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# The comparison of Mandibular Cortical Index based on dental status in women using panoramic radiographs

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## ABSTRACT

**Objectives:** The aim of this study is to analyze the difference of the Mandibular Cortical Index (MCI) between dentate and edentulous regions in women using panoramic radiographs.

**Materials and Methods:** This is a comparative analytical observational research with a cross-sectional approach. The samples used were 250 female panoramic radiographs, which were divided into 125 dental region samples and 125 edentulous samples which were available at the Dental Radiology Installation, Dental and Oral Teaching Hospital (RSGM-P) Faculty of Dentistry, Trisakti University. MCI assessment uses i-Dixel software version 2.2.0.3. Morita Japan. The comparative test was carried out using the Mann-Whitney test to determine whether there was a significant difference or not.

**Results:** There is a significant difference in MCI based on dental status with p-value = 0.000 (p <0.05). The percentage of category C1 was found higher (26%) in the dentate group than edentulous group (9,2%), whereas the percentage of category C3 was found higher in the edentulous group (16,3%) than dentate group (3,2%).

**Conclusion:** There is a significant difference in MCI based on dental status with p-value = 0.000 (p <0.05). The percentage of category C1 was found higher (26%) in the dentate group than edentulous group (9,2%), whereas the percentage of category C3 was found higher in the edentulous group (16,3 %) than dentate group (3,2%).

***Keywords:*** *Bone density, mandibular cortical index, panoramic radiograph, women*

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## INTRODUCTION

The bone functions as a means of supporting the body, protecting various organs in the body, forming body posture, a place where calcium and minerals are metabolized, and as a hemopoietic organ. Normal bone mass is a factor in maintaining bone density. A person will usually lose bone mass slowly when they are around 30 years old.[1] This loss of bone mass will result in a higher risk of bone health problems. A commonly found bone health disorder is osteoporosis. Osteoporosis is a disease that occurs due to low bone mass and damage to the micro-architecture of bone tissue.[2]

Osteoporosis is known as a silent disease because the disease is not felt or is accompanied by symptoms.[3] Osteoporosis commonly occurs in elderly people and most women in the post-menopausal stage, due to withdrawal of the hormone estrogen.[4] Osteoporosis can result in a decrease in jaw bone mass and changes in the structure of the mandible, especially in the inferior border or lower cortex of the mandible.[2] According to WHO, a tool for measuring bone mass reduction can be done using Dual-energy X-ray Absorptiometry (DXA), which has become the Gold Standard because it has low radiation and high accuracy. However, DXA is quite expensive and has limitations in availability.[3]

There is another alternative to see a decrease in bone mass, namely a panoramic radiograph which covers a large area obtained in one receptor, the price is relatively cheaper, the radiation dose used is quite low and the availability of this tool is very wide. Panoramic radiography not only provides information on the condition of a tooth, but signs suggestive of systemic disease are also visible, for example, a decrease in the thickness of the mandibular cortex which is a sign of osteoporosis. Panoramic radiography is generally used as a routine examination in edentulous patients before complete denture construction.[5] The panoramic radiographic index used to assess bone quality, especially in the mandibular cortex area, is the Mandibular Cortical Index (MCI), where the MCI shows porosity.[2] According to Horner and Devlin, the Mandibular Cortical Index is closely related to the bone mineral density of the mandibular body.[6]

Several researchers have stated that MCI is used as an alternative method for assessing low

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Bone Mineral Density (BMD), especially in postmenopausal women.[7] The Mandibular Cortical Index (MCI) has categories based on the classification of Klemetti et al, namely C1 = the endosteal edge of the cortex and is sharp on both sides, C2 = the endosteal edge shows a semilunar defect (lacunar resorption) and appears to form an endosteal cortical residue on one or both sides, C3 = cortical layer forms a heavy endosteal cortical residue and is porous.[8] MCI is well known as a method used to see low bone mass in the mandibular cortex, but there are still few who state that there is a difference in MCI between the dentate and edentulous region. Therefore, this study was performed to determine whether there is a significant difference between MCI based on dental status using panoramic radiographs in women.

## MATERIALS AND METHODS

This comparative analytical study aims to analyze the difference in the Mandibular Cortical Index between the dentate and edentulous regions in women using panoramic radiographs.

This study was carried out from September 2023 to November 2023 and the data used in this research is secondary data in the Dental Radiology Installation, Dental and Oral Teaching Hospital (RSGM-P) Faculty of Dentistry, Trisakti University for the 2021/2022 period. In this study, we used an unpaired categorical comparative analytical sample size formula.

The number of samples used were 250 digital panoramic radiograph of women aged 30 years and above, divided into 125 samples with dentate regions and 125 samples with edentulous regions. All panoramic radiographs were made using digital panoramic machine (Morita VeraviewePocs 2D; J. Morita, Japan). This study has received ethical permission from KEPK-FKG Usakti with number 698/S1/KEPK/FKG/7/2023.

Data was recorded in Microsoft Excel software by writing the medical record number, dental status, and MCI category assessment results. The data was analyzed using SPSS to test interobserver reliability, intraobserver reliability, and then the comparative test. A categorical comparative test was carried out using the Mann-Whitney to find if there is a significant difference in proportions or not. The interobserver and intraobservaer reliability were tested prior to the comparative test. The interobserver assessment was performed by 2 observers consisted of the main observer and a Dentomaxillofacial Radiology Specialist. The interobserver assessed only 10% of a random sample of panoramic radiographs of dentate and edentulous areas. The MCI assessment of this study is based on MCI categories according to the Klemetti, et al. Classification[8] as shown in Figure 1.

## RESULTS

The interobserver and intraobserver reliability was tested in this study using Cohen's Kappa and the results was showed in Table 1.

Table 1 shows the kappa value in the interobserver test is 0.895 and in the intraobserver test is 0.954, which means the level of reliability is strong. The results of this test also show a p-value of 0.000, where the value is <0.05 so it can be concluded that the data is reliable.

Table 2 shows the frequency and percentage results of the MCI categories based on dental status. In the edentulous group, the C1 category represented 23 (9.2%) of the samples and respectively 60 (24%) and C3 42 (16.8%) for the C2 and C3 category. Whereas, the distribution of MCI category in the dentate group are C1 = 65 (26%), C2 = 52 (20.8%), and C3 = 8 (3.2%).

According to Table 3 above, the Mann-Whitney test was carried out and p-value of 0.000 was obtained, (p <0.05). Therefore, it showed that there was a significant difference in the Mandibular Cortical Index (MCI) between the dentate and edentulous regions in women through panoramic radiographs.


**Figure 1.** MCI assessment is based on MCI categories according to the Klemetti, et al. classification.[8] (A) C1, with clear boundaries and no erosion of the mandibular cortex; (B) C2, the boundaries are still clear but there is light erosion and a radiolucent image is visible; (C) C3, the border of the mandibular cortex is no longer visible and is badly eroded.

**Table 1.** Interobserver and Intraobserver Reliability Test

| | N | Kappa value | *p-value* |
|---|---|---|---|
| Interobserver | 25 | 0,895 | .000 |
| Intraobserver | 25 | 0,954 | .000 |

**Table 2.** Frequency Distribution of MCI based on Dental Status

| Dental Status | n | MCI Category | Frequency | Percentage |
|---|---|---|---|---|
| *Edentulous* | *125* | C1 | 23 | 9,2 |
| | | C2 | 60 | 24,0 |
| | | C3 | 42 | 16,8 |
| Dentate | 125 | C1 | 65 | 26,0 |
| | | C2 | 52 | 20,8 |
| | | C3 | 8 | 3,2 |

**Table 3.** Comparative Test of Categorical MCI by Dental Status

| | (p-value) |
|---|---|
| Dental Status | .000 |

## DISCUSSION

The results of this study came from 250 data samples consisting of 125 samples from the dentate region and 125 samples from the edentulous region. The subjects in this study used subjects aged over 30 years because this age is the peak bone mass where the bones have reached maximum density. This study used the female gender because women have more influence on reduced bone density. This is influenced by the female hormone estrogen which can decrease and increase the number of osteoclast activity. Women are more likely to experience bone density abnormalities than men.[4]

The results obtained in this MCI study were that there was a significant difference between the dentate and edentulous groups with p-value 0.000) ($p < 0.05$) as shown in Table 3. The percentage of category C1 was found higher (26 %) in the dentate group than edentulous group (9,2%), in contrast to the edentulous group which the percentage of category C3 was found higher (16,3 %) than in the dentate group (3,2 %).

This study is in line with a study conducted by Gassama, et al. Who revealed that the C3 category was more frequent in edentulous subjects than dentate, with a statistically significant difference $p < 0.05$. [9] In addition, This study was also in line with Gulsahi, et al. which states that there is a significant relationship between MCI and dental status. The results of this study showed that C3 in edentulous cases was 27.30 times higher than in dentulous cases with a p-value < 0.001. Their research also demonstrated that the status of the teeth affects the quality of the mandibular bone. This can be seen in the condition of the tooth attachment which will affect bone density, as in the results of this study which show that a complete set of teeth will produce high bone density.[10] Tanaka et al. also showed that C2 and C3 categories are mostly found in women aged 50 years and above, C1 will decrease with increasing age.[11]

The higher frequency C3 category in the edentulous group may be influenced by residual ridge resorption. Imirzalioglu, et al. showed a significant difference in MCI between the dentate and edentulous group, regarding residual ridge resorption, with C3 results being higher than C1 and C2 ($P < 0.05$). In the edentulous group, residual ridge resorption occurred more often than in complete dentition cases ($P < 0.001$). It may lead to the possibility that the mandibular bone density changes are caused by the resorption process in the alveolar bone. [12] The reduction in alveolar ridge dimensions is a physiological response to tooth loss.[13] Excessive bone resorption can also cause bone density abnormalities such as osteoporosis.[14]

According to the results obtained in this study, MCI alone should not be used as a gold standard for measuring Bone mineral density (BMD) or diagnosing osteoporosis. In addition, there was a limitation of this study since there are unobserved factors such as dental pathologies that related to edentulous condition However, the MCI may be recommended as an alternative tool used for screening early bone density loss in women over 30 years.

## CONCLUSION

Through panoramic radiographs, we can determine the difference in MCI based on dental status in women since this study revealed a significant difference in MCI between the dentate and edentulous group. The loss of teeth in women may lead to any change in the MCI. However, low MCI values in edentulous regions in women cannot be directly interpreted as bone density abnormalities, since other factors still need to be observed.

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## FOOTNOTES

All authors have no potential conflict of interest to declare for this article. This research has received ethical approval from the Research Ethics Commission of the Faculty of Dentistry, Trisakti University with number 698/S1/KEPK/

FKG/7/2023. All procedures conducted were in accordance with the ethical standards.

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# Linear measurement of condyles in edentulous patients with Kennedy classification based on panoramic radiographs

(Study at Ulin General Hospital and Gusti Hasan Aman Oral and Dental Hospital Banjarmasin)

## ABSTRACT

**Objectives:** This research is aimed to determine the value of linear measurement of the condyle position in partial edentulous patients of Kennedy classification based on panoramic radiographs at Ulin General Hospital and Gusti Hasan Aman Oral and Dental Hospital.

**Materials and Methods:** This research is a descriptive-analytic study with a cross-sectional study design. The population used in the study is a digital panoramic radiograph from the Radiology Installation of Ulin General Hospital and Gusti Hasan Aman Oral and Dental Hospital from January 2018 - January 2024 database. Condyle linear measurement landmarks used are anterior joint space, superior joint space, and posterior joint space, according to the research of Ikeda and Kawamura (2013).

**Results:** The results showed that the largest AJS value is the Kennedy Class I and the smallest is the Kennedy Class IV. The largest SJS value is the Kennedy class III and the smallest is the Kennedy class IV. The largest PJS value is Kennedy class II and the smallest is Kennedy class I. Based on gender, men's joint space value is bigger than women's. However, a significant difference was found in the PJS value of Kennedy class I patients, whose value for men is smaller than that of women.

**Conclusion:** The condyle linear measurement of partially edentulous patients based on Kennedy classification Class I, II, III, IV has an abnormal condyle position and has experienced disc displacement with reduction.



*Keywords:* *Condyle, linear measurement, Kennedy classification, partial edentuolous, joint space*

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## INTRODUCTION

Tooth loss is a condition where teeth are removed, which forms a space in the oral cavity called the edentulous space. [1,2] The data from Riskesdas 2018 stated that the proportion of the Indonesian population who experienced partial tooth loss was 19%.[3] The cause of tooth loss is partly due to various factors, including tooth loss due to periodontal disease, caries, trauma, indications for prosthodontics and orthodontics, impaction, supernumerary teeth, hypoplasia, neoplastic and cystic lesions, as well as various other systemic diseases.[4]

Kennedy classified tooth loss into four classes based on the relationship of the edentulous space to the supporting teeth. The Kennedy classification is widely used in dental practice due to its ease of application and direct visualization of partial tooth loss.[1] The four classes in the Kennedy classification include class I (bilateral free-end), class II (unilateral free-end), class III (unilateral edentulous area with natural teeth both anterior and posterior to it), and class IV (single, bilateral edentulous area located anterior to the remaining natural teeth).[4,5]

Loss of teeth in the oral cavity can result in occlusion imbalance which disturbs the stomatognathic system. The imbalance of occlusion load that occurs continuously on one or both sides of the temporomandibular joint can cause changes in the position of the mandible vertically and horizontally so the position of the condyle in the glenoid fossa also changes. Masticatory component changes can affect the temporomandibular joint structure, which can cause Temporomandibular Joint Disorder (TMD).[6–8]

According to Basic Health Research 2018, it shows that cases of partial tooth loss in South Kalimantan province had a proportion of 17.8%.[3] The most frequent cases of partial tooth loss at RSGM Gusti Hasan Aman Banjarmasin are partial tooth loss with Kennedy class III classification, both mandible and maxilla. This results in the loss of class III teeth in the Kennedy classification, becoming one of the most common dental diseases at RSGM Gusti Hasan Aman Banjarmasin.[9] In a study conducted at Ulin General Hospital, Banjarmasin, by Shofi N et al., it was stated that cases of temporomandibular joint disorder based on the etiology of functional disorders had a percentage of 100%. Functional disorders occur due to malocclusion, chewing muscle disorders or one-sided chewing habits, and dental disorders accompanied by chewing muscle disorders.[10]

Panoramic radiography examination has been widely used in dentistry because of its relatively affordable cost and low radiation dose. Panoramic radiography can provide a clear picture of the structure of the articular eminence, glenoid fossa, and condyle head. Changes in the position of the condyles indicate TMD, which is related to disc displacement in the TMJ. Displacement of the disc position causes a change in the position of the condyle in the glenoid fossa.[11]

Radiographically, the position of the condyle in the glenoid fossa can be identified by measuring the joint space. The joint space is a radiolucent zone between the condyle and glenoid fossa containing the articular disc. Joint space measurements via panoramic radiography can be done using linear measurements based on Ikeda and Kawamura's research. Linear measurement measures the anterior, superior, and posterior joint space of the mandibular condyle.[12,13] Based on the background above, researchers are interested in research to determine the results of linear measurements on the condyles of edentulous patients classified as Kennedy class I, II, III, IV based on panoramic radiography at Ulin General Hospital and Gusti Hasan Aman Hospital, Banjarmasin.

## MATERIALS AND METHODS

The research design used in this research is descriptive-analytical research with a cross-sectional research design. The population in this study is secondary data archives of panoramic radiography recorded at the radiology installation of Ulin General Hospital and Gusti Hasan Aman Oral and Dental Hospital Banjarmasin from January 2018 to January 2024. The sampling technique used in this study was non-probability sampling with a purposive sampling method. The sample from this research is archived secondary data from panoramic radiography photos of edentulous patients classified as Kennedy class I, II, III, IV, which were recorded at the radiology installation at Ulin General Hospital and Gusti Hasan Aman Oral and Dental Hospital Banjarmasin for the period January 2018 January 2024.

The sample inclusion criteria in this study were panoramic radiographs with complete data on patients aged 30-70 years, panoramic radiographs of patients with partially edentulous upper and lower jaws based on the Kennedy classification class I, II, III, IV aged 30-70 years, panoramic radiograph with a good quality evaluation, and panoramic radiograph with the head of the condyle located in the glenoid fossa. The research was conducted at Ulin General Hospital and Gusti Hasan Aman Oral and Dental Hospital Banjarmasin from November 2023 to January 2024.

The data collection procedure was obtained by screening to determine which samples were taken according to the inclusion criteria or exclusion. Samples that meet the criteria are continued with measurements using ImageJ software. Linear measurements were based on the method in Ikeda and Kawamura's research. The landmarks used are the anterior joint space (AJS), superior joint space (SJS), and posterior joint space (PJS). Measurements are made by determining the highest point of the condyle head (SC) and closest to the glenoid fossa (SS). A vertical line is drawn from point S to the deepest point in the glenoid fossa. The vertical line length shows the superior joint space (SJS). Next, draw a line from the deepest point of the glenoid fossa tangent to the most anterior point (AC) of the condyle head and draw a line from the deepest point of the glenoid fossa tangent to the most posterior point (PC) of the condyle head. Anterior

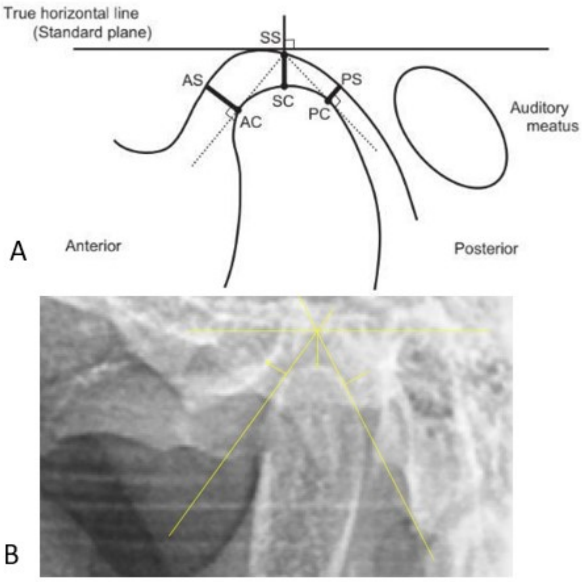


**Figure 1.** (A) Landmark of Condyle Linear Measurement[12], (B) Linear Measurement on Panoramic Radiograph

joint space (AJS) is obtained by drawing a vertical line from point (AC) to the nearest point of the glenoid fossa (AS). Posterior joint space (PJS) is obtained by drawing a vertical line from point (PC) to the closest point of the glenoid fossa (PS).[12] Measurements were taken on the right and left condyles. The data obtained will be analyzed using analytical descriptive statistical analysis presented in table form.

## RESULTS

This research was conducted using digital panoramic radiographs of edentulous patients classified as Kennedy class I, II, III, and IV obtained from the secondary data archives of Ulin General Hospital and Gusti Hasan Aman Oral and Dental Hospital Banjarmasin. Sample characteristics based on age are shown in table 1. The research results in Table 1 show that most of the samples aged 51-60 years with 37 samples. The sample characteristics in Table 2 show that the number of female samples is greater than that of male samples. The highest number of female samples was in the Kennedy class II classification, with 21 samples, and the lowest was in the Kennedy class IV classification, with 15 samples. The highest number of male samples were found in the Kennedy class I and class IV classifications, with 12 samples in each class, and the lowest number of male samples was found in class II, with six samples.

Table 3 shows the results of linear measurements of the right and left condyle of edentulous patients classified by Kennedy class I, II, III, IV. The largest AJS value for the right condyle was in class I at 2.17 ± 0.950 mm and the smallest AJS value for the right condyle was in class IV at 1.58 ± 0.872 mm. The largest AJS value for the left condyle was in class I at 2.07 ± 0.978 mm and the smallest AJS value for the left condyle was in class IV at 1.74 ± 1.018 mm. The largest SJS value for the right condyle was in class III at 2.97 ± 1.124 mm, and the smallest SJS value for the right condyle was in class IV at 2.52 ± 1.235 mm. The largest SJS value for the left condyle was in class III at 3.08 ± 1.065 mm, and the smallest SJS value for the left condyle was in class IV at 2.65 ± 1.164 mm. The largest PJS value for the right condyle is in class II at 2.63 ± 0.994 mm, and the smallest PJS value for the right condyle is in class I at 2.18 ± 0.840 mm. The largest PJS value for the left condyle is in class II at 2.64 ± 0.922 mm, and the smallest PJS value for the left condyle is in class I at 2.13 ± 0.738 mm.

Table 4 shows the results of linear measurements of the condyles of edentulous patients classified by Kennedy class I, II, III, and IV based on gender. The largest AJS value in the female sample was in class I at 2.05 ± 0.688 mm, and the smallest AJS value was in class IV at 1.42 ± 0.865 mm. The largest SJS value in the female sample was in class II at 2.88 ± 1.093 mm, and the smallest SJS value was in class IV at 2.49 ± 1.127 mm. The largest PJS value in the female sample was in class II at 2.55 ± 0.828 mm, and the smallest PJS value was 2.11 ± 1.050 mm. The largest AJS value in the male sample was in class I at 2.20 ± 1.224 mm, and the smallest AJS value was in class II at 1.82 ± 0.698 mm. The largest SJS value in the male sample was in class III at 3.33 ± 1.228 mm, and the smallest SJS value was in class IV at 2.71 ± 1.279 mm. The largest PJS value in the male sample was in class II at 2.94 ± 1.286 mm, and the smallest PJS value was in class I at 1.95 ± 0.745 mm.

The research results in Table 5 show the overall average value of condyles linear measurement of edentulous patients classified by Kennedy Class I, II, III, IV. The largest AJS value is in

**Table 1.** Sample characteristics based on age

| Kennedy Classification | | Age | | | |
|---|---|---|---|---|---|
| | | 30-40 years | 41-50 years | 51-60 years | 61-70 years |
| Maxilla | Mandibula | n | n | n | n |
| I | I | 0 | 1 | 6 | 2 |
| | II | 2 | 2 | 3 | 2 |
| | III | 2 | 4 | 0 | 3 |
| II | I | 1 | 2 | 4 | 2 |
| | II | 1 | 1 | 6 | 1 |
| | III | 1 | 4 | 4 | 0 |
| III | I | 0 | 3 | 5 | 1 |
| | II | 3 | 4 | 2 | 0 |
| | III | 4 | 3 | 2 | 0 |
| IV | I | 0 | 3 | 3 | 3 |
| | II | 5 | 3 | 1 | 0 |
| | III | 6 | 2 | 1 | 0 |
| **Total** | | **25** | **32** | **37** | **14** |

**Table 2.** Sample characteristics based on gender

| Kennedy Classification | | Gender | |
|---|---|---|---|
| | | Female | Male |
| Maxilla | Mandibula | n | n |
| I | I | 3 | 6 |
| | II | 6 | 3 |
| | III | 6 | 3 |
| **Class I Total** | | **15** | **12** |
| II | I | 6 | 3 |
| | II | 7 | 2 |
| | III | 8 | 1 |
| **Class II Total** | | **21** | **6** |
| III | I | 5 | 4 |
| | II | 6 | 3 |
| | III | 7 | 2 |
| **Class III Total** | | **18** | **9** |
| IV | I | 5 | 4 |
| | II | 6 | 3 |
| | III | 4 | 5 |
| **Class IV Total** | | **15** | **12** |
| **Total** | | **69** | **39** |

**Table 3.** Average Value of Condyle Linear Measurement of Edentulous Patients With Kennedy Classification Class I, II, III, IV Based On Right and Left Side

| Kennedy Classification | | Right | | | Left | | |
|---|---|---|---|---|---|---|---|
| | | AJS (mm) (Mean± SD) | SJS (mm) (Mean± SD) | PJS (mm) (Mean± SD) | AJS (mm) (Mean ± SD) | SJS (mm) (Mean ± SD) | PJS (mm) (Mean ± SD) |
| I | I | 2,02±0,398 | 2,54±1,359 | 1,88±0,729 | 1,60±0,775 | 2,77±0,971 | 2,31±0,751 |
| | II | 1,93±1,386 | 2,82±1,103 | 2,25±0,743 | 2,30±0,784 | 3,00±0,837 | 2,19±0,475 |
| | III | 2,55±0,776 | 3,35±1,200 | 2,62±0,604 | 2,32±1,231 | 2,98±2,020 | 1,88±0,934 |
| **TOTAL** | | **2,17±0,950** | **2,91±1,226** | **2,18±0,840** | **2,07±0,978** | **2,92±1,331** | **2,13±0,738** |
| II | I | 1,71±0,773 | 2,45±1,011 | 2,63±0,985 | 1,43±0,739 | 2,61±1,345 | 2,91±0,980 |
| | II | 1,96±0,405 | 3,36±1,081 | 2,45±1,323 | 2,00±0,769 | 3,05±0,740 | 2,14±0,762 |
| | III | 1,69±0,901 | 2,79±1,240 | 2,80±0,649 | 1,81±1,064 | 3,14±0,944 | 2,87±0,895 |
| **TOTAL** | | **1,79±0,707** | **2,87±1,138** | **2,63±0,994** | **1,75±0,871** | **2,93±1,026** | **2,64±0,922** |
| III | I | 2,19±0,902 | 2,57±0,691 | 2,06±0,834 | 2,07±0,680 | 3,06±0,993 | 2,59±0,826 |
| | II | 1,49±0,666 | 3,06±1,551 | 2,99±0,674 | 1,75±1,034 | 3,23±1,229 | 2,63±0,948 |
| | III | 2,28±1,465 | 3,28±0,960 | 2,68±1,420 | 2,09±0,757 | 2,96±1,071 | 2,28±1,097 |
| **TOTAL** | | **1,99±1,086** | **2,97±1,124** | **2,58±1,061** | **1,97±0,820** | **3,08±1,065** | **2,50±0,939** |
| IV | I | 1,72±0,460 | 3,24±0,680 | 2,42±1,119 | 1,58±1,097 | 3,51±0,813 | 2,69±1,210 |
| | II | 1,66±0,326 | 2,23±0,896 | 2,01±0,776 | 1,86±0,668 | 2,49±1,016 | 2,01±1,189 |
| | III | 1,36±1,439 | 2,10±1,675 | 2,83±0,947 | 1,78±1,293 | 1,95±1,144 | 1,92±0,806 |
| **TOTAL** | | **1,58±0,872** | **2,52±1,235** | **2,42±0,981** | **1,74±1,018** | **2,65±1,164** | **2,21±1,099** |

**Table 4.** Average Value of Condyle Linear Measurement of Edentulous Patients With Kennedy Classification Class I, II, III, IV Based On Gender

| Female | | | |
|---|---|---|---|
| **Kennedy Classification** | **AJS (Mean± SD)** | **SJS (Mean± SD)** | **PJS (Mean± SD)** |
| **Class I** | **2,05±0,688** | 2,87±1,212 | 2,32±0,789 |
| **Class II** | 1,75±0,817 | **2,88±1,093** | **2,55±0,828** |
| **Class III** | 1,90±0,828 | 2,87±0,991 | 2,38±0,852 |
| **Class IV** | **1,42±0,865** | **2,49±1,127** | **2,11±1,050** |
| **Male** | | | |
| **Kennedy Classification** | **AJS (Mean± SD)** | **SJS (Mean± SD)** | **PJS (Mean± SD)** |
| **Class I** | **2,20±1,224** | 2,97±1,358 | **1,95±0,745** |
| **Class II** | **1,82±0,698** | 2,98±1,043 | **2,94±1,286** |
| **Class III** | 2,13±1,178 | **3,33±1,228** | 2,85±1,197 |
| **Class IV** | 1,97±0,963 | **2,71±1,279** | 2,57±0,982 |

**Table 5.** Average Value of Condyle Linear Measurement of Edentulous Patients With Kennedy Classification Class I, II, III, IV

| Kennedy Classification | AJS (mm) (Mean±SD) | SJS (mm) (Mean±SD) | PJS (mm) (Mean±SD) |
|---|---|---|---|
| **Class I** | **2,12±0,806** | 2,91±1,010 | **2,20±0,587** |
| **Class II** | 1,77±0619 | 2,90±0,898 | **2,63±0,765** |
| **Class III** | 1,98±0,832 | **3,03±1,017** | 2,54±0,815 |
| **Class IV** | **1,66±0,794** | **2,59±1,117** | 2,32±0,848 |

class I at 2.12 ± 0.806 mm, and the smallest AJS value is in class IV at 1.66 ± 0.794 mm. The largest SJS value was in class III at 3.03 ± 1.017 mm and the smallest in class IV at 2.59 ± 1.117 mm. The largest PJS value was in class II at 2.63 ± 0.765 mm, and the smallest PJS value was in class I at 2.20 ± 0.587 mm.

## DISCUSSION

Mastication patterns can influence the position of the condyle according to the functional load received.[14–16] The condyle surface that experiences the most pressure during mastication is located on the superior aspect.[17] This can affect the value of superior joint space on the condyles of edentulous patients. Table 3 shows the results of linear measurement research on the condyles based on the right and left sides. Kennedy Class I patients experience loss of posterior teeth, which causes them to use teeth still in the oral cavity, namely premolars or anterior teeth.[18] Mastication in premolars or anterior teeth has a chopping type of chewing, and mandibular movements are shorter and slower. The SJS values on the right and left sides of the Kennedy class I classification group showed no significant differences between the two sides. It occurs because the bite force and chewing load are concentrated in the anterior region of the mandible, increasing the TMJ load on both sides of the joint, resulting in the right and left SJS values not experiencing significant differences.[19]

Kennedy class II and class III tooth loss patients experienced unilateral tooth loss. Patients with unilateral teeth loss have a chewing pattern that tends to be on one side. Patients tend to chew on the side with more teeth.[20] The research results in classes II and III show that the right side has a smaller SJS value than the left. This shows an imbalance in the distribution of TMJ load. One-sided mastication results in greater masticatory muscle strength on the chewing side, so the right side has a smaller SJS value.[21] The Kennedy classification class IV group has posterior teeth that can still be used for masticatory functions. Loss of anterior teeth is more likely to cause problems with speech function and aesthetics.[22] The chewing pattern can occur bilaterally with posterior teeth on both sides. If the contact on both sides is balanced, then the changes will be symmetrical between the two sides.[23] This study's superior joint space results have different values between the left and right sides, the SJS value on the right side is smaller than the left. It shows that there is a possibility of one-sided chewing. One-sided chewing with the remaining posterior teeth can occur because the patient tends to chew on the side with better occlusal contact during lateral glide movements when chewing.[24]

The research results based on gender in Table 4 show that in the linear measurement values in Kennedy's classification of edentulous patients, male samples have joint space values that tend to be greater than women. Various research have been found concordance to this research result.[25–28] Joint space values that tend to be greater in men than women could be due to differences of the thickness TMJ compartment soft tissue and the overall size of glenoid fossa and condyle in men and women.[29,30] There is a significant difference in the PJS values in male and female patients in the Kennedy class I classification. Male patients of Kennedy Class I have smaller PJS values than women. The PJS value in male patients in class I in the Kennedy classification has a value of 1.95 ± 0.745 mm while the PJS value of women with a Kennedy class I classification of 2.32 ± 0.789 mm. Tooth loss that occurs in men can be caused by periodontal disease. The prevalence of periodontal disease is more common in men than women. This can be caused by smoking habits, consumption of alcoholic drinks and poor oral hygiene.[31,32] Putri and Shubita's research results stated that most male patients experienced Kennedy class I tooth loss.[6,33] Male patients have an average number of tooth loss greater than females. This can be related to the patient's awareness of maintaining oral hygiene and the need for dental care. Agustina et al's research states that men tend to brush their teeth less than twice daily and only visit the dentist when seriously ill.[34] Bilateral loss of posterior teeth affects the position of the condyles for superior and posterior rotation in the mandibular movement pattern. Loss of posterior teeth can result in loss of vertical dimension and excessive load on the TMJ. The excessive loads that occur continuously and repeatedly can cause degenerative changes and anterior disc displacement.[34] Hu K et al. stated in their research results that the disc tends to move more anteriorly in male patients than in women.[35] Khabadze Z et al., in their research, stated that degenerative signs of TMJ were more common in men even though TMD was more common in women.[36] Gorurgoz C et al.'s research shows that the PJS value in patients experiencing degenerative changes has a value that is smaller than the AJS and SJS values. The data in this study shows that the class I classification sample is primarily male, aged 51-60 years. The risk of degenerative changes in men increases with age. It is related to the differences in care needs for men and women. The need for care is higher in women than in men, and there is a tendency to treat the disease when it is severe.[37] Tabatabaei S et al in their research results, showed that the group of patients who did not have bilateral posterior teeth in the 35-65-year age group had PJS values that were smaller than AJS and SJS.[38]

Table 5 shows the results of overall linear measurements of the condyles in edentulous patients classified as Kennedy class I, II, III, and IV. Based on this study result, the joint space value of each Kennedy Classification class have exceeded the normal value based on Ikeda and Kawamura's research. The normal condyle position values based on Ikeda and Kawamura's research are AJS of 1.3 ± 0.2 mm, SJS value of 2.5 ± 0.5 mm and PJS value of 2.1 ± 0.3 mm. A linear measurement above the normal value indicates that the condyle position is far from the glenoid fossa. In contrast, a linear measurement value less than normal indicates that the condyle position is approaching the glenoid fossa. The research results show that the linear measurement classification for Kennedy Class I, II, III, and IV has AJS, SJS and PJS values that are more than the normal condyle position values. The smallest joint space value is the AJS value, and the largest is the SJS value. Based on the research results, the condyle position is abnormal which located away from the glenoid fossa in an anterior direction.

The Kennedy class I (bilateral free-end) tooth loss pattern has the largest AJS value. An increase in AJS values can be caused by resorption and anterior disc displacement.[39] Bilateral loss of posterior teeth results in the remaining teeth receiving a greater load than before, resulting in abrasion and a decrease in the occlusal plane, which can lead to pathological changes in the temporomandibular joint structure.[40] Condyle resorption occurs on the anterosuperior side, which experiences the greatest load when the mandible moves. Excessive load on the TMJ and the direction of muscle force perpendicular to the bone can increase condyle resorption.[41] Loss of posterior teeth can cause a decrease in the vertical dimension of occlusion so that the TMJ experiences excessive load, and the articular disc experiences a change in position to the anterior.[34,42] The smallest AJS value is in the Kennedy class IV classification. The anterior teeth act as guides or anterior guidance in mandibular movement. The movement pattern of the mandible will change when the anterior teeth are lost.[34] Loss of anterior teeth can increase the activity of the masticatory muscles so that the mandible experiences changes in movement patterns that tend to be anterior.[14,24,43] Bad habits such as biting lips, pencils, nails, and fingers and supporting the chin can cause muscle contractions, so the condyles tend to move anteriorly.[44,45]

The Kennedy Class III classification in this study has the largest SJS value. Large SJS values can occur due to trauma, tooth loss, and unbalanced chewing habits in the TMJ.[46] An increase in the SJS value resulting from trauma may indicate that there is fluid or blood located between the TMJ compartments.[47] Arikan et al in their research stated that the SJS value in edentulous patients was greater than in patients with teeth. This can be influenced by differences in the duration of tooth loss experienced by patients and a decrease in bone volume.[48] Unilateral tooth loss tends to chew on the side with more teeth, so dominant chewing occurs on one side.[20] The side not used for chewing has a smaller chewing muscle contraction force, so the balancing side has a greater superior joint space value.[17] The smallest superior joint space value is in the Kennedy classification class IV. A superior position of the condyles can be caused by excessive chewing loads and muscle contractions.[46] The anterior and posterior teeth carry out the masticatory function in stages. Loss of anterior teeth in the dental arch eliminates the function of breaking down and tearing food during the mastication process so that the function of the posterior teeth becomes more dominant. Larger and more complex foods result in greater muscle work and mechanical load on the TMJ.[24,49]

The largest PJS score in this study was in class II. Loss of posterior teeth on one side of the jaw can cause individuals to avoid chewing where the teeth are missing. Jiang et al. stated that the unpreferred chewing side has a greater PJS value than the preferred chewing side.[21] An imbalance in the load between the two sides of the jaw can result in changes in the form of regressive remodelling that can be seen on the posterior aspect of the condyle.[50] Regressive remodelling occurs as a decrease in the volume and number of tissues, resulting in tissue degeneration.[51] Khabadze et al in their research stated that the PJS value had a greater value, which could be caused by several factors such as density, width, and an index that shows the complexity of the trabecular bone in the TMJ. The complexity of bone trabeculae decreases in patients who experience tooth loss.[36] This study's smallest PJS average value was in the Kennedy classification class I. Salma T stated in her research that individuals who experience bilateral posterior tooth loss tend to have small PJS values.[38] Loss of posterior teeth on both sides of the jaw can reduce the effectiveness of mastication and the vertical dimension of occlusion. Changes in the position of the condyle in edentulous patients occur because the condyle tends to rotate superiorly and posteriorly when the mandible moves, resulting in a decrease in the posterior joint space of the temporomandibular joint.[52,53]

Edentulous spaces in patients with partial tooth loss can result in abnormal forces during the mastication process, resulting in an imbalance in the stomatognathic system. Repeated and persistent unequal distribution of pressure is called microtrauma. The accumulation of microtrauma in the joint structures results in abnormal mandible movement during mastication. This can result in lengthening of the ligaments and thinning of the disc, resulting in TMJ internal derangement.[7,24] Disc derangement can be divided into two, namely disc displacement with reduction (DDwR) and disc displacement without reduction (DDwoR).[24,54] Changes in the joint space of the temporomandibular joint are closely related to the occurrence of disc displacement.[12,39] Previous research conducted by Almasan et al. showed that disc displacement patients with reduction and without reduction had AJS values greater than SJS and PJS. It indicates the condyle's position is more posterior and superior in disc displacement patients.[55] The results of this study show that the position of the condyle is abnormal, with the AJS value being smaller than that of SJS and PJS. This condition indicates that the condyle tends to be located more anteriorly. The results of this study are similar to the results of research by Idan et al., which showed that disc displacement with reduction patients had the smallest AJS scores compared to SJS and PJS.[56]

Imbalanced occlusion that does not match the action of the temporomandibular muscles and joints causes muscle hyperactivity and disc displacement.[57] Giacomo et al.'s research stated that DDwR patients experienced increased temporalis muscle activity. This condition can occur due to a decrease in the vertical dimension of occlusion in patients with tooth loss and DDWR so that the temporalis muscles carry out the dominant muscle movement and the muscle force is more anterior.[58,59] Abnormal muscle forces due to functional changes in masticatory muscles can affect the structure of disc ligaments and masticatory muscle fibres. Disc ligaments are stiff and inelastic, so an abnormal force on the TMJ causes the ligament to lose its stiffness to maintain the disc's position. This causes the disc to be more susceptible to displacement. The temporalis and lateral pterygoid muscle fibres attached to the anterior disc play a role in maintaining the stability of the condyle and disc during mandibular movement. These muscle fibres work by balancing the pressure received on the TMJ with different contraction directions. An imbalance in the activity of these muscle fibres can increase the risk of disc displacement.[24,60]

## CONCLUSION

Based on the research results, the linear measurement value of the condyle of edentulous patients classified as Kennedy class I, II, III, and IV in men has a greater joint space value than in women. The significant difference found in men with Kennedy Class I patients that has a smaller value than in women in Kennedy Class I patients. The results of the analysis of the average linear measurement value of the condyle in edentulous patients classified as class I, II, III, and IV showed that the condyle position was in an abnormal position and experienced disc displacement with reduction.

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## FOOTNOTES

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ORIGINAL RESEARCH ARTICLE

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# Prevalence of alveolar bone crest resorption patterns at the age of 12-30 years from panoramic radiographs at RSGMP Universitas Trisakti

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## ABSTRACT

**Objectives:** The aim of this study is determine the prevalence of alveolar bone crest resorption patterns at the age of 12-30 years from panoramic radiographs.

**Materials and Methods:** This study used consecutive sampling method based on secondary data from panoramic radiographs at the age 12-30 years, who had resorption on central insisivus and first molars at maxilla and mandibula. The samples used in this study were teeth 11, 21, 31, 41, 16, 26, 36 and 46 with using digital measurements from the CEJ to the top of the alveolar bone. Data is presented in tabular form with simple statistical calculations using SPSS and MS. Excel, and intraobserver reliability test. After the measurements were taken, intraobserver reliability was tested using the Cohen's Kappa test. Data processing was carried out using SPSS and Microsoft Excel.

**Results:** The results of this study showed that the prevalence of patients diagnosed with periodontitis was 6.19% with Horizontal bone resorption 4,26% and vertical 1.93%.

**Conclusion:** The prevalence of patients diagnosed with periodontitis in 2022 was 6.19% with horizontal bone destruction patterns of 4.26% and vertical 1.93%.

***Keywords:*** *Panoramic radiograph, prevalence, vertical bone crest resorption, horizontal bone crest resorption*

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## INTRODUCTION

Radiography could be used as a supporting examination in dental practice to establish a diagnosis and plan treatment.[1] Dental radiography consists of intraoral radiography and extraoral radiography. Radiograph panoramic is extraoral radiograph which a type of radiography that is often used, because it can cover both the maxilla, mandible and other supporting tissue structures.[2]Panoramic radiography is also important to see the condition of periodontal disease.[3]

Periodontal disease is an infection or inflammation that attacks the tissues supporting the teeth.[4] The periodontal diseases that Frequently encounter are gingivitis and periodontitis.[5] Periodontitis is a periodontal disease of the teeth that Affecting tooth's tissues support, usually caused by the accumulation of plaque and microorganisms that develop in the oral cavity, which can cause defects in the periodontal ligament and alveolar bone, characterized by pocket formation, gingival recession or both.[6] Obtained showed alveolar bone resorption covering the area and shape with horizontal and vertical patterns.[7,8]

According to the American Academy of Periodontology (AAP) 1999, the classification of periodontal disease and its conditions is classified into gingival disease, chronic periodontitis, aggressive periodontitis, periodontitis caused by systemic disease and the development of acquired deformities and conditions. Chronic periodontitis is often found in adult or pediatric patients. Bone resorption that is often found in chronic periodontitis is horizontal bone resorption. Aggressive periodontitis is found in patients aged <25 years with a vertical pattern of bone resorption.[8] Chronic periodontitis occurs more frequently in adults aged < 35 years, highest in the elderly population (82%), followed by adults (73%) and adolescents (59%).

Periodontal disease is the second largest disease after caries which attacks periodontal tissue. Based on the results of Basic Health Research (RISKESDAS) in 2018, the prevalence of periodontitis in Indonesia reached 74.1%, which shows that the incidence of periodontal disease is still high.[9] Based on research that has been conducted by Ahmad Ridwan Turgani the largest bone resorption In periodontitis was 8,77% horizontal resorption and 2,34% vertical resorption and the vertical resorption pattern is 2.34%.[10] The purpose of this study was to determine the prevalence of alveolar bone crest damage at the

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age of 12-30 years based on panoramic radiographic studies in the Radiology of Dentistry installation RSGMP FKG USAKTI.

## MATERIALS AND METHODS

This research is a descriptive observational study with a cross sectional approach to the pattern of resorption to the alveolar bone crest. The research sample used was secondary data from panoramic radiographs at the Radiology Installation of RSGM-P at Universitas Trisakti. Sampling was carried out using a consecutive sampling technique with a total research sample of 1,291 panoramic radiographs for the period January-December 2022 with inclusion criteria, namely patients aged 12-30 years. The exclusion criteria of this study were images with poor radiograph quality and missing teeth 11,21,31,41,16,26,36,46Measurement of alveolar bone crest resorption above the Cemento Enamel Junction ≥3mm was in accordance with the predetermined inclusion and exclusion criteria. After that, visual observation was carried out, namely by observing the pattern of resorption to the alveolar bone in a vertical and horizontal pattern. Then all secondary data from panoramic radiography results were recorded in Microsoft Excel software and processed using SPSS for intraobserver reliability testing.

## RESULTS

This study conducted an intraobserver reliability test with two measurements at different times. Observations and consistency tests were carried out on teeth 11,21,31,41,16,26,36,46. The results of the intraobserver reliability test can be seen in Table 1.

Based on the results of intraobserver reliability measurements using the Cohen's Kappa Coefficient test, the results show ≥ 0.60, where these results prove that the data taken based on the selected variables is declared reliable.

Table 2 shows the prevalence of alveolar bone crest defects in incisor and molar teeth differentiated by gender. The prevalence of alveolar bone crest defects in females found in incisor teeth was 5.94% and males were 1.9%. The prevalence of alveolar bone crest damage in females found in molar teeth was 4.1% and males were 1.9%.

Based on the number of patients who came for radiographic examinations in January-December 2022, there were 1,291 panoramic radiographs. Based on the samples that have been studied with age grouping 12-30 years, patients diagnosed with periodontitis were found in 80 samples (25,47%), horizontal bone resorption patterns in 55 samples (68.75%), and vertical bone resorption patterns in 25 samples (31.25%). Data on the results of the prevalence calculation can be seen in table .

## DISCUSSION

The results showed that the prevalence of periodontitis found at RSGM-P Trisakti University, West Jakarta was 25,47%, this is said to be low because based on the inclusion and exclusion criteria there were 80 patients diagnosed with periodontitis from 314 panoramic radiography

**Table 1.** Kappa Coefficient Value

| Variable | Number of samples | Result | Category |
|---|---|---|---|
| Periodontitis | 80 | 0,737 | *Moderate* |
| Horizontal bone resorption | 55 | 0,719 | *Moderate* |
| Vertical bone resorption | 25 | 0,771 | *Moderate* |

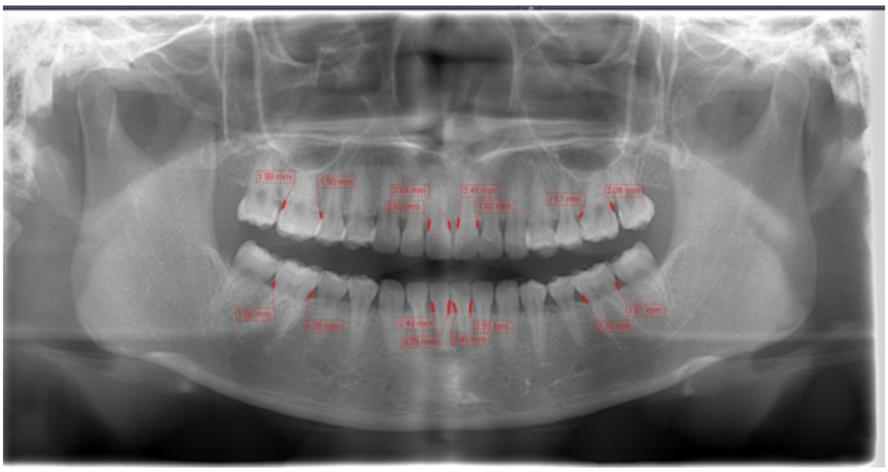

**Figure 1.** Measurement of the alveolar bone crest on a panoramic radiograph

**Table 2.** Prevalence of bone decay patterns occurring in gender differentiated incisors and molars.

| Gender | Insisivus | % | Molar | % |
|---|---|---|---|---|
| Female | 76 | 5,94% | 52 | 4,1% |
| Male | 24 | 1,9% | 24 | 1,9% |

**Table 3.** Prevalence of alveolar bone crest resorption patterns at RSGMP Universitas Trisakti

| Pattern of bone resorption | Number of samples | Percentage based on number of panoramic radiographs |
|---|---|---|
| Horizontal | 55 | 68.75% |
| Vertical | 25 | 31.25% |

samples. This research is in line with the results of research carried out at the dental polyclinic at Tikala Baru Health Center based on ages 20-30 years showing that the prevalence of periodontitis in 2018 was 17.7%.[11] However, there are differences in the results of research conducted by Sugiarti et al which shows that the prevalence rate of periodontitis in 2013 was 60%, then increased in 2014 to 62%.[12]

The research was carried out by measuring the crest of the alveolar bone at 11, 21, 31, 41, 16, 26, 36 and 46. This is in line with the results of research which shows that in periodontitis patients the teeth where the most bone loss occurs are the incisors, then followed by molars, premolars and canines.[13] According to Carranza, it is proven that periodontitis can be found in the incisors and first molars.[8]

Based on Table 3, it can be seen that the prevalence of horizontal bone resorption patterns found in periodontitis is 68.75%. The results of the study were obtained from the number of patients who experienced horizontal bone damage from 314 panoramic samples as many as 55 patients, measured from the CEJ to the apex of the alveolar bone on panoramic radiographs. Research conducted by Naingolan et al. suggested that horizontal bone resorption patterns were found more in patients with periodontitis.[14] This study is in line with the research of Muhammad et al. which shows that the results of research on the profile of alveolar bone loss in patients diagnosed with chronic periodontitis seen based on periapical radiographs found the most horizontal bone resorption pattern of 92%, while the vertical bone resorption pattern was only 8% in the research sample conducted.[13]

Based on Table 2 which shows the prevalence of alveolar bone crest resorption differentiated by gender in incisors and molars. These results were obtained from the number of measurements on the mesial and distal of 16 areas, then divided by the total number of teeth examined in patients diagnosed with periodontitis 1,280.

The prevalence of vertical bone resorption patterns found in periodontitis was 31.25%. the results of the study were obtained from the number of patients who experienced vertical bone damage from 314 panoramic samples as many as 25 patients, measured from the CEJ to the apex of the alveolar bone on panoramic radiographs. The results of this study are not in line with research conducted by Ahmad Ridwan Turgani which shows the prevalence of vertical bone resorption patterns of 2.34% obtained from.[10] The results of this study are in line with research conducted by Hidayat et al showing that the pattern of bone resorption found in aggressive periodontitis patients is a vertical bone resorption pattern.[15] According to Carranza, states that a vertical pattern of bone resorption can be found in patients with aggressive periodontitis and is found in patients aged <25 years.[8]

Research conducted at RSGMP Faculty of Dentistry Universitas Trisakti with the age category 12-30 years in 2022 is low. This is because in samples taken based on ages 12-30 years, patients with periodontitis are more often found in elderly patients. This is in accordance with research conducted by Titin et al which proves that increasing age indicates the severity of the condition of the periodontal tissue. The severity of periodontal tissue can be caused by the aging process so that changes will be seen in periodontal tissue anatomy, morphology and function.[16]

## CONCLUSION

Based on the results of research that has been conducted on the prevalence of alveolar bone crest resorption at RSGMP Faculty of Dentistry Universitas Trisakti at the age of 12-30 years which was reviewed using panoramic radiography in January-December 2022 it was found that 25,47% of patients were diagnosed with periodontitis with a horizontal bone resorption pattern of 68.75% and a vertical bone resorption pattern of 31.25%. the results of the above measurements have differences because they use different parameters namely the radiographs used, medical records and patient diagnosis.

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## FOOTNOTES

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CASE REPORT

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# Simultaneous lesions of complex odontoma associated with dentigerous cyst: case report and critical review in CBCT

Muhammad Fadil Hidayat[1*], Andi Nurul Azizah Tenrilili[1], Barunawaty Yunus[2]

## ABSTRACT

**Objectives:** To our knowledge, there is limited evidence reporting cystic lesions associated with odontoma. Therefore, this case report aims to describe the clinical, histological, and particularly the characteristic cone beam computed tomography (CBCT) diagnostic features .

**Case Report:** A 20-year-old male patient presented with a complaint of a lump in the upper right jaw. There was no history of systemic disease. A panoramic radiograph showed a solid radio-opaque mass surrounded by an osteolytic lesion with a radio-opaque margin causing impaction of the maxillary canine. Given the limitations of panoramic radiography in assessing lesion extent, a CBCT examination was performed. Multiplanar reconstruction revealed a well-defined unilocular hyperdense lesion with a hypodense encapsulation and corticated margin, measuring 31.5 x 32 mm, expanding the buccal cortical plate and pushing the upper right canine tooth into the maxillary sinus cavity. The extensive expansion of the lesion required histopathological analysis to confirm the final diagnosis. The histopathological examination concluded a dentigerous cyst.

**Conclusion:** Several reports in the literature discuss the development of cysts and tumors in the jaw, but some cases are very difficult to identify. The variability of lesions can complicate pattern identification, leading to misinterpretation of conventional radiographs, thus requiring additional CBCT evaluation.

***Keywords:*** *Complex odontoma, dentigerous cyst, cone beam computed tomography (CBCT)*
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## INTRODUCTION

In 1866, Paul Broca was the first to identify "odontoma" as a tumor caused by the enlargement of all dental tissues. Developmental abnormalities in the function of ameloblasts and odontoblasts, which are produced by fully differentiated epithelial and mesenchymal cells, result in odontoma. As a small fraction of all odontogenic tumors, odontomas vary from 23% to 77%.[1,2] Odontomas are classified as compound odontomas, which appear as normal dental tissues arranged in an orderly pattern and resemble multiple small tooth-like structures called odontoids or denticles, and complex odontomas, which consist of an irregular mass of calcified tissue with little or no resemblance to normal teeth. Complex odontomas have an incidence of 40%–68% according to the literature. As one of the most common odontogenic tumors encountered in clinical practice, complex odontomas pose unique diagnostic challenges and therapeutic considerations that require a deeper understanding of their pathogenesis, clinical features, and management strategies.[3,4]

On the other hand, dentigerous cysts appear as developmental cysts associated with the crown of unerupted teeth, often surrounding the crown and causing impaction. Formed from remnants of the dental formation apparatus, dentigerous cysts appear as fluid-filled cavities surrounding the crown of unerupted or partially erupted teeth. Although each lesion exhibits distinct histopathological features and clinical behavior, the simultaneous occurrence of complex odontomas and dentigerous cysts in the oral cavity is relatively rare, with only a few cases documented in the literature.[5]

Given the challenges in diagnosing and managing these dual lesions, the integration of advanced imaging modalities such as Cone Beam Computed Tomography (CBCT) is of paramount importance. CBCT provides high-resolution three-dimensional visualization of dental and maxillofacial structures, offering unparalleled insights into the morphology, extent, and relationship of lesions to adjacent anatomical structures.[6] By utilizing CBCT capabilities, clinicians can achieve accurate preoperative assessments, aid in treatment planning, and improve surgical outcomes in cases involving complex odontomas and dentigerous cysts.

This article presents a detailed case report of a patient diagnosed with both a complex odontoma

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and a dentigerous cyst simultaneously, emphasizing clinical and radiographic findings, case management, and postoperative outcomes. Additionally, we critically review the existing literature, discussing diagnostic challenges, differential diagnosis, and the role of CBCT in enhancing diagnostic accuracy and therapeutic efficacy in similar cases.

## CASE REPORT

A 20-year-old male patient came to the Unhas dental and oral hospital with a complaint of a lump in the upper right jaw that had been present for a year. Occasionally, there was pain in the area of the lump. There was no history of trauma or extraction of permanent teeth, and no history of systemic disease.

Intraoral examination revealed an enlargement in the vestibular and palatal regions of teeth 11, 12, 13, 14, and 15, measuring 4.5 x 3.5 x 2 cm. The consistency was soft, crepitation was present only in the vestibular area, there was no pain on palpation, and the color of the soft tissue in the lesion area was redder than the surrounding tissue. Tooth 13 was unerupted, there were caries in teeth 36, 46, 11, 21, and 53, root remnants of teeth 16 and 24, an edentulous region of tooth 12, and poor oral hygiene (Figure 1). Upon extraoral examination, there was facial asymmetry, with the right third of the face showing expansion and the mouth opening normally (Figure 2).

Panoramic examination results showed a radio-opaque calcified lesion surrounded by a radiolucent lesion with sclerotic borders in the anterior maxilla region. The lesion involved the floor of the nasal cavity and the lateral wall of the right maxillary sinus, causing displacement of tooth 13 and pushing the roots of teeth 11 and 14 (Figure 3).

Due to limitations in assessing the extent of the lesion on the panoramic radiograph, the patient was referred for CBCT imaging. CBCT examination results showed a lesion in the anterior maxilla in the periapical region of the persistent tooth 53; a well-defined unilocular hyperdense lesion with an irregular shape resembling a calcified mass and encapsulated by soft tissue (hypodense) with corticated margins measuring 35 x 41.5 mm (coronal view), 31.5 x 32 mm (sagittal view), and 35 x 37 mm (axial view). The lesion caused expansion of the buccal cortical plate in the right maxilla, elevation of the right nasal cavity floor, and obstruction of the eruption of teeth 12 and 13 (impaction), with tooth 13 pushed into the right maxillary sinus in a vertical position and tooth 12 pushed to the apex of tooth 11 in a horizontal position (crown facing labially and root in the palate) (Figure 4).

**Figure 1.** Intraoral view showing enlargement in the vestibular and palatal regions of teeth 11, 12, 13, 14, and 15

**Figure 2.** Extraoral examination showed facial asymmetry with enlargement in the right third of the face.


**Figure 3.** Panoramic examination showed a radio-opaque calcified lesion surrounded by a radiolucent lesion with sclerotic borders in the right maxilla region, causing displacement of the upper right canine tooth, pushing the roots of the central incisor and first premolar

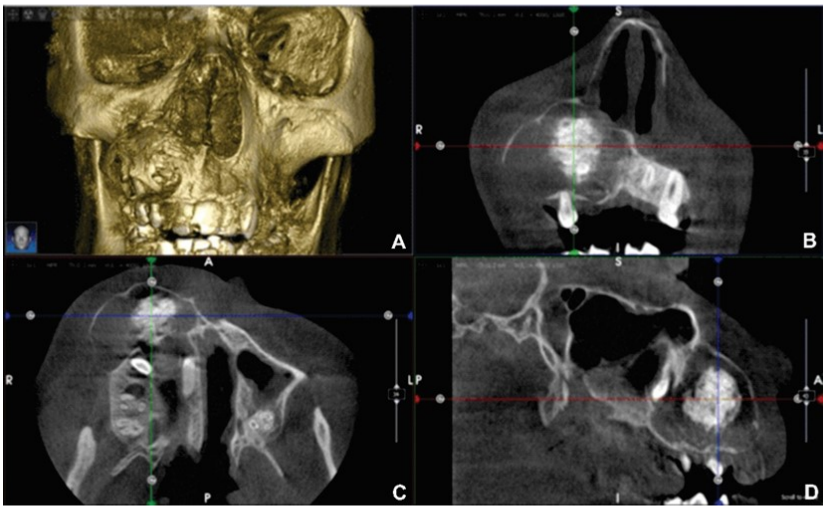


**Figure 4.** A well-defined irregular hyperdense lesion was seen in the right anterior region of the maxilla surrounded by a hypodense capsule with corticated margins. 3D Reconstruction View (A), Coronal View (B), Axial View (C), Sagittal View (D).

Aspiration tests revealed yellow fluid. The patient underwent an incisional biopsy under general anesthesia, and anatomical pathology results with microscopic examination showed tissue with a cystic structure lined with stratified squamous epithelium with connective tissue stroma, including scattered inflammatory lymphocytes and lymphocyte extravasation. Tissue analysis concluded a dentigerous cyst.

## DISCUSSION

Hybrid tumors are much rarer compared to solitary tumors. Odontomas exhibit the proliferation of odontogenic epithelium and ectomesenchymal tissue associated with dental structures. These lesions occur in only about 3% of odontogenic tumors and typically occur in patients under 20 years of age.[7]

Dentigerous cysts are odontogenic cysts associated with the cementoenamel junction of unerupted teeth. Dentigerous cysts are usually asymptomatic and are often identified during routine radiographic examinations. Sometimes, dentigerous cysts can be associated with supernumerary teeth or odontomas.[8]

Since concurrent lesions are uncommon, diagnosing them might be difficult. Odontomas are the most prevalent odontogenic tumor of the jaws among tumoral disorders. Situations where ameloblastomas originated from dentigerous cysts are well-known examples of cystic metamorphosis or development from the tumoural capsule. Otherwise, despite observations in the literature, dentigerous cysts originating from odontomas are highly uncommon and may result in misdiagnosis.[9]

Cases of simultaneous lesions are rare, and diagnosis based solely on radiographic imaging presents a challenge for dentists due to the large size of the lesion and characteristics that can mimic fibro-osseous lesions such as fibrous dysplasia and ossifying fibroma.[10] An inaccurate diagnosis can result in serious damage to maxillofacial structures during treatment.

We also conducted a literature review to clarify and confirm various CBCT radiographic features of simultaneous lesions that are relatively large. Given the rarity of such cases, we focused on literature published over the past fifteen years with homogeneous cases to help characterize the radiographic appearance of simultaneous lesions in the jaw using CBCT imaging (Table 1).

Kwang et al. and Secran et al. reported findings of simultaneous lesions for the category of compound odontoma with characteristic multilobular cysts with fairly clear boundaries. However, it should be noted that the diagnosis of compound odontoma is determined by the presence of a radio-opaque mass resembling dental denticles, in contrast to complex odontoma, which presents as a more homogeneous irregular radio-opaque mass.[16]

Other findings were reported by Josip et al.[12] and Mahnaz et al.,[14] where the location of simultaneous lesions was in the mandibular region. A characteristic sign found was the presence of a calcified mass surrounded by a radiolucent expanding lesion that can usually destroy the cortical plate. Another feature that can be used is the measurement of the density of the mass compared to the density of the teeth, which will increase the diagnostic accuracy for odontoma lesions.

Brazao-Silva et al.[15] demonstrated that the lesion is easily visible using three-dimensional reconstruction in CBCT examination, showing a solid radio-opaque mass resembling enamel with an irregular surface associated with the impaction of tooth upper maxillary canine. As in this case, a large lesion was found related to an odontoma in the right anterior maxilla, which interfered with the eruption of the permanent canine. CBCT examination was very useful in this case to identify the internal structure of the lesion. Calcification

**Table 1.** Related published literatures of homogenous cases

| Study | Age, sex | The lesion accompanying the dentigerous cyst | Localization | CT Findings |
|---|---|---|---|---|
| Kwang S K et al.,[11] Korea, 2019 | 56 year, male | Compound odontoma | Right infraorbital | Well-defined, thin-walled, non-enhancing, multilobulated cystic, size (3.4 x 2.2 x 3 cm) at regio dextra of infraorbital. |
| Josip Biocic et al.,[12] Croatia, 2010 | 10 year | Complex Odontoma | Right mandible | Calcified mass, widened surrounding radiolucent zone, tooth bud, dan a thinned lingual cortex. |
| Sercan K et al.,[13] Turkiye, 2018 | 53 year, male | Compound Odontoma | Right mandibular body | The multilobular structure of the cyst and a radiopaque area surrounded by a thin radiolucent border |
| Mahnaz Sheikhi et al.,[14] Iran, 2016 | 26 year, female | Complex Odontoma | Left mandible | Pericoronal radiolocencies around the impacted teeth, with well -defined sclerotic borders that displaced the teeth apically. There was a well-defined mixed radiolucent- radio-opaque lesion in the position of the first molar, and CBCT densitometry of radioopacities foci of the lesion showed a density near dentin and cancellous bone |
| Brazao-Silva MT et al.,[15] Brazil, 2022 | 21 Year, male | Compound-complex Odontoma | Left maxillary anterior | • Three-dimensional reconstruction of the lesion by computed tomography, showing a solid mass with a density similar to that of dental enamel, with an irregular surface, in proximity to the cystic area and impacted tooth<br>• Sagittal sections by computed tomography show a wide hypodense area and coronal part of the impacted tooth 23. |

within the lesion in the anterior region poses a risk to several vital structures such as the nasal cavity and maxillary sinus cavity, analyzing CBCT radiographs important for the characterization and diagnosis of simultaneous lesions suspected to be a dentigerous cyst associated with an odontoma, which cannot be shown by conventional radiography.[17]

## CONCLUSION

Several reports in the literature discuss the development of cysts and tumors in the jaw, but some cases are very difficult to identify. The variability of lesions can complicate pattern identification, leading to misinterpretation of conventional radiographs, thus requiring additional CBCT evaluation.

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## FOOTNOTES

All authors have no potential conflict of interest to declare for this article. Informed consent was obtained from the patient for being included in this case report.

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REVIEW ARTICLE

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# Differences in characteristics of Central Giant Cell Granuloma with Ameloblastoma, Odontogenic Myxoma and Aneurysmal Bone Cyst through radiographic approach

Prestisia Peramiswara Mandiasa[1], Sarianoferni[2*], Icha Artyas Annariswati[3]

## ABSTRACT

**Objectives:** This study aims to determine the differences in the characteristics of Central Giant Cell Granuloma with Ameloblastoma, Odontogenic Myxoma, and Aneurysmal Bone Cyst through a radiographic approach so as to expand understanding of the characteristics of Central Giant Cell Granuloma with benign lesions of the oral cavity that have similar characteristics.

**Review:** The data used in this study are research journals published on PubMed and Google Scholar search engines. Selecting keywords namely Radiology, Central Gaint Cell Granuloma, Differential Diagnosis by formulating research questions to provide an operational framework using the PICO framework (P: Patient, Population, or Problem; I: Intervention or Exposure; C: Comparison; Outcome). Data collection procedures were carried out through journal identification, then data reduction was carried out, namely selecting journals that were in accordance with the research concept, so that inclusion and exclusion criteria were determined and tested for eligibility and completeness of journals.

**Conclusion:** In this literature review, it was found that Central Giant Cell Granuloma can be diagnosed in comparison with Ameloblastoma, Odontogenic Myxoma, and Aneurysmal Bone Cyst. A total of 41.6% compared with Ameloblastoma, so Ameloblastoma has a higher percentage. 19.4% compared with Odontogenic Myxoma and 38.8% compared with Aneurysmal Bone Cyst.

***Keywords:*** *Central Giant Cell Granuloma, Ameloblastoma, Odontogenic Myxoma, Aneurysmal Bone Cyst*
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## INTRODUCTION

The prevalence of Central Giant Cell Granuloma (CGCG) can reach up to 1.1 per million population per year. Based on clinical findings, CGCG is more common in women. These lesions are also more common in the mandible (condyle, ramus and coronoid) than in the maxilla. Location in the condyle region has a low frequency compared to other posterior regions of the mandible. The first case of CGCG occurred in a 44-year-old woman with lesions located in the condyles.[1] Approximately 60% of cases are found in individuals under the age of 20 years. The sign of CGCG is swelling without pain.[2]

Two-dimensional radiographs can provide an overview of the lesion in terms of location, expansion, and internal structure. The limitations of periapical radiographs are that they cannot show the extent of the lesion, the expansion of the cortical bone, and the effect on the surrounding tissue in depth. Panoramic examination is the gold standard in CGCG examination because it provides a comprehensive picture of the condition of the oral cavity.[3] Cone Beam Computed Tomography (CBCT) examination can help determine lesion expansion with low radiation dose and high resolution. The radiographic picture of CGCG varies greatly, in general, imaging features of CGCG has a multilocular or unilocular shape, predominantly occurs in the mandible and has clear boundaries.[2]

The etiology of this lesion is still controversial, but based on three theories, first; the presence of local irritants, second; developmental anomalies, third; neoplastic implications.[4] CGCG, which has septa, is radiologically similar to aneurysmal bone cyst (ABC), odontogenic myxoma (OM) and ameloblastoma. ABC, OM and ameloblastoma because of their radiographic similarities are considered as differential diagnoses of CGCG. OM occurs in the age range of 20 to 40 years. OM is rare in children and generally occurs in the mandibular region, especially the posterior region.[5] OM can be found as unilocular or multilocular, radiolucent or mixed radiolucent - radiopaque. When the lesion is coronal to the tooth, it will cause tooth impaction.[6]

Ameloblastoma is a benign odontogenic tumour and the second most common odontogenic tumour after odontoma. It often occurs in the mandibular region in two-thirds of the ramus.[7] Radiographs reveal a totally radiolucent or mixed radiolucent-

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radiopaque internal structure with septa. The effect on the surrounding tissue can cause tooth root resorption, apical tooth migration and cortical bone thinning.[2]

Aneurismal Bone Cyst is a benign bone lesion that accounts for approximately 1.5% of reactive lesions of bone. It is often found in the mandible compared to the maxilla in a ratio of (3:2), especially in the ramus, corpus, and mandibular angulus.[8] Radiographically, the lesion has clear boundaries and is circular in shape. The internal structure of the lesion is multilocular with septa. Expansion to the cortical bone, tooth migration and tooth root resorption may occur.[2]

## REVIEW

The type of research used is qualitative research with a literature study approach. The literature study approach is related to systematic research, data collection based on events and time sequences that aim to describe the state of events systematically and theoretically.[9] The literature study approach will describe the characteristics of the event under study. The event is the reason for the research. The case study approach requires systematic data collection to facilitate analysis and compile in detail.[10]

The population in this study uses the same research journal as the selected search engine. Selecting keywords by formulating research questions to provide an operational framework using the PICO framework (P: Patient, Population, or Problem; I: Intervention or Exposure; C: Comparison; Outcome).[11] PubMed search engine using the keywords Radiology, Central Gaint Cell Granuloma, Differential Diagnosis obtained 49 journals. Google Scholar using the keywords Radiology, Central Giant Cell Granuloma, Differential Diagnosis obtained 26,600 journals.

Data was retrieved by selecting journals through PubMed and Google Scholar and determining keywords that match the research title. Then perform data reduction, namely selecting journals that are in accordance with the research concept, so that the inclusion and exclusion criteria are determined. Qualitative data collection was carried out by identifying the year of publication, screening journals and suitable topics and testing the feasibility and completeness of research data so that journals were obtained that met the inclusion criteria.[7]

Central Giant Cell Granuloma has a dominant sexual predilection in women, this is supported by 21 journals out of 36 journals with a percentage of 58.3% stating the same thing in this study. In the results of research by Tenore, et al (2014), CGCG also often occurs in women. CGCG lesions are often found at ages under 30 years or in the second decade and life shows as much as 58.3% (21 journals). This is also in accordance with the theoretical statement by (White and Pharoah, 2014) that CGCG occurs at an age below 20 years.

CGCG predominantly occurs in the mandible compared to the maxilla with a percentage of 52.77% (19 journals). In the mandible, lesions can occur anteriorly or posteriorly. The posterior part

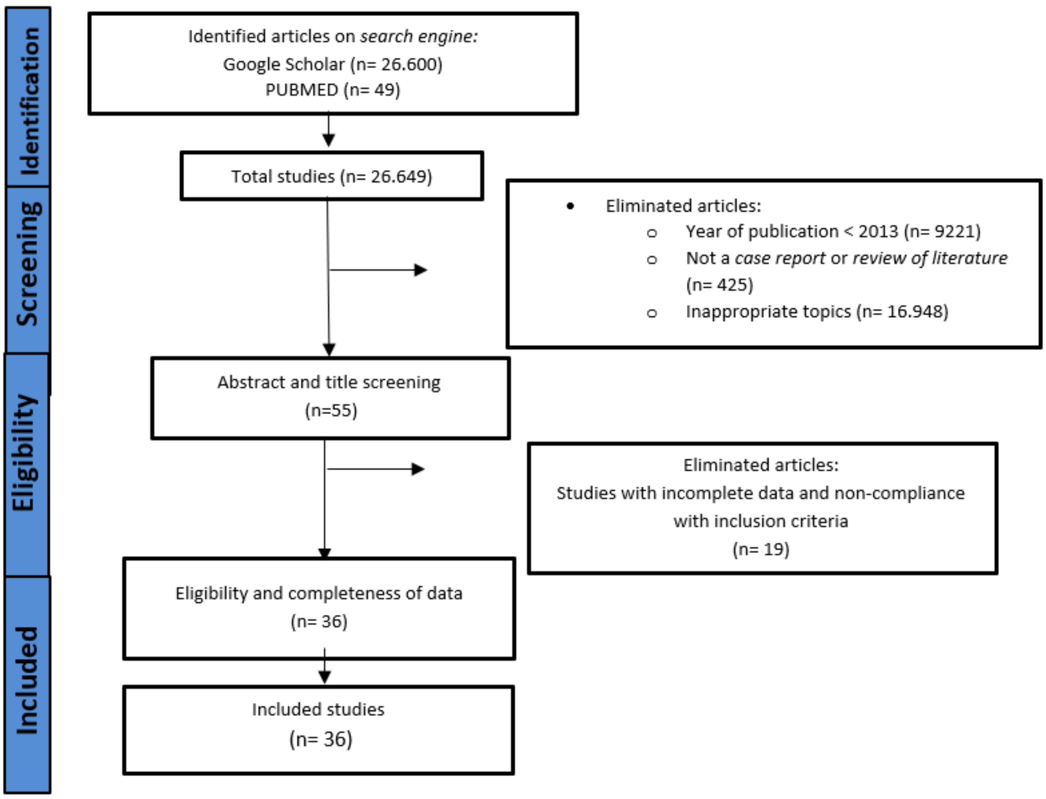


**Figure 1.** Research flow

of the mandible often occurs in the corpus to ramus with a percentage of 38.88% (14 journals), and condyles with a percentage of 5.55% (2 journals). The anterior part of the mandible can occur up to crossing the mandibular midline with a percentage of 27.77% (10 journals).

CGCG can be multilocular with a percentage of 58.33% (21 journals) and unilocular with a percentage of 44.44% (16 journals). If CGCG is multilocular, it has a larger size than unilocular. It has clear or unclear boundaries with a percentage of 38.88% (14 journals). The internal structure of CGCG is dominantly in the form of radiolucent with a percentage of 50% (18 journals) but can be found in a mixed radiolucent - radiopaque form with a percentage of 5.55% (2 journals). CGCG can also be found with a radiopaque internal structure (ground glass) as in the results of a study by Imanimoghaddam, et al (2021). Typical features can be found in the form of fine granules with thin septa. Thin septa were found with a percentage of 13.88% (5 journals).

The size of CGCG varies but if the lesion is aggressive it can reach more than 5cm in size. CGCG can cause cortical bone perforation with a percentage of 58.33% (21 journals), tooth root resorption with a percentage of 41.66% (15 journals), cortical bone expansion with a percentage of 36.11% (13 journals), tooth migration with a percentage of 33.33% (12 journals), mandibular border resorption with a percentage of 5.55% (2 journals), tooth unsteadiness, inferior canaliculus alveolaris urgency, and maxillary sinus lateral wall damage with a percentage of 2.77% (1 journal). The results of this study found that out of 36 journals, 25 journals determined the radiodiagnosis of CGCG with various differential radiodiagnoses. 15 journals stated differential radiodiagnosis with Ameloblastoma, 14 journals stated differential radiodiagnosis with ABC, and 7 journals stated differential radiodiagnosis with OM.

## DISCUSSION

CGCG has a dominant sex predilection in women. This is in accordance with the results of research by Tenore, et al (2014) that the dominant occurrence in women is due to hormonal influences such as the hormones estrogen and progesterone which affect the development of CGCG.[12] This lesion occurs in the age range below 30 years but does not rule out the possibility of occurring in old age.[13] CGCG is mostly found at a young age based on Pharoah (2014) who also stated that these lesions can occur at an age below 20 years.[2]

CGCG is generally found in the mandibular region anterior to the extension of the molar region and can also be found in the posterior region. CGCG is also able to cross the mandibular midline, this is a characteristic of CGCG.[2] The difference in location can occur because it is influenced by age. At a young age the lesion has the ability to extend to the anterior region while at an older age the tendency is to extend to the posterior region. The internal structure of CGCG is generally radiolucent with thin septa.[14] Other internal structures can be mixed (radiolucent-radiopaque) with thin septa. The results of a literature search by Imanimoghaddam, et al (2021), other internal structures that can be found are ground glass appearance. Ground glass appearance is found when CGCG accompanied by thin septa is found in the maxillary sinus and adjoins Fibro-osseous lesion.[15] The characteristic feature of this lesion is that it has a fine granular calcification pattern composed of thin and indistinct septa. The effects on the surrounding tissue of CGCG lesions are mostly capable of causing cortical bone perforation.[2]

CGCG has a variable size that can be influenced by the aggressiveness of the lesion. The more aggressive the lesion can reach larger size, this is also following the results of literature by Eziagu, et al (2022) lesions can reach more than 5 centimeters.[16,17] CGCG with a multilocular shape that can be distinguished from Ameloblastoma,

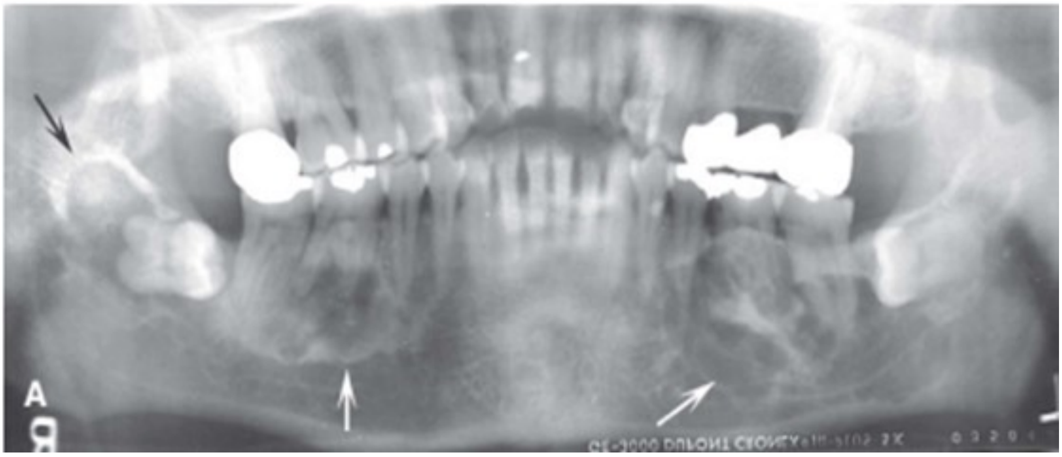


**Figure 2.** Panoramic radiograph of CGCG lesion showing granular edges[10]

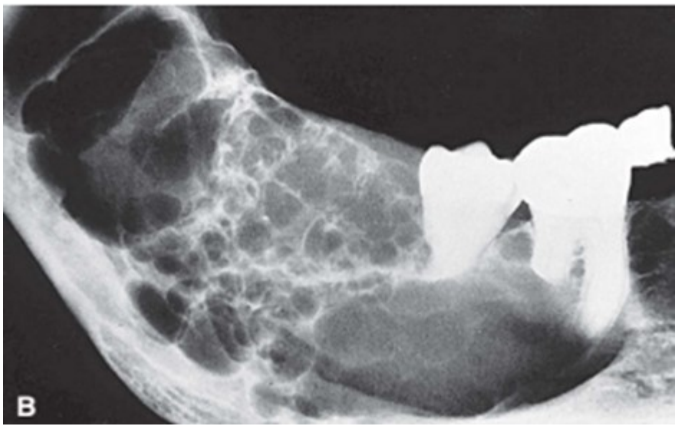


**Figure 3.** Radiograph of multilocular ameloblastoma with soap bubble appearance[10]

Odontogenic Myxoma, and Aneurysmal Bone Cyst.

Ameloblastoma has a predominantly male sex predilection, in contrast to CGCG which is predominantly female. These lesions occur between the ages of 20 - 50 years with an average age of 40 years.[18] In contrast to CGCG which predominantly occurs at a younger age. This is in accordance with the statement by Pharoah (2014) that Ameloblastoma predominantly occurs in males with an age range of 20 - 50 years (average age 40 years).[2]

Ameloblastoma is commonly found in the posterior mandibular region (i.e. corpus, angulus and ramus). The location of Ameloblastoma is different from CGGC which can be found in the anterior region to cross the mandibular midline.[2] Ameloblastoma has unilocular and multilocular forms with a characteristic soap bubble appearance when the lobe of the lesion is large and honey comb appearance when the lobe of the lesion is small.[7] Generally, the lobes are large when located posterior to the mandible and smaller when located anterior to the mandible. Several studies and searches by Ragunathan, et al (2022) and Merbold, et al (2023) revealed that Ameloblastoma has a predominantly radiolucent internal structure and can be mixed radiolucent - radiopaque with septa.[19,20] Effects on the surrounding tissue can be in the form of tooth root resorption, buccal cortical bone expansion, lingual cortical bone expansion, mandibular border thinning, and tooth displacement towards the apical causing tooth impaction.[18] This statement is also supported by the statement by Pharoah (2014) that tooth displacement occurs because Ameloblastoma can originate from the occlusal teeth so that the teeth will point more apically. Expansion and perforation of the cortical bone produces an "eggshell" appearance.[2] Ameloblastoma has a larger size than CGCG, Ameloblastoma has a volume of about 250.044 mm³, while CGCG volume is about 10.31 cm³.[20]

According to Pharoah (2014) the septa in ameloblastoma have curved septa, these septa are derived from normal bone trapped within the lesion.[2] Another study by Figuiredo, et al (2014) Odontogenic Myxoma has the same female sex predilection as CGCG. This lesion occurs at the age of 6-75 years with an average age of 35.5 years.[21] OM can occur in the second and third decades of life. This is in accordance with the statement by Pharoah (2014) that OM lesions occur in the age

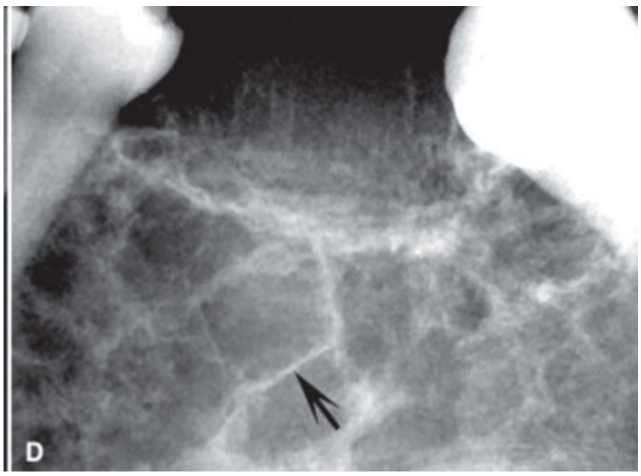


**Figure 4.** Radiograph of OM lesion showing straight septation[10]

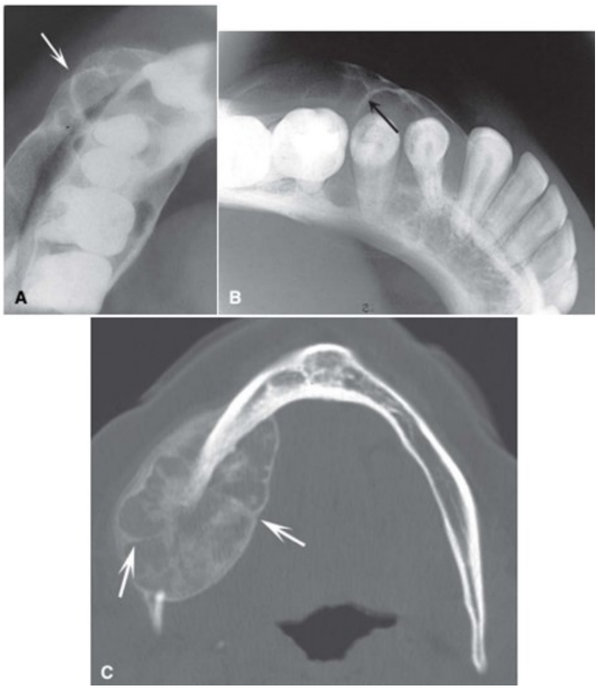


**Figure 5.** (A,B) Occlusal radiographs showing ABC lesion on the mandible with thin septa, (C) CT radiograph showing ABC lesion of cortical bone expansion[10]

range of 10 - 30 years and rarely occur at the age below 10 years or above 50 years.[2]

OM generally occurs in the mandible research by Wang, et al (2017) revealed OM occurs in the posterior mandible involving the ramus and maxilla.[21] This is different from the statement by Pharoah (2014) that OM lesions occur in the mandible of the premolar and molar regions and rarely occur in the ramus and condyle areas because in the ramus and condyle areas there is no dental involvement.[2] The results of the study by Wang, et al (2017) and Goel, et al (2016) were due to the involvement of the third molar. The difference with CGCG is that CGCG lesions are mostly found in the anterior mandible and can cross the mandibular midline.[21,22]

OM can have clear borders, especially in the unilocular form surrounding the crowns of teeth on the posterior mandible. OM with indistinct borders when found in the maxilla but generally has clear borders. The multilocular form of OM has a typical tennis racket appearance (thin straight septa resulting in angular trabeculae and large cusp size).[2] Most septa in OM will appear curved but 1 - 2 straight septa can be found. These septa are derived from residual resorption of trabecular bone and dense fibrous tissue. The internal structure of OM is a mixture of radiolucent and radiopaque with thick septa on the mandibular corpus and thin straight septa on the alveolar crest. The internal structure differs from the CGCG lesion in that it is multilocular with thin septa.[22]

Effects on surrounding tissues include perforation of the inferior cortex of the mandible to a decrease in cortical bone density which is limited by radiographs to a periosteal sunburst.[22] Other surrounding tissue effects can cause tooth loss or tooth displacement and rarely cause tooth root resorption.[2] OM has a beverage size of 1.2cm and a maximum of 6.5cm, making it larger than CGCG.[23]

ABC has a female sex predilection. This lesion occurs at the age of 10-50 years and predominantly occurs under the age of 20 years.[24] This is also in accordance with the statement by Pharoah (2014) that it occurs at a young age under 30 years and 90% occurs in women. ABC is commonly found in the mandible compared to the maxilla.[25] Based on another literature search by Sonone, et al (2022) ABC is located in the mandible extending anteroposteriorly from the left canine to the ramus.[26] This is also in accordance with the statement by Pharoah (2014) that the mandible is a frequent location compared to the maxilla with a ratio of 3:2 in the molar and ramus regions.[2]

ABC lesions are multilocular or unilocular with clear boundaries. ABC has an oval or "hydraulic" shape with clear boundaries because this lesion is a proliferation of blood vessel.[25] The effect on the surrounding tissue is the same as CGCG, ABC is capable of tooth root resorption, tooth displacement and tends to cortical bone expansion so that it can cause rapid swelling in the buccal or labial area.[2]

Ameloblastoma is a differential radiodiagnosis with a high percentage because Ameloblastoma in multilocular form has similar characteristics to CGCG. This is in accordance with the theory by White and Pharoah where both lesions can occur in the posterior mandible, the internal structure is predominantly radiolucent, and capable of causing tooth root resorption, tooth displacement and cortical bone expansion. OM is a differential diagnosis with a smaller percentage this can occur due to limitations in samples and search engines in this study.

## CONCLUSION

The results of this literature review found that Central Giant Cell Granuloma occurs in the anterior or posterior mandible and 27.7% stated that it can cross the midline, 13.8% stated that CGCG has a typical picture of fine granules, with a dominant radiolucent internal structure and incomplete thin septa and unclear boundaries. A total of 41.6% compared with Ameloblastoma, so Ameloblastoma had a higher percentage. Ameloblastoma occurs in the posterior mandible (molar to ramus), has a typical soap bubble appearance and honeycomb appearance, with radiolucent/mixed radiolucent - radiopaque internal structure, septa and clear borders. A total of 19.4% compared with Odontogenic Myxoma occurring in the posterior mandibular (premolar - molar), having a typical tennis racket appearance, with internal structure of radiolucent / mixed radiolucent - radiopaque, septa and clear boundaries. A total of 38.8% compared with Aneurysmal Bone Cyst occurred in the posterior mandibular (corpus to ramus), had a typical "hydraulic" appearance, with an internal structure of mixed radiopaque - radiolucent, incomplete septa and clear boundaries.

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None.

## FOOTNOTES

All authors have no potential conflict of interest to declare for this article.

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# Radiographic evaluation of the healing process of alveolar abscess through regulation of VEGF and angiogenesis

Ichda Nabiela Amiria Asykarie[1*], Lusi Epsilawati[2]

## ABSTRACT

**Objectives:** This review article aims to explain how the regulation of vascular endothelial growth factor (VEGF) and angiogenesis on alveolar abscess healing process evaluation using radiograph.

**Review:** The databases used in this review are Google Scholar, PubMed, and Science Direct. A total of 1280 search results appeared based on keywords. The search results were selected by title and abstract according to their relevance to the review topic. A total of 24 literatures were reviewed. The alveolar bone destruction is one of the signs of an inflammatory lesion in the alveolar bone. Bone damage that occurs in cases of the abscess will reduce the absorption of x-rays thereby giving a radiolucent appearance on radiographic examination. A radiographic examination is a supporting examination that can be used to develop the healing process. The processes of angiogenesis and osteogenesis of bone homeostasis will complement each other for the bone healing process, while VEGF is a growth factor that can increase the expression of BMPs and osteoblast differentiation so that the bone healing process can take place properly.

**Conclusion:** VEGF plays a significant role in both bone healing and regulation of vascular development and angiogenesis. However, excessive VEGF can also be harmful to the process of bone repair because it can stimulate the recruitment of osteoclasts. Therefore, VEGF regulation has an important role in apical abscess healing, and radiographic images that are quantitatively analyzed can be used to quantify this healing process.

***Keywords:*** *VEGF, angiogenesis, abscess alveolar, healing process, radiograph*
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## INTRODUCTION

The alveolar abscess is the most common inflammatory lesion of the mandibular and maxillary alveolar bone. Alveolars abscesses are radiolucent lesions that form in the bone near the apex of nonvital teeth and occur due to bacterial infection. After adequate debridement, disinfection, and obturation, the root canal will heal in many apical lesions but not all of them. Some lesions may take a while to heal. Since the healing of apical lesions entails the regrowth of bone in the damaged area, it is imperative to comprehend the osteogenic signals that initiate and control the apposition of new bone. In some situations, endodontic therapy administered intracanal to apical lesions is ineffective. Apical lesions serve as the host response's defensive mechanism. However, this defense results in the destruction of the apical bone around it. Bone destruction is one of the most important early warning signs of an apical lesion. The ultimate elimination of the bone defect caused by this inflammatory response is the main clinical indicator and tool used to monitor the healing of these lesions. Bone destruction that occurs in cases of the abscess will reduce the absorption of x-rays thereby giving a radiolucent appearance on radiographic examination. Radiographic examination is a supporting examination that can be used to develop the healing process.[1,2]

Healing starts in the related region as inflammation starts. When factors causing the endodontic infection are eliminated with endodontic treatment, inflammatory mediator production in periapical tissues stops. The body's regulating mechanisms deactivate the local mediators that are already present. Prior to the healing of a wound, this procedure occurs. Although factors that cause inflammation are clearly known, there is a relatively low level of knowledge of the factors and mechanisms that cause the process to stop. The effectiveness of histamine and anti-inflammatory cytokines like IL-4, IL-10, IL-13, and TGF-b are known to be dependent on the balance between cyclic AMP levels (adenosine monophosphate) and cyclic GMP (guanosine monophosphate) in the cell. Natural inhibitors of inflammatory mediators (opioids, somatostatin, and glucocorticoids) are also known to be dependent on this mechanism.[2]

The healing mechanism for apical periodontitis lesions after suitable non-surgical root canal treatment is as follows: fibrovascular granulation tissue formation, removal of necrotic tissue and dead bacteria by active macrophages, and repair or regeneration of the wounded tissue. Apical lesion healing mainly occurs with regeneration. Thus, the tissues can return to their original structures. Osteoblasts in the alveolar bone, bone marrow mesenchymal stem cells, and multipotent stem cells in periodontal ligament are the cells that work in periapical lesion healing.[3] The healing process occurs in several phases: inflammatory, proliferative, and remodeling. The alveolar abscess healing process is closely related to the soft and hard tissue regeneration process. Bone tissue regeneration is a mechanism centered on the interaction between the processes of angiogenesis and osteogenesis. The processes of angiogenesis and osteogenesis of bone homeostasis will complement each other for the bone healing process, while VEGF is a growth factor that can increase the expression of Bone morphogenetic proteins (BMPs) and osteoblast differentiation so that the bone healing process can take place properly.[4–6] Several studies on the effect of VEGF in the process of healing and bone regeneration have been carried out, based on this the authors are interested in conducting a literature study on the regulation of VEGF in the process of angiogenesis-related to the evaluation of the abscess healing process through radiographs.

## REVIEW

The databases used in this review are Google Scholar, PubMed, and Science Direct. A total of 1280 search results appeared based on keywords. The search results were selected by title and abstract according to their relevance to the review topic as VEGF regulation on osteogenesis, angiogenesis, and radiographic evaluation of alveolar abscess healing process A. A total of 24 literatures were reviewed.

The establishment of a functional vascular system is crucial during organ development as well as during tissue repair. Blood vessels in bone provide calcium and phosphate, the components for mineralization, in addition to oxygen and nutrition. Additionally, it appears that blood arteries in the bone marrow play a significant role in acting as a habitat for both skeletal stem cells, which produce bone, and hematopoietic stem cells, which form blood. A prompt and coordinated angiogenic response is crucial for effective bone regeneration, which further demonstrates the relationship between angiogenesis and osteogenesis during the healing of abcess. Increasing knowledge of the cellular and molecular mechanisms controlling the angiogenic cascade may aid in the evaluation of abscess healing process.[7,8]

One of the foremost broadly considered angiogenic development components is VEGF, an endothelial cell-specific mitogen. VEGF proteins are discharged by cells included in skeletal advancement and repair, counting endothelial cell, macrophages, fibroblasts, smooth muscle cells, osteoblasts, and hypertrophic chondrocytes. Distinctive from bone improvement, the early organize of bone healing is characterized by hematoma arrangement, which has solid proangiogenic properties, predominantly due to the presence of VEGF. The importance of an appropriate VEGF-mediated stimulation of angiogenesis during bone healing is eminent, as inhibition of VEGF activity through treatment with a soluble VEGFR or VEGF antagonist resulted in impaired healing of bone defects in mice. VEGF leads to moved forward effective bone repair in both models. VEGF can impact bone recovery by influencing bone cells in a roundabout way or specifically. First, through its activity on Endothelial cells, VEGF induces the angiogenic process. Bone-forming precursor cells possibly migrate concomitantly with these blood vessels to the bone callus defect, where they differentiate into osteoblasts. Secondly, through an angiocrine mechanism then VEGF can stimulate Endothelial cells to produce osteogenic cytokines that promote the differentiation of progenitor cells into osteoblasts. Lastly, VEGF may also directly influence osteoblast function. Accordingly, osteoblasts produce VEGF and respond to VEGF itself, which regulates chemotaxis, proliferation, and differentiation of osteoblasts.[8]

Apical abscess radiographically presents a round or oval radiolucent lesion with diffuse borders. In addition, the surrounding trabecular pattern will show a gradual transition from a normal pattern to an abnormal bone pattern.[9,10] X-ray absorption will decrease in abscess conditions due to bone destruction, so the image seen on the radiograph is radiolucent, whereas if an abscess heals, the bone matrix will be formed and the level of fibrous density will change, thereby increasing x-ray absorption. The condition of bone matrix density will affect the film layer, namely silver bromide (AgBr) so that changes in the radiographic pattern can be assessed by performing image processing on the radiograph.[11,12]

The process of bone repair after an injury takes place quickly and efficiently. Cellular and molecular mechanisms of bone repair or bone regeneration occur in several overlapping phases, namely the inflammatory phase, the proliferative phase, the soft callus formation phase, the cartilage bone replacement phase and the remodeling phase. The process that occurs after the formation of an alveolar abscess is inflammation of the infected area, then neutrophils will gather in that area. This process is followed by the entry of macrophages into the area and eating dead neutrophils and increasing the angiogenic response and initiating the healing process, with the invasion of these new blood vessels mesenchymal osteochondral

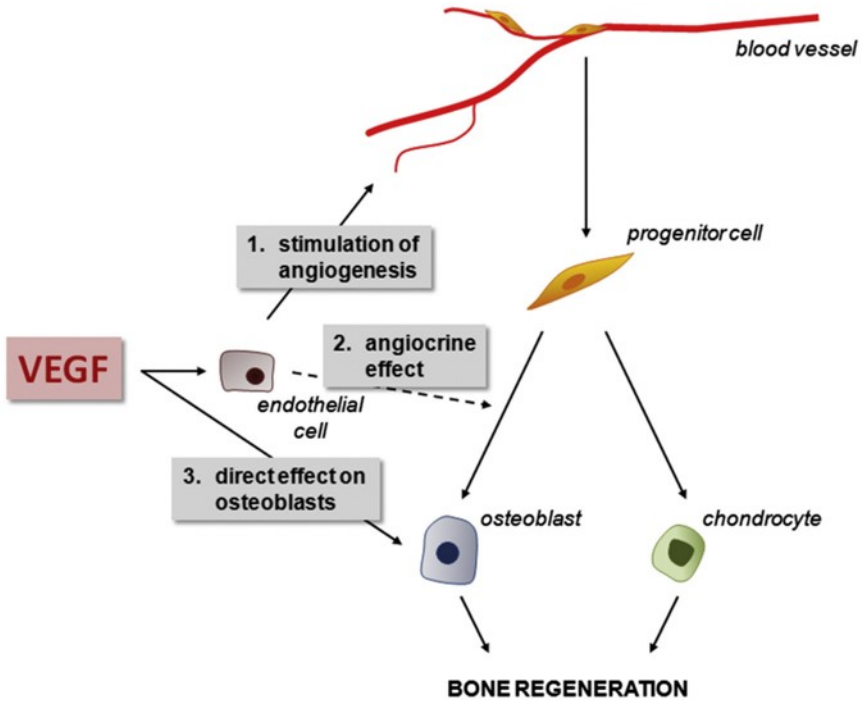


**Figure 1.** VEGF signaling during bone regeneration. VEGF stimulates the formation of new blood vessels, which can bring progenitor cells for bone formation. VEGF upregulates the expression of osteogenic growth factors in endothelial cells, mediating osteoblast differentiation[8]

progenitors will migrate to the area of infection where later these cells will proliferate and differentiate into osteoblasts. or chondrocytes, depending on the stability of the vascular supply, eventually the woven bone formed will gradually be remodeled into lamellar bone.[13,14]

VEGF one of the important growth factors in the regulation of vascular development and angiogenesis, but it also has an important role in bone repair because the processes of angiogenesis and osteogenesis are closely related. VEGF acts in both endochondral and intramembranous ossification processes, besides acting as a very important mediator during this process, not only in angiogenesis but also in various aspects of bone repair, such as chondrocyte differentiation, osteoblast differentiation, and osteoclast recruitment.[15]

VEGF is concentrated in the area of injury and contributes to the recruitment of macrophages or monocytes in the inflammatory phase. In the process of endochondral ossification in the process of bone repair, VEGF stimulates the recruitment of osteochondroprogenitor cells, induces cartilage, and stimulates cartilage resorption and its replacement with bone. Intramembranous ossification also depends on signals from VEGF, because this VEGF can increase the formation of bone mineralization in the area of bone that is affected by injury and besides that VEGF also regulates the maturation and differentiation of osteoclasts, so VEGF is needed in the bone repair process. VEGF acts on adjacent endothelial cells as an intermediary for angiogenic processes, where this process is very important in the process of maintaining vascular integrity and bone mass. In addition, intracellular VEGF in osteoblasts also regulates the balance of osteoblasts.[5,16]

VEGF is involved in various aspects of osteoblast function. Two studies have demonstrated a level-dependent chemoattractive effect of VEGF on human primary osteoblasts and human mesenchymal progenitor cells. In addition to its effect on cell migration, VEGF stimulates cell proliferation by up to 70%. It was also found that VEGF directly promotes primary osteoblast differentiation in vitro by increasing nodule formation and alkaline phosphatase activity. In addition, low levels of VEGF were found in the early process of osteoblast differentiation and continued to increase and then reached maximum expression during the mineralization period. Thus, VEGF has an important role in the regulation of bone remodeling by stimulating osteoblast differentiation.[15,17]

Intramembranous ossification is one of two processes that are important in the formation of bone tissue structure. Intramembranous ossification occurs in the formation of the flat bones of the skull, mandible, maxilla, and clavicle. It is also an important process in normal bone healing. Bone is formed from connective tissue such as mesenchymal tissue, not from cartilage. Intramembranous ossification occurs in several stages, namely the formation of an ossification center, calcification, formation of trabeculae, and development of the periosteum. Cells that are important in the formation of bone tissue through intramembranous ossification are mesenchymal stem cells, these cells will initiate intramembranous ossification and are non-specialized cells, whose morphology has characteristics that change as they develop into osteoblasts. VEGF increases

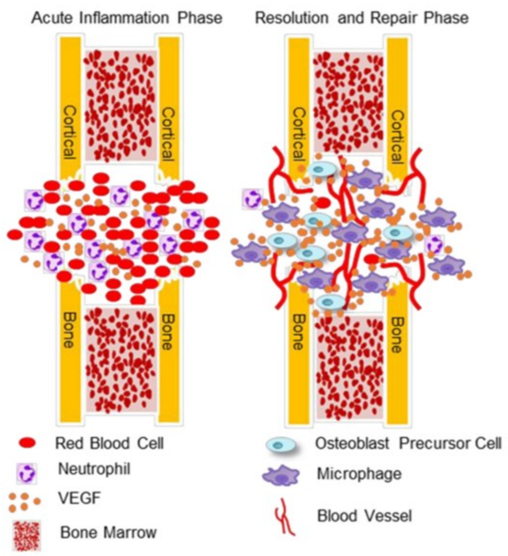


**Figure 2.** Expression and functions of VEGF in the inflammation phase during bone repair[18]

neovascularization, which in turn increases the number of mesenchymal cells in perivascular connective tissue. VEGF also stimulates vascular endothelial cells to secrete growth factors and cytokines that influence the differentiation of mesenchymal cells to enter the osteogenic process and be involved in osteogenesis. Bone repair is a process consisting of several steps involving migration, proliferation, differentiation and activation of several cell types. This repair process is very complex and involves various growth factors including VEGF.[15,19]

The process of intramembranous ossification depends on a merger of angiogenesis and osteogenesis. VEGF plays an important role in this process, stimulated by hypoxia during inflammation, osteoblasts release several factors including VEGF through HIF-1α. VEGF can act through its receptors on endothelial cells to induce angiogenesis, thereby increasing the supply of oxygen and nutrients needed for osteogenesis. Increased vascularity can stimulate bone stem cells and pre-osteoblasts and increase levels of osteogenic growth factors such as BMP2 and BMP4 as well as anabolic signals to further trigger osteoblast differentiation and mineralization. During bone repair, VEGF levels greatly affect the results, so too low levels of VEGF can interfere with bone and blood vessel relationships, whereas too much VEGF can also be detrimental to the bone repair process because osteoblastic maturation and mineralization can be inhibited through VEGFR2 signaling or it can be caused by the recruitment of osteoclasts that resorb new bone formation.[18]

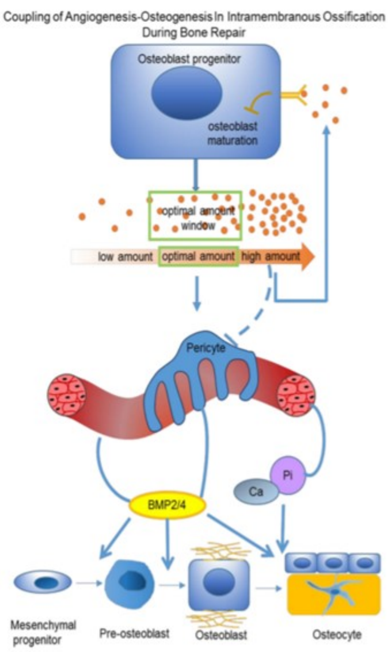


**Figure 3.** The role of VEGF in angiogenesis-osteogenesis during intramembranous ossification bone repair[18]

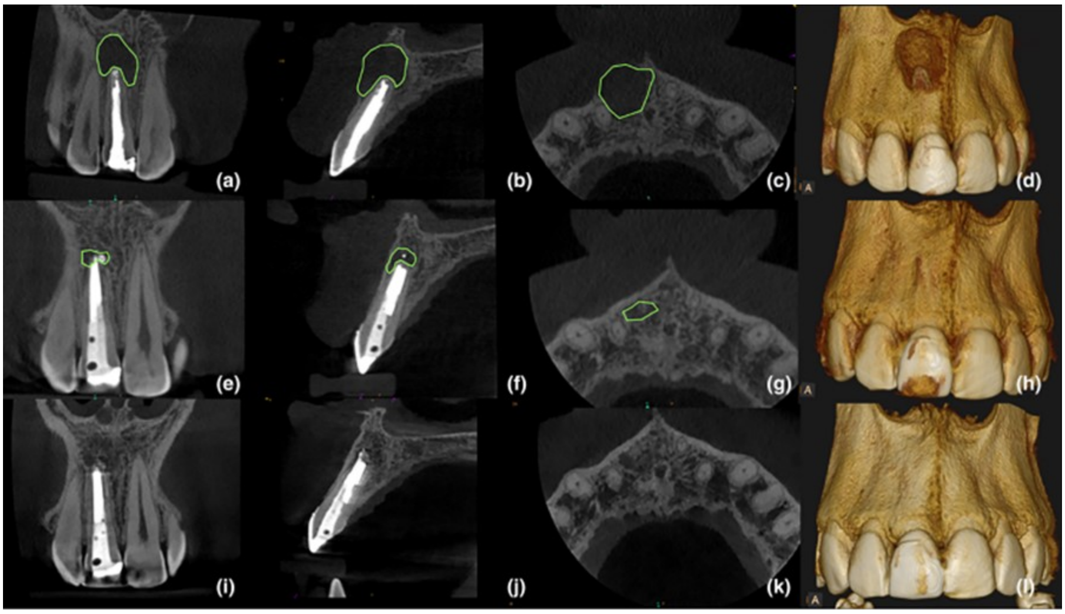


**Figure 4.** CBCT images of periapical bone healing on alveolar abscess[25]

The anatomical structure of bones on radiographs is very interesting and important to study because these images can be used as an aid in diagnosing and evaluating bones. Therefore, several studies have been carried out to identify most of the structures seen on intraoral and extraoral radiographs. The structure of the alveolar bone has attracted the attention of several researchers because it gives rise to various interpretations. The internal aspect of the alveolar bone has several terms such as cancellous, medullary, spongy, and trabecular bone. Researchers and clinicians assumed the lattice-like pattern on intraoral radiographs to represent the internal area of the medullar bone cavity. Trabecular bone has an 8-fold higher turnover than cortical bone and is more responsive to the body's metabolic responses. This is a very important phenomenon because the maxilla and mandible are rich in trabecular bone.[20]

The healing process of the apical abscess will cause the bone matrix to increase and the level of fibrous density will change, thereby increasing the absorption of x-rays which causes changes in the radiographic pattern. Changes in the pattern on this radiograph can be assessed qualitatively or quantitatively. Quantitative assessment results in a more objective assessment when compared to qualitative assessments that are only assessed visually because interpreting visually does not always identify all bone destruction that occurs. To date, many methods have been used to analyze the quality of alveolar bone. In the quantitative assessment of abscess healing, the process of changing radiographic patterns can be assessed using the bone texture morphometric analysis method which is a method of mathematically processing digital radiographic images with the help of software.[17,21–24]

## CONCLUSION

The process of bone repair after an injury proceeds fast and effectively. Due to the tight relationship between the processes of angiogenesis and osteogenesis, VEGF plays a significant role in both bone healing and regulation of vascular development and angiogenesis. Additionally, VEGF induces the release of cytokines and growth factors by vascular endothelial cells, which influence the differentiation of mesenchymal cells to enter the osteogenic process and participate in osteogenesis.VEGF levels during bone repair have a significant impact on the outcomes. However, excessive VEGF can also be harmful to the process of bone repair because it can stimulate the recruitment of osteoclasts, which resorb newly formed bone, or it can hinder osteoblastic maturation. Therefore, VEGF regulation has an important role in apical abscess healing, and radiographic images that are quantitatively analyzed can be used to quantify this healing process.

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## FOOTNOTES

All authors have no potential conflict of interest to declare for this article.

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REVIEW ARTICLE

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# Ameloblastoma radiograpic imaging on 3D CBCT: a literature review

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## ABSTRACT

**Objectives:** This review article is aimed to provide an overview of 3D CBCT in determining the diagnosis of ameloblastoma.

**Review:** This study is a literature review consisting of English articles about the ameloblastoma radiographic imaging on 3D CBCT, published 2013-2023.The article search databases used were Google Scholar, Ebsco, PubMed. The total search results for articles based on keywords obtained were 552 articles, and only 9 articles were include. Ameloblastoma is a persistent and locally invasive tumor; with aggressive but docile growth characteristics. Ameloblastoma is generally associated with impacted teeth, so it requires a more detailed radiographic examination. Computed cone-beam tomography (CBCT) is a more advantageous imaging system with a lower radiation dose and smaller area requirements. 3D CBCT is a radiographic examination with a high modality, so it is very important in helping to establish a diagnosis, especially for cases that show radiographic differences. Ameloblastoma is divided into several types based on the radiological picture. Odontogenic Keratosis Cysts and ameloblastoma may exhibit similar radiographic features, which make diagnosis difficult.

**Conclusion:** 3D CBCT examination is helpful in diagnosing and validating the treatment of ameloblastoma.



***Keywords:*** *Ameloblastoma, CBCT, radiographic*
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## INTRODUCTION

Ameloblastoma is a highly aggressive odontogenic epithelial tumor. The determination of an ameloblastoma diagnosis is supported by clinical and radiographic examination. The radiographic appearance of ameloblastoma frequently serves as a differential diagnosis for numerous cysts and other benign mandible tumors, necessitating a more accurate scan. During surgery, the panoramic radiograph depicts an ameloblastoma-like lesion known as Central Ossifying Fibroma (COF). Dentigerous cysts or odontogenic keratocyst tumors (OKC) are among the differential diagnoses for ameloblastoma.[1,2]

Computed tomography (CT) is a suitable alternative to conventional radiography for defining bony and soft tissue lesions—unquestionable specificity and sensitivity for planning surgical procedures and biopsies. Contrarily, cone-beam computed tomography (CT) does not provide information regarding the boundaries of soft tissues. Cone beam computed tomography (CBCT) can display borders, internal structures, cortical expansions, erosions, and adjacent structures, which aids in preoperative diagnosis and treatment for physicians and radiologists.[3,4]

Cephalometric images synthesized from CBCT can be utilized to reconcile the gap between 2D and 3D analysis, as demonstrated by the 3D scoring method currently under development. Reconcile the gap between 2D and 3D refers to bridging the differences or disparities in information obtained from two-dimensional (2D) and three-dimensional (3D) imaging techniques. Traditional radiographic examinations, such as panoramic radiography, provide 2D images that lack depth and may not fully capture the complexity of anatomical structures. On the other hand, CBCT produces 3D images that offer detailed spatial information, allowing for a more comprehensive assessment of the structures being examined. A 3D CBCT radiographic examination was conducted because the panoramic radiographic examination results required additional information. 3D CBCT is a high-resolution radiographic examination that provides a clearer image.[5]

Radiologically, ameloblastoma can be polycystic or monocytic, and histopathologically, it presents a distinct picture; therefore, it is sometimes necessary to obtain multiple slices to make the correct diagnosis.

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Ameloblastoma can be diagnosed based on the presence of a honeycomb-like lesion structure and predominant labial/buccal expansion with cortical erosions on CBCT images, as well as general tooth root displacement. [6]

The percentage of difficulty in diagnosing ameloblastoma refers to the difficulties healthcare practitioners encounter when successfully identifying this specific form of odontogenic tumor using conventional 2D radiography techniques compared to more sophisticated 3D imaging modalities such as Cone Beam Computed Tomography (CBCT). Conventional 2D radiographic methods, including panoramic radiography, offer a two-dimensional depiction of anatomical components. Although these images are beneficial for initial screening and identifying anomalies, they may not provide the level of intricacy and comprehensiveness required for precise diagnosis of intricate disorders such as ameloblastoma. Determining the precise dimensions, position, and scope of the tumor in respect to other structures can pose difficulties when relying solely on two-dimensional imaging. This constraint might give rise to challenges in devising treatment strategies and may lead to inadequate or erroneous diagnosis.

On the other hand, 3D CBCT provides high-quality, three-dimensional pictures that deliver precise anatomical information without significant distortion. This sophisticated imaging technique enables medical professionals to observe ameloblastomas in three dimensions, which aids in conducting a thorough evaluation of the tumor's dimensions, form, boundaries, and its proximity to other structures like teeth, nerves, and bone. CBCT can assist in preoperative planning by allowing clinicians to precisely locate and quantify the tumor, evaluate its interaction with other tissues, and anticipate any surgical difficulties that may arise.

Based on the previous statment above, the aim of this recent research is to to provide an overview of 3D CBCT in determining the diagnosis of ameloblastoma based on review article published 2013-2023.

## REVIEW

The World Health Organization (WHO) classifies ameloblastoma as ameloblastoma, unicystic type, extraosseous/peripheral type ameloblastoma, and metastatic (malignant) ameloblastoma. Radiologically, unicystic ameloblastoma has a less aggressive unilocular aspect than the solid type, but it has the potential to recur. [7]

According to other journals, ameloblastoma is divided into two major categories: extraosseous, also known as peripheral, and intraosseous, also known as central. As its name suggests, peripheral ameloblastoma is a slow-growing mass confined predominantly to the gingiva or alveolar mucosa without involving the underlying bone tissue. The solid variant of intraosseous ameloblastoma of the mandible is subdivided into unicystic, mixed cystic, and multicystic subtypes.[8]

Ameloblastoma is typically discovered incidentally in patients with asymptomatic swellings or during routine radiographic examinations. Preoperatively and postoperatively, ameloblastoma patients must undergo a multimodal radiographic examination. If the lesion involves soft tissue, MRI and ultrasonography are required. 3D CBCT is highly accurate for exposing hard tissue. Several studies have demonstrated that computed tomography depicts calcifications more accurately. Histopathological findings are consistent with the calcification of ameloblastoma on panoramic radiography and 3D CBCT. [3,9,10]

Ameloblastoma is a benign tumor that can be locally aggressive. It presents diagnostic and therapy issues because it has different clinical presentations and radiographic appearances. In addition to accidental detection through symptomless enlargements or regular radiography screenings, the diagnosis and treatment of ameloblastoma require a thorough strategy that combines different imaging techniques and histological evaluation.

It is crucial to do radiographic evaluation before and after surgery in order to determine the size of the lesion, evaluate the involvement of nearby structures, and arrange the most suitable surgical procedure. Multimodal radiographic exams, such as panoramic radiography, computed tomography (CT), and cone beam computed tomography (CBCT), provide vital information about the shape and structure of the tumor, as well as its anatomical connections.

The radiographic characteristics of ameloblastoma include multilocularity and a propensity to cause cortical expansion and perforation. CT is frequently utilized to predict the internal pattern of lesions and the three-dimensional structure of cortical bone. CT also permits the identification of the lesion's anatomical extension and soft tissue invasion. CBCT is more advantageous than CT because it requires less radiation and less space. The CBCT images demonstrate a multilocular, extensive lesion. [3]

## DISCUSSION

Cases of ameloblastoma are often diagnosed in differential with other cysts in the oral cavity. Therefore, more accurate supporting examinations are needed in making the diagnosis. CBCT provides high-resolution three-dimensional (3D) images, offering superior visualization of bony structures and soft tissues in the maxillofacial region. This review aims to provide an overview of the utility of 3D CBCT in the diagnosis of ameloblastoma. Some examples of ameloblastoma cases are as follows.

A 24-year-old male patient with pain and edema in the lower right posterior tooth for two weeks. The swelling has increased gradually over the past six months, accompanied by a localized, persistent onset of mild discomfort. Utilizing medications frequently without consulting a

**Table 1.** Characteristics of CBCT

| | | |
|---|---|---|
| **Advantages of CBCT** | - Visualization of mandibular borders and alveolar canal proximity.<br>- 3D reconstruction reveals detailed structures not visible on other radiographs.<br>- Better image definition and relationship evaluation with neighboring structures.<br>- Postoperative monitoring. Aid in treatment planning and patient rehabilitation.<br>- Significant potential for orthodontic and surgical diagnosis and treatment. | 4,11,12,13,14 |
| **Diagnostic Superiority of 3D CBCT** | - High-quality diagnostic tool providing three-dimensional morphological and anatomical perspectives.<br>- Increased sensitivity and specificity compared to orthopantomogram.<br>- Optimal for benign lesions due to reduced radiation dose.<br>- Indispensable for diagnosis and differentiation of benign radiolucent lesions in the maxilla.<br>- Spatial resolution for precise diagnosis and treatment planning.<br>- Demonstrates buccal and lingual expansion. | 15,16,17,18 |
| **Applications of 3D CBCT** | - Improves surgical planning and predicts likelihood of treatment for facial injury.<br>- Detects peri-implant bone defects and aids in postoperative implant diagnosis.<br>- Beneficial for assessing intracyst volume reduction and bone apposition observation. | 2,19 |
| **Limitations of 3D CBCT** | - Dependence on software algorithm, spatial resolution, and operator's expertise.<br>- Opportunities for advancement in 4D radiography.<br>- 4D CBCT provides patient-optimized doses and superior image quality for moving targets, but with longer irradiation duration and potential patient discomfort. | 20,21 |

physician. On extraoral examination, a diffuse enlargement measuring 4 cm x 3 cm extending anteroposteriorly from the corner of the mouth to the angle of the mandible and superior-inferiorly from the ala-tragus line to the inferior border of the mandible was found to be associated with significant facial asymmetry. In the right vestibular sulcus, an intraoral examination revealed an indistinct, 2-centimeter-wide enlargement. The patient was then directed to undergo a CBCT examination following Figure 1 and was diagnosed with unicystic ameloblastoma.[17]

A 47-year-old male nonsmoker with an asymptomatic lesion on the buccal gingiva of the right mandibular canine premolar-molar region. The lesion has been growing slowly for about one year without changing dimensions over the past eight months. Well-demarcated lesion measuring 1 x 1 x 0.5 cm, sessile and firm in consistency with ulceration on the wound surface. Intraoral

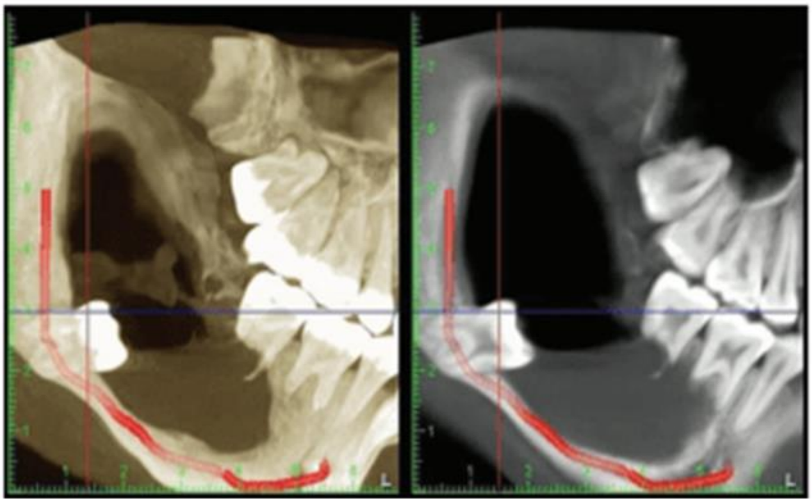

**Figure 1.** CBCT images showing buccal and lingual expansion in a case of unicistic ameloblastoma from a 24-year-old male patient with clinical symptoms of swelling in the left lower back region for 6 months. (Source: Journal of Oral Research and Review)[17]


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periapical radiography showed resorption of interdental bone in the area of teeth 27 and 28. After a 3D CBCT examination, the doctor diagnosed it as peripheral ameloblastoma (see Figure 2).[22]

A 51-year-old male, without comorbidities complaining of a volumetric increase in the right submandibular area associated with enlargement of the intraoral bone, was discovered after five months during a radiological examination for dental implant placement. On palpation, strong swelling approx. 3.5 cm, significant facial asymmetry. During intraoral examination, the mandibular mucosa was erythematous, and local tooth displacement was seen. Radiographic and tomographic examination in Figure 3 revealed a radiolucent multilocular lesion in the mandible extending from the right mandibular ramus to the left mandibular parasymphysis, and then ameloblastoma was diagnosed.[19]

A 55-year-old female patient with the main complaint of slow-growing edema in the lower right face for 8 months. Accompanied by a history of pain in the lower right posterior tooth area for three months intermittently. At first, it was severe and gradually subsided by itself. On extra-oral examination, facial asymmetry of the right mandibular body was seen with hard consistency from anterior to posterior. Oval in shape, measuring 5 cm × 4 cm, extending from the corner of the mouth to the canine area and supero-inferiorly from the corner of the mouth to the inferior border of the mandible without local temperature rise. After the CBCT examination shown in Figure 4, the patient was then diagnosed with unicystic ameloblastoma.[13]

A 9-year-and-2-month-old girl with the primary complaint of edema in the left mandibular premolar region. The extraoral examination revealed facial symmetry, and the intraoral examination revealed mixed dentition and unerupted lower left first and second premolars. A panoramic radiographic examination revealed a well-defined, unilocular radiolucency in the left lower premolar region, extending from the canine area distal to the mesial root area of the first molar, with the erupted first and second premolars positioned lower than those on the right side. The roots of the first and second lower left molars resorb to the tooth stem.

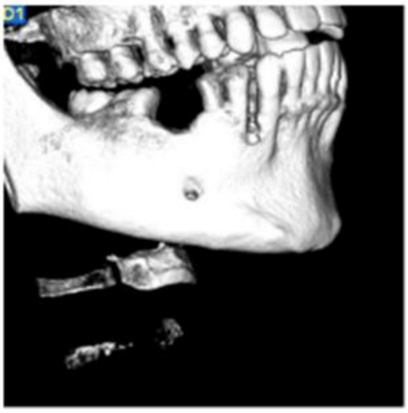

Figure 2. 3D CBCT image showing missing buccal cortical plate in the same area in a 47-year-old male with peripheral ameloblastoma. (Source: International Journal of Current Research)[22]

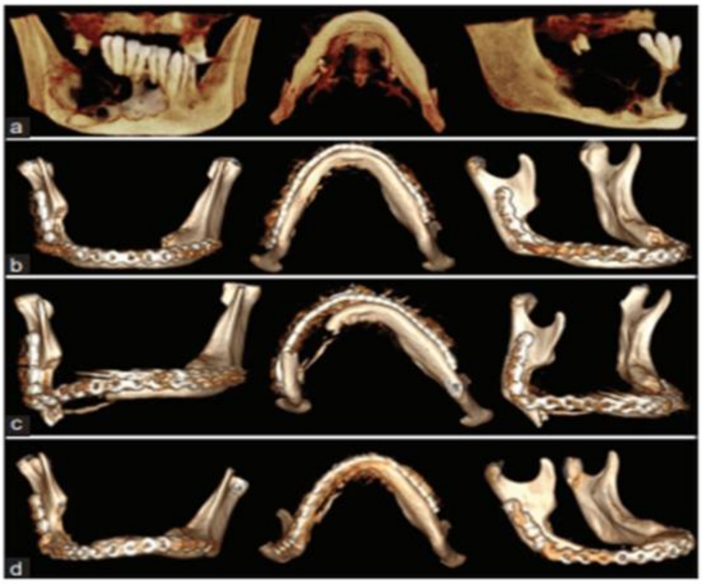

Figure 3. a. 3D CBCT image of a 51-year-old male patient in a case of ameloblastoma with bone expansion. b. 3D CBCT image posts mandibular marginal resection. c. CBCT 3D image of facial trauma with bone loss. d. 3D CBCT images eight months post-intervention and waiting for opportunities for rehabilitation with dental implants. ( Source: Annals of Maxillofacial Surgery)[19]

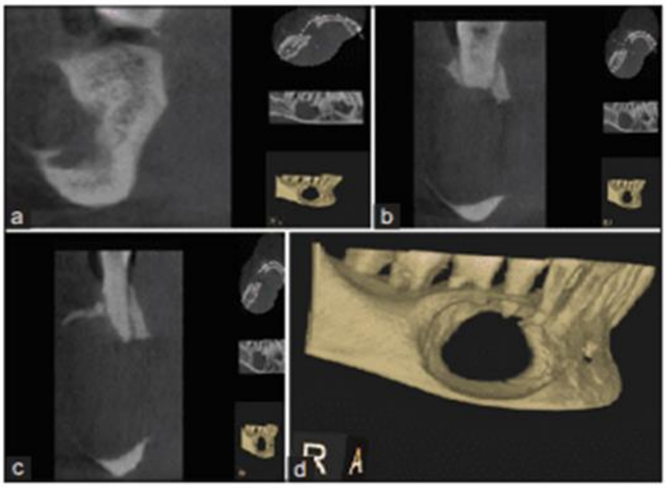


**Figure 4.** CBCT images show displacement of the inferior alveolar nerve, buccal and lingual cortical perforations, resorption of the roots of teeth 45 and 46 due to tumor growth, and two lesion margins with the destruction of the buccal bone. (Source: Universal Research Journal of Dentistry)[13]

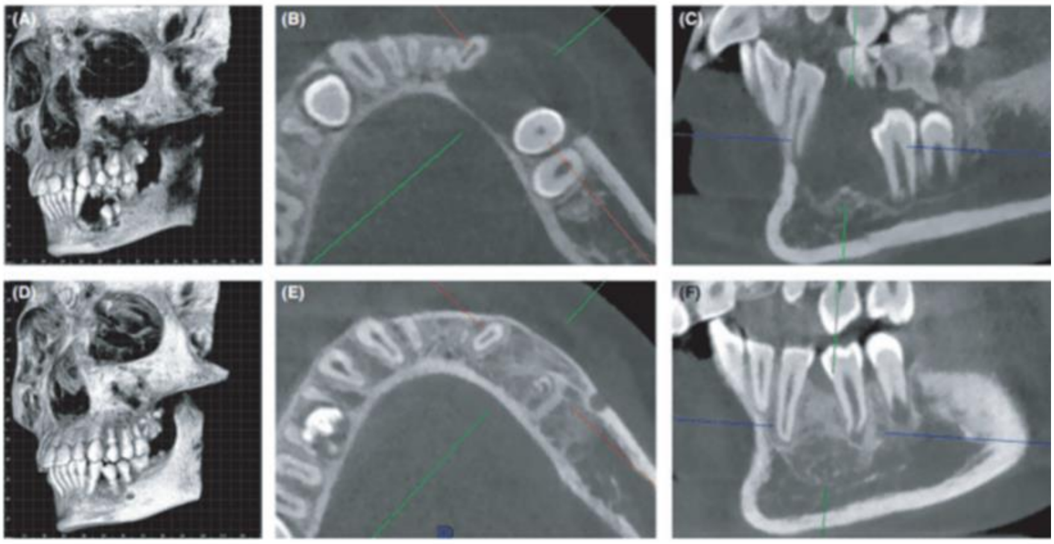


**Figure 5.** CBCT image on the initial visit. (A) 3D CBCT reconstruction demonstrating low bone density surrounding the unerupted first and second lower left premolars. (B) Axial CBCT image of the mandible demonstrating expansion of the buccal and lingual cortex. (C) Coronal CBCT view of the mandible. Images were captured at the age of 9 years and 2 months. CBCT obtained ten months after the marsupialization procedure. (D) 3D CBCT reconstruction demonstrating bone regeneration around the first and second premolars on the lower left side. (E) Axial CBCT image of the mandible displaying normal trabeculae replacing areas of low density. (F) Coronal CBCT view of the mandible. (Source: Clin Case Rep)[23]

Indicating a case of unicystic ameloblastoma, a CBCT examination was conducted to confirm the location of the lesion and its relationship to adjacent anatomical structures. According to the marsupialization after ten months (age: 10 years), the radiolucent area had completely disappeared after ten years.[23]

For two years, a 47-year-old female patient has complained of facial tenderness and swelling on the left side. There was a swelling on the left side of the jaw that began small and progressively grew to its present size. As shown in Figure 6, a 3D CBCT examination reveals "soap bubbles" that are characteristic of ameloblastoma.[14]

On examination and palpation, the right mandible of a 22-year-old female presented with a firm, asymptomatic enlargement. On intraoral examination, the enlarged right mandibular lesion was covered with normal-appearing mucosa, and the involved right mandibular premolars and molars did not respond to mobility tests and percussion. The intraoral swelling of the right mandible was firm and mildly tender upon palpation. Since five months ago, there has been swelling, which has progressively grown in size. Dental CBCT images depict calcifications of varying sizes within the lesion from multiple angles. On a variety of three-dimensional (3D) images, calcification in cavity lesions can be seen distinctly. The differential diagnosis includes ameloblastoma and odontogenic keratocist (OKC). Histopathologically, it appears that there is some central squamous differentiation, and the ameloblastic cells are more dense, as shown in Figure 10 below.[10]

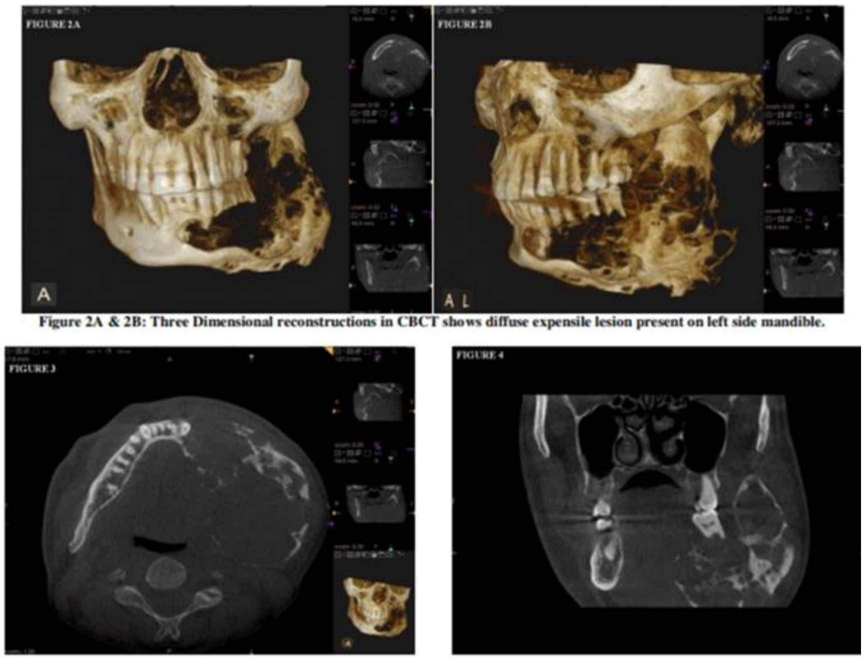


**Figure 6.** The 3D CBCT image reveals that the lesion has spread to the left side of the mandible. An axial view of the buccolingual cortical plate reveals expansion and perforation on the same side. The coronal section reveals diffuse, multilocular lesions with a soap-bubble-like appearance. Additionally, buccolingual expansion is noted. (Source: International Journal of Research & Review)[14]

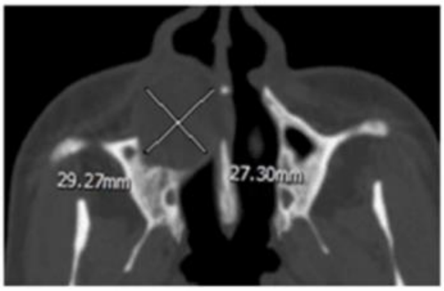


**Figure 7.** The axial section of the right maxilla reveals a circular ameloblastoma measuring 29.77 mm in length and 27.30 mm in width. (Source: Dentomaxillofacial Radiology)[18]

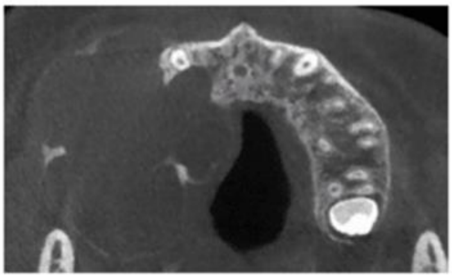

**Figure 8.** Axial CBCT section shows lobular-circular maxillary ameloblastoma. (Source :Dentomaxillofacial Radiology)[18]

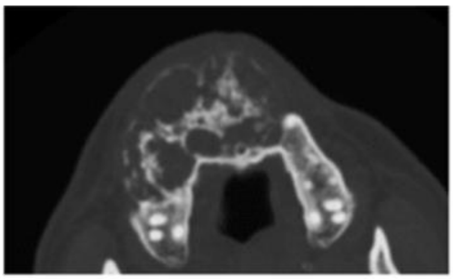

**Figure 9.** Axial section shows lobular-circular desmoplastic ameloblastoma. A mixed radiolust and radiopaque appearance suggest a fibro-osseous lesion. (Source : Dentomaxillofacial Radiology)[18]

For three months, the main complaint of a male patient aged 18 was edema in the right lower posterior. Initially, the swelling was the size of a small pea, but it progressively grew over 3–4 days. Extra oral examination reveals a 3 x 2.5 cm solitary, diffuse swelling on the lower 1/3 of the right side of the face, extending superiorly to inferiorly from 1 cm below the ala tragus line to the base of the mandible and anteriorly to posteriorly from 2 cm posterior to the corner of the mouth to 1.5 cm anterior to the ear pinna. On palpation, the swelling has a consistency ranging from tender to firm, with

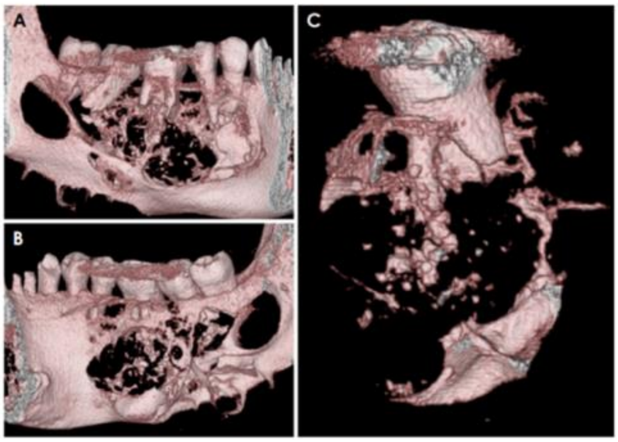

**Figure 10.** A. 3D buccal view demonstrating numerous discrete calcifications of varying diameters dispersed throughout the multilocular cavity of the right mandible. B. Lingual vision C. View through the right mandibular first molar showing calcifications of varying diameters with buccal and lingual cortical boundaries. (source: Imaging Science in Dentistry)[10]

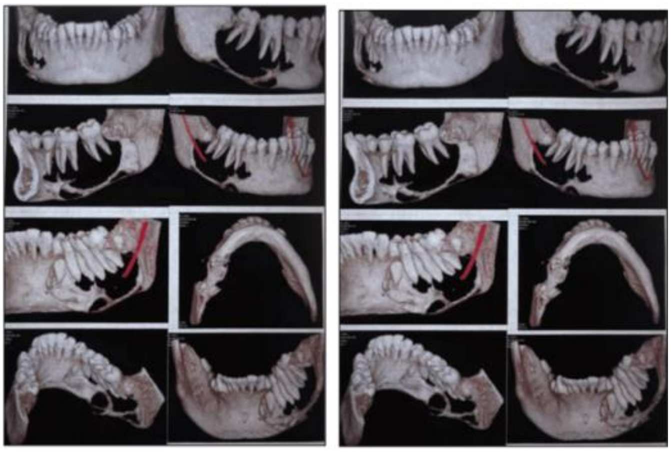

**Figure 11.** Pre-op CBCT 3D view showing lesion expansion and post-op healing (Source: International Journal of Oral Health and Medical Research)[11]

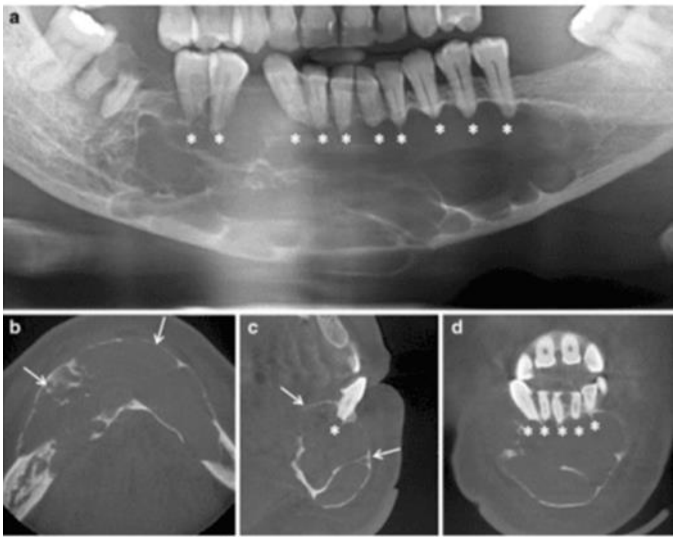

**Figure 12.** A large ameloblastoma in the mandible of a 55-year-old female, (a) panoramic view, (b) CBCT axial view, (c) sagittal view, (d) coronal view demonstrating a lesion with dentate margins and multilocular appearance. (source: Oral Radiology)[12]

no change in the skin's surface and no increase in local temperature. In regions 45, 46, and 47, the cortical plate expanded, and there was degree 2 mobility. The results of vitality experiments on electric pulp were 45, 46, and 47 non-vital. Figure 11 depicts the absence of third molars. A provisional diagnosis of an aneurysmal bone lesion with ameloblastoma as a differential diagnosis.[11]

Based on the previous discussion, ameloblastoma cases have multiple differential diagnoses. Exams such as conventional radiography, panoramic radiography, orthopantomography, cone beam computed tomography (CBCT), and laboratory histopathology are crucial and mutually supportive for establishing the correct diagnosis. An accurate diagnosis will determine the efficacy of the following treatment.

## CONCLUSION

The review of literature spanning from 2013 to 2023 underscores the critical role of 3D CBCT in diagnosing ameloblastoma, a locally aggressive odontogenic epithelial tumor. With its ability to provide high-resolution, three-dimensional images, 3D CBCT offers significant advantages over conventional radiography, enabling more accurate visualization of bony structures and soft tissues in the maxillofacial region. This advanced imaging modality is particularly valuable for differentiating ameloblastoma from other cysts and benign tumors that share similar radiographic features, thereby facilitating precise diagnosis and appropriate treatment planning. The comprehensive search of English articles conducted for this review highlights the growing recognition of 3D CBCT as an indispensable tool in the management of ameloblastoma cases. By offering enhanced visualization and spatial resolution, 3D CBCT aids clinicians and radiologists in assessing the extent of tumor involvement, evaluating its relationship with adjacent structures, and predicting surgical challenges. Additionally, its lower radiation dose and reduced space requirements make it a preferred imaging option for patients requiring frequent radiographic evaluations.

## ACKNOWLEDGMENTS

None.

## FOOTNOTES

All authors have no potential conflict of interest to declare for this article.

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