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A Retrospective 2-D and 3-D Radiographic analysis of Osseous Changes in Oral Squamous Carcinoma

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Abstract

Aim: To evaluate the 2D and 3D radiographic features of oral squamous cell carcinoma involving jaws for understanding the pattern of bone involvement, for an improved treatment plan. **Materials and Methods:** Thirty histologically diagnosed patients of oral squamous cell carcinoma were included in the study and the detailed analysis of Orthopantogram (OPG), Computed Tomography (CT)/Cone Beam Computed Tomography (CBCT) / Magnetic Resonance Imaging (MRI) was undertaken. Lesions borders, surrounding and internal structures were evaluated. **Results:** 2D images aid in identifying the location of the lesion while 3D images help in defining the extension of the lesion. 2D images result in overdiagnosis of extent while 3D images provide an accurate diagnosis of the structures involved. **Conclusions:** Early screening of the lesion can be done by OPG while CBCT/CT/MRI should be considered as a confirmatory tool to see the extent of disease and for guidance in surgical planning.

Keywords: Oral Squamous Cell Carcinoma, 2D, 3D Diagnosis

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1. Introduction

Oral cancer accounts for up to 30–50 % of all cancers in India. In Gujarat, its prevalence rate is 18.1 per 1 lakh population and as per GCRI during 2012-13 head and neck cancer accounted for 31.53%. Oral malignancy is responsible for considerable morbidity and mortality, therefore, an accurate staging, which include evaluation of bone involvement, is crucial for treatment planning and for improving survival rates. These tumors have tendency to invade the surrounding bone structures, and this occur in 12-88 % of the cases[1,2].

Malignancies involving oral cavity can be carcinoma, metastatic lesion from distant malignancies, sarcoma, or malignancy of hematopoietic system. Oral Squamous Cell Carcinoma (OSCC) is the 8th most common cancer of the oral cavity and constitutes 90-95 % of all oral malignancies in which involvement of jaw bones occurs in 12-56 % of cases. Clinical examination must be complemented by radiological examination for assessment of size, thickness and depth of tumors as well as degree of bone invasion.

The death rate of these cancers has been relatively high, particularity owing to presentation at a late stage in the course of disease. Clinical examination has paramount role in early detection as it allows direct visualization of subtle lesions, which cannot be perceived by imaging modalities. In established cases of oral cancer, imaging is needed to accurately evaluate the locoregional extent. Imaging provides guidance in deciding appropriate management strategy (single or multimodality), assessing resectability, and estimating precise extent of resection[3].

Hence this study aimed to analyze the radiographic features of oral squamous cell carcinoma involving jaws in 2D and 3D images. The objective of this study was to

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evaluate the limitations and benefits of both 2D and 3D imaging.

2. Material and Methods

A retrospective study was conducted including 30 patients having Oral Squamous Cell Carcinoma of jaws which were histologically and radiologically diagnosed. All demographic data and radiographic data were retrospectively evaluated. Data were evaluated according to jaw involved either maxilla, mandible or both and according to segment involved, i.e., either anterior or posterior. Panoramic radiographs (2D) and CT or CBCT or MRI scans (3D imaging) were studied in detail according to assess the periphery, internal structure, and effect on surrounding structures, as explained in diagnostic criteria. Only those radiographs showing definite osseous changes in mandible, maxilla or both were included in the study. Radiographs of patient with recurrence of carcinoma after chemotherapy or radiotherapy and metastatic carcinoma were excluded.

Diagnostic criteria to detect bone invasion in oral squamous cell carcinoma in OPG and CT/CBCT/MRI[2-5].

2.1 Periphery

a. Borders either ragged or smooth (Figures 1, 2 and 3).
b. Shape present either semicircular, round, saucerization or zig zag. In case of 3D radiograph either erosive or infiltrative (Figure 1(c)).

2.2 Internal Structure of Lesion

a. Complete radiolucent/presence of little residual bone (soft tissue shadow or enhancement and radiopaque foci)/septa within radiolucent lesion (Figures 1(a), 1(e), 1(i) and 2(a)).

2.3 Surrounding Structures

i. Destruction of antral/nasal floor in maxillary lesion and destruction of cortical outline of mandibular canal in mandibular lesion. In case of 3D radiograph destruction of either buccal, lingual or both cortical plates (Figures 1(j), (g), Figures 2(c) and 2(d)).
ii. Root resorption (Figure 1(b)).
iii. Floating tooth appearance as surrounding bone and lamina dura both are affected (Figures 1(f), 1(h), and 2(e)).

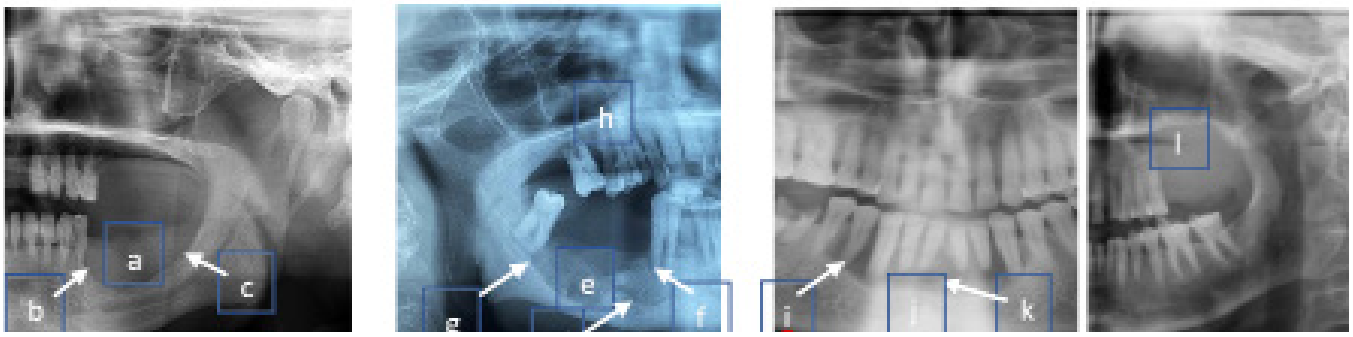


Figure 1. 2D radiographic presentation of oral squamous cell carcinoma. **(a)** Radiolucency with soft tissue shadow. (b) Root resorption. **(c)** Smooth border and saucer shape. **(d)** Ragged border, **(e)** Radiolucency with flecks of radioopacity. **(f)** Loss of lamina dura. **(g)** Destruction of alveolar canal. **(h)** Superimposition of hardpalate. **(i)** Floating tooth. **(j)** Shadow of the spine. **(K)** Complete radiolucency. **(l)** Destruction of floor of maxillary sinus.

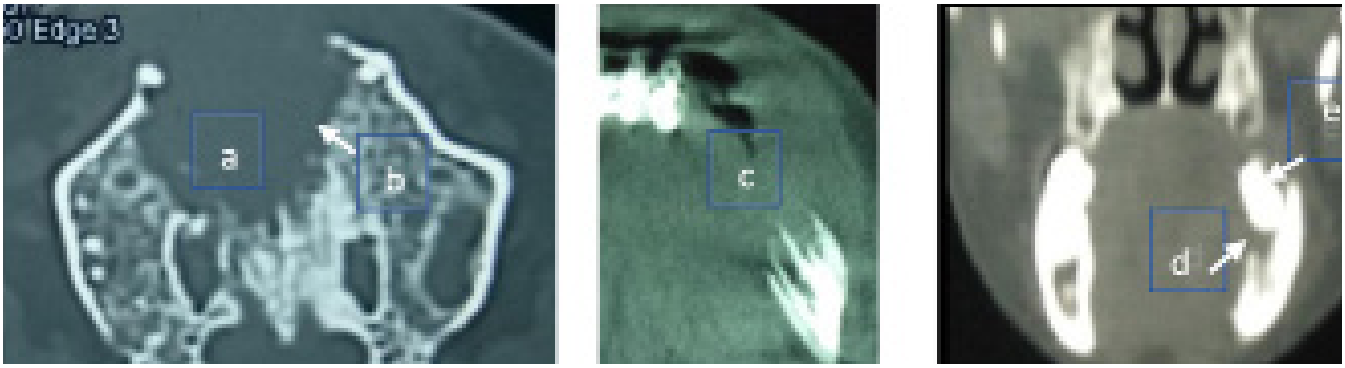


Figure 2. 3D radiographic presentation of oral squamous cell carcinoma on CT/CBCT images. **(a)** Hypodensity with flecks of hyperdensity. **(b)** Ragged border. **(c)** Complete destruction of both cortical plates. **(d)** Destruction of lingual cortical plate. **(e)** Floating tooth appearance.

3. Results

In present study, the age of patients ranged from 21-77 years. Maximum number of patients were in the age group of 41-60 (n = 18, 60 %) and minimum number of patients in age group above 60 (n = 5, 16%). In case of gender distribution, there were 22 males (73.4%) and 8 females (26.6%). Out of 30 radiographs, involvement of maxilla was seen in 5 cases (16.6%) and that of mandible is 25 cases (83.3%). Out of 5 cases in maxilla, 1 case (20%) involved anterior maxilla and 4 cases (80%) involved posterior maxilla and out of 25 cases in mandible, 2 cases (8%) involved anterior region and 23 cases (92%) were in posterior mandible. In OPG, shape of lesion was round in 1 case (3.3%), saucer shaped in 23 cases (76.6%) and zigzag shape in 6 cases (20%). Assessment of internal structure showed all the lesions had radiolucent internal structure with 10 cases (33.3%) showing soft tissue shadow and 2 cases (6.6%) showing flecks of calcification. Pathological fracture was noted in 17 cases (56.6%), destruction of mental foramen in 5 cases (16.6%) and that of alveolar canal in 11 cases (36.6%) was seen. In CBCT, internal structure in all lesions shows hypodensity in which 10 cases (33.3%) had soft tissue shadow, 5 cases (16.6%) showed flecks of hyper density. When evaluating the pattern of spread, 23 cases (76.6%) showed infiltrative and 7 cases showed erosive pattern. 14 cases (46.6%) showed buccal plate involvement, 3 cases (10%) showed lingual plate involvement and both the plates were involved in 6 cases (20%). Pathological fracture was seen in 17 cases (56.6%). Destruction of mental foramen in 2 cases (6.6%) and that of alveolar canal in 6 cases. Regarding the effect on surrounding structures, both OPG and CBCT showed loss of lamina dura in 29 cases (96.6%), 5 cases (16.6%) showed spike type of root resorption, 18 cases showed floating tooth appearance. Borders in both OPG and CBCT were ragged in 28 cases (93.3%) and smooth in 2 cases (6.6%) as shown in Tables 1, 2 and 3.

Table 1. Descriptive statistics of oral squamous cell carcinoma based on age and gender

Age	**Male (n = 22) (73.3 %)**	**Female (n = 8) (26.6 %)**
Below 20	0	0
21- 40 (n = 7) (23.3 %)	5 (22.7 %)	2 (25 %)
41- 60 (n = 18) (60 %)	12 (54.5 %)	6 (75 %)
Above 60 (n = 5) (16.6 %)	5 (22.7 %)	0

Table 2. Descriptive statistics of oral squamous cell carcinoma according to site of involvement

Site	**Anterior (n = 3) (10 %)**	**Posterior (n = 27) (90 %)**
Maxilla (n = 5) (16.6 %)	1 (20 %)	4 (80 %)
Mandible (n = 25) (83 %)	2 (8 %)	23 (92%)

Table 3. Descriptive statistics of radiographic appearance of oral squamous cell carcinoma and site of involvement. Distribution of patients acc. to 2D and 3D features and site

Features		2D		3D	
		Maxilla	Mandible	Maxilla	Mandible
Border	Ragged	4 (80 %)	24 (96 %)	3 (60 %)	25 (100 %)
	Smooth	1 (20 %)	1 (4 %)	2 (40 %)	0
Shape	Round	0	1 (4 %)	-	-
	Saucerization	3 (60 %)	20 (80 %)	-	-
	Zigzag	2 (40 %)	4 (16 %)	-	-
Internal density	Hypodensity / radiolucency	3 (60 %)	15 (60 %)	3 (60 %)	12 (48 %)
	Hypodensity / radiolucency with soft tissue shadow	2 (40 %)	8 (23 %)	2 (40 %)	8 (32 %)
	Hypodensity / radiolucency with flecks of hyper density	0	2 (8 %)	0	5 (20 %)
Involvement of cortical plate	Buccal	-	-	3 (60 %)	11 (44 %)
	Lingual	-	-	0	3 (12 %)
	Both	-	-	2 (40 %)	4 (16 %)
Pattern	Infiltrative	-	-	3 (60 %)	20 (80 %)
	Erosive	-	-	2 (40 %)	5 (20 %)
Effect on tooth	Destruction of PDL space	4 (80 %)	17 (68 %)	3 (60 %)	18 (72 %)
	Loss of lamina dura	4 (80 %)	25 (100 %)	3 (60 %)	25 (100 %)
	Spike type of root resorption	1 (20 %)	4 (16 %)	1 (20 %)	4 (16 %)
	Floating tooth	2 (40 %)	16 (64 %)	1 (20 %)	16 (64 %)
Pathological fracture		1 (20 %)	16 (64 %)	1 (20 %)	16 (64 %)
Destruction of mental foramen		0	5 (20 %)	0	2 (8 %)
Destruction of alveolar canal		0	11 (44 %)	0	6 (24 %)

4. Discussion

Oral Squamous Cell Carcinoma is one of the most common malignancies affecting the oral cavity, its management and prognosis is influenced by the presence and extent of bone involvement. 2D helps in knowing the location and extension of the lesion but it fails in identifying initial bone invasion until 30% of the mineral is lost and is deficient in evaluation of the lesion involving the symphysis region. In these cases, 3D imaging radiographs like CT scan with slice thickness 0.8-3 mm gives high resolution images of bony structures and helps in detecting minimal erosions[2,6,7].

In the present study, maximum number of patients were in age group of 41-60 which is like previous studies[1,6,7]. Studies have shown male predominance which is like our study[2]. This is because they are more involved in habit as compared to females.

Similar to available studies, mandible (83%) is more involved than that of maxilla (16.6%) with posterior region commonly involved than the anterior region. It is because placement of tobacco more common in posterior mandibular sulcus. Bony changes in maxilla and that of the anterior mandible are not clearly visible in OPG due to the overlapping of the cervical spine over the hard palate, anterior maxilla and mandible which is visualized in 3D images.

The borders of SCC lack sharp or clear demarcation from the adjacent normal bone due to its faster destruction rate. In our study, 96% of lesions in mandible shows ragged border and 4% showed smooth border in 2D while in 3D none of the cases showed smooth border. Same lesion might show smooth border in 2D while ragged in 3D leading to false negative report and misguided treatment. In case of maxilla in 2D imaging, 80% cases showed ragged border and 20% showed

smooth border and in 3D images, 60% were ragged and 40% were smooth[2]. Malignancy results in destruction of bone leading to osseous defect. In 2D images, it is seen as round, semicircular or saucer shaped or zigzag. In 3D it can be seen as erosive or infiltrative pattern[2,3]. In the present study 80% cases showed semicircular shape defect in mandible and 60% cases in maxilla and 16% cases showed zigzag shaped defect in mandible and 40% in maxilla. Only 4% case showed round shaped defect in 2D. While in 3D imaging of the mandible, 80% cases showed infiltrative pattern and 20% cases erosive pattern. In maxilla, 60% were infiltrative and 40% had erosive pattern of osseous defect. Destruction of buccal and lingual cortical plates are seen accurately in 3D rather than in 2D images. In the current study, destruction of buccal cortical plate was seen in 44% cases in mandible and 60% cases in maxilla and that of lingual plate only 12% cases in mandible. Both the cortices were destroyed in 16% cases of mandible and 40% cases of maxilla.

Osteolytic nature of carcinoma leads to the radiolucent internal structure with or without soft tissue shadow or flecks of residual bone[1]. In present study majority of cases showed complete radiolucency with 8 cases in mandible and 2 cases in the maxilla showed soft tissue shadow. Flecks of residual bone were seen in 5 cases of the mandible in 3D while only in 2 cases in 2D imaging.

Due to its rapid growing and invasive nature, it destroys the surrounding structure like alveolar bone and PDL resulting in floating tooth appearance and seldom results in spike type of root resorption[1,8]. In the present study 64% cases of mandible showed floating tooth while in maxilla 40% cases were seen in 2D as compared to only 1 case in 3D images. Spike like root resorption is seen in 4 cases in mandible and 1 case in maxilla. In advanced cases of SCC there is severe destruction leading to pathological fracture of the jaw as seen in 64% of cases in mandible and 20% cases in maxilla in the current study. Involvement of neurovascular bundle is common finding in SCC[1,9]. The present study showed 44% cases in 2D and 24% cases in 3D in mandible which is in disagreement with the study done by Shah PH *et al.* (80%). This results in overdiagnosis of the lesion in 2D images.

5. Conclusions

Radiographic evaluation of oral malignancy is important for treatment and prognosis of the condition. 2D imaging helps to screen bone involvement and helps in identifying location of the lesion and gross relation to the vital structures in relation to malignancy. In locations where 2D images are deficient in diagnosing, 3D imaging helps in proper evaluation. In case of therapeutic and prognosis, 3D imaging plays a major role and gives clear identification of its boundary and its extension.

List of Abbreviations: SCC – Squamous Cell Carcinoma, OSCC – Oral Squamous Cell Carcinoma, OPG – Orthopantomogram, CT – Computed Tomography, CBCT – Cone beam Computed Tomography, MRI – Magnetic Resonance Imaging, 2D - 2 Dimension, 3D – 3 Dimension, GCRI – Gujarat Cancer and Research Institute

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