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CBCT - The Advanced Three Dimensional Diagnostic Tool for Assessment of Maxillofacial Architectural Changes in Oral Malignancy - A Pilot Study.

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ABSTRACT:

Introduction: Oral cancer is a global health problem with increasing prevalence and mortality rates. It results from a multistage process from normal to dysplastic lesions and eventually leading to carcinoma. Due to its increased incidence worldwide, there is a need to have a recent diagnostic modality to detect the invasion of disease to prevent the mortality and provide best possible treatment to the patient. In this paper, we discussed 50 cases of maxillofacial malignancy diagnosed with Cone Beam Computed Tomography (CBCT).

Objective: To assess changes in bone architectural pattern and involvement of inferior alveolar nerve canal in patients with maxillofacial malignancy using CBCT.

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Method: 50 patients with malignancy involving maxilla and mandible of both genders in the age range of 40- 85 years were subjected to CBCT scan and changes were assessed in terms of site, extension of invasion, altered bone trabecular pattern, cortex involvement, discontinuity of inferior alveolar nerve canal and mental foramen and effect on dentition.

Results: In this research, 80% of patients were male as compared to females. In maxilla the most commonly affected site was anterior alveolus region in 20% of patients and in mandible right posterior region was involved in 40% of patients. There was maximum anterio-posterior extension with 70% invasive infiltrative pattern. Maximum lingual cortex involvement was observed with involvement of inferior alveolar nerve in 71% and floating tooth appearance in 16% of cases.

Conclusion: CBCT is useful in assessing various osseous changes and maxillofacial invasion caused by oral malignancy that can be helpful in better patient evaluation and treatment planning for resection of lesion with indistinct borders; thereby ensuring enhanced patient care and low morbidity.

Key words: Oral Cancer; CBCT; Osseous Changes; Infiltrative; Erosive.

ADVANCES IN KNOWLEDGE STATEMENT -

Our research provides a new perspective in the field of diagnostic modalitiesfor orofacial oncology . The age old modalities , for diagnosing oral cancer , still used in many hospitals are the two dimensional X rays, CT scans . Our research reflects , CBCT is an advanced ,three dimensional tool , causing less harm (lower radiation dose to the patient compared to conventional CT and is cost effective) and giving a better detailed picture of the oral malignancy .

The advent of CBCT , has revolutionised the staging and accurate diagnosis of oral malignancy . The purpose of this research paper , is to reflect that CBCT is an astounding modality for the assessment of maxillofacial architectural changes in oral malignancy ,thus is a very essential tool for the treatment planning (surgical resection cases especially).

Thus we aim to create awareness regarding the great diagnostic potential of CBCT for accurately diagnosing the orofacial malignancy .

INTRODUCTION

Oral cancer describes the term that cancers originating in the oral cavity, that can affect the structure like buccal mucosa, lips tongue, floor of mouth, maxilla, mandible(fig.1) that generally appears as growth or ulcer that persists

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for days and does not go away. It is a problem of both developed and developing countries, wherever there is habit of tobacco taking in any form and basically where it all starts and causes destructive changes. So, any variation occurring in oral cavity will reflect specific mucosal changes that may present with features like alteration in colour, surface characteristics, growth of oral tissues, the occurrence of swelling, or loss of integrity of the oral mucosal surface. Thereby affecting the quality of life by interfering with the patient's essential activities like eating, swallowing, and speech presenting with the symptoms of burning, irritation, and pain. Method to deal with the examination of Oral cancer follows chronological diagnostic approach starting from the History taking, clinical examination, and investigations including Imaging, histopathological Investigations. Today, Cone Beam Computed Tomography, has become as an alternative to conventional computed tomography in diagnosing and treatment planning of various oro facial malignancies. CBCT has raised up as an alternate with lower radiation dose and easy setup being one of the major advantages it has been a remarkable development in the field of dentistry or dental radiology. It has allowed clinicians to view the hard tissues of the maxillofacial region with greater ease. This study was undertaken to evaluate the accuracy of CBCT in diagnosing the patients with maxillofacial malignancy.

Materials and methods:

Study design:

The study was conducted on CBCT scans on patient who were suspected for malignancy . The present study comprised of a total of 50 patients of both genders (10 females and 40 males) with age range in between 40-85 years.

CBCT scans were conducted on patients having a history of growth and pain in the orofacial region. All the patients were examined clinically and later assessed with CBCT imaging who gave voluntary consent were included in this study. Subjects having history of recurrence, previous radiotherapy, had been excluded from this study. These patients were assessed with a good quality CBCT scan were the inclusion criteria for the present study. The patient

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demographic information was recorded in case history performa and patients were subjected to thorough clinical examination following which CBCT scanwas taken with New Tom Giano CBCT unit operating at 10mA, 76kVp with voxel size of 0.1x0.1x0.1(mm) with exposure time of 18 seconds. Field of view (FOV) was adjusted at 11x8 cm with accessory attachments (like computer) and other facilities . Newtom new technology (NNT) software was used for this study. CBCT scans were recorded in all three planes i.e. coronal, axial, sagittal, also multiplanar reformation (MPR) was reconstructed. Thickness of image slides was 0.5mm for sagittal and coronal section. sagittal, coronal, axial and 3D images were assessed with the following characteristics:

- **Erosion**: an area of decreased density or discontinuity or irregularity of the cortical bone
- **Extension of invasion** in anteroposterior and superior inferiordirection
- **Site of lesion distribution** in maxilla and mandible
- **Distribution of pattern of invasion** in bone whether invasive,infiltrative and mixed
- **Inferior alveolar nerve canal and mental foramen** involvement

Statistical analysis

The results obtained in this study were tabulated and subjected to statistical analysis. The results were recorded as mean and percentages. Mann Whitney U test was used for comparison between left & right side and both genders. The level of significance (p) was set below 0.05.

CONFLICTS OF INTEREST STATEMENT -

The authors have no conflict of interests to declare. All co authors agree with the content of manuscript, and there is no financial interest to report.

Results

The age range among the participants was from 40 to 85 years old, with the mean age being 60.4 (graph 1). Approximately 20% of the maxilla's anterior alveolus region was affected (table2, fig.1.), and 40% of the mandible's right posterior region (table 2, fig.2.) Maximal anterio-posterior extension with 70% invasive infiltrative pattern was seen. Maximum lingual cortex involvementwas observed with 71% of cases involving inferior alveolar nerve and 16% of cases displaying floating teeth.

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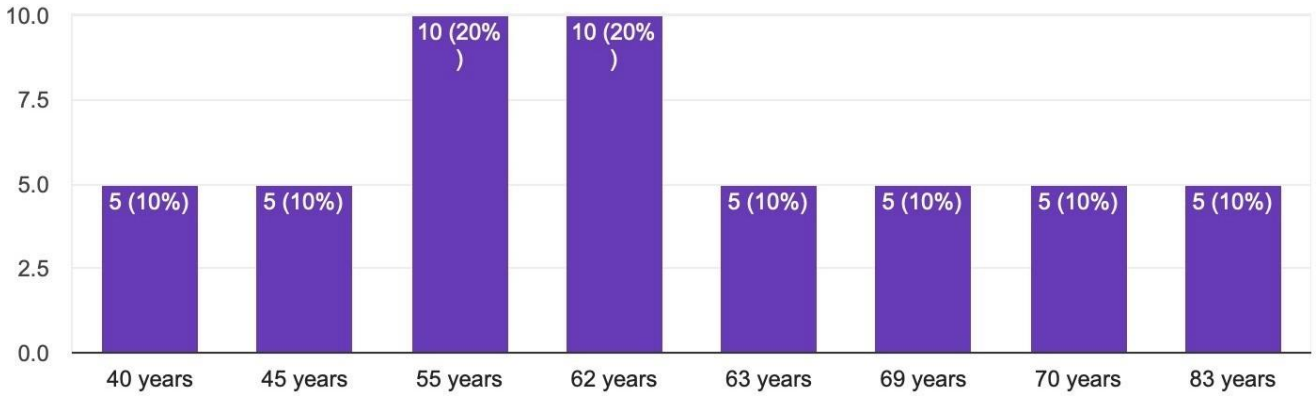
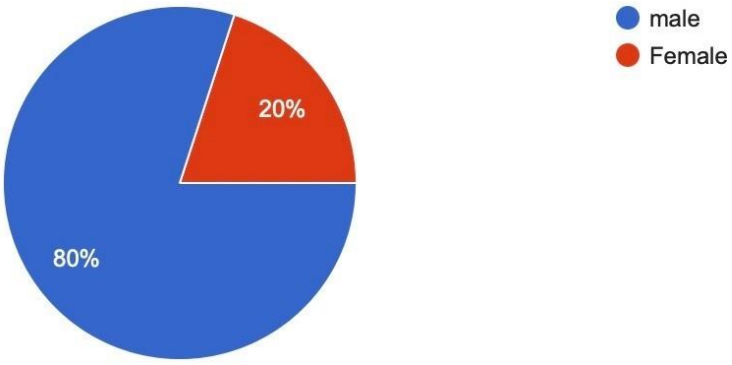
GRAPH 1a: AGE DISTRIBUTION



The age range of the patients was 40 - 85 years old and the mean age wascalculated to be 60.4 years.

GRAPH 1b- GENDER DISTRIBUTION:



Among the study population , there were 80% (40 males) and 20%(10 females.

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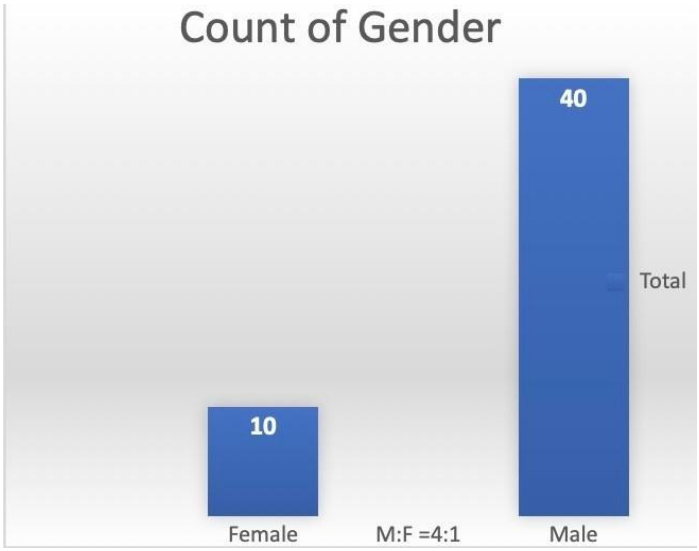

The male to female ratio was calculated to be 4:1.

TABLE 2: SITE OF LESION DISTRIBUTION

REGION	Site	Frequency	Percentage
MAXILLA	Right Posterior Alveolus	5	10%
	Left Posterior Alveolus	0	0%
	Anterior Alveolus	10	20%
MANDIBLE	Right Posterior Alveolus	20	40%
	Left Posterior Alveolus	10	20%
	Anterior Alveolus	5	10%

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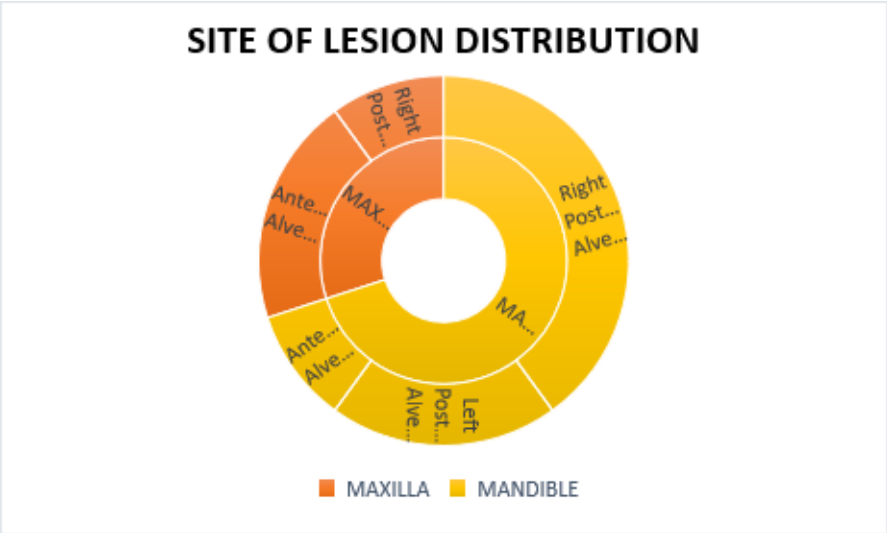

Graph 2- *represents the site of lesion distribution in maxilla and mandible.*

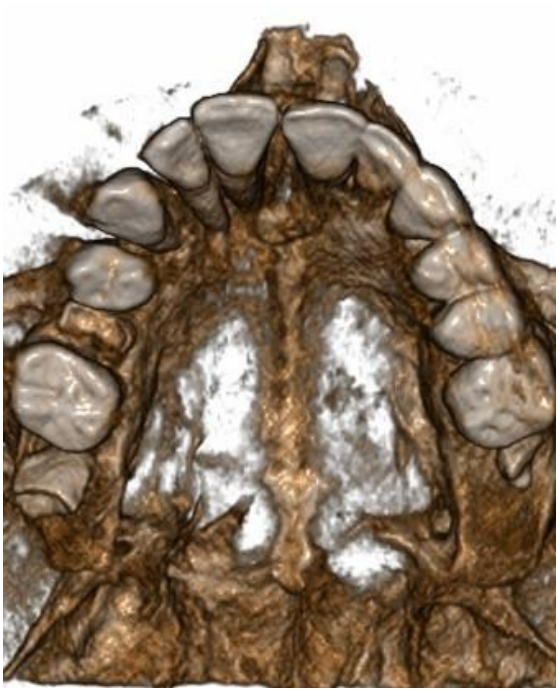

Fig. 1 **Fig 2.**

Fig 1- *This CBCT image shows 20%. Of maxilla's anterior alveolus region was affected*

Fig 2 *- This CBCT image shows 40% of mandibular right posterior region was affected.*

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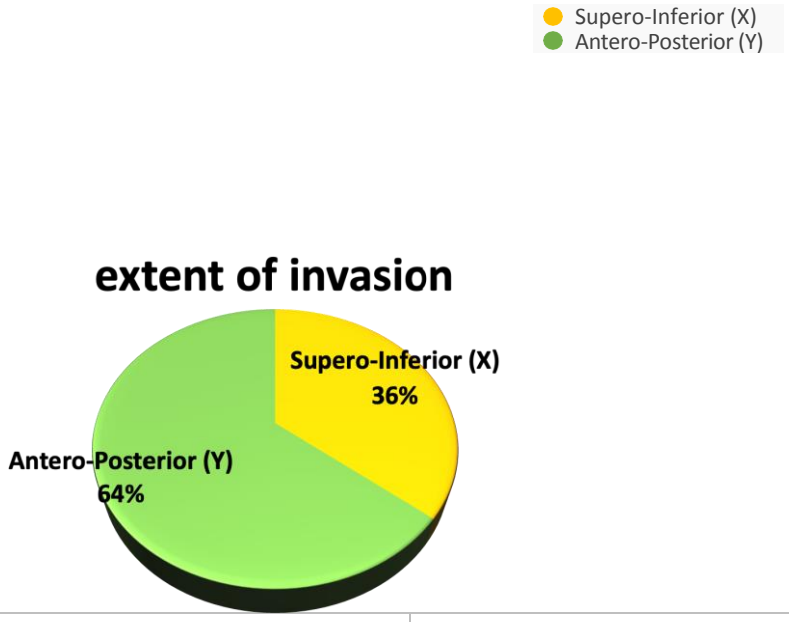
GRAPH 3: EXTENSION OF INVASION



Extension	Mean
Supero-Inferior (X)	11.3
Antero-Posterior (Y)	20.3

TABLE -3

Fig.3- These CBCT images represents the anterio- posterior extent of invasion

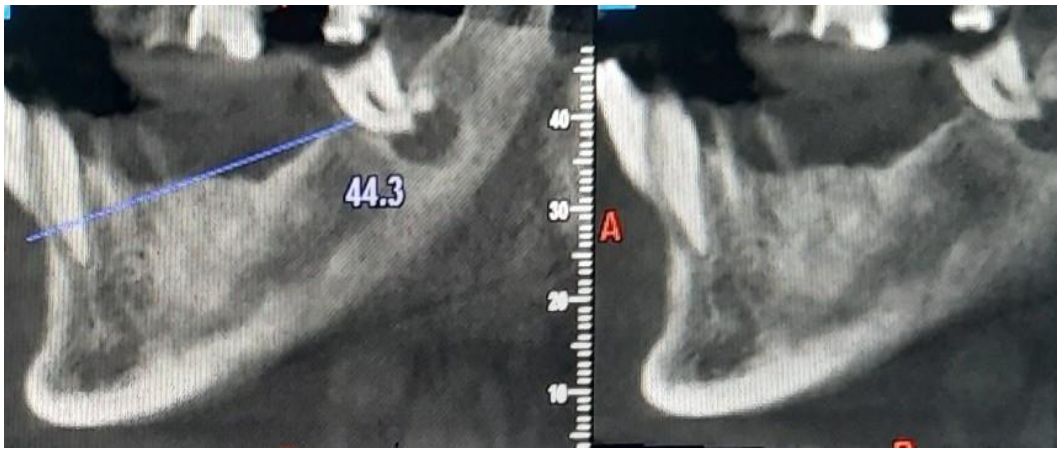


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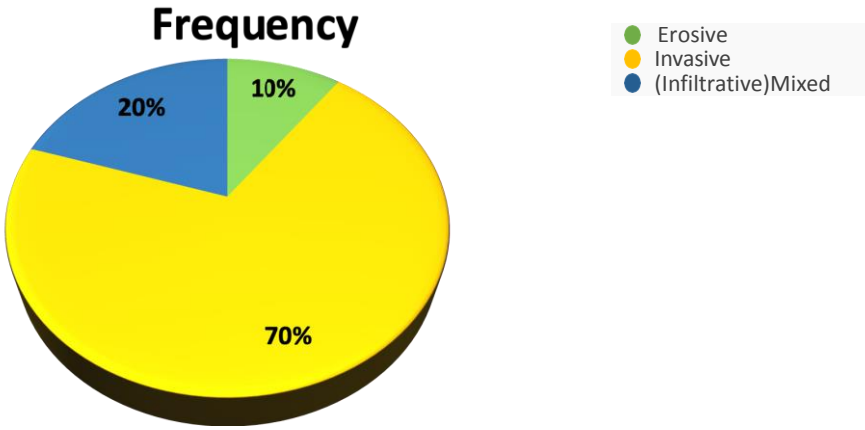
TABLE 3: DISTRIBUTION OF PATTERN OF INVASION IN BONE

Invasion Pattern	Frequency	Percent
Erosive	5	10%
Invasive (Infiltrative)	35	70%
Mixed	10	20%
Total	50	100%



Graph 4 -*Represents the distribution of pattern of invasion in bone*

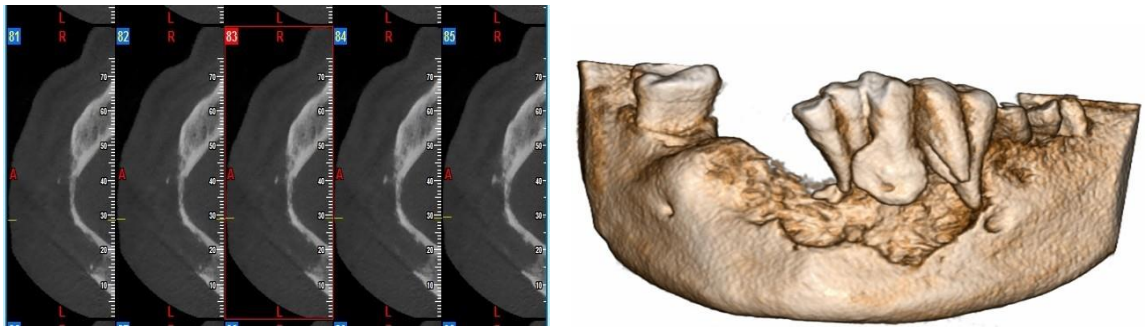


Fig 4 - These CBCT images represent the buccal and lingual cortex involvement

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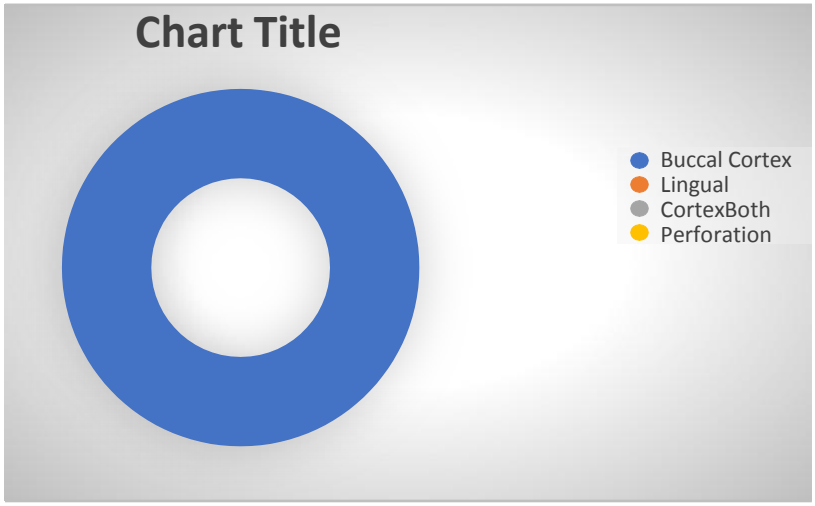
TABLE 4: DISTRIBUTION OF CORTEX INVOLVEMENT

CBCT Features			
Buccal Cortex	Lingual Cortex	Both	Perforation
15	25	10	25



Graph 4

TABLE 5: IAN CANALAND MENTAL FORAMEN INVOLVEMENT

Parameter	IAN canal	Mental Foramen

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Intact	10	20
Involved with lesion	25	15

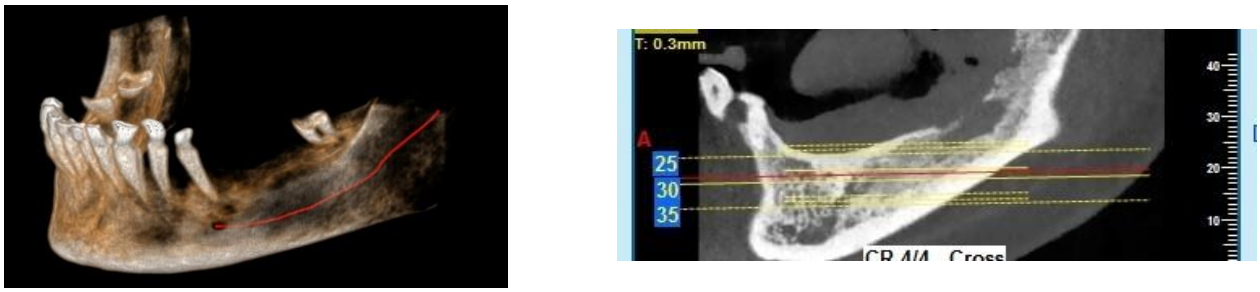

Fig 5- *These CBCT images depict the mental foramen and inferior alveolar nerve canal involvement.*

TABLE 6: CBCT ASSESSMENT OF EFFECT ON DENTITION

Structure	Effect detected on CBCT	Percentage
Lamina Dura	Intact	2%
	Lost	98%
Tooth Displacement	Present	80%
	Absent	20%
PDL Space	Intact	4%
	Widening	80%
	Destruction (Floating tooth)	16%

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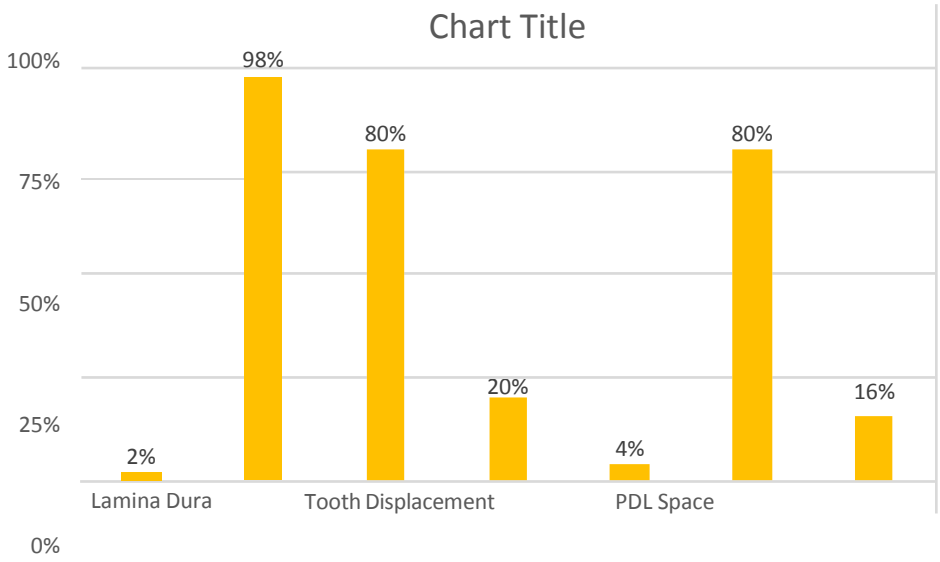
GRAPH 6- Represents the various oral cavity structures involved



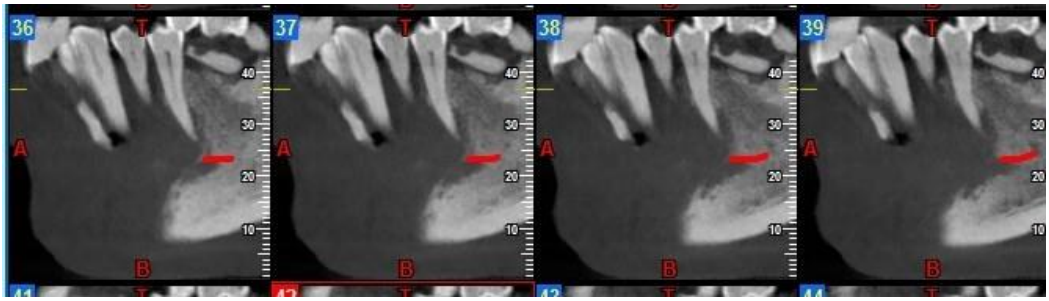


Fig. 6 -*These CBCT images show the impact of malignancy on the dentition(the lamina dura and periodontal ligament space)*

Discussion

Oral cavity is one of the body cavities which includes a variability of structuresincluding hard tissues and soft tissues. These both perform differently in maintaining the overall functioning of the body. Various molecular and structural changes occurring in as a result of numerous etiological factors such as microbial infections, local trauma or irritation, systemic diseases, and most importantly consumption of tobacco, betel quid, and alcohol results in one of

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the deadliest effects that is oral cancer. The tobacco industry is largely responsible for the development of oral cancer.[1]

It becomes important to undergo diagnostic imaging which is an adjunct to the clinical diagnosis of these patients. Although there are various 2-D diagnostic methods like intraoral and extraoral projection radiography, the latter including rotational panoramic radiography can provide details of lesions in a limited part.[2] Since clinical examinations and imaging are frequently used by surgeons to assess the presence or absence of bone invasion for determining the extent ofsurgical resection of the lesion.[3]Although, in order to stage oral cavity cancer and determine bony invasion, the most widely accepted imaging modalities are the multislice CT and MRI.[4]

Over the last few years, the use of 3-D information in dentomaxillofacial radiology has revolutionised the era in the management of these patients with such devastating diseases. In dental radiology, with the coming of this recent technology, of Cone-beam CT (CBCT) uses a cone-shaped X-ray beam to capture a three-dimensional image in a single scan has enabled to analysis and evaluate the different bony invasion caused by oral carcinomas.[5]

Due to its high spatial resolution and low radiation dose, CBCT was first used to assess lower gingival carcinoma invasion in Momin et al.'s study, and the results were superior to those obtained from orthopantomograms.[6]

The very few studies have been conducted to evaluate the extent of bone architectural pattern using CBCT. During this study, the extent and pattern ofbone invasion, as well as the involvement of osseous and nerve tissue, were studied.

Slieker et all was well in providing the details of involvement by squamous cellcarcinoma in maxilla which helped surgeons in better patient management.[7]

Observation of the bone invasion entity in the preoperative phase is hampered by the fact that there is no imaging technique that can provide 100% accuracy in the anatomical measurements of the sections, creating concerns about resection according to apparently safe margins of tissue.[8]

As compared to CT, CBCT offers high spatial resolution and low radiation dose. The X-ray source produces a cone-shaped X-ray beam. As a result, it is possible to capture the entire image in one sweep, rather than capture each individual slice separately as with MSCT[9]. CBCT has the advantage of scanning the patient in an upright position; the soft tissues are not distorted by gravity as is the case in MSCT while the patient is supine.[10]

Thus, we conducted this study to determine how CBCT which is the latest-generation reconstruction imaging technique helps in quantifying the degree of

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bone tissue invasion in patients with oral squamous cell carcinomas (OSCC).

In all the cases the site of lesion was related with the habit of keeping tobacco in the involved region. This study had 40% of cases that involved right posterior alveolus, 20% left posterior alveolus, 10% anterior alveolus region in respect to the mandibular region as seen in **Table 2**. While in relation to maxilla, 20%cases had involved anterior part and 10% had involvedthe right posterior region. The results were consistent with the fact that in the Indian subcontinent, the sulcus of the gingiva, the tongue, and the buccal mucosa were frequently affected by cancer due to the placement of tobacco quid under the tongue, under the buccal mucosa, and under the lip. [11,12] **.**The study found that 50% of patients had ipsilateral paresthesia of the lower lip andgingiva of the mandible. This suggests an invasion of tumour through the inferior alveolar canal, causing destruction of the inferior alveolar nerve that is responsible for sensory supply to the areas of the lower lip and gingiva. **Table 6**shows effect on teeth in terms of loss of lamina dura , PDL space widening, tooth displacement and floating tooth appearance and it was found that in 98% of cases teeth had absence of lamina dura . 80% cases showed PDL widening, 80 % cases showed presence of displacement and in 16% cases floating tooth appearance was evident.

Based on the analysis of the pattern of extension, it was found that the bone invasion in superio inferior (X) and anteroposterior (Y) directions were 11.3mm and 20.3mm respectively **(Table 3).** Suggesting that cancer invades more horizontally than vertically**.** According to Nakamaya, all three invasion pattern i.e. Erosive, Infiltrative and Mixed were exhibited in these patients..46 among which 10% cases had Erosive pattern of bone invasion, 70% cases had infiltrative pattern of bone invasion and 20% cases had mixed invasive pattern**.(Table 3)**

In the study, assessment of involvement of cortex revealed 30% cases had buccal cortical involvement and 50% cases had lingual cortical involvement.**(Table 4).** As seen in **Table 5,** 50% of cases had Inferior alveolar Canal involvement. In 30% of cases observed, mental foramen was involved . On assessing Correlation of Inferior alveolar canal involvement with complaint ofparesthesia, we noted that all cases with Inferior alveolar canal cortical destruction had paresthesia. These findings show ability of CBCT in detectinginvolvement of vital structure in the oral and maxillofacial region.

Conclusion

The results of our study show that CBCT offers a practical method to determine the extent of the lesion, and the invasive pattern in the underlying

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structures but that MRI is still necessary to find out soft tissue invasion. However, our results aid in better patient evaluations and treatment planning.

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