Original Research Article

Evaluation of potential role of HRUSG as an adjunct imaging tool in carcinoma buccal mucosa

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Abstract

Background: Oral cavity continues to pose a diagnostic challenge to the radiologists due to its complex anatomy and opposing mucosal surfaces. Currently, puffed cheek Computed tomography (CT) and Magnetic resonance imaging (MRI) are the most widely used radiological investigations in the evaluation of the oral cavity. Recently, High resolution ultrasound (HRUSG) is being increasing used as an adjunct tool in evaluation of pathology of oral cavity, particularly in the evaluation of oral sub-mucosal fibrosis and buccal mucosa carcinoma. The aim of this study was to evaluate the role of HRUSG in (1) early detection of buccal mucosal carcinoma (2) assessment of depth and extension of the tumor into various layers of buccal mucosa in comparison with puffed cheek CT/MRI. (3) in evaluating the lymph node status in proven cases of buccal cancers. **Methods***:* Prospective observational study was performed over a period of 6 months from March 2016 to September 2016. All Biopsy proven cases of carcinoma buccal mucosa were evaluated with HRUSG and puffed Cheek CT/MRI of the face and neck. Various variables were analyzed on HRUSG and compared against puffed-Cheek CT /MRI Images) on PACS. Statistical analysis was performed using Chi square test. **Results:** Our study included 25 biopsy proven cases of carcinoma buccal mucosa. Statistically significant p values were observed in assessment of medio-lateral thickness of the tumor and in assessment of involvement of buccinator complex, masseter muscle and skin and subcutaneous tissues. **Conclusion***:* In our study, we observed that HRUSG is a very useful adjunct tool in diagnosis of buccal cancers. USG being an easily available, less expensive, safe imaging modality can be particularly useful in evaluating of high risk patients from lower socio-economic status for buccal mucosal cancers.
Key words: Buccal mucosal cancers, Puffed Cheek CT, Ultrasound

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INTRODUCTION

Oral and pharyngeal cancers, together form the sixth most common cancer in the world.[3] Buccal mucosal cancer constitutes the most common cancer of oral cavity in India.[4] The high incidence of buccal mucosal carcinoma in India is mostly attributable to the habit of smoking and usage of tobacco in various forms [3]. Despite advances in imaging techniques, oral cavity continues to pose a diagnostic challenge to the radiologists due to its complex anatomy and opposing mucosal surfaces. Currently, puffed cheek contrast enhanced Computed Tomography(CECT) and Magnetic resonance imaging (MRI) are the most widely used radiological investigations in the evaluation of oral cavity. High resolution ultrasound (HRUSG) is used mainly in evaluating lymph node status and in guiding biopsies in patients with head and neck cancers.[2] Recently, HRUSG has proven to be a cost effective, adjunct tool in evaluation of pathology of oral cavity, particularly in oral

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sub-mucosal fibrosis and buccal mucosal cancers. Recent studies in literature have shown that HRUSG can be used to measure tumor thickness of buccal mucosal cancers in early stages with accuracy comparable to CT or MRI [2]. The aim of this study is to evaluate[1] the role of HRUSG in early detection of buccal mucosal carcinoma. [2]The efficacy of HRUSG in assessment of medio-lateral(ML) thickness of tumor and extension of the tumor into various layers of buccal mucosa in comparison with cross sectional imaging like puffed cheek CT. [3] the role of HRUSG in evaluating the lymph node status in proven cases of buccal mucosal carcinoma .

MATERIALS AND METHODS

Research design

Single centre, prospective observational study was performed over 6 months period from March 2016 to September 2016 after obtaining approval from Institutional Ethics committee.Written informed consent was obtained from patients. All Biopsy proven cases of carcinoma buccal mucosa referred from SDM Dental College to Radio-diagnosis department , SDM medical college were considered for the study . All the patients who underwent HRUSG Cheek and neck and puffed Cheek CT of the face were included in the study. All cases of carcinoma of floor of maxillary sinus, hard palate, alveolar arch and recurrent carcinomas were excluded from our study.

Our study population consisted of 25 patients in the age group of 35 to 80 years.

Image acquisition and post processing

All patients included in our study were first evaluated by Puffed cheek CT followed by HRUSG.

Puffed cheek CT scan All CT scans were performed on a 128 slice CT scanner (SIEMENS SOMATOM DEFINITION AS). Using a pressure injector, 40 to 60 ml of intravenous (IV) contrast, Omnipaque (300 mg/mL) was injected at 3 to 4 ml/sec . A dual phase CT scan was performed in arterial and venous phases after an unenhanced CT scan. Bolus tracking technique was used with trigger placed on arch of aorta. Arterial phase acquired after 15 to 20 s delay and venous phase acquired at 50 to 60 s delay . Images were acquired in axial plane in cephalo-caudal direction. Raw data were generated in axial plane with 3 mm thickness and later reconstructed in coronal and sagittal planes with 1 mm thickness and reconstruction interval 1 mm . Images were transferred to picture archiving and communication system (PACS) for review. After the CT scan, the patients underwent HRUSG of Cheek and neck . HRUSG of cheek was performed using high frequency linear probe (7.5 – 12 MHz) using Philips HD 11 machine with panoramic imaging facility. Patient was instructed to blow and cheek was studied in puffed up position. HRUSG was performed in both axial and coronal planes. Serial axial planes starting from lower border of mandible to a plane extending upto an imaginary line connecting nasal ala to tragus were taken [2]. Coronal sections were obtained at 1 cm slice gap from angle of mouth anteriorly to tragus of the ear posteriorly. Performing cheek ultrasound in puffed up position makes the layers of Cheek taut ,so that they are visualized better as compared to scanning in resting position .

Image analysis

HRUSG results were compared with present gold standard imaging Puffed Cheek CECT.

Various variables were analyzed on HRUSG and compared against puffed-Cheek CT images . The variables studied were assessment of medio-lateral (ML) thickness , involvement of buccinator complex , skin and subcutaneous tissues, masticator space, retro-molar trigone, bone destruction and abnormal lymph nodes.

Data was tabulated and analyzed using statistical methods.

Statistical analysis

Sensitivity and specificity of USG was compared against Puffed Cheek CT using Chi square test. Pearson co-relation was used for comparing ML thickness between HRUSG and CT. Agreement between CT and USG in assessment of variables was studied using Kappa statistics. Microsoft word and Excel were used to obtain charts and graphs.

OBSERVATIONS AND RESULTS

From March 2016 to September 2016, a total of 25 patients with carcinoma buccal mucosa , confirmed on biopsy were evaluated with both puffed Cheek CT study and HRUSG study of Cheek and neck . Observation and results demonstrated in tables(1 to 4),Graphs(1 to 5) and figures (1 to 6). Patients characteristics were as per table 1. 21(84%) patients were males and 4(16%) were females, with a wide age range between 28 to 80 years.

Table 1: Distribution of patients by sex with mean and SD age

Sex	No of patients	%of patients	Mean age	SD age
Male	21	84.00	55.24	14.93
Female	4	16.00	63.25	3.95
Total	**25**	**100.00**	**56.52**	**14.02**

Pearson co-relation for Medio-lateral thickness measurements comparing the HRUSG and CT was statistically significant, p = 0.0001 ($p<0.05$) * at the level of 0.01%. as per table 2a ,2b.

Table 2a: Comparison of CT and USG in assessment of ML

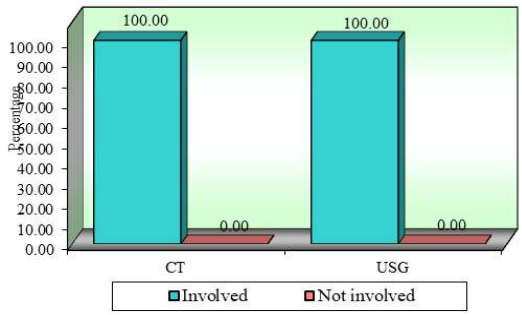
Method	Mean	Std.Dv.	Mean Diff.	SD Diff.	Paired t	p-value
CT	17.44	7.55				
USG	16.72	7.40	0.72	3.01	1.1971	0.2430

Table 2b: Correlation between CT and USG in assessment of ML

Methods	Correlation between CT with		
	r-value	t-value	p-value
USG	0.9193	11.2018	0.0001*

*p<0.05

25/25 cases(100%) show involvement of buccinator complex in both HRUSG and CT with a sensitivity and specificity of 100%(graph 1).



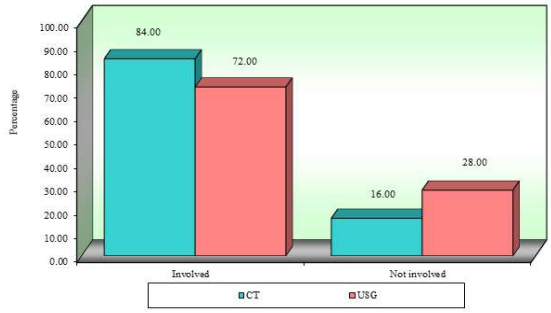
Graph 1: Comparison of CT and USG in assessment of buccinators complex

18/25(72%) cases showed involvement of masseter muscle on HRUSG while 21/25 cases (84%)showed involvement on CT with sensitivity of 94.44% and specificity of 42.86 %. Agreement between CT and USG in assessment of masseter muscle by Kappa statistics was significant with p=0.0112* (p<0.05).(Table 3,graph 2)

Table 3: Agreement between CT and USG in assessment of masseter muscle /masticator space by Kappa statistics

Agreement	Expected Agreement	Kappa	Std. Err.	Z-value	p-value
80.00%	64.96%	0.4292	0.1879	2.2800	0.0112*

*p<0.05



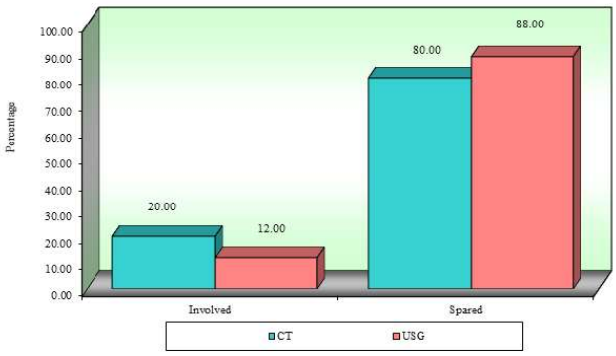
Graph 2: Comparison of CT and USG in assessment of masticator space

3/25 cases (12%) showed involvement of skin and subcutaneous tissues on HRUSG while 5/25 cases(20%) showed involvement on CT with a Sensitivity of 100% and specificity of 90.91%. Agreement between CT and USG in assessment of skin and subcutaneous tissue by Kappa statistics was significant with p= 0.0001*(p<0.05)(table 4 and graph 3).

Table 4: Agreement between CT and USG in assessment of skin and subcutaneous tissue by Kappa statistics

Agreement	Expected Agreement	Kappa	Std. Err.	Z-value	p-value
92.00%	72.80%	0.7059	0.1912	3.6900	0.0001*

*p<0.05



Graph 3: Comparison of CT and USG in assessment of skin and subcut tissue

However ,agreement between CT and USG in assessment of retromolar trigone , bone destruction and abnormal lymph nodes by Kappa statistics were not significant.13/25 cases(52%) showed involvement of retro-molar trigone on HRUSG whereas 20/25 cases(80%) showed involvement on CT. 14/25 cases(56%) showed bone destruction on HRUSG whereas 17/25 cases(68%) showed bone destruction on CT. 21/25 cases(84%) showed abnormal lymph nodes on HRUSG while 22/25 cases (86%) had marginally enlarged lymph nodes on CT. 1/22 cases showed necrotic lymph node on CT which was suggestive of metastasis whereas morphology of lymph nodes could not be made out on CT in 21/22 cases.

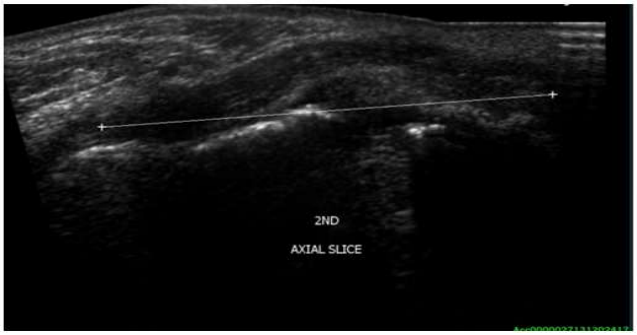


Figure 1: Panoramic view of Axial Section of Cheek in a proven case of carcinoma buccal mucosa – demonstrating antero-posterior measurement

Figure 2: Coronal Section of Cheek in a proven case of carcinoma buccal mucosa – demonstrating Cephalo-caudal measurement

Figure 3: Coronal Section of Cheek in a biopsy proven patient of carcinoma buccal mucosa– demonstrating maximum medio-lateral thickness(indicated between +...+)

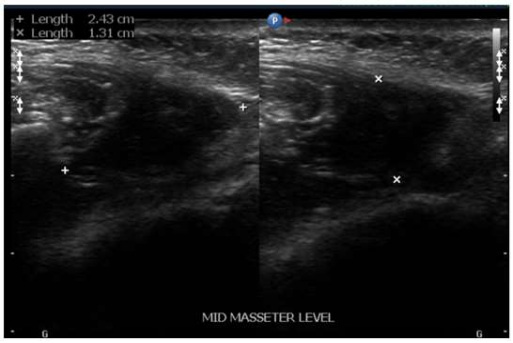


Figure 4: Axial section of Cheek in a patient with buccal cancer shows hypoechoic lesion extending into the infiltration into masseter muscle and masticator space with loss of normal fibrillar architecture of muscle.

Figure 5: Sub- masseteric space extension: Axial section of Cheek in a biopsy proven case of carcinoma buccal mucosa demonstrating extension of hypoechoic lesion beneath the echogenic muscle

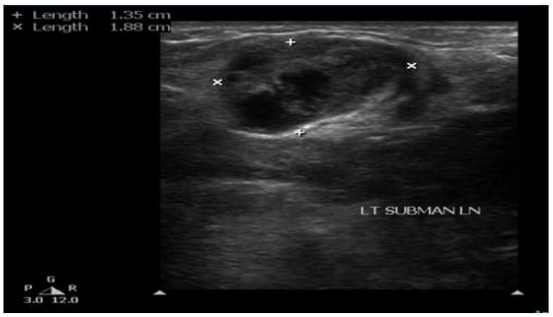


Figure 6: Transverse section of sub-mandibular region of neck in a case of buccal mucosal cancer demonstrating abnormal oval shaped lymph node with loss of central fatty hilum and areas of necrosis within suggestive of metastatic lymph node .

Epidemiology and screening recommendations:

Buccal mucosal cancer forms the commonest cancer of oral cavity in India [4].Its high incidence is mostly attributable to the habit of smoking and usage of tobacco in various forms like chewing or smoking [3]. Of all subtypes of oral cancers, Gingivobuccal squamous cell carcinoma consisting of those arising from buccal mucosa, the gingival mucosa covering the upper and lower alveolus and from gingivobuccal sulci are the most common variety . Lower gingiva-buccal carcinoma ,popularly called as " Indian oral cancer" is most frequently associated with tobacco usage[6] . Hence, a population based screening programme is strongly recommended to reduce mortality in high risk individuals with habits of tobacco chewing, tobacco smoking or alcoholism or both. There is a high quality evidence to support this recommendation. Early detection of pre-malignant conditions like oral submucosal fibrosis can help in reducing morbidity among cancer patients and improve their survival rate [2]. HRUSG being easily available, easy to perform and more economical compared to cross sectional imaging can be used as screening tool in diagnosis of oral submucosal fibrosis and early buccal mucosal cancers in high risk population . It has no radiation risk unlike CT scan and has good patient compliance.

Imaging modalities in buccal mucosal cancers

Imaging evaluation of buccal mucosal cancer should address tumor thickness , extent of submucosal spread, involvement of bones, retromolar trigone , pterygomandibular raphe and cervical lymphatic spread [6].Bone erosion by squamous cell carcinoma is an indicator of adverse prognosis which needs some form of mandibular resection.

Currently, puffed cheek CT and MRI are the most widely used radiological investigations in evaluation of oral cavity. CT is very useful in diagnosis of loco-regional extent of primary tumor , bone involvement and cervical lymph node metastases . However ,owing to its poor soft tissue resolution ,MRI is now considered as more suitable

than CT for assessing primary oral cancer .Other limitations of CT are poor soft tissue details, compared to MRI, risk of radiation and higher susceptibility for metallic artefacts .

Conversely, MRI provides excellent soft tissue resolution and is considered more appropriate for accurate T-staging [7,8,9,10,11,12,13] . MRI has high sensitivity and specificity in evaluation of soft tissue involvement , bone invasion and also in assessing lymph node metastases [7,14].

Current role of ultrasound in evaluating pathology of oral cavity

Till recently ,Ultrasound was increasingly used in assessing the lymph node metastases in head and neck cancer [15] . Accurate preoperative assessment of lymph node status can obviate the need for extensive surgeries and hep to reduce morbidity and improve the prognosis among survivors . Studies performed by Stuckensen *et al.* and Aggarwal *et al.* have shown that HRUSG is very useful in assessing metastatic lymph nodes [16,17].

Now , the scope of High resolution Ultrasound in oral cavity has been increased . It was wider applications in evaluation of pathology of oral cavity and maxillo-facial regions including evaluation of pre-malignant conditions like oral submucosal fibrosis and early buccal mucosal cancer . Joshi PS *et al.* [18].

Ultrasound in evaluation of Tumor thickness in buccal mucosal cancers:

Tumor thickness is an important variable in evaluating buccal mucosal cancers. It can predict subclinical nodal metastasis ,local recurrence and survival among buccal cancer patients[19]. Pre-operative evaluation of tumor thickness can be made using CT,MRI and US. A study performed by Shintani *et al.* demonstrated that tumor as small as one mm can be detected on intra-oral US and measurement obtained on CT and MRI were more than that obtained on US and histology[20]. Taylor *et al.* found that ultrasound measured tumor thickness was comparable to histologically measured tumor thickness [21] . Joshi S.K *et al.* stated that ultrasonography can be used as a reliable tool in measuring tumour thickness in early stage of buccal cancers with high accuracy, comparable with that of cross sectional imaging and also in evaluation of metastatic lymph nodes . In another study conducted by Joshi PS *et al.*. tumour thickness and depth of invasion assessed on ultrasound correlated significantly with histopathologic findings [18].

LIMITATIONS

- The study period is short with small sample size . Further studies with larger sample size is recommended.

CONCLUSION

In our study, we observed that HRUSG is a very useful adjunct tool in diagnosis of buccal cancers. Statistically significant p values were observed in assessment of ML thickness of tumor , involvement of buccinator complex, masseter muscle and skin and subcutaneous tissues. Thus, we conclude that Ultrasound being easily available , less expensive , safe imaging modality can be particularly useful as a screening tool for buccal mucosal cancers in high risk patients from lower socio-economic status [2]. Ultrasound can be used as a reliable imaging modality in evaluating tumor thickness in early stages of buccal mucosal cancers with accuracy comparable to cross sectional imaging.

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