabulated in Table 3. from the results we could conclude the following:

- There was a moderate positive correlation between Mesial Bone Loss diameter and Mesial Bone Loss Area (r = 0.647), and this correlation was statistically highly significant at the 0.01 level (P0.01 < & confidence 99 %).
- There was a moderate positive correlation between Mesial Bone Loss diameter rand Distal Bone Loss Area (r = 0.485), and this correlation was statistically highly significant at the 0.01 level (P > 0.01& confidence 99 %).
- There was a moderate positive correlation between Distal Bone Loss diameter and Mesial Bone Loss Area (r = 0.614), and this correlation was statistically highly significant at the 0.01 level (P0.01 < & confidence 99 %).

- There was a moderate positive correlation between Distal Bone Loss diameter and Distal Bone Loss Area (r = 0.605), and this correlation was statistically highly significant at the 0.01 level (P0.01 < & confidence 99 %).

Table (3) *Correlation between linear measurements (Mesial and distal bone loss) and linear measurements (Mesial and distal bone loss).*

	Mesial Bone Loss Area (mm^3)	Distal Bone Loss Area (mm^3)
Mesial Bone Loss (mm)	0.647** 0.000^{HS} Moderate positive	0.485** 0.000^{HS} Moderate positive
Distal Bone Loss (mm)	0.614** 0.000^{HS} Moderate positive	0.605** 0.000^{HS} Moderate positive

- *** Pearson Correlation value*

-^{HS} *Highly significant (Correlation is significant at the 0.01 level).*

DISCUSSION

In the last 30 years, classification of periodontitis has been modified several times to fit it with new scientific information. The workshop (2017) agreed that three types of periodontitis can be identified, based on current pathophysiology knowledge: periodontitis as a manifestation of systemic disease, necrotizing periodontitis, and the previous forms of periodontitis "chronic" or "aggressive," ar currently in a single category, "periodontitis" [4] .The group agreed on a framework for periodontitis categorization while updating the classification that is further defined by a staging and grading system with multiple dimensions that becomes available as new evidence [18].

The present knowledge gaps that could lead to a more accurate periodontitis classification and should be investigated in the future. Improved approaches for assessing longitudinal soft and hard tissue changes related with periodontitis progression should be developed. Using a set of established methodologies, and collecting and reporting detailed information on both patient-related and oral health issues, and periodontal variables is the future for accurate periodontal assessment. To support complete analysis, open access to detailed data is critical [19].

Thus, the aim of the present study was the correlation between clinical and radiographic findings using custom–made newly developed software program to guide clinician for accurate diagnosis using clinical and radiographic data from 3D volumetric rendering of cone beam computed tomography. This has been done based on the new classification of periodontal diseases (of 2018). This randomized clinical study was performed on hundred and fifty patients with periodontal diseases of both gender with age range (30-60) years old. All the included patients were evaluated according to the criteria of new classification scheme for periodontal and peri-implant diseases and conditions [3] which were assessed radiographically.

There were no systemic illnesses among the subjects, and none of them had taken any medications. Tobacco-exposed tissues respond by expressing higher quantities of cytokines in those tissues, probably as part of the damage response mechanism, hence smokers were excluded from this study [20]. Females who were lactating or pregnant were also eliminated, because pregnancy has been shown to influence cytokine levels in the blood [21].

Because of its numerous advantages, CBCT (cone beam computed tomography) was applied. The limitations of periapical and panoramic radiography, where horizontal bone changes could not be identified, have been totally resolved by CBCT. Furthermore, it is possible to reduce the slice thickness to tens of micrometers, which is critical for monitoring Oral and maxillofacial fine structure with precision. It enables quantifiable measurements to be made that can be conveniently retrieved using image reconstruction [22].

Volume measurements are helpful in a variety of medical circumstances, including monitoring periodontal health and bone loss in hemodialysis patients in China [23]. This method can also be used to show the relationship between thickness of the maxillary sinus mucosa and periodontal bone loss, as well as to detect periodontal bone resorption utilizing intraoral radiography and CBCT [24]. The accuracy of the bone status must be evaluated for diagnosis, treatment planning, and prognosis of periodontal disease [25].

Because software capabilities and applications have grown increasingly vital, medical devices have become more sophisticated. Failures in software functionality can result in a patient's death or significant damage. As a result, the software development process is critical, and ensuring that it is regulated across all medical devices is regarded as a crucial core part of medical device manufacturing[26].

The result of this study showed that the Pearson correlation test between Clinical data (CAl and Max PD) and linear measurements (Mesial and distal bone loss) showed that there is a clear moderate positive correlation between Clinical data (CAL and Max PD) and linear measurements (Mesial and distal bone loss). This correlation was statistically highly significant at the 0.01 level (P0.01 < & confidence 99 %). Also there is a clear moderate positive correlation between Clinical data (CAl and Max PD) and Volumetric measurements (Mesial and distal bone loss Area).

From the current study there is a clear moderate positive correlation between linear measurements (Mesial and distal bone loss) and volumetric measurements (Mesial and distal bone loss Area). This correlation was statistically highly significant at the 0.01 level (P0.01 < & confidence 99 %). This is in accordance with new classification of periodontal diseases (of 2018). based on criteria of periodontitis staging and grading system of and this confirm the truth of our hypothesis That is the correlation between clinical and radiographic findings using custom–made newly developed software program to guide clinician for accurate diagnosis using clinical and radiographic data from 3D volumetric rendering of cone beam computed tomography. This is considered the first trial has been done.

The current study showed that there is a positive correlation between Clinical data (CAL and Max PD) and linear measurements (Mesial and distal bone loss). This correlation was statistically highly significant at the 0.01 level (P0.01 < & confidence 99%). This is in accordance with the study [7] ascertained that there was a positive correlation between clinical measurements of periodontal bone defects with periodontal probe and measurements taken by CBCT to the same defects. Moreover, this is results conceded with the study [11] showed that there was no statistically significant difference. between the clinical measurement from the surgical defects and CBCT (p = 0.84).

From the current study there is a clear moderate positive correlation between linear measurements (Mesial and distal bone loss) and volumetric measurements (Mesial and distal bone loss Area). This correlation was statistically highly significant at the 0.01 level (P0.01 < & confidence 99 %). This in accordance with the study [25] showed that no statistical difference between manual methods and Image J software program volumetric measurements so that Image J software are reliable and accurate.

CONCLUSION

It was concluded that clinical and radiographic linear measurements from CBCT for patients in all stages and grades based on new classification system were correlated. Using clinical and Radiographic data for staging and grading based on new classification system were correlated to volumetric measurements of CBCT in all patients in the current study.3D volumetric Rendering using newly developed third party software program is an effective method in volume measurement of bone loss.

RECOMMENDATIONS:

Further clinical, radiographic and histological studies in larger sample size studies are required to evaluate this study outcomes. Expansion of existing epidemiological databases needed utilizing additional research strategies to cover previously under-represented regions in the world, standardized methodology, and data collection and reporting.

CONFLICT OF INTEREST

No conflict of interest.

FUNDING

No funding was received for this study.

REFERENCES

1. Dubey P, Mittal N. Periodontal diseases- A brief review. Int J Oral Health Dent. 2020;6: 177- 87.
2. Rajendra S AB, Jones T. Tropical Oral Disease: Analysing Barriers, Burden, Nutrition, Economic Impact, and Inequalities. Front Nutr. 2021; 8:1-13.
3. Kuraji R, Sekino S, Kapila Y, Numabe Y. Periodontal disease–related nonalcoholic fatty liver disease and nonalcoholic steatohepatitis: An emerging concept of oral-liver axis. Periodontol 2000. 2021;87: 204– 40.
4. Papapanou PN, Sanz M, Buduneli N, Dietrich T, Feres M, Fine DH. Periodontitis: consensus report of workgroup 2 of the 2017 world workshop on the classification of periodontal and peri-implant diseases and conditions. J Clin Periodontol. 2018; 45: 162–70.
5. Ko TJ, Byrd KM, Kim SA. The chairside periodontal diagnostic toolkit: past, present, and future. Diagnostics. 2021;11: 932 -55.
6. Albandar JM, Susin C, Hughes FJ. Manifestations of systemic disease and conditions that affect the periodontal attachment apparatus: case definitions and diagnostic considerations. J Clin Periodontol. 2018; 45: 171–89.
7. Mohan R, Mark R, Sing I, etal. Diagnostic accuracy of CBCT for Aggressive Periodontitis. J clinc imaging sci. 2014; 4:2-7.
8. Fine DH, Patil AG, Loos BG. Classification and diagnosis of aggressive periodontitis. J Clin Periodontol. 2018; 45: 95–111.
9. Billings M, Holtfreter B, Papapanou PN, Mitnik GL, Kocher T, Dye BA. Age-dependent distribution of periodontitis in two countries: findings from NHANES 2009 to 2014 and SHIP-TREND 2008 to 2012. J Clin Periodontol. 2018; 45: 130–48.
10. Tonetti MS, Greenwell H, Kornman KS. Staging and grading of periodontitis: Framework and proposal of a new classification and case definition. J Clin Periodontol. 2018; 45: 149– 61.
11. Elbatawy w, Ahmed D. Clinical and radiographic evaluation of open flap debridement with or without Nanocrystalline Hydroxyapatite bone graft in management of periodontal intrabony defects. Egypt Dent J 2021;67:433-46.
12. Mark R, Mohan R, Gundappa M, Balaji MDS, Vijay VK, Umayal M. Comparative evaluation of periodontal osseous defects using direct digital radiography and cone-beam computed tomography. J Pharm Bioallied Sci. 2021;13: 306-11.
13. Kwon TH, Lamster I B, Levin L. Current Concepts in the Management of Periodontitis. Inter Dent J,2021; 71:462-476.
14. YanL, Masood TB, Sridharamurthy R, Rasheed F, Natarajan V, Hotz I, Wang B. Scalar field comparison with topological descriptors: properties and applications for scientific visualization computer graphics forum. 2021;40:599-633.
15. Pratik K, Rahangdale P, Jangra D, Bundele M, Chattopadhyay CH. An interactive 3d volume rendering and visualization framework. Indian Institute of Technology Jodhpur. 2018;12 :1-10
16. Wayne W, Wiley D. Biostatistics: a foundation for analysis in the health sciences. 7th ed .New York. 1999.
17. Seymour GJ, Powell RN, Davies WJR. Conversion of a stable T cell lesion to a progressive B cell lesion in the pathogenesis of chronic periodontal disease. J Clin Periodontol. 1979; 5:267-77.
18. 18-Tonetti MS, Greenwell H, Kornman KS. Staging and grading of periodontitis: Framework and proposal of a new classification and case definition. J Periodontol. 2018; 89:159-72.
19. American Academy of Periodontology task force report on the update to the 1999 classification of periodontal diseases and conditions. J Periodontol. 2015;86: 835–38.
20. Strzelak A, Ratajczak Al, Adamiec Al, Feleszko W.Tobacco Smoke induces and alters immune responses in the lung

triggering inflammation, allergy, asthma and other lung diseases: a mechanistic review. Int J Environ Res Public Health. 2018; 5 1033.

21. Collier AY, McMahan K, Yu J. Immunogenicity of COVID-19 mRNA vaccines in pregnant and lactating women. JAMA. 2021; 23:2370-80.
22. Erdelyi RA, Duma VF, Sinescu C, Dobre GM, Bradu A, Podoleanu A. Optimization of X-ray investigations in dentistry using optical coherence tomography. 2021; 21:45-54.
23. Anter E, Zayet MK, El-Dessouky SH. Accuracy and precision of cone beam computed tomography in periodontal defects measurement (systematic review). J Indian Soc Periodontol. 2016; 3:235-43.
24. Zhang, T., He, Z. and Tian, H. Association between periodontal status and degree of maxillary sinus mucosal thickening: a retrospective CBCT study. BMC Oral Health. 2021; 21: 392.
25. Fadili A, Alehyane N, Halimi A, and Zaoui F. An alternative approach to assessing volume of interest accuracy using CBCT and image J soft ware: in vitro Study. Hindawi. 2015;2015:5.
26. Rodziewicz TL, Houseman B, Hipskind JE. Medical error reduction and prevention. treasure island (fl): stat pearls publishing; 2021; 6:1-45.