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# Cone-Beam Computed Tomography to Assess Mandibular Invasion in Oral Squamous Cell Carcinoma.

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## ABSTRACT

**Background:** Oral squamous cell carcinoma which occurs closely to the mandible has a tendency to invade mandible. An accurate preoperative evaluation of mandibular invasion is important for optimum treatment planning. Aim of this study is to determine the accuracy of CBCT in detection of mandibular invasion in oral squamous cell carcinoma.

**Study design:** In this prospective observational study 35 patients of histologically proven squamous cell carcinoma which was close proximity to the mandible were selected. The results of preoperative CBCT scan of mandible were compared with that of post operative histopathology of bone and thus sensitivity, specificity, negative predictive value, positive predictive value were calculated.

**Results:** Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy of CBCT were 96%, 90.90%, 96%, 90.90%, 97.14% respectively (Chi squared with Yates correction equals 21.844 with 1 degrees of freedom, p value < o.oooo1).

**Conclusion:** Cone beam computed tomography is a sensitive test and has an acceptable range of specificity.

## KEY WORDS:

**Oral squamous cell carcinoma, Cone beam computed tomography**

## INTRODUCTION:

Oral Squamous Cell Carcinoma (OSCC) which is in close proximity to the mandible has a tendency to invade it. According to different studies the prevalence of mandibular bone involvement ranges from 12%-56% [1]. The incidence of mandibular invasion in oral cancer ranges from 12 to 56% according to various studies[2, 3]. Carcinoma that involves the mandible has a recurrence rate of as high as 70% and the survival rate is as low as 26% [4]. It has no doubt that under treatment makes local control difficult, on the other hand, over treatment affects the quality of life negatively. , As an example, too many mandibles are sacrificed without any histological evidence of mandibular invasion. On the other hand, it is understandable that for better quality of life, it is possible to preserve mandible as much as possible without compromising the local control.

A recent study in BSMMU claimed if squamous cell carcinoma would involve the buccal mucosa, preoperative CT scan suggested no lingual cortical invasion [5]. For this reason, optimum treatment planning and accurate identification of such bone invasion is important.

Various imaging techniques are currently being used to asses the mandibular invasion. These includes plain radiographs, bone scintigraphy[6], magnetic resonance imaging (MRI)[7], computed tomographic scan ( CT scan)[7], single photon emission computed tomographic scans ( SPECT)7. But no single imaging modality is able to predict mandibular invasion 100% reliably[7]. Moreover, every technique has its some limitations and disadvantages. Recently, a diagnostic algorithom has been designed for the prediction of mandibular invasion. This is either multi-slice computed tomography (MSCT) or MRI; followed by bone SPECT in case the first scan is negative. This diagnostic algorithom predicts accurately mandibular invasion in 85% patients without yielding false negative results[8].

However, In 1998, Mozzo[9] et al. introduced the New Tom - 9000 (Aperio-Inc, Sarasota, FL) cone beam computed tomography (CBCT) scanner. Different studies have shown that CBCT is accurate in evaluation of mandibular invasion in OSCC. Moreover, It has some advantages over other imaging modalities.

Plain radiograph is commonly used to asses mandibular invasion, it is readily available, inexpensive, non invasive procedure, but has limitation to detect early invasion; midline area cannot be well visualized[10]. On the other hand, MRI[11] and SPECT7 have more false positive results and frequently overestimate the extent of tumour invasion. Similarly, bone scintigraphy is a sensitive but non- specific tool[12]. Different studies and their results regarding detection of mandibular invasion were showed in table 1.1. Some studies also show CT scan as a preferred imaging modality to asses the mandibular bone invasion, but it is expensive, time consuming, and exposes more radiation to the patients in contrast to CBCT scanning [10,13]. In Bangladesh, CT scan is widely used to asses mandibular invasion. It exposes more radiation to the patient from the 474 uSv to 1160 uSv where in CBCT exposes only [13] uSv to 82 uSv[14]. Hashimoto et al. [15] claimed that skin doses with the multi-detector CT were 458 mSv per examination, whereas the doses with the 3DX cone beam computed tomography were [1.19] mSv per examination. So, CBCT can be used in a wide range of patients.

In addition, it takes shorter examination time, non invasive, it needs no extra preparation and presents 3D image. On the other hand, bone scintigraphy or SPECT are invasive procedure, need extra preparation for the patients. As the patient is scanned in upright position with CBCT, it is comfortable for the claustrophobic patients. In contrast, MRI and CT scanning are not well tolerated by the claustrophobic patients. CBCT is the least expensive procedure next to the plain radiographs among the available imaging modalities.

Regarding the performance of CBCT, different studies showed its better accuracy in predicting malignancies' bone involvement as it can compete with MSCT and SPECT7,[16]. The image quality of the 3DX CBCT was better than the multi-detector CT for all items ($P$ <.01) of studies of Hashimoto et al [15]. On the other hand, various studies to evaluate the performance of CBCT showed a wide range of specificity, 60% from Momin et al. [17] to 100% from Hendrix et al. [13]. So, it is assumed that more studies would clarify the efficacy of CBCT to asses the mandibular invasion.. Current study is such an attempt to evaluate the efficacy of CBCT to detect mandibular invasion.

**Table 1.1: Comparison of different diagnostic tools to assess mandibular invasion**

| Researcher | Diagnostic tool | Sensitivity | Specificity |
|---|---|---|---|
| **Hendrikx et al.**[13] | OPG | 55% | 92% |
| | MRI | 82% | 67% |
| | Plain radiograph | 97% | 64% |
| **Close et al.**[22] | CT scan | 97% | 100% |
| **Brown et al.** [19] | Plain radiograph | 76% | 93% |
| | CT scan | 53% | 90% |
| **Chan et al.**[23] | SPECT | 100% | 100% |
| **Van Den Breckel et al.**[18] | Plain radiograph | 63% | 90% |
| | CT scan | 64% | 89% |
| | MRI | 94% | 73% |
| **Mukherji et al.**[24] | CT scan | 96% | 87% |
| | CT scan * | 45.5% | 94.7% |
| **Yamamoto et al.** [25] | SPECT | 100% | 88.5% |
| **Suzuki et al.**[26] | CT scan | 70.6% | 100% |
| **Imaizumi et al.** [11] | CT scan | 100% | 88% |
| | MRI | 96% | 54% |
| **Lewis-Jones et al.**[6] | Radionuclide bone imaging | 100% | 86% |
| **Dreseidler et al.**[7] | MSCT | 80% | 100% |
| | SPECT | 91% | 40% |
| **Uddin**[20] | CT scan | 86% | 96% |
| **Mamun**[21] | Bone scan | 94.44% | 100% |

*In next year, Mukherji studied again and found different results.

35 patients of histologically proven oral squamous cell carcinoma close to mandible in the department of oral and maxillofacial surgery, Dhaka Dental College were selected by convenient sampling and were studied from 1st Jan, 2012 to 31st Dec, 2013. Ethical clearance was taken from the "Ethical Committee" of Dhaka Dental College before starting the study. All scans were performed by PreXion 3D CBCT machine and thickness of sections was 0.146mm. Detection criteria of mandibular invasion was set as thinning or irregularity of cortex adjacent to the lesion scalloping of underlying bone and radiolucent plane of the lesion extending into cortex and medulla. After resection of mandible the specimens were cut into 5 mm bucco-lingual sections. From the findings of CBCT scan, the actual site of invasion was identified and marked in relation to tooth. After sufficient fixation with 10% formalin solution the bone specimens were decalcified in 3% nitric acid solution for 5-7 days,

processed in paraffin wax and sectioned at 5um thickness and stained with haematoxylin and eosin. The histopathologist followed the set criteria for the detection of mandibular invasion which were bone cells replaced by squamous cell, bone lysis, nests of squamous cells within the bone, squamous cells in between bony trabecule. Data were collected in a pre designed data collection form The data were entered on to the template of SPSS 16. The diagnostic validity of preoperative CBCT was compared against histopathology.

## RESULTS:

The age range was from 30 years to 70 years, Mean age was 51.6 years. The sites of involvement were only buccal mucosa 40% while buccal mucosa and retromolar trigone involved in 31.43% and 17.14% involved only on the retromolar trigone. Among the positive invasion of bone which was confirmed by histopathology 96% were detected by CBCT scan. Among the patients diagnosed to have no bony invasion by hsitopathology, 90% were also diagnosed same by CBCT scan. (P< 0.00001).

**Table 3.1 Distribution of respondents by CBCT scan and histopathological result of excised bone**

| CBCT scan | Histopathology of excised bone | | Total |
|---|---|---|---|
| | Bone Invasion Present | Bone invasion absent | |
| Bone Invasion Present | 24 (96%) | 1 (10%) | 25 (71.43%) |
| Bone Invasion absent | 1 (4%) | 9 (90%) | 10 (28.57%) |
| Total | 25 (100%) | 10 (100%) | 35(100%) |

Chi squared with yates correction equals 21.844 with 1 degree of freedom p value < 0.00001

**Table 3.2 Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy of CBCT scan**

| Parametres | Percentage |
|---|---|
| Sensitivity | 96 |
| Specificity | 90.90 |
| Positive predictive value | 96 |
| Negative predictive value | 90.90 |
| Accuracy | 97.14 |

Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy were 96%, 90.90%, 96%, 90.90%, 97.14% respectively.

## DISCUSSION:

Oral squamous cell carcinoma adjacent to the bone has a tendency to invade the bone. Thus accurate preoperative staging is important to make a treatment plan. To evaluate the bone invasion, different types of investigating modalities are being used but none of them are accurate enough. Momin et al.17 first used CBCT to assess mandibular invasion in lower gingival carcinoma due its high spatial resolution and low radiation dose and the result was better than that of orthopentamogram.

A total 35 patients of histopathologically confirmed squamous cell carcinoma adjacent to the mandible were recruited for this study. Age range was from 30 years to 70 years. Mean age was 51.6 years but mostly affected (39.14%) age group was 40 years to 49 years. Present study observed buccal mucosa to be mostly affected (40%) site. This finding is also consistent with the findings of Molla and Hasan18.

Result of 35 cases of CBCT scan regarding mandibular invasion were compared to that of histopathology report. CBCT scan correctly detected 96% of cases to have bone invasion confirmed by histopathology, so sensitivity was 96%. Specificity was 90.90%, positive predictive value, negative predictive value and diagnostic accuracy were 96%, 90.90% and 97.14% respectively. These results of present study were compared to the results of different studies conducted by different researchers (Table 4.1).

Six observers found a wide range of sensitivity and specificity of CBCT scan in same cases in the study of Momin et al[17]. These were for alveolar bone invasion from 84% to 91% respectively

and for mandibular canal invasion 29 to 86%. In his study, among 50 cases, 36 cases or more were of true positive and 6 or less were of true negative. Maximum 5 cases were of false positive and maximum 7 cases were of false negative. These false negative results were found in cases with subtle bone invasion limited to a slight portion of alveolar crest. The specificity was low because CBCT scan showed a significant number of false positive cases for alveolar invasion. As the gingival carcinomas easily invade the alveolar bone at an early stage, only a little case was found to be true negative in his study. Moreover, there were some cases of false positive that were due to the difficulties to differentiate the actual mandibular invasion from the bone loss due to the periodontal diseases. In contrast, in case of mandibular canal involvement due to lack of dental artifacts as the distance is more, the false positive cases were lesser.

In contrast to the study of Momin et al[17]. Hendrikx et al[13]. Found a better specificity. It may be due to larger cases of true negative and no false positive results in his study, but due to small sample size ( n=23), the conclusions were not statistically significant.

**Table 4.1 Results of CBCT scan in different studies**

| Researcher | Total | Diseases | Sensitivity | Specificity | PPV | NPV | Accuracy |
|---|---|---|---|---|---|---|---|
| Momin et al.[17] | 50 | OSCC A* | 89% | 60% | | | |
| | | OSCC B* | 99% | 93% | | | |
| Hendrikx et al.[13] | 23 | OSCC | 91% | 100% | 100% | 92.3% | 95.7% |
| Dreiseidler et al.[7] | 77 | Malignancy of oral cavity | 92% | 96.5% | 98% | 87% | |
| Present study | 35 | OSCC | 96% | 91% | 96% | 91% | 97% |

(A*: Invasion into alveolar Bone, B*: Mandibular canal involvement).

However, Dreiseidler et al[7]. Studied on a larger sample size of 77 cases of malignancy of oral cavity. He reported a better result in sensitivity than both of them although the specificity was lower than that of Hendrikx et al[13]. Present study found sensitivity in between that of the study of Momin et al.[26] when observed in cases of mandibular canal involvement, Hendrikx et al.[22] and Dreiseidler et al.[7] , although in present study the sensitivity was little higher than that of the studies of Hendrikx et al.[13] and Dreiseidler et al.[7]. It was due to in the present study, the actual true positive cases were larger than that of both of them, it may be said in another way that in the present study, there were more cases of advanced stage. On the other hand, specificity was lower than that of the last two studies although the former study reported a very low specificity. It was clear that in the study of Momin et al.[17], the cases those whom he selected had more number of periodontal diseases which rendered a higher false positive rate and subsequently specificity was lowered. The present study also experienced a case of false positive which was due to the periodontal disease. Moreover, lesser cases of early staging in the sample gave few numbers of true negative cases that lowered the specificity rate although it was close to the results of the latter two studies. It may be due to in Bangladesh, patients get surgical treatments at an advanced stage. So, from this study it would not be possible to get adequate information on specificity due to smaller true negative cases. Sensitivity of Cone beam computed tomography in this study was 96%, only one false negative case was found. So, it may be concluded that cone beam computed tomography can aid a lot to detect mandibular invasion and depending on the results of cone beam computed tomography scan decision of either mandibulectomy is needed or not can be taken although there are little chances to have under treatment as it shows some false negative cases (4%). As the high sensitive test is clearly important where the test is used to identify the life threatening condition, cone beam computed tomography is a better diagnostic tool, since it possesses a better sensitivity. Specificity of cone beam computed tomography was 91%. So, from this study it could be said that cone beam computed tomography is not an accurate diagnostic tool to say that there is bone invasion in all cases as it shows more false positive results (9% cases), especially in presence of periodontal diseases. So, decision depending on only the result of cone beam computed tomography scan may give over treatment to the patient. As the true negative cases were small in the present sample, more study with a larger number of cases with early staging may give a more accurate result. From the results of this study and different studies mention on table 1.1, it is clear that cone beam computed tomography is a sensitive tool and it has an acceptable range of specificity. It can be able to detect mandibular invasion accurately.

The present study had the following limitations. So, these limitations should be kept in mind while deciding any implications of the findings of the study. As the specimen was decalcified in nitric acid solution, the extent of the invasion could not be evaluated which may give more precise information.

## CONCLUSION:

Cone beam computed tomography is a sensitive test and has an acceptable range of specificity. In presence of periodontal diseases, it may give false positive results. Due to its low radiation hazard and low cost but giving an accurate result, it may be used as a valid diagnostic tool to asses mandibular invasion in oral squamous cell carcinoma.

## RECOMMENDATION:

As cone beam computed tomography gives a false positive result in presence of periodontal diseases, a judicious intra oral clinical examination and an orthopentamogram that is supplied with the CD of CBCT scan or separately obtained from another machine should be carefully evaluated to asses whether the bone destruction is for periodontal disease or due to mandibular invasion.

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