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# Distribution of dental anomalies in panoramic radiography at RSGMP Universitas Airlangga

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## ABSTRACT

**Objectives:** This research was aimed to determine the distribution of dental anomaly cases on panoramic radiographs at Universitas Airlangga Dental Hospital (RSGMP).

**Materials and Methods:** This research used a descriptive observational design with a total sampling technique from panoramic radiographic data at the Radiology Clinic of RSGMP Universitas Airlangga during 2018–2020, which had cases of dental anomalies.

**Results:** The result showed 116 cases of dental anomalies, with more incidence in female (64%) than in male (36%). The most common dental anomaly category was the number of teeth anomalies (47.41%), followed by tooth size anomalies (29.31%), tooth shape anomalies (23.28%), and there were no cases of anomalies in tooth structure and position. The most common types of dental anomalies were microdontia (27.59%), missing teeth/agenesis (25%), supernumerary teeth (22.41%), dilaceration (16.38%), talon cusp (3.45%), taurodontism (2.59%), macrodontia (1.72%), gemination (0.86%).

**Conclusion:** The most common cases of dental anomalies were based on their categories, namely anomalies in the number of teeth, followed by tooth size, and tooth shape.

***Keywords:*** *Health services, distribution, dental anomalies, panoramic radiography*

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## INTRODUCTION

According to the Regulation of the Minister of Health of the Republic of Indonesia, Article 1, Number 1173, 2004, a public health service facility that provides dental and oral health services in the form of treatment and recovery services with health promotion and disease prevention carried out through outpatient, emergency services, and medical action. Based on its function, Rumah Sakit Gigi Mulut Pendidikan (RSGMP) Universitas Airlangga is an educational dental and oral hospital that provides dental and oral health services. Besides that, it is also used as a means of learning, education, and research for dental students.[1]

Radiography is an imaging technique using X-rays that aims to project an image of a clinically invisible body part that makes it easier to diagnose a disorder or disease, determine treatment plans and evaluate the results of treatments that have been carried out.[2] Radiography has an important role in the field of dentistry because more than 80% of cases of dental and oral disease management require a radiographic examination. There are two imaging technique, namely intra-oral and extra-oral techniques.[3] One of the extra-oral radiography techniques is panoramic radiography which can describe the morphology and relationships of the dentomaxillofacial components, observing growth and development, and can be used to see any abnormalities in the dentomaxillofacial area including dental anomalies.[4]

A dental anomaly is one of the disorders related to the growth and development of teeth. There are several types of abnormalities, including the number of teeth, tooth size, tooth shape, tooth structure, and tooth position.[5] Anomalies in teeth quite often cause complications in dental treatment, such as root canal treatment, tooth extraction, and orthodontic treatment. Dental anomalies can complicate endodontic treatment because of abnormalities in the shape of the teeth. For example, teeth with dens invaginatus can complicate access to the root canal.[6] Dental anomalies are often found in patients undergoing orthodontic treatment. According to several studies, orthodontic patients had at least one dental anomaly. The high incidence of anomalies in orthodontic patients requires dentists to pay more attention to the initial examination for their presence. This is because dental anomalies have an important role in the occlusion and alignment of teeth, so the presence of dental anomalies will

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affect the planning and success of orthodontic treatment.[7]

There are several studies from various countries regarding the prevalence of dental anomalies. Research in Turkey conducted by Bilge et al[5] found that the prevalence of dental anomalies that occur in women is 54%, while in men it is 46%. The most common types of dental anomalies were impacted teeth (45.5%), dilacerations (16.3%), hypodontia (13.8%), and taurodontism (11.2%). Research in Thailand[8], 29.16% of the cases were dilacerations, 13.17% were missing teeth, 7.21% were microdontia, 3.29% were taurodontism, 2.66% were supernumerary teeth, and 1.56% were transpositions.

RSGMP Universitas Airlangga found many cases of dental anomalies that were found accidentally on panoramic examinations because there were no complaints from patients. However, until now, there has been no research that presents data related to the number of cases of dental anomalies through panoramic radiography at RSGMP Universitas Airlangga. Based on this background, researchers are interested in conducting research to find out the description of the distribution of dental anomaly cases in patients who come to the RSGMP Universitas Airlangga in terms of panoramic radiographs.

## MATERIALS AND METHODS

This research was conducted in an observational-descriptive by exploring data from panoramic radiographs to describe the distribution of dental anomalies on panoramic radiographs at RSGMP Universitas Airlangga. The population of this study was all data from panoramic radiographs taken at the Radiology Clinic of RSGMP Universitas Airlangga during 2018-2020. The sampling technique was carried out by taking all samples of panoramic radiographic data that met the inclusion criteria. The sample criteria used are panoramic radiographic data that has good evaluation quality and has cases of dental anomalies. Missing teeth/ agenesis in adult needs to be checked in the medical record if there is a history of patient extraction or trauma, and the size and shape of the anomaly need to be checked in the medical record if there is any history of orthodontic or endodontic treatment.

The research was conducted at the Dental Radiology Clinic of RSGMP Universitas Airlangga in September-December 2021. This research has been conducted as an ethical test at the Health Research Ethics Commission, Faculty of Dentistry, Universitas Airlangga with no. 404/HRECC.FODM/VII/2021. The tools and materials used were a computer, stationery, and panoramic radiography medical record data belonging to RSGMP Universitas Airlangga. The data was selected according to the inclusion criteria. Observations were made on panoramic radiographs of cases of dental anomalies by the researcher with the assistance of two supervisors. The cases obtained from the interpretation of the panoramic radiographs were collected and grouped according to the existing dental anomaly categories, namely abnormalities in the number of teeth, tooth size, tooth shape, tooth structure, and tooth position. The data is compiled, presented in table form, and analyzed. Data analysis used descriptive analysis in the form of frequency, mode, and percentage, so that the distribution of dental anomaly cases on panoramic radiographs at RSGMP Universitas Airlangga can be seen during 2018–2020.

## RESULTS

From 1,317 panoramic radiographic data, 116 cases of dental anomalies (8.81%) were found, 36% of them were male and 64% female. The results of the study in Figure 2 show that the most common dental anomaly cases on panoramic radiographs based on the category were the number of teeth 55 cases (47.41%), followed by anomaly in tooth size 34 cases (29.31%), there were 27 cases of anomaly in tooth shape (23.28%), and no cases of anomaly in tooth structure and tooth position were found.

The results of the research in Figure 3 show that the most common types of dental anomalies are microdontia 32 cases (27.59%), then missing teeth/ agenesis 29 cases (25%), supernumerary teeth 26 cases (22.41%), dilaceration 19 cases (16.38%), talon cusp 4 cases (3.45%), taurodontism 3 cases

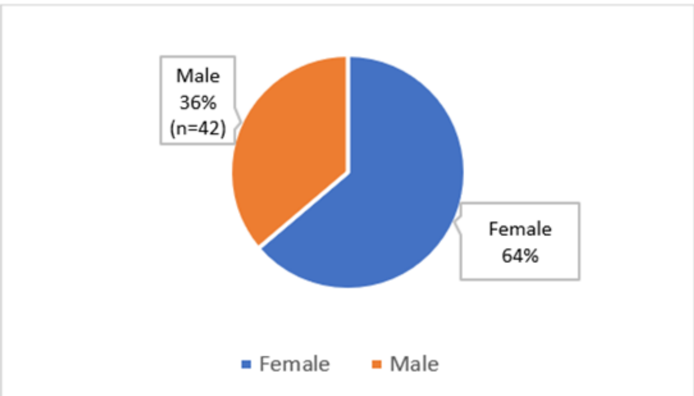


**Figure 1.** Percentage of dental anomalies discovered in male and female

**Table 1.** Percentage of dental anomalies in panoramic radiographic data at the RSGMP Universitas Airlangga in 2018-2020

| Dental Anomaly Category | Total | Percentage | Type of Dental Anomaly | Total | Percentage |
|---|---|---|---|---|---|
| Number of Tooth | 55 | 47,41 % | Supernumerary teeth | 26 | 22,41 % |
| | | | Missing teeth/agenesis | 29 | 25 % |
| Tooth Size | 34 | 29,31 % | Macrodontia | 2 | 1,72 % |
| | | | Microdontia | 32 | 27,59 % |
| Tooth Shape | 27 | 23,28 % | Taurodontism | 3 | 2,59 % |
| | | | Dilaceration | 19 | 16,38 % |
| | | | Fusion | 0 | 0 % |
| | | | Gemination | 1 | 0,86 % |
| | | | Talon cusp | 4 | 3,45 % |
| | | | Dens in dente | 0 | 0 % |
| | | | Concrescene | 0 | 0 % |
| Tooth Structure | 0 | 0 % | Amelogenesis imperfecta | 0 | 0 % |
| | | | Dentinogenesis imperfecta | 0 | 0 % |
| | | | Dentine dysplasia | 0 | 0 % |
| Tooth Position | 0 | 0 % | Transposition | 0 | 0 % |
| | 116 | 100 % | | 116 | 100 % |

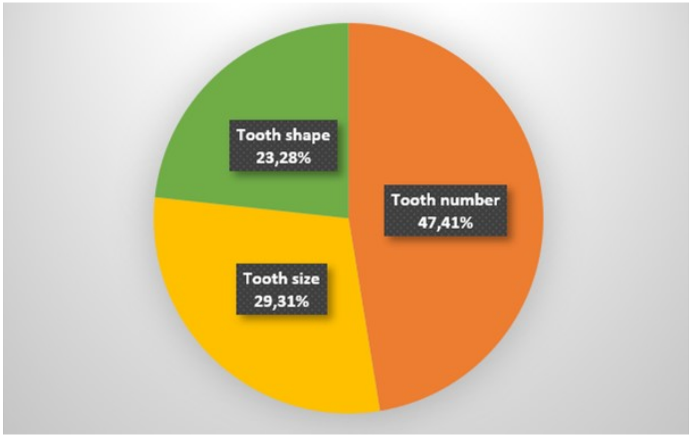


**Figure 2.** Percentage of dental anomalies by category of anomalies

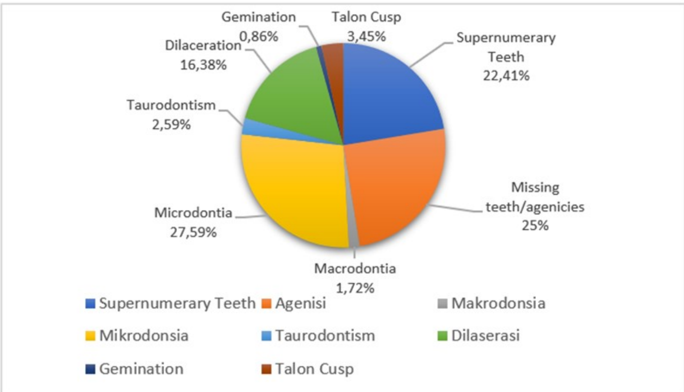


**Figure 3.** Percentage of dental anomalies by type of anomalies

(2.59%), macrodontia 2 cases (1.72%), gemination 1 case (0.86%). Other anomalies, such as fusion, dens in dente, concrescene, amelogenesis imperfecta, dentinogenesis imperfecta, dentine dysplasia, and transposition were not discovered at all.

The results of the study in table 2 show that the classification of supernumerary teeth based on

**Table 2.** Type of supernumerary teeth

| Type of Supernumerary Teeth | Total | Percentage |
|---|---|---|
| Mesiodens | 2 | 1,72% |
| Paramolar | 17 | 14,66% |
| Distomolar | 7 | 6,03% |
| **Total** | 26 | 22,41% |

**Table 3.** Type of missing teeth/agenesis

| Type of Missing Teeth/Agenesis | Total | Percentage |
|---|---|---|
| Hypodontia | 23 | 19,83% |
| Oligodontia | 6 | 5,17% |
| **Total** | 29 | 25% |

their location: supernumerary-paramolar 17 cases (14.66%) were the most, followed by distomolar 7 cases (6.03%), and the least is mesiodens 2 cases. (1.72%). The results of the study in table 3 show that the most common dental anomalies based on the classification of missing teeth/ agenesis was hypodontia 23 cases (19.83%), and followed by oligodontia 6 cases (5.17%).

## DISCUSSION

From 1,317 data points obtained from panoramic radiographic data during 2018–2020 at RSGMP Universitas Airlangga, 116 dental anomalies (8.81%), with the incidence in female 64%) more than in male (36%). In a study conducted by Saberi et al[9], the prevalence of dental anomalies was 18.17%, of which cases in women were also higher than in men.

The results of the study by category showed that the most common dental anomalies on panoramic radiographs were found in the category of abnormalities based on the number of teeth 47.41%, followed by tooth size anomalies 29.31%, and tooth shape anomalies 23.28%, and there were no cases of anomalies in tooth structure and tooth position.

Of the five categories of dental anomalies, the most dental anomalies were found was the number of teeth anomalies at 47.41%, with missing teeth incidence 25%, higher than supernumerary teeth 22.41%.

The most common missing teeth in this study was hypodontia 19.83%, while oligodontia accounted for only 5.17% of the total missing teeth cases. This is in accordance with previous research conducted by Yassin[10] in which cases of dental anomalies that often occur are anomalies in the number of teeth, with the most common type of anomaly being in the form of hypodontia. Congenital missing teeth of permanent teeth is one of the most common causes, although the location of the missing teeth is reported to differ by race. The incidence of missing teeth in European and Caucasian populations is often found in the mandibular second premolars, followed by the maxillary and mandibular central incisors, and the maxillary second premolars. In the Japanese population, the mandibular lateral incisor was most commonly found, whereas in the Indian population it was most commonly found in the maxillary lateral incisor. Karadas et al[11] also reported that maxillary lateral incisors were most common. The results obtained from this study were in accordance with the research in India, namely that there were more missing teeth of maxillary lateral incisors, followed by mandibular lateral incisors, and maxillary and mandibular second premolars. So the location of the missing teeth can be determined by race. Missing teeth is a congenital abnormality caused by a disturbance in the early stages of tooth development. The causes are quite diverse, such as environmental factors and genetic factors, including trauma, infection, and drugs.[12]

Supernumerary teeth based on their location in the premolar region (Paramolar) had the highest incidence of 14.66%, followed by the distal second molar region (Distomolar) of 6.03%, and the lowest was the incisive region (Mesiodens) of 1.72%. In this study, there were more supernumerary teeth in males than in females. This is in accordance with research conducted by Ata-Ali et al[13], where supernumerary teeth in permanent teeth are usually rare in women. The relationship between the incidence of supernumerary teeth and race or ethnicity is still controversial. In some studies, the incidence of non-white races is quite high, but in other studies there are no reported racial differences. A study in Japan reported a very low prevalence of this anomaly (0.05%) compared to China (0.44%), Caucasians (0.64%), and Finland (0.4%). There are also studies that report significant differences in Japan and China, even though both are Mongoloid races. Therefore, more studies should be carried out to prove the relationship between the two.[14] The etiology of supernumerary teeth remains unclear. There are several theories, one of which is the hyperactivity theory of the dental lamina, whereby supernumerary teeth are formed from hyperactivity of the dental lamina, which develops into an extra tooth bud, and supernumerary teeth are formed. In addition, there is a phylogenetic atavism process that can explain the development of supernumerary teeth and the dichotomy theory, which states that the tooth germ splits into two equal or different parts and produces two teeth of the same size or normal or dysmorphic sized teeth. Supernumerary teeth can cause crowding, interfere with tooth eruption, retention of teeth, abnormal tooth root formation, and cysts.[15,16]

The most common tooth size anomaly found in this study was microdontia 27.59% of all anomaly cases. The incidence of microdontia mostly occurred in the posterior teeth or third molars. Based on research by Puranik & Gandhi[17], cases of microdontia often occur in lateral incisors and third molars according to this study. Incidence of microdontia in women was higher. The etiology of microdontia is commonly associated with dwarfism due to pituitary gland hypofunction. Atavism can be the cause of imperfect tooth development, which results in cone-shaped teeth.[16] Several studies have stated that cases of microdontia occur in patients with Down syndrome.[17]

In this study macrodontia, accounting for 1.72% of all cases. Likewise, in the research conducted by Kathariya et al[18] and Yassin[10], which found cases of macrodontia with a prevalence of 1.3% and 1.8%. Macrodontia is a rare condition and is generally associated with gigantism due to hyperpituitary, which can cause the length of the bones and teeth to be longer than normal. Other systemic conditions that affect macrodontia include insulin-resistant diabetes, oto-dental syndrome, KBG syndrome, and XYY syndrome. The prevalence of the incident is reported to be higher in males. In addition, it can be caused by marriage between parents who have small jaws and large teeth, so that one gene is more dominant. This condition could be the reason why, in this study, only a few macrodontia were found.[16,17]

In this study, the most common dental anomaly among all types of dental deformity was dilatation, which accounted for 16.38% of the total anomaly cases. Most of the dilacerations were found in the posterior teeth, especially the mandibular third molars. Dilaceration cases are often followed by a history of trauma to the primary teeth, where the teeth are pushed apically or into the jaw[16]. Most cases of lacerations were found in women compared to men, in line with the study of Majeed et al[19], which reported that cases of lacerations in women and men were 66.67% and 33.33%. Root lacerations are quite difficult to find on panoramic radiographs because panoramic techniques alone are not the method of choice to see this anomaly case, especially lacerations that occur on the buccal/labial or palatal/lingual side. Thus, different radiographic techniques are needed to assist in the diagnosis.[20]

The incidence of talon cusp is as much as 3.45% of the total anomaly. It is the most anomalous tooth shape after laceration. In this study, the cases of the talon cusp in women and men were equally large, which is the same result as the study conducted by Mostafa et al[21]. Meanwhile, Sreeshyla's research[22] reported that the incidence of talon cusp in women was higher than in men. This may be due to the difference in the number of samples observed. Talon cusps located on the canines and incisors usually originate from the palatal cingulum as tubercles protruding from the palatal surface. Anomalies of this etiology are quite diverse, including environmental and genetic factors. Talon cusps occur due to disturbances during the morphodifferentiation or odontogenesis stage that affect the shape and size of the teeth. This anomaly can also be influenced by trauma that affects the tooth germ or hyperactivity of the dental lamina.[16] Examination of the talon cusp on panoramic radiographs is sometimes difficult because of the superimposition of the talon cusp with the dental crown. So other techniques are needed, such as CBCT to help diagnose.[23]

Taurodontism and gemination were the least common dental anomalies after dilaceration and talon cusp, which were 2.59% and 0.86% of the total anomaly cases, respectively. Taurodontism is an anomaly in tooth development that is characterized by the absence of constriction of the cementoenamel junction (CEJ) so that the pulp chamber is more apical and appears wider than normal. In this study, there was no significant gender difference in the case of taurodontism. However, there are studies that state that the prevalence in men is lower than in women. These results are based on studies of chromosomes in males with an extra X chromosome such as 47XXY (Klinefelter's syndrome), indicating that the X chromosome may contain genes that influence the development of taurodontism teeth. This may be related to the higher frequency of taurodontism in normal women[24]. The rarity of gemination cases is in line with the research conducted by Mostafa et al[21], which only reported one gemination case, and the study of Hagiwara et al[25], which showed a prevalence of gemination of 0.01%. The etiology of gemination is caused by the division of the tooth germ during the development of the tooth, or during the bud stage, fusion occurs where the normal tooth then fuses with the developing supernumerary teeth, so that this anomaly can be mistaken for the occurrence of supernumerary teeth.[16]

In this study, there were no anomalies in the shape of the teeth in the form of fusion, dens in dente, and concrescene. Similarly, anomalies in tooth structure such as amelogenesis imperfecta, dentinogenesis imperfecta, and dentin dysplasia, as well as anomalies in tooth position in the form of transposition, were not found. The absence of this anomaly could be caused by differences in race, variations in patient age, and the number of samples. If more samples are used, the possibility of finding this anomaly will also be greater.

## CONCLUSION

Based on the research data, the highest percentage of dental anomalies based on the category, namely anomalies in the number of teeth, followed by tooth size, and tooth shape. Meanwhile, anomalies in the structure and position of the teeth were not found.

## ACKNOWLEDGMENTS

None.

## FOOTNOTES

All authors have no potential conflict of interest to declare for this article. This study has received ethical approval approved by the Health Research Ethical Clearance Commision Faculty of Dental Medicine Universitas Airlangga (404/HRECC.FODM/VII/2021). All procedures conducted were in accordance with the ethical standards.

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# Differences in mental index value in patients with type II diabetes mellitus using panoramic radiography

(Review based on the length of suffering at Ulin General Hospital Banjarmasin)

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## ABSTRACT

**Objectives:** This research is aimed to determine the mandibular cortical thickness by the Mental Index value using panoramic radiography in patients with type 2 DM based on length of suffering ≤ 5 years and > 5 years.

**Materials and Methods:** This research is using unpaired comparative analytical design with a cross -sectional stratified random sampling method and unpaired T-test statistic.

**Results:** 34 samples of patients with type 2 DM showed that the mean mental index was 4.219 ± 1.223. The two groups did not have a difference in the meaning of the MI value. The MI of the group with a shorter history of suffering (≤ 5 years) was 4.227 ± 1.063 and the group with a longer history of suffering (>5 years) was 4.211 ± 1.399. There were 8 people who experienced thinning bone from the whole age group, the most were from the age group of 51-60 years old.

**Conclusion:** Mental Index (MI) value is greater or exceeds the normal value (≥ 3,1 mm) in both groups of patients with type 2 DM based on length of suffering ≤ 5 years and > 5 years.



***Keywords:*** *Diabetes mellitus type 2, mental index, mandibular cortical bone, panoramic radiography*

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## INTRODUCTION

The American Diabetes Society defines diabetes mellitus as a group of metabolic disorders resulting in hyperglycemia due to defects in insulin secretion or insulin action. The prevalence of diabetes mellitus sufferers in Indonesia is estimated at 6.2% with around 10 million people.[1] Based on 2018 Riskesdas data, the prevalence of diabetes mellitus sufferers in South Kalimantan reaches 1.30%, and especially in Banjarmasin City reaches 2.12%.[2]

The main characteristic of type 1 and type 2 DM is the presence of hyperglycemia or high blood glucose levels.[3] Hyperglycemia is considered to significantly affect decreasing bone quality in people with diabetes mellitus. Hyperglycemia is associated with the accumulation of Advanced Glycation End Products (AGEs) in the bone matrix.[4] AGEs can increase the expression of RANKL (Receptor Activator of Nuclear Factor Kappa B Ligand) and inhibit the performance of OPG (Osteoprotegerin).[5] RANKL is a protein that plays a role in increasing osteoclast activity so that increases bone resorption. OPG inhibits osteoclast maturation to reduce bone resorption. An imbalance between the processes of bone resorption and bone formation can lead to a decrease in Bone Mineral Density (BMD).[6–8]

The research generally shows that type 1 DM is associated with a decrease in BMD, but in type 2 DM this is still a matter of controversy. Research studies that have been conducted on BMD in type 2 DM patients have shown mixed results, namely, there may be an increase, decrease, or no change in BMD.[9] Dual Energy X-Ray Absorptiometry (DEXA) is the gold standard in measuring bone mineral density, especially in the lumbar vertebrae, collum femoris and antebrachium. DEXA measurement of mandibular BMD is rarely used because of superimposition and high costs. Panoramic radiography is a more economical alternative to assessing bone density. Panoramic radiography has been performed routinely in dental practice.[9,10] Panoramic Radiomorphometric Index can be used in measuring bone mineral density. This index consists of the Mandibular Cortical Index (MCI), Panoramic Mandibular Index (PMI), Mental Index (MI), Antegonial Index (AI), and Gonial Index (GI). One of the indices that is most often used and has the best accuracy is the Mental Index (MI). MI can measure mandibular cortical thickness by measuring from a perpendicular vertical line connecting the mental foramen to the tangent to the lower border of the mandibular bone. The normal value for Mental Index is ≥ 3.1 mm.[9,11–14]

Diabetes mellitus is related to bone conditions. Previous studies still provide mixed results regarding BMD values in type 2 DM patients. Low BMD can increase the risk of fractures. Dentists have an important role in detecting the risk of bone fractures with systemic involvement, one of which is in diabetes. Panoramic radiography has been used to predict low BMD. This study aims to determine the condition of BMD through the thickness of the mandibular cortical bone in patients with type 2 DM through panoramic radiography. This study compared BMD values based on the duration of diabetes. Thus, our study carried out the measurements of mandibular cortical thickness of the mandible through the Mental Index value in type 2 DM patients using panoramic radiography which is reviewed based on a long history of suffering ≤ 5 years and > 5 years.

## MATERIALS AND METHODS

This research was conducted after being declared ethically feasible by the Health Research Ethics Commission, Faculty of Dentistry, Lambung Mangkurat University, Banjarmasin No. 046/KEPKG-FKGULM/EC/III/2023. The research was carried out from April to June 2023 at the Ulin Hospital in Banjarmasin. Sampling locations were in the Internal Medicine Sub-Endocrine Metabolic Polyclinic and the Diabetic Foot Polyclinic. X-ray samples were taken at the Radiology Installation. Sampling was carried out using a stratified random sampling technique in a cross-sectional manner. This study used an unpaired comparative analytic design. The study sample consisted of 34 people who were divided into 2 groups based on a long history of type 2 DM, namely ≤ 5 years and > 5 years. The sample criteria were patients who were diagnosed with a history of type 2 DM without comorbidities by a doctor, were able to communicate, and were willing to become research respondents. The results of the panoramic radiographs that have been analyzed will be recorded on a ratio scale in millimeters (mm). The Mental Index values of the two groups will be measured from each left and right region, then the average will be taken. All data obtained will be statistically tested using the Shapiro-Wilk normality test, then continue with the hypothesis test, the unpaired T-test.

## RESULTS

Table 1 shows that the distribution of the study sample based on a long history of suffering ≤ 5 years and > 5 years is the same. Most of the samples in this study were female, namely 19 people (56%), while 15 people (44%) were male.

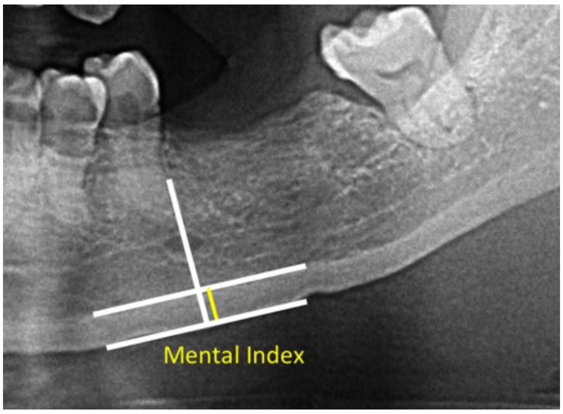


**Figure 1.** Mental index measurement

**Figure 1.** Sample characteristic frequency distribution

| Characteristic | Frequency | Percentage |
|---|---|---|
| Length of suffering | | |
| ≤ 5 years | 17 | 50% |
| > 5 years | 17 | 50% |
| **Total** | **34** | **100%** |
| Gender | | |
| Male | 15 | 44% |
| Female | 19 | 56% |
| **Total** | **34** | **100%** |

**Table 2.** Mental Index values on both sides of the jaws in Type 2 DM patients

| Length of suffering | N | Mental Index Value | |
|---|---|---|---|
| | | Right side (Mean ± SD) | Left side (Mean ± SD) |
| ≤ 5 years | 17 | 4,210 ± 1,090 | 4,159±1,130 |
| > 5 years | 17 | 4,108±1,156 | 4,315±1,531 |
| P-value | | 0,75 | 0,8 |

**Table 3.** Statistical analysis of differences in Mental Index values based on the length of suffering

| Length of suffering | N | Mental Index Value | | | | |
|---|---|---|---|---|---|---|
| | | Mean | SD | Min | Max | P |
| ≤ 5 years | 17 | 4,227 | 1,063 | 2,216 | 6,234 | 0.971 |
| > 5 years | 17 | 4,211 | 1,399 | 1,665 | 6,342 | |
| Total | 17 | 4,219 | 1,223 | 1,665 | 6,342 | |

**Table 4.** Status of cortical bone thickness in patients with type 2 DM by measuring Mental Index values

| Length of suffering | n | Status of cortical bone thickness | |
|---|---|---|---|
| | | No thinning occurs | Thinning occurs |
| ≤ 5 years | 17 | 13 | 4 |
| > 5 years | 17 | 13 | 4 |
| Total | 34 | 26 | 8 |

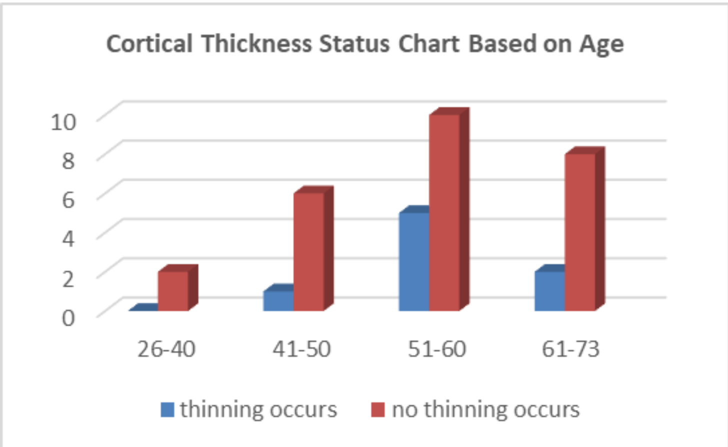


**Figure 2.** Chart of the mandibular cortical thickness status based on range in patients with type 2 DM

The mean mental index values for the two groups on both sides of the jaw are shown in Table 2. Patients with a history of suffering for ≤ 5 years had a mean mental index value on the right side of 4.210 ± 1.090 and on the left side of 4.159 ± 1.130. Patients with a long history of suffering > 5 years have a mean mental index value of 4.108 ± 1.156 on the right side and 4.315 ± 1.531 on the left side. The p-value > 0.05 showed no difference in the MI values on both sides of the jaw in the two groups.

The mental index values in both groups based on the duration of suffering are shown in Table 3. The mean mental index in all type 2 DM patients was 4.219 ± 1.223. The mean mental index in the ≤ 5 years group was 4.227 ± 1.063. The mean mental index in the > 5 years group was 4.211 ± 1.399. The results of the statistical analysis obtained a p-value > 0.05, which means that Ho is accepted so that the two groups have no significant difference related to the mental index value.

Table 4 shows the status of cortical bone thinning in patients with type 2 Diabetes Mellitus by measuring the mental index. The cut-off value of cortical bone thinning status is < 3.1mm. Patients with a long history of suffering ≤ 5 years had 13 people who did not experience bone


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thinning and 4 people did. Patients with a long history of suffering > 5 years had 13 people who did not experience bone thinning and 4 people did.

Figure 2 shows individuals experiencing mandibular cortical bone thinning in terms of age ranges. There were 8 people who experienced bone thinning from the total age group. No individuals had bone thinning from the age group of 26-40. There was 1 person from the age group of 41-50 with bone thinning, 5 people from the age group of 51-60, and 2 people from the age group of 61-73.

## DISCUSSION

The results of this study showed a minimal difference in cortical thickness based on the MI value when viewed from both sides of the mandible. Based on Table 2, the group ≤ 5 years has thicker cortical bone on the right side. Group > 5 Years has thicker cortical bone on the left side. This could be due to several things. The difference in the cortical thickness of the mandibles of the right and left jaws can be associated with one-sided chewing patterns.[15] Loss of posterior teeth causes a person to experience limitations in carrying out masticatory activities.[16] The mandible is stimulated by the masticatory muscles, especially during the mastication process. This bone is composed of trabecular and cortical bones. Mandibular bone mineral density and cortical bone thickness are correlated with masticatory function and occlusal forces.[17]

The intraoral examination carried out during this study showed that there were attrition of teeth in some type 2 DM patients. Dental attrition is a type of tooth wear caused by contact between teeth resulting in loss of tooth tissue on the incisal or occlusal surfaces. Tooth attrition can be caused by bruxism, namely the habit of clenching and grinding carried out by a person.[18] Eninanc et al in 2021 stated that the habit of bruxism can also affect the MI value on each side of the jaw. The results of their research showed that individuals with bruxism had a greater MI value than control individuals, both on the right, left, and on the average from both sides. Bruxism causes a reactive response in the mandibular cortex due to the pressure exerted on the mandibular corpus by masticatory forces.[11]

Measurement using the MI method of cortical thickness of the mandible is considered to have the highest sensitivity.[19] Cortical bone of the mandible in the mental foramen area is thicker in size compared to cortical bone in other areas that are more posterior along the inferior border of the mandible.[20] This could indicate that if there is thinning of the cortical bone in the area of the mental foramen, then the cortical bone in other areas may also experience thinning.[19,20]

The Mental Index is a method for measuring the cortical width of the mandible in the mental foramen area. The normal value of the mental index is ≥ 3.1 mm.[12–14] Previous research that has been conducted on populations in Indonesia shows that the thickness of the mandibular cortical bone under normal conditions has a value of 3-2.7mm in men and 3-2.6mm in women.[10] This study shows that the MI value is higher than the normal threshold. The results of this study are not in line with the results of the research by Epsilawati et al in 2018 and David et al in 2017 which stated that there was a decrease in the Mental Index value in patients with a history of type 2 DM. Various previous studies have also reported different results, namely there may be an increase, decrease, or no change in BMD in type 2 DM.[9,10]

Mathkoor & Abdullah in 2023 stated that type 2 DM patients had higher BMD values than the non-diabetic control group. They also observed that the condition of bone density and disease duration in diabetic patients did not have a significant relationship. This study is not in line with the study of Jang et al in 2018 which stated that groups with a longer duration of type 2 DM had lower BMD values than groups with shorter durations.[21–23] Type 2 DM disease allows a person to have higher bone density. Some of the things that might influence this include a history of obesity, physical activity, and also vitamin D intake.[22–28]

Obesity is very common among patients with a history of type 2 DM. Most of these patients have a body mass index above 30. Obese patients with type 2 DM may experience increased leptin levels and decreased adiponectin levels. These two adipokines have an influence on bone remodeling. Leptin can inhibit the process of osteoclastogenesis by increasing the ratio of OPG/RANKL in osteoblasts. Leptin can reduce bone resorption and increase bone growth by stimulating osteoblast proliferation and differentiation. Adiponectin is considered to be able to reduce the ratio of OPG/RANKL. The combined effect of high leptin levels and reduced adiponectin levels on bone formation and resorption is the reason for the high BMD in type 2 DM patients with a history of bone obesity.[22,23]

Physical activity plays an important role in the condition of bone density. This activity has been shown to be clinically significant in increasing bone density. Studies show that physical activity is one of the most effective and inexpensive non-pharmacological methods for the prevention and control of osteoporosis. Physical activity transmits mechanical forces to the bones and stimulates intracellular processes in the bone tissue through mechanical loads. Mechanical load is something that exerts an opposing force on the system so that the system requires more power to perform the activity. Mechanical loading on bone activates a series of signaling pathways within bone cells. This increases the deposition of minerals in the bones and results in increased density in the bone tissue thereby maintaining bone strength. Mechanical load is an important factor in maintaining bone mineral density. Physical activity increases bone density through activating anabolic processes and increased bone mineral density has been shown to increase by up to 20% in areas of bone that are subjected to mechanical stress.[24–26]

Levels of vitamin D also have a positive relationship with bone density. The role of vitamin D in calcium absorption and bone formation has a good influence because calcium is an important element of bones. High concentrations of vitamin D can increase bone mineral density in adults. Vegetables and fruits are also considered major natural sources of vitamins, which may benefit bone health. Calcium and vitamin D are recommended for people at risk for osteoporotic fractures.[27,28] The association between vitamin D and calcium with BMD in people with DM type 2 was observed by Reema et al in 2020. They demonstrated that the loss of BMD could be due to low calcium levels.[29]

The chart in Figure 2 shows that with the increasing age range of individuals, the status of thinning bones also increases. Although the age range of 61-73 has decreased slightly, this is due to the lack of comparison between the number of individuals in the group so the chart curve decreases.

Nachankar in 2021 observed an increase in bone density loss with age. These findings suggest that old age is a deterministic factor in the loss of bone mineral density in diabetic patients.[27] Type 2 DM patients have a high prevalence and are more prone to osteoporosis. Type 2 DM and Osteoporosis are the most common metabolic diseases in adults and the elderly. Osteoporosis is a metabolic bone disease characterized by lower bone mass, microstructural damage to bones, greater bone fragility, and a higher risk of fractures.[30,31] The prevalence of osteoporosis increases with age. People can significantly develop osteoporosis at an older age. Women over the age of 50 are 5 times more likely than the normal population to develop osteoporosis and twice as likely to have osteopenia than men. Osteoporosis occurs more frequently in women than men. The female has a risk factor for osteoporosis in old age. This has been associated with postmenopausal decreased estrogen in women. Estrogen has an important role in preventing bone resorption by inhibiting osteoclasts.[32,33]

Increasing age causes an imbalance between resorption and formation (higher resorption than formation), thereby increasing the loss of BMD. Increasing age can also result in degenerative changes thereby reducing one's physical activity. Reema et al in 2020 observed that increasing age may be associated with an increase in bone density loss.[29] Prakash et al in 2017 also observed that there was a relationship between loss of bone mineral density and old age.[34] The relationship between old age and loss of bone mineral density is a universal phenomenon that is seen in all populations regardless of type 2 DM status. [34]

The association between long history of type 2 DM and loss of BMD is often confused with aging. In studies with older patient samples, the duration of type 2 DM often coincides with increasing age. Amit Nachankar's research states that there is no relationship between the duration of type 2 DM and BMD which can be caused by the relatively younger age of the patient.[27]

Mandibular cortex width also gradually decreases with age. The results of research using the mental index method conducted by Sghaireen et al in 2020 show that the width of the mandibular cortex is higher at younger ages and lower at older ages.[35] Hormonal factors are mentioned in this regard. Research by Sarifah et al in 2022 stated that the age group of women who are at risk for osteoporosis have the lowest mandibular cortical thickness values, namely in the age group of 51-60 years. This is of course in line with the analysis of mandibular cortical bone thinning which is reviewed based on the age range.[15]

## CONCLUSION

The mandibular cortical thickness of the mental index values obtained in type 2 DM patients based on the duration of suffering ≤ 5 years and > 5 years are both greater or exceed the normal value (≥ 3.1 mm). The two groups did not have significantly different MI values due to the possibility that the difference in long-suffering history was too close. The age of the sample used is still in the productive age range so it becomes a confounding factor in this study.


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None.


## FOOTNOTES

All authors have no potential conflict of interest to declare for this article. This study has received ethical approval approved by the Health Research Ethics Commission, Faculty of Dentistry, Lambung Mangkurat University, Banjarmasin (046/KEPKG-FKGULM/EC/III/2023 ). All procedures conducted were in accordance with the ethical standards.

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# The effect of changing vertical irradiation angle of periapical radiography bisecting technique on the length dimension of mandibular teeth

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## ABSTRACT

**Objectives:** This research is aimed to determine the effect of changing the vertical irradiation angle with a change in angle of +10°, +5°, -5°, -10° in bisecting technique periapical radiography on the length dimension of mandibular teeth.

**Materials and Methods:** This study used a laboratory experimental method with a post test only control group design. The samples used in this study were teeth I1, I2, C, P1, P2, M1, and M2 region 4. All teeth were treated by changing the angle from the standard angle recommended by White and Pharoah with changes of +10°, +5°, -5°, and -10° in each tooth using a Morita Veraview iX 70 Kv, 7mA dental X-ray unit.

**Results:** The results showed that the angle change of -10°, -5° causes foreshortening and +10°, +5° causes elongation. Based on the results of the Saphiro-Wilk and Kruskal-Wallis test, it is known that there are significant differences in the dimensions of tooth length at +10°, +5°, -5°, -10° against changes in the angle 0° or angulation form White and Pharoah ($p < 0.05$) .

**Conclusion:** There is a significant effect on the change of vertical irradiation angle with angle changes of +10°, +5°, -5°, -10° in bisecting technique periapical radiography on the length dimension of mandibular teeth.

***Keywords:*** *Bisecting technique, vertical angulation, tooth length*
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## INTRODUCTION

Radiographic examination in dentistry has a role as a supporting examination that helps dentists see the condition of the patient's mouth more clearly and in detail.[1] The quality of radiographic images needs to have parameters such as contrast, sharpness, and noise to provide clear and complete information results to make a diagnosis.[2,3] Radiographic techniques for supporting examinations are chosen by dentists because the images obtained are faster and more accurate, and can evaluate the condition of the teeth and mouth after treatment.[4] Medical radiography is divided into two types, intraoral and extraoral. Intraoral radiography consists of periapical, bitewing, and occlusal. Intraoral radiography consists of 3 techniques, one of which is periapical radiography.[5] Periapical radiographs depict a crown in detail, the tooth root, alveolar bone, and surrounding tissues. Periapical radiographs consist of bisectris and parallel techniques.[6]

The bisecting angle technique is commonly used in dental practice as it is easier to place the receptors, making it more adaptable to patients.[7] However, there are often errors when determining the length of radiographic images, such as distortion or variations in interpretation due to a lack of three-dimensional aspects.[8] Distortion can occur in the form of elongation or foreshortening of the tooth size due to incorrect vertical angle settings.[9]

The management of dental treatment requires high accuracy as in the case of root canal treatment, the occurrence of vertical distortion causes failure in the obturation process. images with vertical distortion need to be repeated which causes the patient to be exposed to excessive radiation exposure.[10] Excessive radiation exposure has the potential to cause cancer because it is carcinogenic. Excessive exposure to radiographic light is not in accordance with the ALARA (As Low As Reasonably Achievable) principle of avoiding excess radiation that has no benefit to the patient, as a dose reduction concept in radiation protection.[11]

Difficulties such as the presence of mandibular anatomical obstacles such as a shallow floor of the mouth, short frenulum, and short arch width cause the position of the receptor to be not ideal.[12] The change in measurement of the radiographic image with tooth length is an important parameter in the success of an action.[13] So it is necessary to find an angle tolerance in irradiation so as not to affect the

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measurement of the vertical dimension. Therefore, the authors would like to conduct a study to determine the effect of vertical irradiation angle in bisectric technique periapical radiography on radiographic images of mandibular tooth length.

## MATERIALS AND METHODS

This study used a laboratory experimental method with a post test only control group design. The data obtained were primary data conducted at the Radiology Installation, Educational Dental and Oral Hospital, Faculty of Dentistry, Universitas Trisakti which was conducted in September - November 2023.

The population used in this study is all mandibular dental elements, region four in the jaw model. The samples used in this study used 7 teeth that had been implanted in the region 4 phantom, incisor 1, incisor 2, canine, premolar 1, premolar 2, molar 1, and molar 2.

The inclusion criteria in this study are having a crown that is still intact, if there are defects (abrasion, attrition, caries) it does not affect the vertical and horizontal dimensions of the tooth, the root is still intact and, the apical foramen is still good. The exclusion criteria in this study were crown fracture, and root fracture.

The tools used in this study are digital calipers, lecrons, wax knives, water passes, glass plates, white cloth mats, spirtus lamps, HP all-in-one 22-c0xx devices with a resolution of 1920 x 1080, dental X-ray unit Morita veraview V080 type EX-2 70 kV. 7mA. 2 sec, DBSWIN 5.11.0 software, microsoft excel software, Dürr dental Vistascan mini plus.

In this study, the teeth of incisor 1, incisor 2, canine, premolar 1, premolar 2, molar 1 and molar 2 of region 4 were measured first using digital calipers vertically to obtain the actual tooth length. After measurement, all teeth were planted using baseplate wax on the mandibular model by shaping according to the angulation in humans so that the position of the teeth in the phantom matches the original. Furthermore, radiographs were taken

**Table 1.** Radiograph capture results

| Teeth | Actual Tooth Length | Angle Change | | | | |
|---|---|---|---|---|---|---|
| | | -10° | -5° | White and Pharoah | +5° | +10° |
| **Incisor 1** | 19,8 mm | 18,6 mm (Foreshortening 6%) | 19,2 mm (Foreshortening 3%) | 20,2 mm (Elongation 2%) | 20,8 mm (Elongation 5%) | 21,3 mm (Elongation 7,5%) |
| **Incisor 2** | 20,8 mm | 19,6 mm (Foreshortening 5,7%) | 20 mm (Foreshortening 3,8%) | 20,8 mm | 21,4 mm (Elongation 2,8%) | 22 mm (Elongation 5,7%) |
| **Canine** | 25,1 mm | 22,8 mm (Foreshortening 9,1%) | 23,4 mm (Foreshortening 6,7%) | 25,1 mm | 25,4 mm (Elongation 1,1%) | 25,8 mm (Elongation 2,7%) |
| **Premolar 1** | 23 mm | 22,4 mm (Foreshortening 2,6%) | 22,6 mm (Foreshortening 1,7%) | 23,2 mm (Elongation 0,8%) | 23,6 mm (Elongation 2,6%) | 24,4 mm (Elongation 6%) |
| **Premolar 2** | 23,8 mm | 21,5 mm (Foreshortening 9,6%) | 22,4 mm (Foreshortening 5,8%) | 23,7 mm (Foreshortening 0,4%) | 24,4 mm (Elongation 2,5%) | 26 mm (Elongation 9,2%) |
| **Molar 1** | 19 mm | 17,4 mm (Foreshortening 8,4%) | 18,2 mm (Foreshortening 4,2%) | 19 mm | 19,8 mm (Elongation 4,2%) | 21,1 mm (Elongation 11%) |
| **Molar 2** | 20,6 mm | 19,7 mm (Foreshortening 4,3%) | 20,4 mm (Foreshortening 0,9%) | 20,7 mm (Elongation 0,4%) | 22 mm (Elongation 6,7%) | 23,1 mm (Elongation 12,1%) |

**Table 2.** Post hoc test results of angle changes of 10°, -5°, +5°, +10° against White and Pharoah angulation

| | Angle Change | **Incisor 1** | **Incisor 2** | **Canine** | **Premolar 1** | **Premolar 2** | **Molar 1** | **Molar 2** |
|---|---|---|---|---|---|---|---|---|
| 0° | -10° | 0.008* | 0.006* | 0.008* | 0.007* | 0.007* | 0.005* | 0.005* |
| | -5° | 0.008* | 0.007* | 0.005* | 0.007* | 0.006* | 0.007* | 0.006* |
| | +5° | 0.008* | 0.007* | 0.007* | 0.006* | 0.008* | 0.004* | 0.004* |
| | +10° | 0.008* | 0.007* | 0.008* | 0.007* | 0.007* | 0.006* | 0.006* |

**Table 3.** Results of taking radiographs based on White and Pharoah's textbook angulation

| Teeth | Results |
|---|---|
| Incisor 1 | Elongation 2% |
| Incisor 2 | No change |
| Canine | No change |
| Premolar 1 | Elongation 0,8% |
| Premolar 2 | *Foreshortening* 0,4% |
| Molar 1 | No change |
| Molar 2 | Elongation 0,4% |

**Table 4.** Results of taking radiographs with a change in vertical irradiation angle of –10°

| Teeth | Results |
|---|---|
| Incisor 1 | Foreshortening 6% |
| Incisor 2 | Foreshortening 5,7% |
| Canine | Foreshortening 9,1% |
| Premolar 1 | Foreshortening 2,6% |
| Premolar 2 | Foreshortening 9,6% |
| Molar 1 | Foreshortening 8,4% |
| Molar 2 | Foreshortening 4,3% |

**Table 5.** Results of taking radiographs with a change in vertical irradiation angle of –5°

| Teeth | Results |
|---|---|
| Incisor 1 | Foreshortening 3% |
| Incisor 2 | Foreshortening 3,8% |
| Canine | Foreshortening 6,7% |
| Premolar 1 | Foreshortening 1,7% |
| Premolar 2 | Foreshortening 5,8% |
| Molar 1 | Foreshortening 4,2% |
| Molar 2 | Foreshortening 0,9% |

**Table 6.** Results of taking radiographs with a change in vertical irradiation angle of +5°

| Teeth | Results |
|---|---|
| Incisor 1 | Elongation 5% |
| Incisor 2 | Elongation 2,8% |
| Canine | Elongation 1,1% |
| Premolar 1 | Elongation 2,6% |
| Premolar 2 | Elongation 2,6% |
| Molar 1 | Elongation 4,2% |
| Molar 2 | Elongation 6,7% |

**Table 7.** Results of taking radiographs with a change in vertical irradiation angle of +10°

| Teeth | Results |
|---|---|
| Incisor 1 | Elongation 7,5% |
| Incisor 2 | Elongation 5,7% |
| Canine | Elongation 2,7% |
| Premolar 1 | Elongation 6% |
| Premolar 2 | Elongation 9,2% |
| Molar 1 | Elongation 11% |
| Molar 2 | Elongation 12,1% |

using the provisions of the standard angle of vertical angulation by White and Pharoah, all teeth were treated by changing the angle from the standard angle to -10°, -5°, +5°, +10° on each tooth using a Dental X-ray unit Veraview V080 type EX-2 70 kV. 7mA with five repetitions each angle change. The angle was changed to see if the change could cause distortion in the form of lengthening and shortening. The results of taking radiographs were observed and measured vertically and horizontally using DBSWIN 5.11.0 software. Data processing of this study used the SPSS program.

## RESULTS

In this study, all subjects were given treatment in the form of taking radiographs from the standard angle recommended by White and Pharoah to changes in angles of -10°, -5°,+5°, +10° with the results in Table 1. Based on Table 1, it can be seen that the tooth length from radiographs given negative angle changes, -10° and -5°, experienced foreshortening, and at positive angle changes, +10° and +5°, experienced elongation.

Data analysis was carried out using the data

**Table 8.** Comparison between positive and negative vertical irradiation change

| | Angle Change | Incisor 1 | Incisor 2 | Canine | Premolar 1 | Premolar 2 | Molar 1 | Molar 2 |
|---|---|---|---|---|---|---|---|---|
| Elongation | -10° | 6% | 5,7% | 9,1% | 2,6% | 9,6% | 8,4% | 4,3% |
| | -5° | 5,7% | 3,8% | 6,7% | 1,7% | 5,8% | 4,2% | 0,9% |
| Fore-shortening | +5° | 5% | 2,8% | 1,1% | 2,6% | 2,5% | 4,2% | 6,7% |
| | +10° | 7,5% | 5,7% | 2,7% | 6% | 9,2% | 11% | 12,1% |

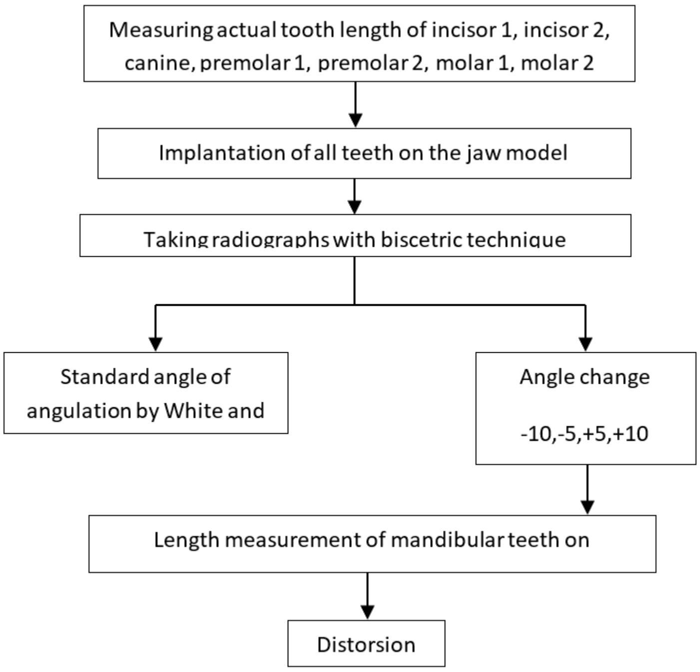


**Figure 1.** Bisectric technique taking scheme and vertical dimension change analysis

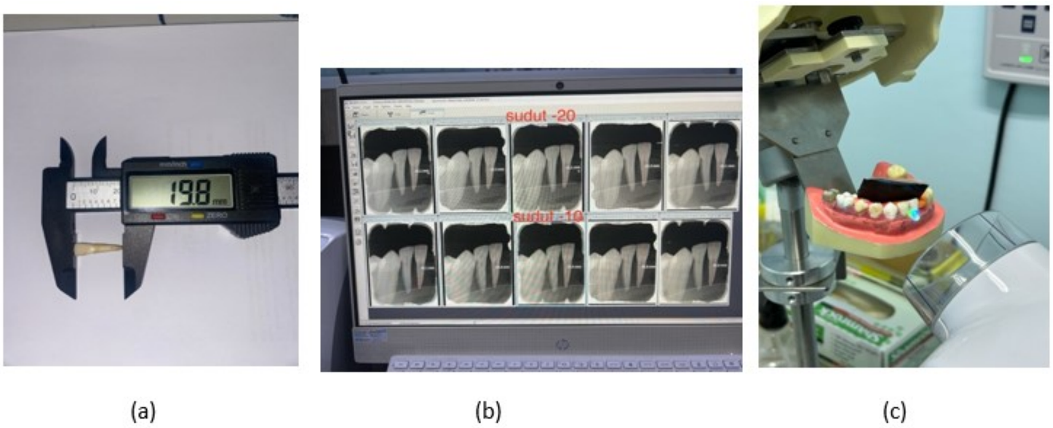


**Figure 2.** Research process on incisor 1, (a) Measurement of actual tooth length, (b) Radiograph with White and Pharoah angulation and measurement of radiograph, (c). X-ray tube alignment

normality test, the Shapiro-Wilk test because the number of samples was less than 50 data. The normality test of tooth length dimension showed that the data was not normally distributed (p<0.05). The Kruskal-Wallis test showed a significant difference between the test groups (p<0.05), so the Mann-Whitney Post Hoc test was performed. In the 1st incisor, 2nd incisor, canine, 1st premolar, 2nd premolar, 1st molar, 2nd molar all tooth length dimensions in the angle change groups -10°, -5°, +5°, +10°. showed significant changes against White and Pahroah angulation, which is the angle of angulation according to White and Pharoah's textbook (Table 2).

## DISCUSSION

The result of radiograph taken with White and Pahroah angulation to the actual tooth length is a reduction and increase in tooth size on the radiographic image. result of radiograph taken with White and Pahroah angulation can be seen in Table 3. Based on the results of the White and Pharoah angulation, it can be said that with the angle recommended by White and Pharoah without modification, there is a mismatch between the natural teeth and the radiograph image on the 1st incisor, 1st premolar, 2nd premolar, and 2nd molar.

The results of measurements on all teeth were taken by changing the vertical irradiation angle by -10°. This resulted in radiographs of reduced teeth or foreshortening. The results of the -10° angle change can be seen in Table 4. The results of measurements on all teeth made by changing the vertical irradiation angle to -5°, resulted in foreshortening of the tooth on radiographs. The results of the -5° angle change can be seen in Table 5. The radiographs taken with a +5° vertical irradiation angle showed tooth lengthening or elongation. The results of the +5° angle change can be seen in Table 6. The radiographs appeared longer due to changes in the vertical irradiation angle +10°. The results of the +10° angle change can be seen in Table 7. Foreshortening and elongation occur when X-ray direction and the imaginary line between tooth axis and receptor are not perpendicular, by changing the vertical irradiation angle from the standard angle will cause the x-ray direction to be not perpendicular and distortion will occur.

Based on data the vertical irradiation angle changes in the negative direction, it causes foreshortening in the radiograph image. Conversely, changes in the positive direction result in lengthening or elongation. Based on this difference, it can be concluded that the relationship between changes in the vertical irradiation angle in molar teeth is bi-directional. Specifically, the greater the change in angle in the positive direction, the more elongated the tooth appears. Similarly, the greater the change in angle in the negative direction, the more foreshortened the tooth appears The percentage change produced at each angle and tooth change is different. can be seen in table 8.

In research conducted by Anggara et al (2018), changes in vertical irradiation angles of +20°, +30°, +40°, +50° and +60° on maxillary premolars 1, changes in vertical irradiation angles of +30 produce tolerable tooth lengths of less than 1 mm.[6] Primazetyarini et al (2018), said that the irradiation angle can still be tolerated until the angle of +15° because the change in tooth length is still below 1 mm while the change in the vertical irradiation angle to -15° there is no significant change in the change in tooth length dimensions.[5]

The results of the normality test with the Saphiro-Wilk test found that the data were not normally distributed because the p-value was smaller than 0.05. Then it can be continued with the Kruskal-Walli's test. The results of the Kruskal-Wallis test obtained a p-value smaller than 0.05. So that the angle changes of +10°, +5°, 0°, -5°, -10° provide significant differences in tooth length. In the post hoc test, it was found that changes in angles of +10°, +5°, -5°, -10° caused significant changes in tooth length dimensions against White and Pharoah angulation in all teeth.

Poor image quality affects interpretation and diagnosis, technical errors in taking periapical radiographs in determining the vertical irradiation angle can be in the form of foreshortening, elongation, and in determining the horizontal irradiation angle in the form of overlapping.[14] Accurate measurement of tooth length dimensions is crucial in dental practice, particularly in root canal treatment. The success of this treatment greatly depends on the precision of the working length, which can be determined through periapical radiographic images. Therefore, any errors in determining the vertical irradiation angle can significantly impact the success of the treatment.[15]

## CONCLUSION

There is a significant effect on the change of vertical irradiation angle with angle changes of +10°, +5°, -5°, -10° in bisectris technique periapical radiography on the length dimension of mandibular teeth. For optimal and accurate results, future research can utilize models that represent more detailed human oral anatomy and larger sample sizes.

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## FOOTNOTES

All authors have no potential conflict of interest to declare for this article. This study has received ethical approval approved by the the Research Ethics Commission of the Faculty of Dentistry, Trisakti University (685/S1/KEPK/FKG/7/202). All procedures conducted were in accordance with the ethical standards.

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# Knowledge of the senior high-school students in Sukarami subdistrict of Palembang about dental radiographic examination

Dewi Kartika[1*], Cek Dara Manja[1], Vini Heliza[1]

## ABSTRACT

**Objectives:** The study on knowing lay-persons' radiographic examination is still rare. It actually can provide the description of how well they understand it in dentistry, especially in dentistry's radiography. This research is aimed to find out the senior high school students' level of knowledge about dental radiographic examination.

**Materials and Methods:** This research used a descriptive survey method with a cross-sectional design. The population was the grade XII students of SMA 13, Palembang, and 174 of them were used as the samples, taken by using purposive sampling technique and was in accordance with the inclusion and exclusion criteria, using Google form questionnaire, and analyzing descriptively.

**Results:** The result showed that 23 respondents (13.22%) had good knowledge, 108 respondents (62.07%) had moderate knowledge, and 43 respondents (24.71%) had poor knowledge.

**Conclusion:** The students' level of knowledge at SMA 13 Palembang high school about dental radiographic examination was moderate.



***Keywords:*** *Radiography, dentistry, knowledge, students*

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## INTRODUCTION

The data of Riskesdas in the period of 2018 revealed that there was the increase in the percentage of young respondents at the age of 10-14 who had the problems with their teeth and mouths.[1] Dental treatment sometimes requires radiographic examination. Dental radiographic examination is part of supporting examination which helps in diagnosis, treatment planning, or assessment of the result from previous treatment. The use of radiographic examinations can increase the success of patient dental treatment[2]

Patients are sometimes still afraid when radiographic examinations are carried out. Studies had been conducted to assess the level of patient knowledge of radiographic examinations. Raidha F, et. al., 59.75% of the students of SMA had moderate knowledge of dentistry's radiography. Their average poor knowledge was in radiation protection (only 39.42%).[3] Chew SY, et. al., 90.1% of the patients who were being treated in radiographic imaging got explanation about the need for radiography. Patients got an explanation about the risks of radiation only 26.5%.[4] Purmal K, et. al. point out that of the 200 patients who visited the Dentistry Clinic of the University of Malaysia, most of them did not understand the reason why X-ray had to be done and what about its benefit.[5]

Previous research states that medical radiation knowledge is still limited by patients, and the perception given can be related to age and education level.[6,7] Lack of knowledge about radiographic examination can cause misperception that this examination is dangerous and having no significant use. Incorrect perceptions can lead to the failure of radiographic examinations.[3]

Therefore the objective of the research was to find out the senior high school student's level of knowledge about dental radiographic examination. Through the description of the level of knowledge, dentists and radiographers are expected to have good communication before taking X-rays, so that radiographic examinations can be successfully carried out.

## MATERIALS AND METHODS

This research used descriptive survey method with cross-sectional design. The population was the grade XII IPA (Natural Science) high-school students of Sekolah Menengah Atas (SMA) 13, Palembang, and 174 of them were used as the samples. The sample was aken by using purposive sampling

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technique.

Knowledge measurement is done by using Google form-based online questionnaire, consisting of questions about socio-demography and 14 multiple choice questions. Of the 14 multiple choice questions, 12 of them were assessed. Every right answer was scored 1 while every wrong answer was scored 0. Maximum value was 12 points. They were then classified to become three categories: 1) Good if the right answers were between 76% and 100%, 2) Moderate if the right answers were 56% and 75%, and 3) Poor if the right answers were < 56% of the total of 12 questions.[8] This research had been approved by the Research Ethics Committee of the University of Sumatera Utara, Number: 1224/KEP/ USU/2021.

## RESULTS

In this study, the age and gender characteristics of the respondents aged 17 years are the largest age category, namely 79.9%. Respondents aged 16 years were 10.9%, 18 years old were 8.6%, and 15 years old were only 0.6%. Respondents who were female were 64.4% while 35.6% were male.

There are 12 questions in Table 1, the 3 questions with the highest correct answers are about pictures about the types of dental x-rays, types of dental radiographic examination (dental x-ray), one of the uses of dental radiographic examination (dental x-ray). The 3 questions with the highest number of wrong answers were regarding wrong statements about dental radiography, action to reduce excessive exposure as the protection of radiation for patients, what condition of dental x-ray which can cause danger to the body.

Figure 1 shows that 14.4% of respondents have had dental radiographic examinations. As many as 85.6% of respondents have never had a dental radiographic examination. Data from Figure 2 shows that 25.3% of the respondents received information about dental radiography from the dentist's explanation. As many as 64.4% of respondents read from social media or the internet and 10.3% of respondents read from school textbooks, magazines or newspapers. Figure 3 shows that 43 respondents (24.71%) have a low level of knowledge, 108 respondents (62.07%) have a sufficient level of knowledge, and 23 respondents (13.22%) have a good level of knowledge regarding radiographic examinations of dentistry.

## DISCUSSION

The data from Table 1 are the questions about radiographic examination (X-ray) in dentistry, pictures about the types of dental X-rays, and types of dental radiographic examination (dental X-ray) are answered correctly by the respondents (70,7%, 99,4%, and 84,5% respectively). The research conducted by Raidha F, et. al. pointed out that 97.6% of the respondents knew about the X-rays in dentistry, and 96.4% of them knew the dental X-

**Table 1.** Knowledge of dental radiographic examination

| Questions | Answers | | | |
|---|---|---|---|---|
| | Right | | Wrong | |
| | n | % | n | % |
| There is radiographic examination in dentistry | 123 | 70.7 | 51 | 29.3 |
| Pictures about the types of dental X-rays | 173 | 99.4 | 1 | 0.6 |
| Types of dental radiographic examination (dental X-ray) | 147 | 84.5 | 27 | 15.5 |
| Purpose of radiographic examination in dentistry practices | 115 | 66.1 | 59 | 33.9 |
| One of the uses of dental radiographic examination (dental X-ray) | 146 | 83.9 | 28 | 16.1 |
| Wrong statement about dental radiography | 67 | 38.5 | 107 | 61.5 |
| Protective effort towarX-ray radiation in order to give protection to dentists and operators (radiographers), the people/environment and patients | 83 | 47.7 | 91 | 52.3 |
| Action to reduce excessive exposure as the protection of radiation for patients | 67 | 38.5 | 107 | 61.5 |
| Dental radiographic examination (dental X-ray) cannot stand by itself in detecting patients' illnesses | 128 | 73.6 | 46 | 26.4 |
| What condition of detal X-ray which can cause danger for the body. | 68 | 39.1 | 106 | 60.9 |
| Organs which can cause the risk of making dental radiography. | 142 | 81.6 | 32 | 18.4 |
| Long-term effect which can occur, due to exposure to needless and excessive radiation in the body | 77 | 44.3 | 97 | 55.7 |

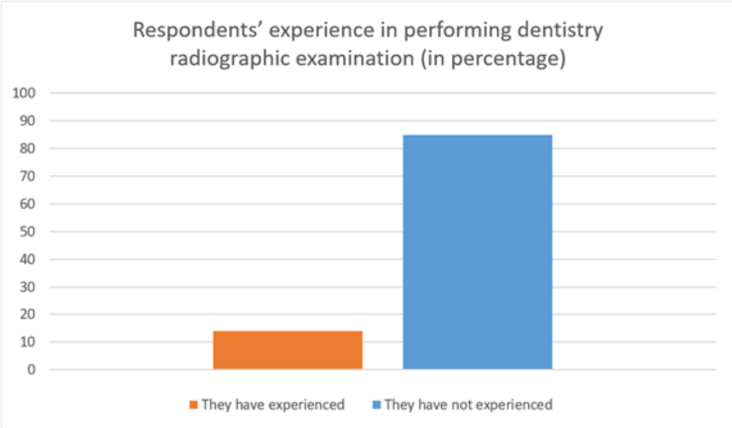


**Figure 1.** Respondents' experience in performing dentistry radiographic examination

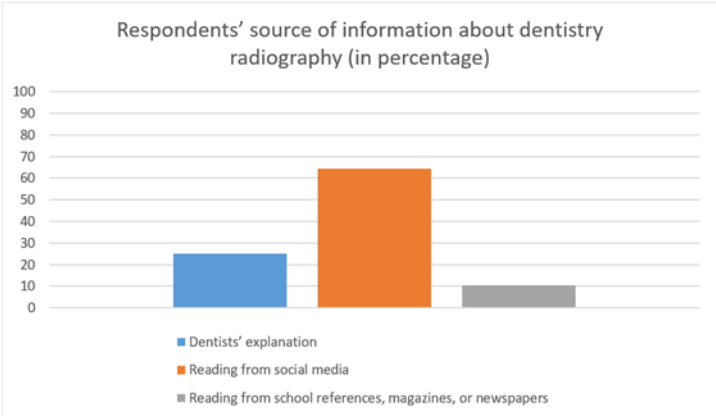


**Figure 2.** Respondents' source of information about dentistry radiographic examination

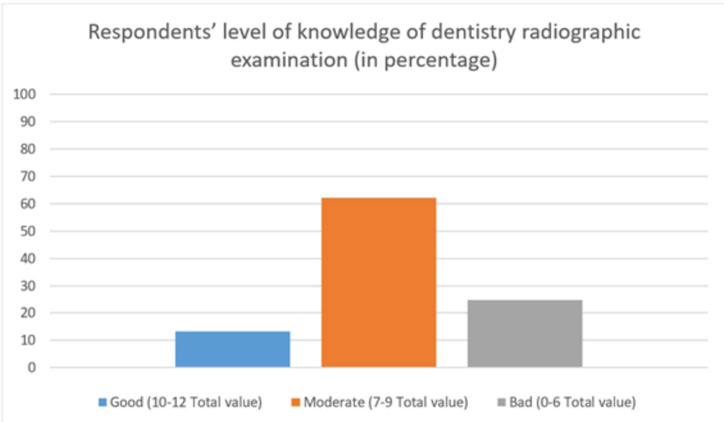


**Figure 3.** Respondents' level of knowledge of dentistry radiographic examination

rays. The result of this research was categorized as good and was in accordance with the research conducted by Raidha F, et. al on the students of SMAN 1, Cipatat.[5]

The respondents' right answers of these questions could be caused by their good basic knowledge. There were learning materials about the structure and the function of tissue arrangement cells in digestive system. One of the discussions in it included the materials on devices, digestive organs which one of them was teeth. Respondents could differentiate pictures of dental X-rays probably because they had obtained knowledge of the shape of teeth in general. Respondents' good knowledge was probably because they had had basic knowledge of X-ray and its application in human life in general.[9,10]

Questions about the purpose of radiographic examination in the dentistry practice were answered correctly by 66.1% of the respondents.

This research was different from the result of the research conducted by Raudha F, et. al which indicated good result. 84.2% of the respondents knew the function of dental X-ray to determine treatment planning.[5] Description of the result of dental radiographic examination became very important for dentists, especially for finding out the invisible or unclear abnormality in clinical examination. Dental radiographic examination is very helpful for dentists, especially to uphold diagnosis in determining treatment planning and evaluating it.[11]

Questions about one of the uses of dental radiographic examination (dental X-ray) were answered correctly by 83.9% of the respondents. They knew that dentistry radiographic examination could find out and detect dental caries. The research conducted by Raidha F, et.al 92018) also had the same result, 82.9% of the respondents knew that one of the functions of dental X-ray was to find out the cavity area.[5] There are many diseases and conditions which have no clinical symptom which are usually found through dental radiographic supporting examination. Radiographic examination has the capacity to project the invisible area clinically.[12,13] Questions about wrong statements about dental radiography were answered correctly by 38.5% of the respondents. It seemed that they still had poor knowledge about the use of dental radiographic examination. The research conducted by Al Faleh W, Mubayrik AB, and Al Dosary, S. showed that 42% of the respondents in their research considered that radiography was not important in diagnosing oral disease.[14] The research conducted by Chris, et. al. revealed that the patients did not know exactly the X-ray.[15] Dental radiographic examination has contributed to assessing the growth and the development of teeth and jaws of children and adolescents and detecting various abnormalities and pathological condition in the oromaxillofacial which cannot be seen clinically. Some of the examples are detecting invisible caries lesion, periodontal disease, detecting the possibility of dental impaction, by the potential dentigrous cysts in the related teeth, showing non-eruption teeth, periapical disease, and helping upholding diagnosis of various kinds of cyst and benign and malignant tumors.[16]

Questions about the objective of protection against X-ray radiation to protect patients, radiographers, dentists, and the people/ environment were answered correctly by 47.7% of the respondents. It was categorized as poor result. The research conducted by Yunus and Sirajuddin on D3 students of Poltekkes Makassar, showed that the respondents' knowledge of protection against X - X-ray radiation was poor.[11] They considered that the protection against the X-ray radiation was done only toward patients. Implementation of the optimization of protection and safety from radiation should be done so that not only patients but also the personnel in charge of radiation in the radiology installation as well as the people surrounding the installation have to be protected so that they will be exposed to radiation as low as possible.[17]

Questions about action to reduce excessive exposure to protect against radiation in patients by wearing radiation protecting clothes (apron) and thyroid collars were answered correctly by 38.5% of the respondents. It was in accordance with the research conducted by Raidha F, et. al which showed that the respondents' knowledge was still very poor about protection against radiation. Many of them considered that radiation caused by radiographic examination was insignificant so that the protection against radiation was not needed during the examination.[5] Exposure to radiation in dental radiography should be minimized if it is possible even though the dosage of radiation in dental radiographic examination is low. Lead apron and thyroid collars are patients' protecting equipment which can minimize the exposure to spread radiation. The thyroid collars which are highly suggested to be worn by children and pregnant women because they are very vulnerable to the effect of radiation.[18,19]

Questions about dental radiographic examination (dental X-ray) cannot stand by itself in upholding and detecting patients' diseases since previous medical interview (anamnesis), complete physical/clinical examination, the history of patients' health have to be performed. These questions were answered correctly by 73.6% of the respondents. Radiographs cannot be used to detect disease prior to clinical examination . A clinical examination should be done completely by considering the history of the patient, doing the previous radiographic review; if there is any, the risk of being affected by caries should be evaluated and the need for dental health in patients should be considered before radiographic examination is done.[18]

Questions about the condition of dental X-ray which could cause hazard for the body were answered correctly by 39.1% of the respondents. The research conducted by Ashok NG and Kumar VJ indicated that there was the lack of knowledge of the safety of dental radiography.[20] The research conducted by Al-Faleh, W., et.al. revealed that more than a half of the respondents (55%) never or almost never asked about taking any measures for safety before doing radiographic examination.[21] Dental radiographic examination can provide benefit for patients' dental health rather than getting the risk of getting injured if clinical examination has not been done, referred to, exposed, and processed properly. Radiology examination can only be done be medical professionals for special purpose when the benefit is more than the risk of biological injury in patients, and it is done only when there is a specific indication in specific patients.[16]

Questions about the possibility of an organ to have the risk of making dental radiography were answered correctly by 81.6% of the respondents. Radiation in dental radiography was done in the area of the students' heads and necks. The IPA students of SMA had studied about the materials of endocrine in which one of them is thyroid. In these materials, the students were taught about anything which was related to endocrine, including its location, thyroid.[9] Thyroid is an organ which becomes the attention in dental radiography because of its anatomical position and its relatively high radio sensitivity. The research conducted by Memon, A, et. al. provided some supports for hypothesis that exposure to dental X-ray, especially double exposure which could be related to the increase in the risk of thyroid cancer.[22] The research conducted by Al Faleh, W., et. al. indicated that most of the respondents agreed that eyes are one of the organs which was affected by radiation.[20]

Questions about the long-term effect which occurred due to the exposure to needless and excessive radiation in the body such as genetic mutation, fetus defective, cataract, and cancer were answered correctly by 44.3% of the respondents. The research conducted by Ricketts ML., et.al. pointed out that the majority of the patients were not informed about the risk of radiation concerning the examination, and they had wrong perception on the use of radiation and its risk.[23] X-ray is dangerous for human beings and it can cause genetic damage, leukemia, and oncogenesis. Exposure to radiation in thyroid during pregnancy is related to low birth weight. Thyroid protective collars can substantially decrease exposure to radiation in thyroid during the procedure of dental radiography. Therefore, it is recommended that all patients, especially children, productive-aged women, and pregnant women use them.[19,24]

Figure 1 shows that 85.6% of the respondents have never had dental radiographic examination. This is probably because dental radiographic examination is a supporting examination so that not all dental cases should be handled by doing dental radiographic examination. According the regulation by BAPETEN No. 4/2020, Article 40, paragraphs 1 and 2, all medical exposures should be through the process of justification by considering one of them –clinical indication which indicated that patients should be given medical exposure.[17]

Respondents' source of information about dentistry radiography shown in Figure 2 indicated that 64.4% of the respondents read from social media or internet. The data from BPS (Central Bureau of Statistics) revealed that 33.38% of the internet users in Indonesia were in the aged-group of 13-24 years.[25] Access to internet today is becoming rapid and easy so that it can be done anywhere and anytime by using cell-phones. Today, social media begin to replace the role of conventional mass-media in spreading information and news, along with the increase in the development and acceleration of social media.[26] The Covid-19 pandemic has caused the use of Smartphone to be much more frequent.[27]

Figure 3 showed the result of the level of knowledge of dentistry radiographic examination in the students of SMAN13, Palembang. The result of the research showed that the respondents' knowledge of dentistry radiographic examination was categorized as moderate (62.07%). This was probably related to their basic knowledge of the learning materials at school. Lesson topics are usually about general knowledge about radiation only.

History of radiographic examination may play a role in increasing patient knowledge about radiographic examination in dentistry. Almost all respondents did not have a history of radiographic examination, so it was certain that the respondents had never received an explanation of radiographic examination from medical personnel such as dentists. Therefore, in this study most of the respondents' knowledge was mostly obtained through social media, so that the respondents' knowledge of radiographic examination was at a moderate level. The role of dentists is very important in providing introduction and knowledge about radiographic examination in dentistry. Researchers argue that if dentists play an active role in introducing radiographic examinations and treatment actions in dentistry to the public through videos uploaded on social media, then the knowledge of respondents or the public will automatically increase for the better.

## CONCLUSION

The level of knowledge among high-school students in Sukarami Sub-district, Palembang in this study, regarding dental radiographic examination was moderate. Previous history of radiographic examinations and information from social media can help in improving knowledge about radiographic examinations in dentistry.


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## FOOTNOTES

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# Case report: Detection of maxillary sinusitis with inverted impacted teeth using Cone-beam Computed Tomography

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## ABSTRACT

**Objectives:** The aim of this case report is to describe radiographically the specific features of maxillary sinusitis on CBCT radiograph.

**Case Report:** A 20-year-old female patient came to RSGM UNPAD with a consul letter from Oral Surgery specialist for a CBCT radiography examination to see impacted teeth. The results showed radiointermediate images in the maxillary sinus which showed thickening of the sinus mucosa and an inverted impacted teeth on the right maxillary.

**Conclusion:** Maxillary sinusitis could be assessed using extra oral radiography and CBCT. CBCT examination was used in determining the source of the lesion, the extent of the lesion, and the thickness of the maxillary sinus mucosa.

***Keywords:*** *Maxillary sinusitis, impacted teeth, CBCT*

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## INTRODUCTION

Maxillary sinusitis can occur in both children and adults. Maxillary sinusitis is an inflammatory condition of the sinus mucosa which interferes with ciliary function and sinus secretion. Maxillary sinusitis can be caused by allergens, bacteria, or viruses.[1,2] Assessment of maxillary sinusitis can be done through clinical examination, supporting examination of conventional extra oral radiography and CBCT. The radiographic image of the maxillary sinus floor is thin radiopaque lines. Tooth impaction in the maxillary sinus is a rare case, and is usually found accidentally on radiographic examination.[3–5] Radiographic image of maxillary sinusitis is radiopacification along the sinus floor, around the entire wall of the sinus, or near-complete or complete of the sinus, and fluid level of antral cavity with a characteristic meniscus shape.[6,7]

Panoramic radiographs can detect impacted teeth, as well as viewing pathological conditions in the jaws. Panoramic radiographs can clearly depict the mesiodistal and vertical positions of impacted teeth. However, it cannot evaluate the position of the impaction or lesion in the buccolingual direction. Therefore, a follow-up examination using 3D CBCT is sometimes required.[6,7] 3D CBCT is indicated when the ectopic tooth is associated with a lesion in the maxillary sinus and requires surgery.[8] 3D CBCT is helpful for the clinician in determining the hard tissue margin of the soft tissue invasion of the lesion. The advantage of 3D CBCT is that it provides multiplanar reformation with volume reconstruction and 3D images with a much lower radiation dose compared to computed tomography (CT). 3D CBCT allows clinicians to accurately assess the extent of the lesion and its proximity to adjacent vital structures.[9]

## CASE REPORT

A 20-year-old female patient came to the Radiology Installation of Dentistry, Padjadjaran University Dental and Oral Hospital on consulship from an Oral Surgery specialist for a CBCT examination related to tooth impaction. The CBCT examination results showed coronal, sagittal, and axial views of the sinistra mandible (Figure 1). The panoramic view of the mandibular sinistra showed an inverted impacted tooth in region 18 and a radiointermediate lesion in the maxillary sinus showing thickening of the sinus mucosa (Figure 2). The coronal view showed the impaction of tooth 18 in an inverted position, located in the dextra maxillary sinus. The crown width was 10.46 mm and the height (coronal-apical) was 13.46 mm. There was a thickening of the dextra maxillary sinus mucosa, with a thickness of 4.86mm from the crown and a radiolucent appearance at the edge of the crown (yellow arrow) (Figure 3). The sagittal view showed the impaction of tooth 18 in an inverted position, located in the maxillary sinus. The tooth width (mesial-distal) was 10.87 mm and height (coronal-apical) was 14.19 mm. There was

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thickening of the sinus mucosa on the superoanterior wall of about 13.00 mm and on the posteroinferior 7.70mm. and radiolucent appearance on the apical (blue arrow) (Figure 4). The axial view showed the impaction of tooth 18 with a tooth width (buccal-palatal) of 10.30 mm and a tooth width (mesial- distal) of 11.16 mm. There was radiolucency at the crown edge (yellow arrow). The impression of this case is the impaction of tooth 18 with an inverted angulation position, the crown position is in the dextra maxillary sinus. Radiodiagnosis suspicion is inverted impaction level C sinus approximation, accompanied by dextra maxillary sinusitis. The patient will undergo odontectomy surgery on the impacted tooth and will be treated for maxillary sinusitis found on radiographic examination.

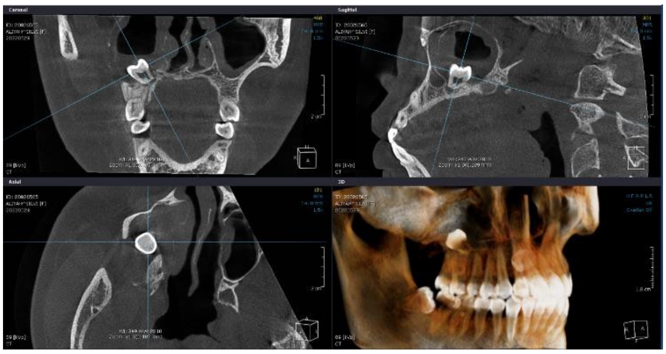

**Figure 1.** MPR view of tooth 18 region

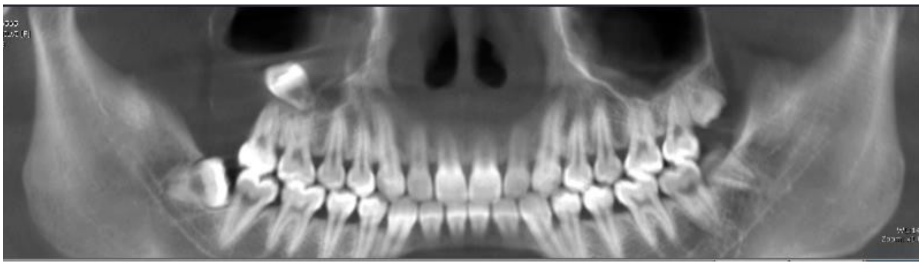

**Figure 2.** Panorama view of tooth 18 region

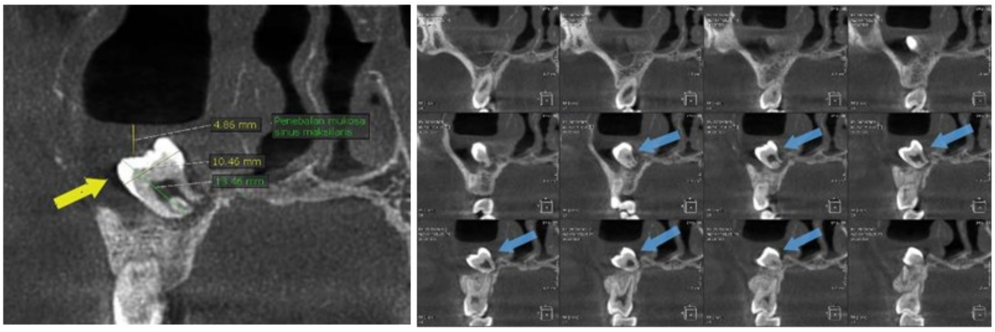

**Figure 3.** Coronal view (left) and coronal slicing view (right) of tooth 18 region

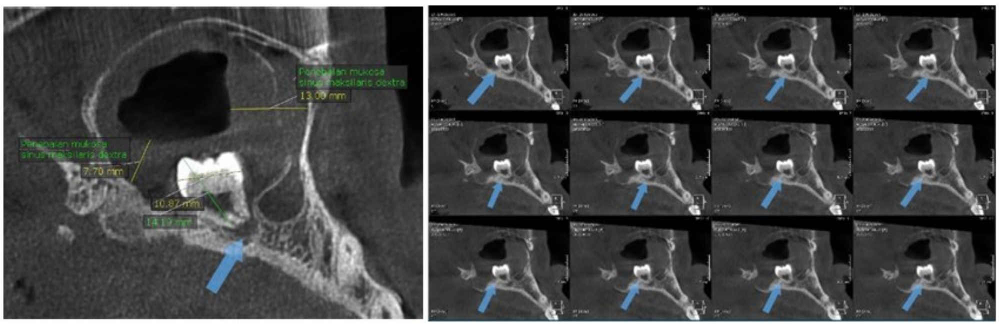

**Figure 4.** Sagittal view (left) and sagittal slicing view (right) of tooth 18 region

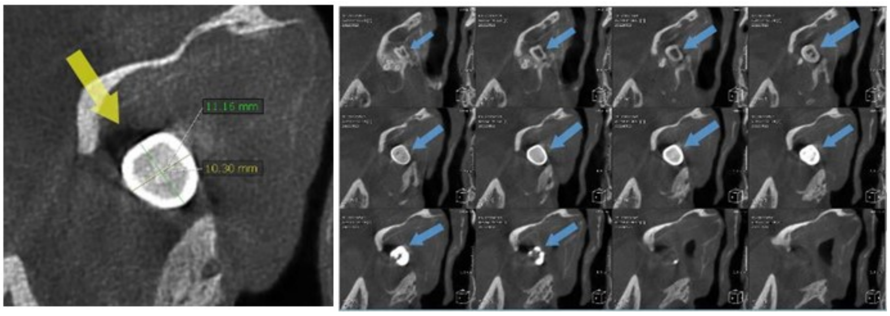


**Figure 5.** Axial view (left) and axial slicing view (right) of tooth 18 region

## DISCUSSION

Impaction is usually not visible in the oral cavity. Although rare, impacted teeth in different areas such as the mandibular condyle, coronoid processus, nasal cavity, palate, and maxillary sinus have been reported.[10] The etiology of these impacted teeth is still unknown, but many theories such as trauma, infection, genetic factors, developmental anomalies, iatrogenic, idopathic activities, and pathological conditions such as dentigerous cysts can be the cause. This condition is believed to push the tooth seed due to expansion of the cyst lesion causing the tooth to become impacted. [11,12]

Panoramic, water's view, and plain skull are simple methods that are easy to perform in daily practice. However, they present two-dimensional images that are difficult to interpret due to the overlap with other cranial bone structures.[13] Advanced specialized radiographic techniques such as Computed Tomography (CT) and Cone Beam Computed Tomography (CBCT) are essential in diagnosing cysts involving the maxillary sinus.[14]

Radiographic examination to see the condition of the maxillary sinus can use extra oral radiography and CBCT. Maxillary sinusitis is an inflammation because of infection, chemical irritation, allergy, introduction of a foreign body, of facial trauma. The imaging changes associated with inflammation include thickened sinus mucosa, air-fluid levels, polyps, empyema, and retention pseudocysts.[6,7] Radiographic images of maxillary maxillary sinusitis are radiointermediate meets or air-fluid levels in the maxillary sinus.[15] This case show radiopaque near-complete around the entire wall of the sinus, indicates sinus maxillaris. Sometimes it is difficult to differentiate mucositis from sinusitis mucositis is localized thickened sinus mucosa. Radiographic imaging of mucositis is a well-defined, noncorticated radiopaque band of increased radiopacity paralleling the bony wall of the sinus while sinusitis radiopacification along the sinus floor, around the entire wall of the sinus, or near-complete or complete of the sinus, and fluid level of antral cavity with a characteristic meniscus shape.[6,7]

CBCT is very useful in demarcating hard tissue edges from soft tissue invasion of lesions.[16] The main advantage of CBCT is that it can present multiplanar reformation with volume reconstruction and 3D images with a much lower radiation dose when compared to CT. This allows the surgeon to accurately assess the extent of the lesion as well as assess its proximity to adjacent vital structures.[17,18] Unilocular radiolucency with well-corticated margins above the crown of the involved tooth, attached to the cemento-enamel junction (CEJ) of impacted tooth was seen at the CBCT. As the result in the radiographic finding the characteristic is similar as dentigerous cyst or also known as follicular cyst. The CBCT in this patient's case showed an inverted impacted tooth with a dentigerous cyst extending into the maxillary sinus.[19]

The goals of treatment of maxillary sinusitis are to control the infection, promote drainage, and relieve pain. Acute maxillary sinusitis is usually treated medically with decongestants to reduce mucosal swelling and with antibiotics in the case of a bacterial maxillary sinusitis. Chronic maxillary sinusitis is primarily a disease of obstruction of the ostia; thus the goal is ventilation and drainage. This is often accomplished through endoscopic surgery to enlarge obstructed ostia or by establishing an alternate path of drainage.[1,3,6,7,20]

## CONCLUSION

Maxillary sinusitis can be assessed using extra oral radiographs and CBCT. CBCT examination is useful in determining the source of the lesion, the extent of the lesion, and the thickness of the maxillary sinus mucosa. The CBCT results showed a radiointermediete image of the maxillary sinus showing thickening of the sinus mucosa and an inverted impacted tooth on the dextra maxilla.

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## FOOTNOTES

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# Enhancing the diagnosis of sublingual sialolith using CBCT: a case report

Dimas Satria Putra[1,2], Lusi Epsilawati[1]

## ABSTRACT

**Objectives:** This case report was created to provide further insight into the use of CBCT in detecting sialolith lesions.

**Case Report:** A 27-year-old female patient was referred to the radiology department of Padjadjaran University Dental Hospital for CBCT radiograph examination related to complaints of swelling in the right lingual area of the mandible and pain. The results of the radiograph examination analysis showed irregular, well-defined radiopaque, in the lingual area of regio 44-45, measuring 34.31 mm2, and the lesion was not associated with the mandible. Intra-oral examination revealed irregular swelling and the same color as the lingual mucosa of regio 44-45. The analysis showed that the lesion was located in the salivary duct of the sublingual area and the patient was diagnosed with sublingual sialolithiasis dextra.

**Conclusion:** CBCT analysis can be used to accurately identify the position, quantity, and morphology of sialoliths and interpret their three-dimensional positioning in relation to adjacent structures.



***Keywords:*** *Sialolithiasis, salivary stone, CBCT 3D*
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## INTRODUCTION

Sialolithiasis is a condition marked by the presence of sialoliths in various regions of the salivary glands. This disease is the most common condition affecting the salivary glands and is a significant factor to dysfunction in these glands, resulting in swelling and pain in one side of the salivary gland.[1,2] The prevalence of this condition is estimated to be 1.2% among adults, typically manifesting between the ages of 30 and 60. Males face a higher frequency of occurrence compared to females, whereas children are rarely affected.[3]

Various imaging techniques have been used to accurately diagnose and treat this condition. Ultrasonography (USG) is widely used because to its widespread availability, affordability, and lack of radiation exposure. The previous case from Kim J et al. (2016), compared the diagnostic performance of panoramic and occlusal radiograph. Although the result displayed satisfactory diagnostic performance but they concluded that three-dimensional radiograph is required for surgical planning.[4]

Cone-beam computed tomography (CBCT) is being used more and more for diagnosing conditions related to the head, neck, and dento-maxillofacial area. CBCT scanners give high-resolution imaging of the hard tissues in the maxillofacial region, allowing for the assessment of skeletal structure and the observation of sialolith lesions in three dimensions.[5] The aim of this case report is to see the ability of CBCT to diagnose sialolith lesions.

## CASE REPORT

The 27-year-old female patient was referred to the Dental Radiology installation of Padjadjaran University Dental Hospital for CBCT examination due to complaints of swelling in the area under the tongue and intermittent pain for 2 months. Intra-oral clinical examination showed that there was swelling in the lingual area of the tongue in the region of 44-45, and the swelling area was the same color as the surrounding mucosa (Figure 1). There was no extraoral swelling, no medical history, and no previous treatment related to the complaint.

CBCT examination showed a radiopaque, well-defined mass in the lingual area of regio 44-45 with a size of 34.31 mm2 around 7,2 x 3,9 mm. In axial and sagittal views, the lesion did not appear to be associated with the mandibular bone area (Figure 2). Density examination using region of interest (ROI) showed 950-1065 Grayscale, which is similar to hard tissue. It was also confirmed by the 3D view on the CBCT software where the radiopaque lesion did not attach to or involve the hard tissue area (Figure 3).

Based on the patient's history of intermittent

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pain and hard swelling for 2 months, clinical examination with findings of hard and mucosa-colored swelling, as well as findings on radiographic analysis, it was concluded that the lesion was soft tissue related and located in the sublingual area dextra region 44-45 involving the salivary ducts. Thus, we gave a suspect radiodiagnosis of sublingual sialolithiasis dextra.

## DISCUSSION

Sialolithiasis is considered to be the most common salivary gland disorder and it accounts for about 1.2% of unilateral major salivary gland swellings. Submandibular gland has the highest predilection for sialolithiasis with 80% occurrence

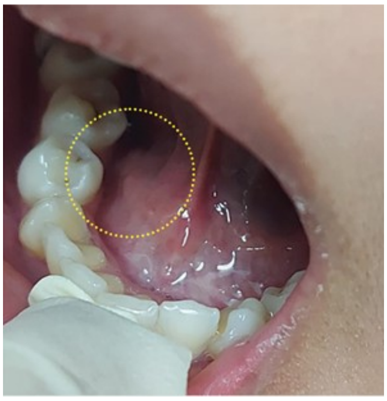

**Figure 1.** Intra-oral showing irregular swelling on the right lingual posterior of the mandible

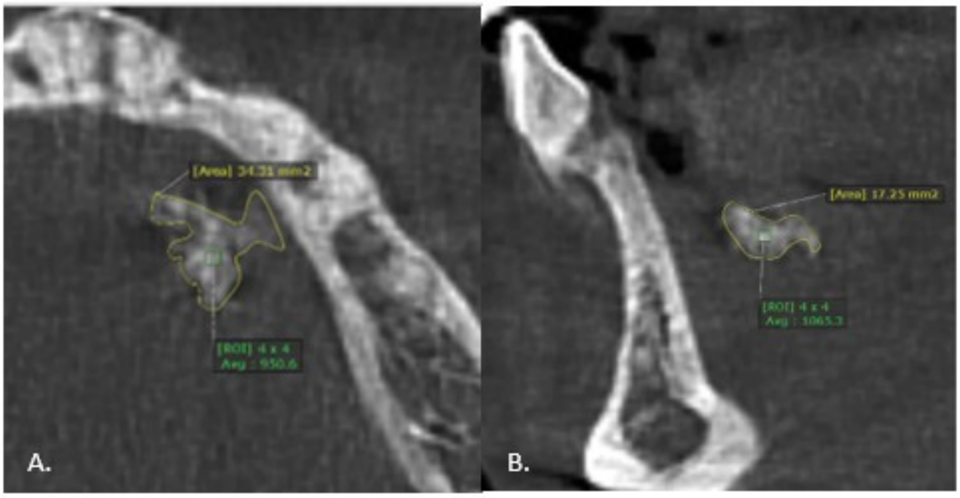


**Figure 2.** CBCT analysis, (A) A right mandible sialolith lesions (yellow border) from axial view,
(B) Sagittal view shows the radiopaque lesion (yellow border) did not involve mandibular bone structure

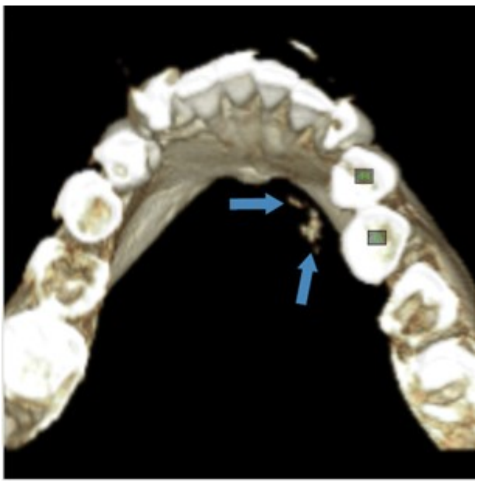

**Figure 3.** 3D Visualization of Sialolith in right lingual mandible (blue arrow)

rate, followed by the parotid (19%) and the sublingual (1%) glands. Sialolithiasis is usually seen between the age of 30 and 60 years. It is uncommon in children as only 3% of all sialolithiasis cases has been reported in the pediatric population. Males are affected twice as much as females.[6] The etiology of sialolithiasis is currently unclear however, some researchers hypothesize that changes in saliva flow and an excess of mucus contribute to the formation of amorphous phosphate tricalcium, which then crystallizes and converts into hydroxyapatite. The matrix contains many components that oppose each other and subsequently undergo calcification, resulting in the formation of the sialolith.[7,8] Sialolithiasis is frequently accompanied by clinical manifestations, such as intermittent pain or swelling of the affected salivary gland.[9] Radiographicly sialolith are visualized as single or multiple radiopaque lesion, round or oval shape, and cylindric or irregularly shaped calcifications.[10] In this case, the lesion appeared in a female patient under 30 years old, therefore making this case quite uncommon. Similarity was found in the characteristics of the lesion with the theory, the lesion in this case is well-defined, irregularly shaped, radiopaque calcification.

Various diagnostic tests are employed to identify salivary calculi. Each of these imaging techniques has its own set of advantages and disadvantages when it comes to the usage of ionizing radiation, price, availability, and the ability to visualize the ductal system. USG and 2D radiography are commonly employed in daily medical practice due to their cost-effectiveness, widespread accessibility, and minimal or negligible radiation exposure. Panoramic radiograph are extensively utilized in dentistry to assess overall pathological characteristics in the maxillofacial region due to their ability to capture a broad range of locations with minimal radiation exposure and at a cheap expense.[5] Panoramic radiograph can be used to diagnose many disorders, such as soft tissue calcification. Nevertheless, panoramic radiograph have fundamental limitations in accurately diagnosing sialolithiasis, even when augmented with artificial intelligence. Approximately 20% of siaoliths are poorly calcified, and therefore not visible on 2D radiographs. moreover, the deposition of a radiopaque sialolith on the body of the mandible area is barely visible on 2D radiographs.[11,12]

The use of CBCT has become increasingly common in maxillofacial radiology due to its superior image quality and reduced radiation exposure in comparison to Computed Tomography (CT). It provides enhanced visualization of the ductal system compared to traditional sialography.[13] The CBCT scanner employs a cone X-ray beam and utilizes two-dimensional detectors to gather data through a solitary spin around the patient, which typically lasts between 9 and 40 seconds. The reconstruction is subsequently conducted, resulting in an isotropic picture matrix. The system's software offers a range of processed images, including multiplanar reconstruction, volume rendering, cross-sectional, and partly panoramic images. The use of isotropic voxels allows for explicit and accurate reconstruction of anatomic features in any plane.[14]

There has been limited study on the potential use of CBCT in diagnosing salivary stones.[13] CBCT offers excellent spatial resolution, a wide variety of grey densities, and high contrast, collectively with a favorable pixel-to-noise ratio.[15] Tomographic images can be transformed into three-dimensional images, which offer a more accurate representation of the anatomy and allow for a better understanding of anatomical structures and the operative condition that needs to be taken into consideration.[16,17] The grey density of a sialolith is similar to hard tissue, thus making CBCT an effective method for accurately visualizing the location and morphology of the lesion. In this example, the lesion is immediately visible through 3D viewing (Figure 3). Jadu et al. (2010) concluded that the effective doses from CBCT tests centered on the parotid and submandibular glands were comparable to those calculated for plain radiography for sialography. This similarity was shown when a 15 cm field of view (FOV) was selected, along with exposure conditions of 80 kVp and 10 Ma.[9] As in this case, CBCT analysis can provide clear information about the location and size of the lesion so that it can facilitate the operator in performing treatment.

Multiple researchers have previously reported the usefulness of CBCT in the precise detection of sialolithiasis. The primary objective is to enhance intraoperative orientation through a more comprehensive understanding of the stone's location. Additionally, CBCT enables accurate diagnosis and identification of the stone's spatial topography in relation to the surrounding structures. This will boost the surgeon's confidence in utilizing a direct method and raise the probability of quickly finding the sialolith.[9,13,18,19] CBCT can be used to verify the full removal of calculi by comparing the number and shape of the extracted stones. The significance of these additional findings will be notably relevant in situations involving many calculi or megaliths, as they are vulnerable to fragmentation during the extraction process. The morphology of the sialolith observed on a CBCT can assist in reconstructing the stone in cases of disintegration. Consequently, CBCT is equally reliable as medical CT in accurately diagnosing and measuring sialolith lesions.[18,19]

## CONCLUSION

The utilization of CBCT analysis can be an additional examination method for precise identification of the position, quantity, and morphology of the sialoliths, and specifically for a precise interpretation of the three-dimensional positioning of the salivary stones in relation to the adjacent structures.

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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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CASE REPORT

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# CBCT-3D radiographic analysis of an infected radicular cyst of the upper jaw: a case report

Ade Prawira[1], Barunawaty Yunus[1], Fadhlil Ulum Abdul Rahman[1], Mukhtar Nur Anam[2]

## ABSTRACT

**Objectives:** The purpose of this case report is to show CBCT can analyze in detail a radicular cyst case where it has the ability to determine the density of a lesion. An overview of the density pattern of a radicular cyst can help determine the lesion and its margins.

**Case Report: :** A 40-year-old patient complained of swelling in the palate that had been felt for about a year with a history of trauma due to an accident fifteen years ago. The patient underwent CBCT examination with the results of a hypodense area compared to the surrounding bone in the maxillary anterior area involving teeth 11,21,22 to 23 accompanied by a discontinuity of the cortical plate of the palatal bone and extending to involve the base of the nasal cavity. Part of the lesion is clearly demarcated, while the other side is diffuse. The suspected radiodiagnosis of the case was a moderately aggressive radicular cyst with a differential diagnosis of an odontogenic tumor.

**Conclusion:** The final diagnosis of this case was a radicular cyst with chronic granulomatous inflammation, based on a combination of radiographic findings, clinical findings, and histopathological examination.



***Keywords:*** *CBCT, radicular cyst, infected cyst*
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## INTRODUCTION

The radicular cyst is also known by other names, such as a periapical cyst or root-end cyst, as it occurs in the periapical region or the root end of the affected tooth. The radicular cyst is usually asymptomatic and is accidentally discovered by routine radiographic examination. Patients affected by radicular cyst usually complain of swelling in the vicinity of the affected tooth region by such cyst. Some patients may even complain of pain in the affected tooth region if the radicular cyst is infected. Radicular cyst occurs more commonly among males in the anterior maxilla region.[1,2] The teeth commonly affected by radicular cyst are the ones that are more prone to trauma, including the maxillary central incisor, maxillary lateral incisor, mandibular central incisor, and mandibular lateral incisor. The patient usually gives a history of trauma; some even forget the history of the traumatic episode. Here we report a case of radicular cyst in a 22-year- old-female, who underwent an access opening root canal treatment procedure in a nearby private dental clinic four years back but has not followed further follow-up visits.[3,4] Radicular cyst is one of the most common cysts in the jaw. With conventional radiographs sometimes difficult to distinguish from other lesions. To diagnose the lesion we can look at the border of lesion. CBCT radiographs have the ability to determine the density of a lesion. The most common location is 60% in the maxilla, especially the anterior region and the mandible in the posterior region. The incidence is highest in the 3rd and 4th decade of life and rare in children. Radicular cysts are more common in males (approximately 58% compared to 48% in females).[4]

This case report presents the cone-beam computed tomography (CBCT) analysis and treatment plan of an extensive radicular cyst. The conventional radiographs show a two-dimensional image of the three-dimensional object and its surrounding structures. CBCT provides three-dimensional images of the object from sagittal, coronal, and axial directions to overcome image defects, such as overlap and deformation.

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## CASE REPORT

A 40-year-old patient complained of swelling in the palate that had been felt for about a year with a history of trauma due to an accident fifteen years ago. The patient underwent CBCT examination with the results of a hypodense area compared to the surrounding bone in the maxillary anterior area involving teeth 11,21,22 to 23 accompanied by a discontinuity of the cortical plate of the palatal bone and extending to involve the base of the nasal cavity. Part of the lesion is clearly demarcated, while the other side is diffuse. The suspected radiodiagnosis of the case was a moderately aggressive radicular cyst with a differential diagnosis of an odontogenic tumor.

The treatment carried out on the patient was enucleation of the cyst and followed by a biopsy with histopathological examination results in the form of an epithelial cyst that could support a radicular cyst accompanied by chronic granulomatous inflammation.

## DISCUSSION

The word “cyst,” which is derived from the Greek “Kystis,” means “sac or bladder.” A cyst is a diseased hollow pathological cavity bordered with epithelium that grows in a centrifugal, expansive manner.[1] The radicular cyst is the most common inflammatory odontogenic cyst in the human jaw. It is known by other names such as “Periapical cyst,” as it occurs in the periapical region of the affected tooth. “Root end cyst” occurs at the end of the tooth's root.[5] The radicular cyst is more common among males in the anterior region of the maxilla or mandible, as it is the most common site for trauma. It is crucial to note that dental caries not only result in forming a radicular cyst, but trauma can also induce the formation of a radicular cyst. The radicular cyst usually causes swelling, which may not be prominent initially. Still, if the treatment is neglected, it can gradually cause cortical expansion, devitalize the adjacent teeth, and result in pathological migration of the teeth. The pathogenesis of radicular cyst is controversial.[6]

Radiographically, the radicular cyst appears as round or pear-shaped unilocular radiolucency at the apex of a non- vital tooth as in the present case but was an extensive lesion. Other odontogenic cysts such as dentigerous cysts, odontogenic keratocysts, and odontogenic tumors such as mural ameloblastoma, Pindborg tumor, and odontogenic fibroma may share similar radiological features.[2,7] Hence, histopathological evaluation is necessary to diagnose these giant lesions. In extensive lesions, radiographs alone may not be sufficient to show the full extent of the lesions, and advanced imaging is


**Figure 1.** Clinical examination, (A) extra oral and (B) intra oral view of the patient

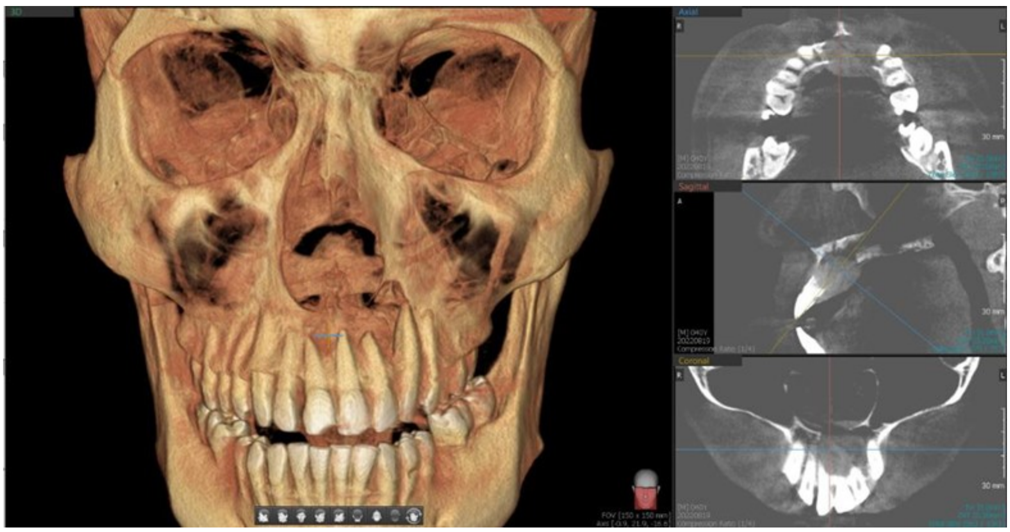

**Figure 2.** CBCT multiplanar radiograph of the lesion

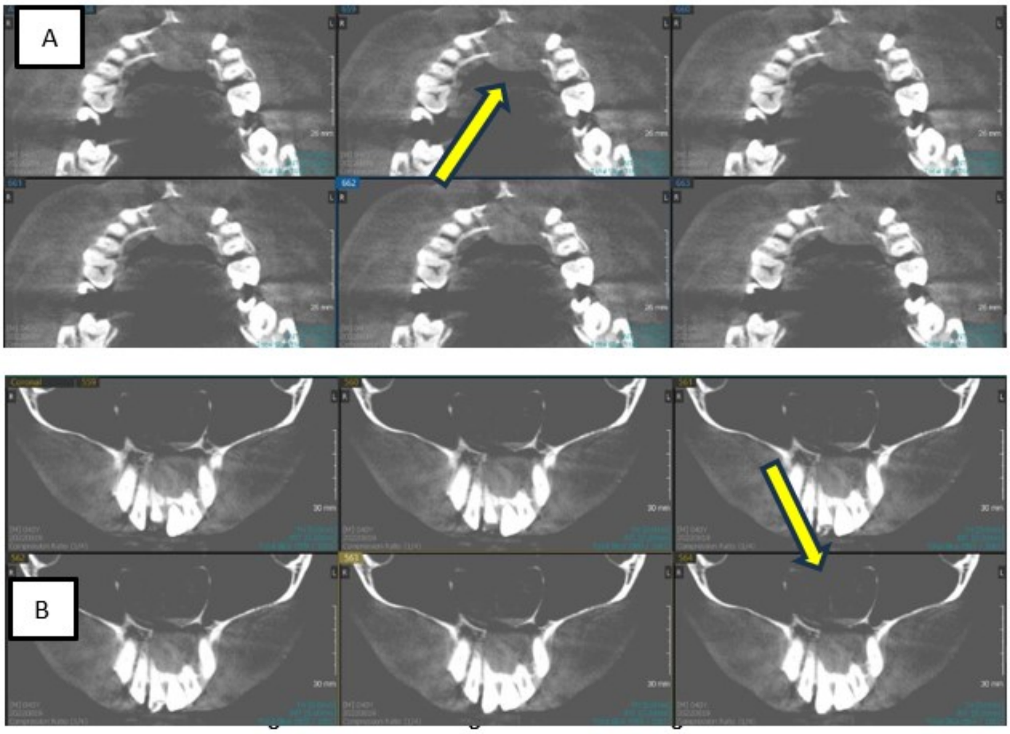


**Figure 3.** CBCT radiograph, (A)axial and (B) coronal view of the lesion

needed.[5,13] CBCT provides a 3D image that allows complete visualization of an area in question, in axial plane, the sagittal, and coronal planes and it also adds depth of field to conventional radiographs.[14]

Cone Beam Computed Tomography 3D is a radiographic technique that utilizes cone-shaped x-rays and computerized volumetric reconstruction to produce three-dimensional radiographs. It utilizes cone-shaped x-rays and computerized volumetric reconstruction that produces three-dimensional radiographs: sagittal, coronal, and axial. 3D CBCT can show histograms, radiographs in specific areas of interest to patients and doctors, distance and area measurements, density, distance measurements from a room to a slice, surface images, intensity modulation, osseointegrity, and others. This three-dimensional-based radiography aircraft can overcome the problems of conventional radiography tools that have existed before, such as the lack of accurate measurement of remaining bone thickness, the completeness of hard tissue details, the radiation dose that is large enough for patients, and the display of anatomical structures that are only in one aspect in one shot.[15] Based on the results of radiographic examination using CBCT, it can be seen from the sagittal, coronal, and axial views that there is a diapical radiolucent lesion from the region of teeth 11,21,22. Based on the quality of the radiographic image, it can be seen by eye that the radiolucent lesion in the 11,21,22 region is clearly demarcated and firm. This is in accordance with the radiologic features listed in several literatures that the image of a radicular cyst appears as an osteolytic or radiolucent lesion (circular or oval in shape) with a firm radiopaque border of varying size surrounding the tooth apex, unless the cyst is infected then the radiopaque image at the edge will disappear.[5,6,8]

The radicular cyst is the most common inflammatory odontogenic cyst in human jaws. Patients affected by such infected radicular cysts usually complain of pain and report to the oral physician. A careful history and clinical and radiological evaluation are necessary for patients to decide on treatment planning and efficient management of radicular cyst. In addition to being caused by trauma, radicular cysts can also grow as a result of injury to the periapical tissues beneath the tooth, such as from improper follow-up after a root canal procedure and from an access opening done on the root canal attempted tooth.[9,10] When the patient has not followed up on further subsequent treatment visits, untreated radicular cysts may result in buccolingual growth of the underlying bone and asymmetric facial features. Radicular cysts are frequent in the tooth- bearing regions of the mandible and maxilla. Lesions accidentally discovered to be smaller during a radiological evaluation do not show any symptoms. CBCT can be used to assist in the diagnosis of radicular cysts. The density pattern at the periphery and inside of a radicular cyst lesion is tapered with a steep slope towards the inside of the lesion. Trope and colleagues state that in distinguishing between granulomas and radicular cysts, the density of the lesion area can be measured using computed tomography. Density is the density of mineral elements in a particular region of the measured area.[11,12] Bone densitometry is the art and science of measuring the bone mineral content and density of a particular skeletal or whole body. Such bone measurements are used to assess bone strength, diagnose diseases associated with low bone density (e.g. osteoporosis), monitor the effects of therapy for some diseases, and estimate fracture risk. Lower density is seen in radicular cysts, while higher density is seen in granulomas compared to cysts. Determining the characteristics of the lesion margin based on quantity can be done by analyzing the density profile of the lesion margin.[16,17]

## CONCLUSION

The final diagnosis of this case was a radicular cyst with chronic granulomatous inflammation, based on a combination of radiographic findings, clinical findings, and histopathological examination. CBCT may provide more information for the diagnosis of a radicular cyst through the analysis the density of the lesion.

## ACKNOWLEDGMENTS

None.

## 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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# A novel approach of tongue cancer diagnostic imaging: a literature review

Gavrila Samitra Dwiputri[1*], Fadhlil Ulum Abdul Rahman[2]

## ABSTRACT

**Objectives:** This review article is aimed to provide a scientific information about novel approach of tongue cancer diagnostic imaging based on evidence-based reputed published studies.

**Review:** The databases used in this literature review are Google Scholar, PubMed and Elsevier. The research results were selected by title and abstract according to their relevance to the review topic, then the results were selected again based on the inclusion and exclusion criteria. A total of 13 literatures were reviewed. This review shows the diagnostic imaging is a useful tool for staging and management planning in tongue cancers. In this era of technological development, a novel diagnostic imaging technologies that can be used for the diagnosis of tongue cancers such us Ultra High-Frequency Ultrasound (UHFUS), Diffusion-Weighted Imaging MRI (DWI-MRI), Dynamic Contrast-Enhanced MRI (DCE-MRI), Optical Coherence Tomography (OCT), Positron Emission Tomography (PET), Endoscopic images, and the other noninvasive imaging methods like vital staining, autofluorescence, Narrow-Band Imaging (NBI), and in vivo confocal microscopy. Besides that, imaging of tongue cancer requires a multimodality imaging approach to obtain accurate information about pathological condition such as PET/MRI, FDG PET/CT, and SPECT-CT.

**Conclusion:** Each diagnostic imaging has limitations in imaging the patient's condition, so it can be used alone or in combination with one another to obtain accurate information about pathological conditions. FGD PET-CT and UHFUS reportedly provide a high level of sensitivity and specificity to diagnose and staging of tongue cancer.

***Keywords:*** *Tongue cancer, diagnostic imaging, advanced modality*

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## INTRODUCTION

According to the Global Cancer Observatory (GLOBOCAN), Oral Cavity Cancer (OCC) is the most prevalent form of malignancy in the head and neck area. It is anticipated that the global occurrence of new OCC will surpass 29 per 100,000 individuals by the year 2030, affecting both genders and all age groups.[1] Oral cavity cancers (OCC) rank sixth in global cancer incidence, with squamous cell carcinomas (SCC) accounting for approximately 90% of all oral cancer cases. Squamous cell carcinoma (SCC) affecting the oral tongue is a frequently encountered subsite of SCC in the oral cavity. In males, SCC of the oral tongue is recognized as the 12th most prevalent cause of cancer-related mortality. According to estimates for the year 2018, there will be a total of 17,110 fresh incidences of oral tongue cancer, with 12,490 cases occurring in men and 4,620 cases developing in women (constituting one-third of the total cases). According to estimates, the mortality rate attributed to oral tongue cancer in the year 2018 was 2,510 fatalities, with 1,750 occurring in males and 760 in females.[2]

The early diagnosis of oral cancer is a crucial matter of interest in public health, as it leads to reduced morbidity post-treatment and a more favorable prognosis for patients. Patients who receive an early diagnosis of oral cancer tend to exhibit a more favorable long-term survival rate, ranging from 60% to 90%. In contrast, patients diagnosed with advanced stage oral cancer have a significantly lower survival rate, ranging from 20% to 50%. For patients receiving palliative care, the survival rate is less than 5%. The initial stage in the examination and diagnosis of oral cancer and precancer involves traditional oral exploration and palpation, as the majority of such tumors are discernible without the aid of magnification. Then, the definitive diagnosis is established by histological study of the biopsy specimen. Accurate disease diagnosis and staging, crucial for effective treatment planning, necessitates the utilization of complementary imaging modalities that provide supplementary information, spanning from conventional X-rays to highly advanced technologies.[3,4]

Currently, diagnostic imaging of radiology technology in dentistry is no longer superior in visualizing hard tissue changes, but also its developed various imaging modalities that can visualize soft tissue pathological conditions such as soft tissue malignancy including tongue. In the early -stage detection of tongue cancer and in making informed decisions regarding oral tongue cancer management, diagnostic imaging analysis has the potential to assist pathologists and clinicians. The gold standard for the diagnosis of tongue cancer is established based on the results of histopathological examination of the biopsy specimens, while the clinical staging of oral cancer is determined based on the results of clinical examination and diagnostic imaging. The utilization of diagnostic imaging is crucial in instances of tongue cancer as it aids in the determination of the clinical stage by assessing the primary tumor's extent, metastases to regional lymph nodes, and the degree of metastases. Additionally, it assists in identifying the most suitable treatment approach for the patient. The utilization of imaging techniques is imperative in facilitating the accurate and effective management of these cancers. Awareness of specific issues related to spread of oral cancers at various subsites and the principles of management would help the radiologist choose a deal imaging approach and provide the clinician with a relevant report.[5]

The early detection of tongue cancer combined with appropriate imaging methods for proper staging is highly required and crucial. In this era of technological development, a novel diagnostics imaging technology has also been exploited in this field. In this article, a novel approach, combined with appropriate imaging methods used for the diagnosis of tongue cancer is discussed. This review article is aimed to provide scientific information about a novel approach of tongue cancer diagnostic imaging based on evidence-based reputed published studies. This research is expected to provide information regarding a novel diagnostic imaging of tongue cancer based on published studies and assist in establishing the diagnosis of tongue cancer.

## REVIEW

A literature review using 3 databases, Google Scholar, PubMed, and Elsevier was conducted to explore the existing literature on the diagnostic imaging of tongue cancer. The research result was selected by title and abstract according to their relevance to the review topic, the result was selected again based on the inclusion and exclusion criteria. The inclusion criteria in this study were articles that discuss the diagnostic imaging of tongue cancer and literatures published between 2020-2023. Exclusion criteria in this study were duplicated literatures, unavailable full-text and written in other languages than English or Indonesian. Based on the selection criteria 13 literatures were collected and reviewed.

### TONGUE CANCER

Tongue cancer is a form of malignancy affecting the tongue, with Squamous Cell Carcinoma (SCC) accounting for approximately 95% of all diagnoses. Tongue carcinomas predominantly arise on the anterior two-thirds of the tongue, with a prevalence of 40-75%, typically affecting the lateral and the lower edges of the organ. This particular malignancy accounts for a prevalence of 1% among all carcinomas throughout the body, and represents the most prevalent form of oral malignancy, with an incidence rate ranging from 25% to 45%. The delayed diagnosis of over 50% of cases results in a decrease in the patient's survival rate. [6] Oral tongue squamous cell carcinoma is a type of cancer that is anatomically characterized by its occurrence in the anterior two-thirds of the tongue. This area is situated within the oral cavity and spans from the apex of the tongue in the anterior direction to the circumvallate papillae in the posterior direction. In contrast to oral tongue cancer, which is situated at the anterior two-thirds of the tongue and is found in the oral cavity, base of tongue cancer is localized at the posterior one-third of the tongue and is situated within the oropharynx. The secondary spread of oral tongue squamous cell carcinoma may occur to the base of tongue or other contiguous oral cavity subsites, including the floor of mouth, gingiva, mandible, and beyond. However, the carcinoma is characterized by its origin from the oral tongue. [7]

The etiology of tongue carcinoma is considered to be multifactorial, with a known correlation to tobacco consumption, such as in the form of cigarettes. Tobacco use is considered a significant risk factor in the etiology of squamous cell carcinoma (SCC) of the tongue. The consumption of tobacco products, such as cigarettes, cigars, pipes, chewing tobacco, and snuff, represents the most significant risk factors for the development of head and neck cancer, including the tongue. Tobacco use has been found to be associated with 85% of head and neck cancers. Alcohol, constitutes a risk factor for the onset of oral cavity and tongue cancer, albeit being a less potent carcinogenic agent than tobacco. Individuals who engage in the consumption of tobacco and alcohol concurrently exhibit a synergistic effect, leading to a significant increase in risk. The magnitude of this risk is estimated to be between 30 to 36 times higher for individuals who engage in heavy smoking and drinking.[2,6]

### DIAGNOSTIC IMAGING METHODS IN TONGUE CANCER

The use of radiographic imaging has entirely revolutionized diagnosis and treatment planning in medical sciences. The role of imaging in oral malignancies can be broadly grouped in those used to evaluate primary disease and those to evaluate metastatic disease. It is a useful tool for staging and management planning in oral tongue cancers.[8] The identification and detection of early-stage oral tongue cancer through imaging pose a significant challenge. Numerous imaging modalities are available for the detection of tongue cancers within the oral cavity. Hence, a meticulous examination of the literature derived from diverse studies is imperative to ascertain and synthesize a novel diagnostic imaging approach for tongue cancer. Table 1 presents a comprehensive overview of the latest research conducted on the diagnostic imaging modalities utilized in the detection of tongue cancer, as described below.

This review shows the diagnostic imaging is a useful tool for staging and management planning in oral tongue cancers. In this era of technological development, a novel diagnostic imaging technology that can be used for the diagnosis of tongue cancers such us Ultra High-Frequency Ultrasound (US), Diffusion-weighted imaging MRI (DWI-MRI), Dynamic contrast-enhanced MRI (DCE-MRI), Optical coherence tomography (OCT), Single-photon emission computed tomography (SPECT), Positron emission tomography (PET), Endoscopic images, and the other noninvasive imaging methods like vital staining, autofluorescence, narrow-band imaging (NBI), and and in vivo confocal microscopy. Besides that, imaging of tongue cancer requires a multimodality imaging approach to obtain accurate information about the pathological condition such as PET/MRI, PET/CT, and SPECT-CT.

**Table 1.** Summary of the recent studies on the diagnostic imaging methods in tongue cancer

| Author (Year) | Title | Conclusion | Identified Diagnostic Imaging Methods | Design of Study |
|---|---|---|---|---|
| Yang et.al [9] (2023) | Deep-Learning Based Automated Identification and Visualization of Oral Cancer in Optical Coherence Tomography Images | It is proved that automatic identification methods combining the powerful learning capabilities of deep learning with the advantages of OCT imaging are feasible, which is expected to provide decision support for effective screening and diagnosis of oral cancer and precancerous tissues. | OCT | Deep learning Model |
| Tang et.al [10] (2022) | Assessment of tumor depth in oral tongue squamous cell carcinoma with multiparametric MRI: correlation with pathology. | E-THRIVE was the optimal MR sequence to measure the MR-derived DOI, and DOI derived from e-THRIVE could serve as a potential cut-off value as a clinical T staging indicator of OTSCC. | DWI-MRI<br>DCE-MRI | Retrospective analysis |
| Heo et.al [11] (2022) | Deep learning model for tongue cancer diagnosis using endoscopic images | The deep learning model developed based on the verified endoscopic image dataset showed acceptable performance in tongue cancer diagnosis. | Endoscopic image | Deep learning Model |
| Aydos and Cebeci [12] (2023) | Prognostic role of primary tumor metabolic-volumetric parameters of 18F-fluorodeoxyglucose positron emission tomography in tongue squamous cell carcinoma | Primary tumor MTV is an independent prognostic factor in resectable TSCC. PET volumetric features can be used as a prognostic biomarker to predict patients with poor prognosis. | PET | Retrospective study |
| Novikov et.al [13] (2021) | Single photon emission computed tomography-computed tomography visualization of sentinel lymph nodes for lymph flow guided nodal irradiation in oral tongue cancer | Localization of sentinel LNs determined by SPECT-CT corresponds to the localization of metastatic LNs in terms of side and levels. | SPECT-CT | Retrospective study |
| Linz et.al [14] (2021) | Accuracy of 18-F Fluorodeoxyglucose Positron Emission Tomographic/Computed Tomographic Imaging in Primary Staging of Squamous Cell Carcinoma of the Oral Cavity | The results of this study suggest that combined FDG PET/CT is a valuable diagnostic tool in the preoperative staging of SCC of the oral cavity. The use of FDG PET/CT was associated with a high NPV and was superior to stand-alone morphologic imaging. | FDG PET/CT | Prospective diagnostic study |

**(Cont.) Table 1.** Summary of the recent studies on the diagnostic imaging methods in tongue cancer

| Author (Year) | Title | Conclusion | Identified Diagnostic Imaging Methods | Design of Study |
|---|---|---|---|---|
| Izzetti et.al [15] (2021) | Evaluation of Depth of Invasion in Oral Squamous Cell Carcinoma with Ultra-High Frequency Ultrasound: A Preliminary Study | UHFUS has the potential to become a valuable technique for the evaluation of OSCC lesions, and give insight into its application in OSCC diagnostic work-up and surgical management. | UHFUS | Retrospective study |
| Iandelli et.al [16] (2023) | The Role of Peritumoral Depapillation and Its Impact on Narrow-Band Imaging in Oral Tongue Squamous Cell Carcinoma | In our study, clinical peritumoral depapillation is associated with PNI on the pathology report. Its presence does not affect the NBI's ability to detect perilesional neoangiogenesis and delineate resection margins. | NBI | Retrospective study |
| Ikeda et.al [17] (2020) | Usefulness of fluorescence visualization-guided surgery for early-stage tongue squamous cell carcinoma compared to iodine vital staining | We strongly suggest that FV-guided surgery is a useful method for accurate resection in early-stage tongue squamous cell carcinoma. | Vital staining Autofluorescence | Prospective study |
| Kanno et.al [18] (2020) | Comparison of diagnostic accuracy between [$^{18}$F]FDG PET/MRI and contrast-enhanced MRI in T staging for oral tongue cancer | Although shallow DOIs are often overestimated, regional [$^{18}$F] FDG PET/MRI without fat suppression and gadolinium enhancement is comparable to and may be substituted for ceMRI in preoperative T staging for OTC patients, reducing metal artifacts and avoiding the adverse effects of GBCAs. | FDG PET/MRI | Retrospective study |
| Guo et.al [19] (2020) | Quantitative dynamic contrast-enhanced MR imaging can be used to predict the pathologic stages of oral tongue squamous cell carcinoma. | The quantitative DCE-MRI parameter Kep can be used as a biomarker for predicting the pathologic stages of OTSCC. | DCE-MRI | Prospective study |
| Jeng et.al [20] (2021) | Multiclass classification of autofluorescence images of oral cavity lesions based on quantitative analysis. | The QDA algorithm outperforms the LDA classifier in the analysis of autofluorescence images with respect to all of the standard evaluation parameters. | Autofluorescence | Retrospective study |
| Contaldo et.al [21] (2020) | Intraoral confocal microscopy of suspicious oral lesions: a prospective case series | In vivo reflectance confocal microscopy (RCM) can reveal dysplastic/neoplastic signs occurring in oral lesions, thus supporting their diagnostic pathway. | In vivo confocal microscopy | Prospective study |

## DISCUSSION

An accurate analysis of the stage of tongue cancer is vital in deciding the therapy offered to the patient. Even though tongue is an organ, which is visible, clinical examination is difficult as most of the patients with carcinoma of tongue cannot open their mouth wide and many cannot tolerate palpation. Furthermore, these tumors are infiltrative, and if they cross the barrier of lingual aponeurosis, they will grow beneath it extensively involving the musculature while the mucosal surface shows a small or even no abnormality. Hence diagnostic imaging and staging of tongue cancer are indispensable.[22]

### OPTICAL COHERENCE TOMOGRAPHY (OCT)

The utilization of optical coherence tomography (OCT) as an optical modality has the potential to furnish an optical manifestation of tissue and discern structural modifications transpiring in both benign and malignant lesions (Figure 1). Optical Coherence Tomography (OCT) is a non-invasive imaging modality that facilitates the quantification of epithelial thickness and structural alterations by analyzing data scans. The utilization of optical coherence tomography resulted in a sensitivity of 85% and a specificity of 78% when evaluating oral disorders that have the potential to become malignant or are already malignant. The accuracy of the assessment based solely on architectural changes was dec be 82%. Achieving resolutions of

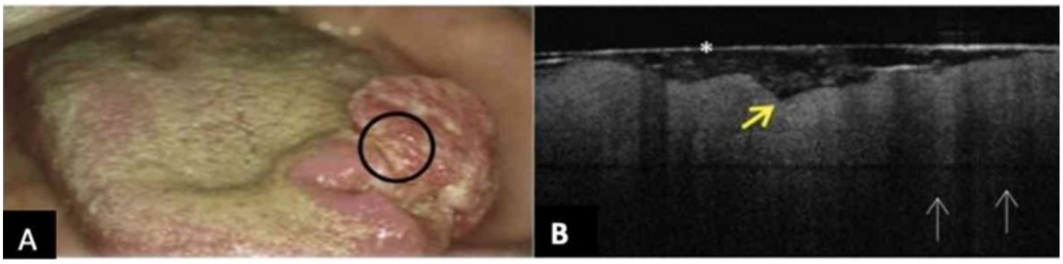


Figure 1. Representative image of tongue cancer on (A) Clinical, (B) Optical Coherence Tomography (OCT)[24]

up to 1-2µm is possible, which is approximately 100 -250 times greater than high-resolution ultrasound and comparable to that of microscopy. OCT imaging has demonstrated a significant correlation with histology in epithelial tissues, thereby establishing its potential in facilitating the diagnosis of pathological lesions and detecting cancer-free or positive margins following resection.[23]

## DIFFUSION-WEIGHTED IMAGING MRI (DWI-MRI)

The utilization of Diffusion-weighted Imaging (DWI) is employed to examine the cellularity of tissues and the integrity of cell membranes through the measurement of the stochastic movement of water molecules in biological tissues (Figure 2A). DWI magnetic resonance imaging (DWI-MRI) is a technique that quantifies variations in tissue microarchitecture by analyzing the stochastic motion of water molecules. The quantification of discrepancies in water mobility is accomplished through the utilization of the apparent diffusion coefficient (ADC), which exhibits an inverse correlation with tissue cellularity. Therefore, the aforementioned technique has the capability to distinguish between tumorous tissue and normal or necrotic tissue. The metastasis of lymph node in patients diagnosed with oral squamous cell carcinoma (OSCC) is a negative prognostic indicator, necessitating precise identification to facilitate optimal treatment. The current investigation revealed that DWI-MRI exhibited a sensitivity of 75%, a specificity of 88.24%, and an accuracy of 96.69%. [25] Diffusion-weighted imaging (DWI) has the capability to accurately identify cancer-involved structures and distinguish reactive lymph nodes from metastatic ones. Consequently, it is recommended to evaluate lymph nodes prior to surgical intervention. Furthermore, DWI-MRI has the potential to aid in the evaluation of the initial response of the neoplasm to chemotherapy, with possible detection as early as one to two cycles of chemotherapy. The drawbacks associated with the utilization of this imaging modality include the existence of ferromagnetic substances, patients experiencing claustrophobia, and patients who have implanted pacemakers.[4]

## DYNAMIC CONTRAST-ENHANCED MRI (DCE-MRI)

Dynamic contrast-enhanced magnetic resonance imaging, also known as DCE-MRI, is a method that collects a sequence of sequential pictures during contrast enhancement (Figure 2B). The utilization of DCE-MRI in clinical settings has been growing steadily over the past several years. Quantitative and semi-quantitative analyses are the two primary classifications that may be used in the DCE-MRI techniques of data analysis. Opportunities to investigate the properties of the tissue may be found via the use of quantitative and semi-quantitative methodologies. The prospective application of DCE-MRI in the management of patients afflicted with cancers includes assessing factors such as the treatment response, tumor differentiation, and tumor stage. DCE-MRI has the potential to give complete information about tumor features and has the ability to evaluate the stages of tongue cancer in a clinical environment without the use of invasive procedures.[26] The utility of DCE-MRI has been established in the diagnosis and differential diagnosis of both benign and malignant tumors in the head and neck region. Additionally, it is effective in characterizing metastatic cervical lymph nodes, assessing tumor cell proliferation and microvessel attenuation, predicting treatment

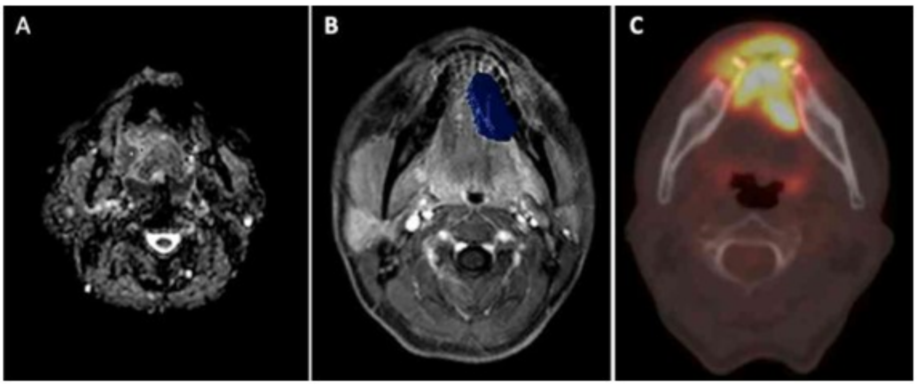


Figure 2. Representative image of tongue cancer on (A) DWI-MRI[10], (B) DCE-MRI[19], (C) PET[28]

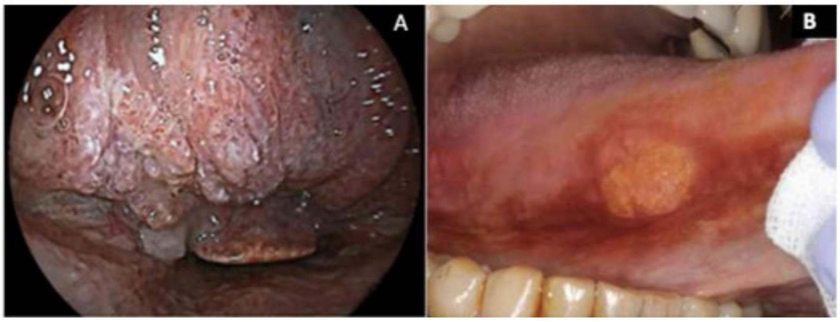


**Figure 3.** Representative image of tongue cancer on (A) Endoscopic[31], (B) Iodine Vital staining[17]

response, and evaluating treatment outcomes and prognosis in head and neck cancers. The utilization of DWI-MRI yielded a sensitivity of 89.2% and a specificity of 82.6% in the evaluation of oral lesions with potential malignancy or malignancy.[19]

**POSITRON EMISSION TOMOGRAPHY (PET)**

The utilization of radioisotopes that undergo positron emission decay is a fundamental aspect of Positron Emission Tomography (PET). The patient is encompassed by a detector that identifies the paired gamma photons that are emitted due to decay and record the occurrence as an image (as illustrated in Figure 2C). The preferred radionuclide utilized in positron emission tomography (PET) is [18F]-fluoro-2-deoxy-d-glucose (FDG).[27] Positron emission tomography (PET) utilizing 18F-fluorodeoxyglucose, a radioactive compound, can be administered either orally or intravenously to assess tissue metabolic activity. This technique has been employed to ascertain the metastatic potential of tumor cells. PET scans have additional applications such as facilitating the preparation of adjuvant therapy, approximating the likelihood of recurrence, and detecting the primary tumor location in instances of early metastasis, specifically in carcinoma of unknown primary.[4] Positron emission tomography (PET) utilizing 18F-fluorodeoxyglucose is a modality for assessing tissue metabolic activity. This is utilized in the context of devising supplementary therapeutic interventions and forecasting the likelihood of relapse-free survival. The application of this method enables the identification of metastatic lymph nodes with a sensitivity of 83% and a specificity of 88%. It allows for an estimation of the risk of recurrence.[28]

**ENDOSCOPIC IMAGES**

Endoscopy is a minimally invasive, simple and efficacious technique utilized for the diagnosis of tongue cancer. Nevertheless, the interpretation of endoscopic findings (as shown in Figure 3A) is a skill possessed by only a limited number of experts. If a dubious lesion is detected at a nearby clinic, it is recommended that the patient be directed to a specialist to verify the disease status and implement additional measures for its management. Inexperienced general practitioners may erroneously identify visual patterns as indications of ulceration or oral mucosa disease when diagnosing patients with tongue cancer. The employment of artificial intelligence (AI) analysis of oral endoscopic images has emerged as a promising approach to enhance the prospects of early detection of tongue cancer, thereby serving as a primary diagnosis method. Prior research on oral cancer has utilized images captured in non-clinical settings through the use of smartphones or digital cameras, rather than in a medically validated environment employing an endoscope. Additionally, the sample size of images was limited, consisting of less than 300 images. The endoscopic method yielded an accuracy rate of 84.7%, with a sensitivity of 81.1% and a specificity of 86.8%, in the detection of tongue cancer.[11]

**VITAL STAINING**

Vital staining is commonly employed as an adjunctive aid in vivo to visualize potentially malignant lesions within the oral cavity and/or to better define their margins and extent. The aforementioned dyes are non-toxic agents that possess the ability to infiltrate viable cells and adhere to particular biological structures. Toluidine blue (TB) and Lugol's iodine (LI) are the most frequently utilized agents in clinical practice. TB, a metachromatic dye, exhibits selectivity towards tissues that are abundant in nucleic acids due to its acidophilic properties. Therefore, neoplastic or highly dysplastic lesions, characterized by cells with a high concentration of DNA and RNA, exhibit a clinical presentation of royal blue staining (TB-positive), whereas healthy and non-dysplastic/non-neoplastic tissues display a pale blue color or do not exhibit any dye uptake (TB-negative). The diagnostic accuracy of tuberculosis (TB) in identifying tumors ranges from 93.5% to 97.8% with a specificity of 73.3% to 92.9%. The iodine staining principle involves the reaction between iodine and cytoplasmic glycogen of cells, resulting in iodine-starch reactions that can be clinically observed through a distinct color change, typically brown-orange in appearance (as depicted in Figure 3B). Hence, in the course of mucosal inspection under Lugol's staining, the mucosa that is considered normal exhibits a brown or orange hue owing to its elevated glycogen concentration. Conversely, dysplastic or neoplastic tissues do not undergo staining and manifest as pale yellow in contrast to the adjacent tissue.The diagnostic accuracy of LI in the detection of tumors is reported to range from

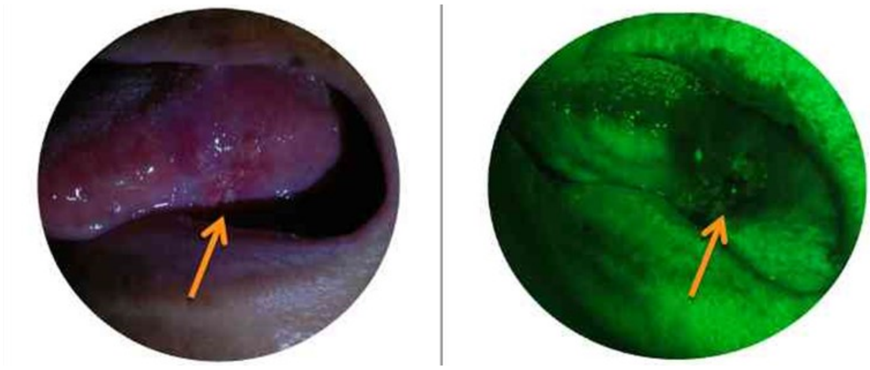

**Figure 4.** Representative image of tongue cancer on Autofluorescence[33]

87.5% to 97.2% with a corresponding specificity of 60% to 84.2%. The combined utilization of LI and TB can enhance the substantiation for distinguishing the dysplastic/neoplastic region from the healthy area in and around a mass.[29, 30]

**AUTOFLUORESCENCE**

Tissue autofluorescence (AF) is based on the detection of the inherent fluorescence emitted by tissues upon exposure to a specific light wavelength (Figure 4). Autofluorescence imaging utilizes blue light within the range of 400-460 nm to prompt the discharge of green fluorescence, which occurs at the wavelength of 500-520 nm, from endogenous fluorophores. These fluorophores include keratin, collagen, elastin, and NADH, and their interaction with tissues leads to the aforementioned emission. On the other hand, it has been observed that hemoglobin, porphyrins, and melanin possess a tendency to absorb incident blue light, leading to a reduction in the autofluorescence of tissues. A negative correlation has been observed between the progression of dysplasia and the fluorescence intensity. As dysplasia progresses from a mild stage to carcinoma, there is a gradual decrease in fluorescence intensity. Eventually, neoplastic lesions become undetectable due to this decrease in fluorescence intensity. In addition to TB, AF has significant utility in discriminating malignant tumors, identifying early-stage neoplasms, in situ carcinomas, and tumor recurrences, prior to the manifestation of typical clinical symptoms.[29] Autofluorescence has been found to exhibit a notable degree of specificity and sensitivity in detecting both oral cancer and precancerous lesions, with rates of 72.4% and 63.79%, respectively. The acquisition of such data can also furnish significant insights for diagnostic purposes, facilitate the formulation of strategies for margin resection in surgical excision, and enable the tracking of the therapeutic response throughout the follow-up period.[32]

**ULTRA HIGH-FREQUENCY ULTRASONOGRAPHY (UHFUS)**

Ultra-high frequency ultrasound (UHFUS) is a technique that can examine extremely minute structures and provide high-resolution pictures with dynamic, real-time, and comparative assessment (Figure 5). UHFUS produced pictures with exceptionally high resolution, revealing novel lymphatic vessel features. The use of UHFUS in the investigation of oral lesions is one of the most significant advances in US imaging of the head and neck region. The conventional ultrasonography (CUS) approach employs probes with frequencies ranging from 10 to 15 MHz, whereas UHFUS, with accessible frequencies of 48 and 70 MHz, may photograph the superficial layers of the mucosa as well as oral cavity diseases. In comparison to CUS, UHFUS has a higher spatial resolution, despite the constraint of a modest penetration depth of 1-3 cm. In reality, 48 MHz probes have a depth of penetration of 23.5 mm, whereas 70 MHz probes can image the first 10.0 mm below the scanning surface.[34] UHFUS has values for sensitivity, specificity, and negative predictive value that all surpass 90%. For mucosal growths and oral cancer diagnosis, sensitivity and negative predictive value were both 100%. Specificity varied from 97% to

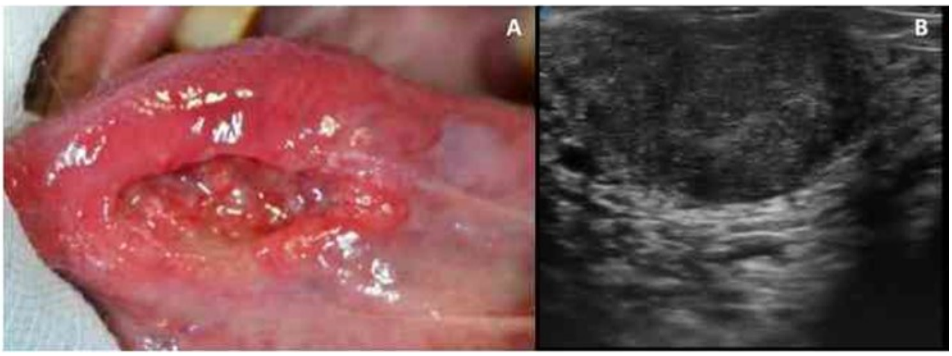


**Figure 5.** Representative image of tongue cancer on (A) Clinical, (B) UHFUS[15]

99%, while positive predictive value ranged from 83% to 99%.[35]

## NARROW-BAND IMAGING

The technique of Narrow-band imaging (NBI), which is also referred to as virtual chromoendoscopy with magnification (VCM), is widely employed in the identification and monitoring of cancer. Its primary purpose is to differentiate tumor vascular patterns from non-neoplastic conditions (as illustrated in Figure 6A). Narrow-band imaging (NBI) is a technique that involves the integration of standard endoscopes with magnification capabilities and a conventional white-light source that is enhanced with narrow-bandwidth filters. These filters enable the sequential emission of green-blue light, which alters the spectral characteristics of the incident light. The strong adsorption of green and blue light by hemoglobin and the wavelength-dependent absorption and scattering processes in tissue structures result in good contrast for mucosa microvasculature. Specifically, blue light at 415 nm highlights the more superficial vessels of the submucosa, while green light at 540 nm can penetrate deeper into the tissue and improve visualization of deeper vessels beyond the mucosa. The utilization of NBI either independently or in conjunction with other diagnostic modalities can enhance the diagnostic procedure, particularly in instances of early cancers and high-grade dysplasia. The findings indicate that NBI has high sensitivity (92.3%) and specificity (88.2%) in early detection of oral squamous cell carcinomas (OSCC).[29, 36]

## IN VIVO CONFOCAL MICROSCOPY

The technology of in-vivo microscopy (IVM) enables the visualization of living tissue in patients with high resolution and in real-time, at depths of approximately 200-300 µm, without the need for tissue removal, fixation, freezing, or staining. The oral cavity can be evaluated for both soft and hard tissues, as depicted in Figure 6B. The phenomenon under consideration involves the utilization of refracted light emission subsequent to its interaction with incident light of a particular wavelength. In vivo confocal microscopes utilize laser light of specific wavelengths to induce the emission of fluorescent or refracted light from living tissues, based on the presence of fluorophores or the refractive indices of the tissue's various compounds, respectively. This process is non-invasive and harmless. The correlation between in vivo confocal images and histological sections is robust and, therefore be considered “optical biopsie”’. The capacity to observe cells within living tissue, without the requirement of biopsies and fixation, provides novel and valuable insights into both health and disease. The detection of oral squamous cell carcinoma (OSCC) was accomplished through in vivo confocal microscopy with a sensitivity of 89.9% and a specificity of 78.6%.[29,37]

## MULTIMODALITY IMAGING

Each imaging modality has limitations in imaging conditions patients, so they can be used single or in combination with each other to obtain accurate information about pathological conditions in the oral cavity. Until now there is no specific imaging modality that is ideal for tumor examination. Thus the examination of tumors and cancers involving the oral soft tissue requires a multimodality imaging approach.[5]

The integration of Positron Emission Tomography (PET) and Computed Tomography (CT) into a single device, known as PET/CT (Figure 7A),

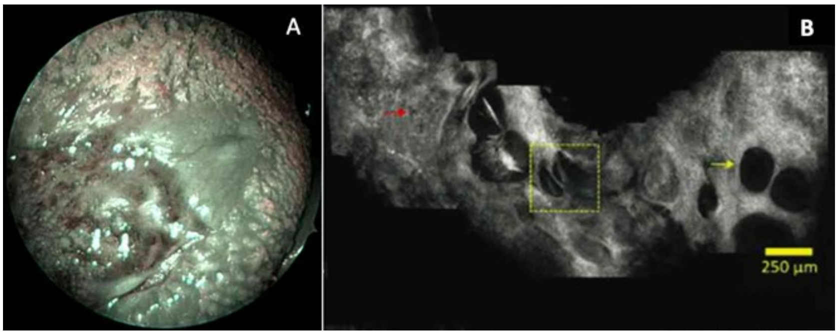


**Figure 6.** Representative image of tongue cancer on (A) NBI[16], (B) In Vivo Confocal Microscopy[38]

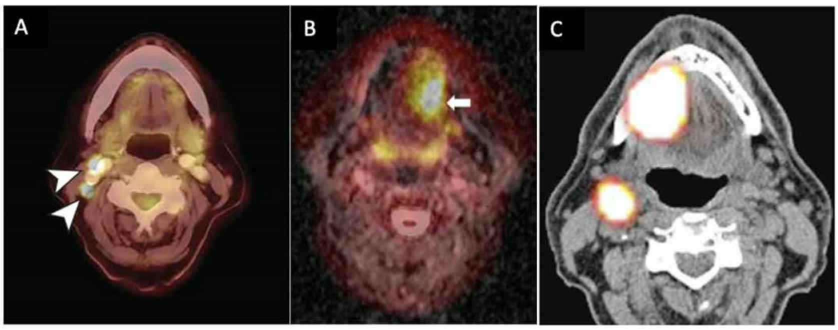


**Figure 7.** Representative image of tongue cancer on (A) PET-CT[14], (B) PET/MRI[39], (C) SPECT-CT[40]

represents a significant advancement in PET technology. This innovative technology enables the acquisition of highly accurate and integrated functional as well as anatomical information simultaneously. Although widely regarded as the most precise imaging modality presently available, it is not without limitations, including high expenses, limited accessibility, and the incapacity to identify micrometastases.[8] PET/CT imaging with fluorine-18 fluorodeoxyglucose (18F-FDG) is a hybrid molecular imaging method used in the main stage of head and neck tumors to identify lymph node and distant metastases. [12] FDG PET/CT is a very accurate noninvasive imaging method for pre-surgical diagnosis and staging of tongue squamous cell carcinoma and is extremely sensitive for diagnosis and highly accurate for pre-surgical staging. PET-CT detected tongue cancer with a sensitivity of 97.8% and a specificity of 100%.[14]

The technology of simultaneous positron emission tomography and magnetic resonance imaging (PET/MRI) has emerged as a promising imaging modality that offers superior diagnostic capabilities compared to either modality alone due to the complementary information of each modality. Furthermore, the employment of concurrent PET/MRI is anticipated to be more advantageous due to its reduced radiation exposure and offers better soft-tissue contrast resolution. The utilization of PET/MRI in head and neck cancer is significant owing to its exceptional soft-tissue contrast, which facilitates the detailed visualization of small anatomical structures. A prior investigation has documented that the employment of PET/MRI concurrently (as depicted in Figure 7B) could potentially result in a synergistic impact, thereby enhancing the precision of staging.[39] The integration of PET/MRI technology utilizing 2-[18F]-fluoro-2-deoxy-d-glucose ([18F]FDG) offers several benefits, including the ability to conduct PET and MR imaging concurrently. This approach also provides enhanced soft tissue contrast, multiplanar image acquisition, and functional imaging capabilities, all without the need for fat suppression or gadolinium-based contrast agents (GBCAs). Standard clinical PET/MR scans utilizing [18F]FDG for oncology purposes typically involve a regional scan to assess local tumor invasion, as well as a whole-body scan to identify lymph nodes and distant metastases. The utilization of PET-MRI yielded a sensitivity rate of 90% and a specificity rate of 91% in the detection of tongue cancer.[18]

The clinical application of combining single-photon emission CT (SPECT) with CT, known as the SPECT/CT dual-imaging modality technique (Figure 7C), has proven to be highly relevant in oncological applications. This technique has demonstrated improved sensitivity and specificity in producing registered anatomical and functional images. The amalgamation of two modalities can potentially enhance the staging and monitoring of treatment efficacy when assessing treatment outcomes. The majority of research findings suggest that SPECT-CT improves the informative value of localizing the sentinel lymph nodes (SLNs) and yields supplementary SLNs.[41] SPECT/CT achieved Sentinel node biopsy (SNB) with 76% sensitivity and 100% specificity.[40]

The availability of various imaging techniques, either alone or in conjunction with one another, has increased with the progress of technology, facilitating the assessment of oral malignancies, such as tongue cancer. The review shows that each diagnostic imaging has a different sensitivity and specificity value. FGD PET-CT and UHFUS reportedly provide a high level of sensitivity and specificity to diagnose and staging of tongue cancer. The sensitivity and specificity of FGD PET-CT were 97.8 % and 100 % while UHFUS were 100 % and 97-99%.

## CONCLUSION

Diagnostic imaging is a part of the protocol for diagnosis and treatment of tongue cancer. Each diagnostic imaging has limitations in imaging the patient's condition, so it can be used alone or in combination with one another to obtain accurate information about pathological conditions. FGD PET -CT and UHFUS reportedly provide a high level of sensitivity and specificity to diagnose and staging of tongue cancer. FDG PET/CT and UHFUS are novel potential approaches diagnostic imaging for the early detection of tongue oral cancer. Further refinement of diagnostic imaging techniques is mandatory to improve their accuracy until it approaches that of the gold standard.

## ACKNOWLEDGMENTS

None.

## FOOTNOTES

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

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