ULTRASONOGRAPHIC EVALUATION OF CARCINOMA OF BUCCAL MUCOSA: ULTRASOUND TECHNIQUE AND EVALUATION OF NEOPLASTIC CONDITIONS

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ABSTRACT

INTRODUCTION

Ultrasound in head and neck region is mainly used to evaluate salivary glands, thyroid glands, and cervical lymph nodes. Being a versatile imaging modality, its use can be extended to evaluate maxillofacial region. Buccal mucosa is an important structure in the maxillofacial region as malignancy in this region is on the alarming rise in both developing and developed countries. Diagnosing malignancy at an early stage yields good prognosis. In this study, we discuss: 1) Ultrasound anatomy of buccal mucosa and evaluation techniques. 2) Evaluation of early buccal mucosal cancer on ultrasound. 3) Evaluate the extent of reliability of ultrasound, and its limitations in buccal mucosal cancers.

KEYWORDS

Oral Cancer, Ultrasound, Diagnosis, Puffed Cheek, Tongue Touch, Fruit Jelly, Buccal Mucosa, CT, MRI.

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INTRODUCTION: Squamous cell carcinoma (SCC) of the buccal mucosa is the most common form of oral cancer seen in India.[1] It accounts for 10% of all the oral cancers seen in the United States.[2] Around 275,000 oral and 130,300 pharyngeal cancers excluding nasopharynx are seen annually;[3] 6% of these occur in patients under 45 years.[4] Increased incidence is due to the habit of chewing tobacco mixed with lime. Buccal cancer is a locally aggressive tumour with 80% recurrence rate.[2] Buccal space has limited anatomical barriers and provides no resistance to the spread of the tumour. Further, tumours invading through buccinator muscle have increased incidence of local recurrence.[5] Diagnosis in early stage has a good prognosis. Most of the patients with buccal cancer belong to the low socioeconomic class and cannot afford CT (computed tomography) or MRI (magnetic resonance imaging) which results in refusal of treatment.[3] Purpose of this study is to evaluate the efficacy of ultrasound in buccal cancers and whether it can serve as a reliable cost effective alternative to CT or MRI in early stages of the disease.

MATERIALS AND METHODS:

Research Design: The Study was carried out in a Medical college teaching hospital. We commenced the study after getting approval from the Institute Ethics Committee. Written informed consent was obtained from both the healthy volunteers and the patients. The patients were referred from the Department of Oral and Maxillofacial Surgery from the Dental College. After explaining the study protocol, we first established the ultrasound technique and the anatomy with the healthy volunteers. Later this technique was used on patients with clinically suspected growth involving cheek. The ultrasound findings were then compared with CT or MRI and later confirmed with postoperative histopathological analysis.

Instruments Used: Ultrasound was performed on HD11 and Envisor units (Philips Medical Systems, Andover MA USA) with panoramic imaging facility using a 3-12 MHz linear transducer. CT was performed on a 128-slice Somatom definition AS unit (Siemens, Malvern, PA USA) 0.75 mm thick plain and post-contrast images were acquired with puffed cheek in axial and coronal plane in soft tissue and bone window settings. MRI was performed on a 1.5 Tesla Hde Signa unit (GE Milwaukee USA) 3 mm slice thickness and 0.5 mm inter-slice gap T1W and T2W images were obtained in axial plane and T1W, T2W and STIR images were obtained in coronal plane. Thickness of tumour acquired on ultrasound was measured using 'KLONK' image measuring software with appropriate calibration.

Oral cavity, buccal mucosa and cheek: Buccal mucosa is defined as an area including the mucosal surfaces of the cheek, lips, extending from the line of contact of opposing lip to pterygomandibular raphe posteriorly and to the line of attachment of the mucosa of upper and lower alveolar ridge supero-inferiorly with buccinator forming the lateral wall of oral vestibule.[6]

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Ultrasound appearance of different buccal mucosal layers: Understanding the normal ultrasound anatomy and appearance of normal tissues is important before understanding the pathological conditions. Echogenicity of tissues on ultrasound depends on the bulk modulus (stiffness) of the tissue, collagen is the major source of echogenicity in tissues and different organs display varied echo pattern due to their varying collagen content.[7] Both mucosa and submucosa appear hyperechoic,[8] but submucosa appears less echogenic than mucosa. Muscle appears hypoechoic or dark,[9] while fat appears markedly echogenic.[7]

Methods for evaluation of buccal mucosa:

Resting and Puffed Cheek Technique: Patient was instructed to blow and cheek was studied in puffed up position. Ultrasound scan was performed in both axial and coronal planes. Cheek, in puffed up position made the layers taut improving the visibility of the layers and helped in accurately defining the size of the lesion than in resting position.

Limitation: Mirror image artefact was noted in this technique. Resting phase and puffed cheek techniques were less sensitive in the evaluation of lesions in the vestibule (gingivobuccal sulcus).

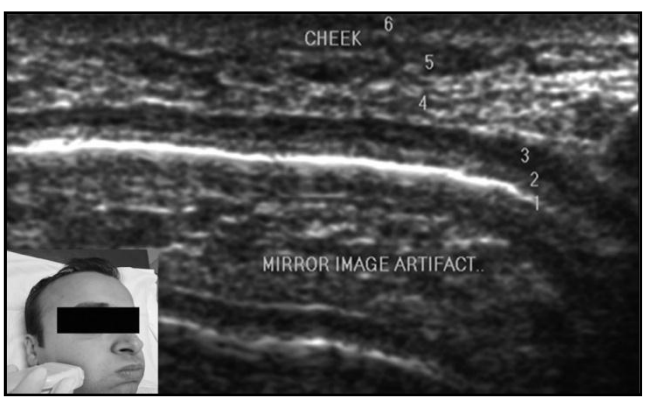

Fig. 1: *Puffed Cheek Technique Depicts Layers of Cheek.* ***1****=Mucosa.* ***2****= Submucosa.* ***3****=Buccinator.* ***4****=Buccal fat.* ***5****=Subcutaneous tissue.* ***6****=Skin.*

Tongue Touch Technique: Patient was asked to feel the lesion with the tongue. This manoeuvre brought the lesion closer to the probe and provided a better acoustic window leading to better visualisation of details. In cases of primary tongue carcinoma, approximation of tongue against the buccal mucosa delineates the tongue lesion better. This technique was performed to evaluate superficial mucosal lesions involving the buccal mucosa and lesions involving the anterior half of the tongue and its lateral borders.

Limitation: Growth along the posterior half of the tongue and its corresponding lateral borders were inaccessible by this technique.

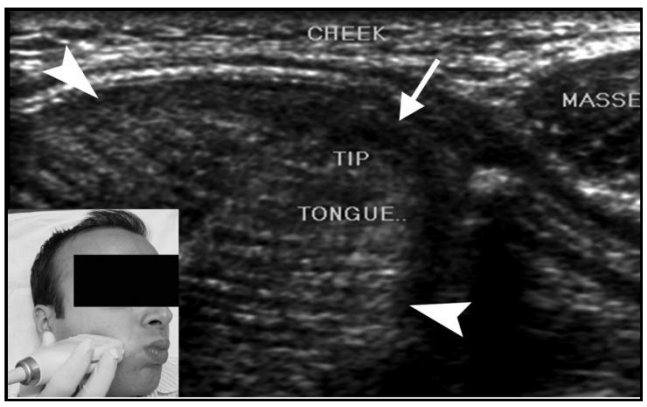

Fig. 2: *'Tongue Touch' Technique. Scan of Cheek Shows Tongue Touching the Cheek Demonstrating the Layers of Cheek as well as the Anterior Half of Tongue, Tip, and its Lateral Border*

Fruit Jelly Technique: One of the disadvantages of the puffed cheek technique was that it introduced gaseous interference in the vestibule. Further, old age patients and patients with facial nerve palsy found it difficult to hold the puffed cheek for a long time. To overcome this problem, we began using water as a medium to maintain the cheek in puffed up position. This was associated with artefacts from bubbles and non-compliance from the patient. Then we used commercially available fruit jelly instead of water, it obliterated the air in the vestibule and thus enhanced the delineation of structures in this region. Commercially available 'Fruit jellies' in oval or conical shapes were placed in upper and lower gingivo-buccal sulcus (groove between the gingiva and the buccal mucosa). The patient was then asked to close the mouth and then scan was performed.

Advantage: Artefacts due to bubbles were not seen. Patients were comfortable keeping the jelly in the mouth. We were able to study the vestibular extension of lesions by this technique.

Limitation: Lesions involving far posterior aspect of vestibule were not studied by this technique.

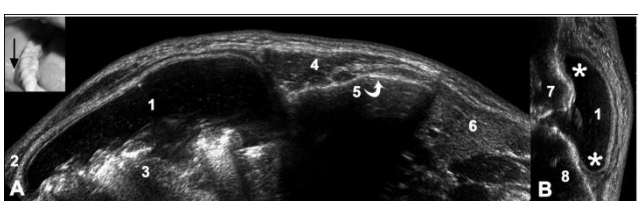

Fig. 3: *Panoramic Ultrasound Image of Cheek with Fruit Jelly in the Gingivo-Buccal Sulcus.*

A, *Axial panoramic.* ***B,*** *Coronal image.* ***1.*** *Jelly* ***2.*** *Angle of mouth* ***3.*** *Alveolar process* ***4.*** *Masseter* ***5.*** *Mandible* ***6.*** *Parotid* ***7.*** *Maxilla* ***8.*** *Mandible.* ***(Asterix)-****Upper and lower gingivo-buccal sulcus.*

Scanning levels: Scan is performed at six different levels along coronal and axial planes.

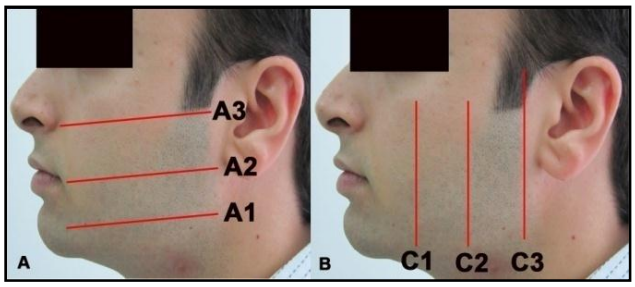

Fig. 4 A & B: *Scan levels on cheek in axial and coronal planes.*

Axial Sections:
A1. Along the lower border of the mandible.
A2. Angle of the mouth to the ear lobule.
A3. Nasal ala to the tragus.

Coronal Sections:
C1. Vertically from mandible up to the lateral canthus.
C2. This section is approximately one-inch posterior to C1.
C3. Extends from the angle of mandible to temporal region.

A1. Lower Border of The Mandible:

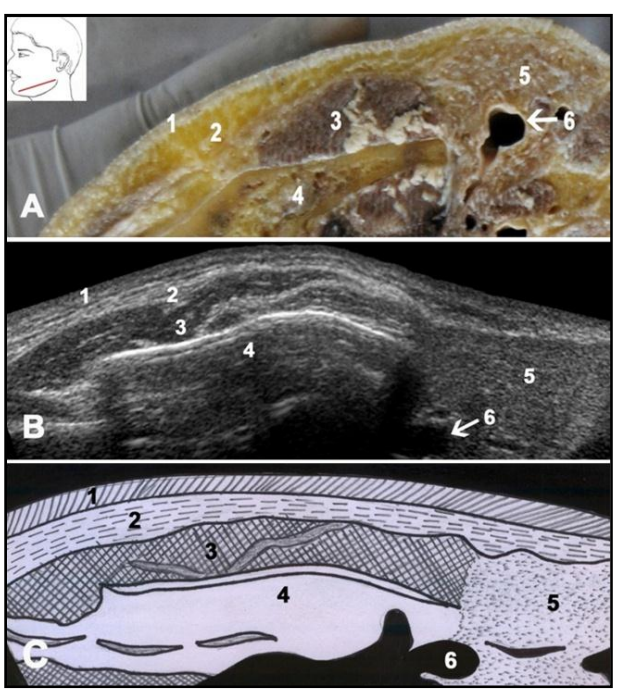

Fig. 5: Axial scan level A1 **A**, Cadaveric section. **B**, Panoramic ultrasound image. **C**, Line diagram. **1**. Skin. **2**. Fat. **3**. Masseter. **4**. Mandible. **5**. Parotid gland. **6**. Retromandibular vessels.

A2. Angle of the Mouth to the Ear Lobule:

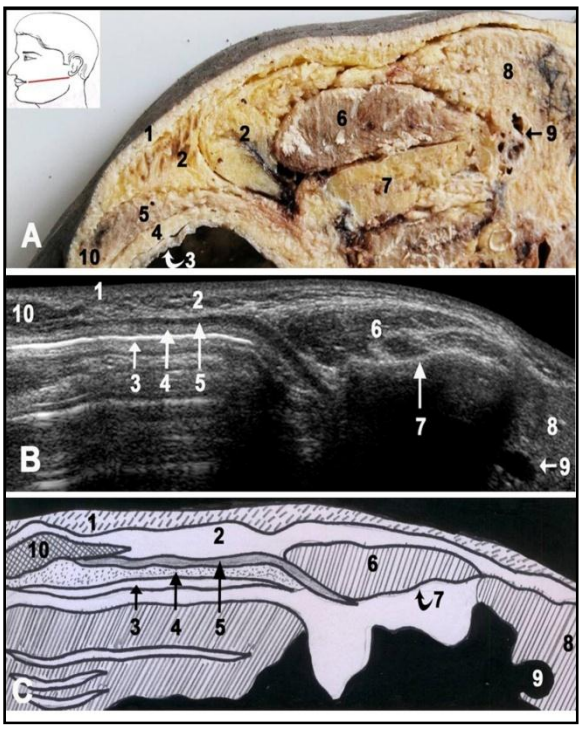

Fig. 6: Axial scan level A2 **A,** Cadaveric section. **B**, Panoramic ultrasound image. **C**, Line diagram. **1**. Skin **2**. Fat. **3.** Mucosa **4.** Submucosa **5.** Buccinator **6.** Masseter **7.** Mandible **8.** Parotid gland **9.** Retromandibular vessels **10**. Orbicularis oris.

A3. Nasal ala to the tragus:

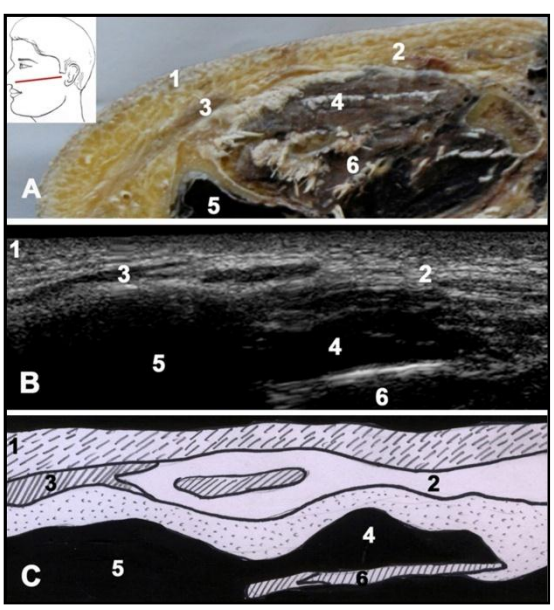

Fig. 7: Axial scan level A3. **A,** Cadaveric. **B,** Panoramic ultrasound image. **C,** Line diagram. **1**. Skin **2**. Fat **3**. Zygomaticus muscle **4**. Masseter **5**. Maxillary sinus **6**. Mandible.

C1. Vertically from mandible up to the lateral canthus:

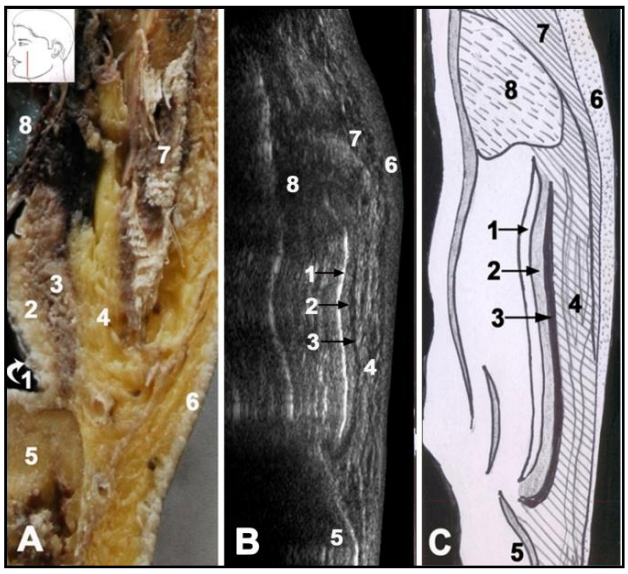

Fig. 8: Coronal scan level C1 **A,** Cadaveric. **B,** Panoramic Ultrasound. **C,** Line diagram.**1.** Mucosa **2.** Submucosa **3.** Buccinator **4.** Fat **5.** Mandible **6**. Skin **7.** Masseter **8.** Maxillary sinus.

C2. This section is approximately one-inch posterior to C1:

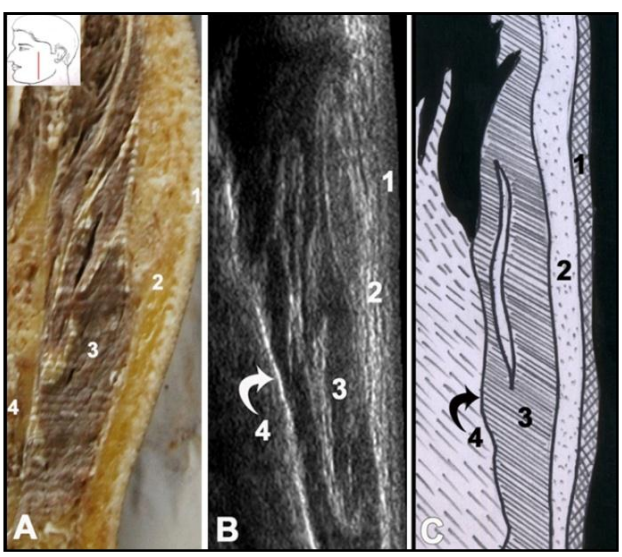

Fig. 9: Coronal scan level C2 **A,** Cadaveric. **B,** Panoramic ultrasound image. **C,** Line diagram. **1.** Skin **2**. Fat **3**. Masseter **4.** Mandible

C3. Extends from the angle of mandible to temporal region:

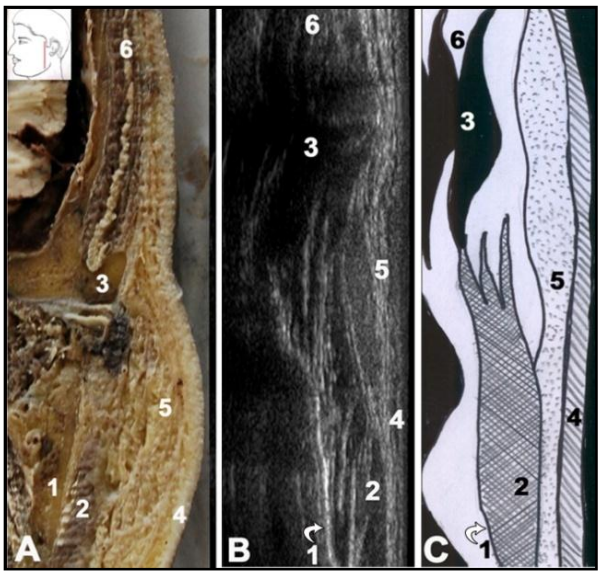

Fig. 10: Coronal scan level C3 **A,** Cadaveric. **B,** Panoramic ultrasound image. **C,** Line diagram. **1.** Mandible **2.** Masseter **3.** Zygomatic bone **4.** Skin **5.** Fat **6.** Temporalis.

RESULTS:

Ultrasound demonstration of early stage buccal mucosal cancer:

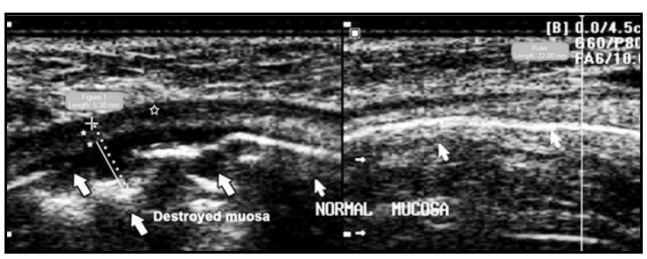

Fig. 11

Fig. 11: Squamous cell carcinoma of buccal mucosa in a 55-year-old male presenting with ulceration of mucosa. Puffed cheek axial ultrasound of cheek reveals a growth predominantly involving the mucosa measuring approximately 5.36 mm in thickness resulting in disruption of mucosal white line, the mass appears distinct from submucosa (between asterix), buccinator (star) appears normal.

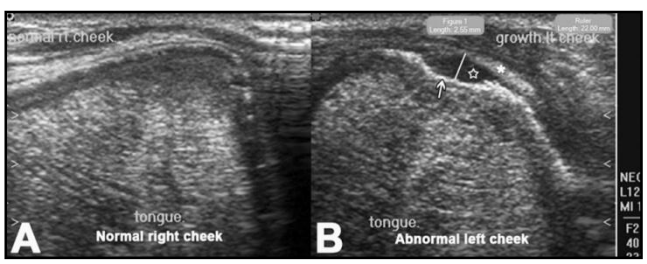

Fig. 12

Fig. 12: Squamous cell carcinoma of buccal mucosa in a 60 yr male presenting as a ulcer along the mucosa on clinical exam, **B,** Tongue touch technique demonstrates a growth (star) of approximately 2.55mm involving the mucosa and submucosa. Tongue margin (arrow) appears normal. **A,** Normal anatomy is appreciated on right side.

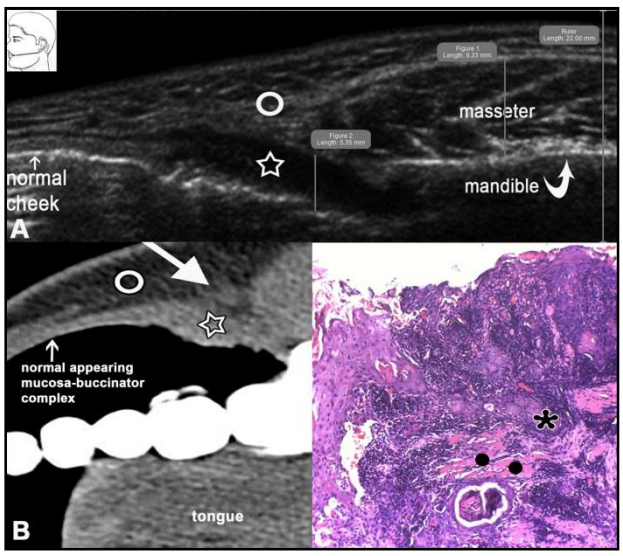

Fig. 13

Fig. 13: Squamous cell carcinoma of buccal mucosa in a 52 year old man. **A,** Axial panoramic scan of cheek using puffed cheek, reveals growth involving mucosa, submucosa and buccinator (star) measuring approximately 5.35mm. **B,** Post contrast axial puff cheek CT reveals mass lesion (star) involving the posterior aspect of buccal mucosa. **C,** 10x H&E stain shows neoplastic process (asterix) involving the mucosa, submucosa and the muscle. (dots).

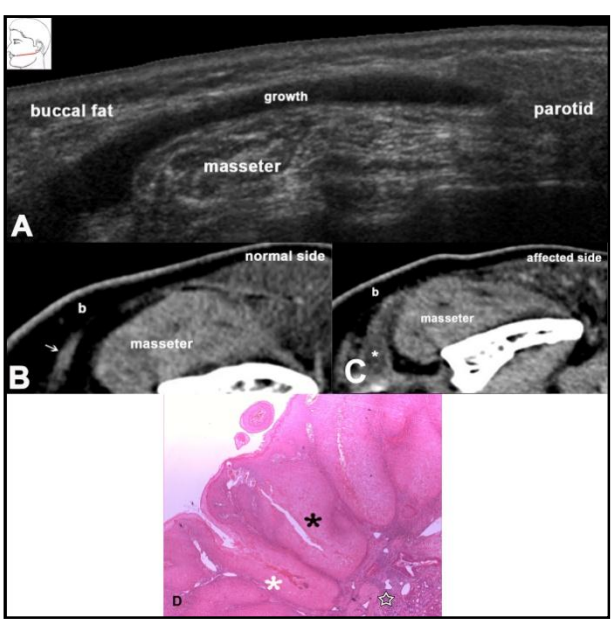

Fig. 14

Fig. 14: Verrucous carcinoma of buccal mucosa in a 57 year old man. **A,** Axial panoramic puffed cheek ultrasound reveals growth involving mucosa-submucosa–buccinator with an approximate thickness of 6.48mm (asterix), **B,** Axial puffed cheek CT reveals normal appearance of buccal mucosa (arrow), b-buccal fat. **C,** Irregularly thickened buccal mucosa **D,**40x H&E stain shows verrucous carcinoma with proliferative bulbous rete ridges (black asterix) and keratin plugging (white asterix), connective tissue (star).

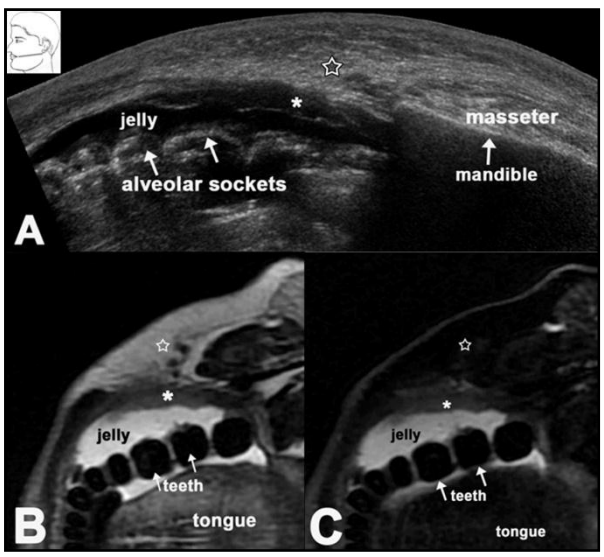

Fig. 15

Fig. 15: Squamous cell carcinoma of buccal mucosa in a 56 yr old man unable to perform puff cheek. **A,** Fruit jelly technique axial panoramic ultrasound image of cheek shows growth (asterix) at the posterior aspect of buccal bucosa involving mucosa-buccinator complex extending into adjacent tissue (star). **B,** T2 W. **C,**T2 fat sat MRI with jelly reveals growth (asterix) with illdefined lateral margin extending into adjacent tissue (star).

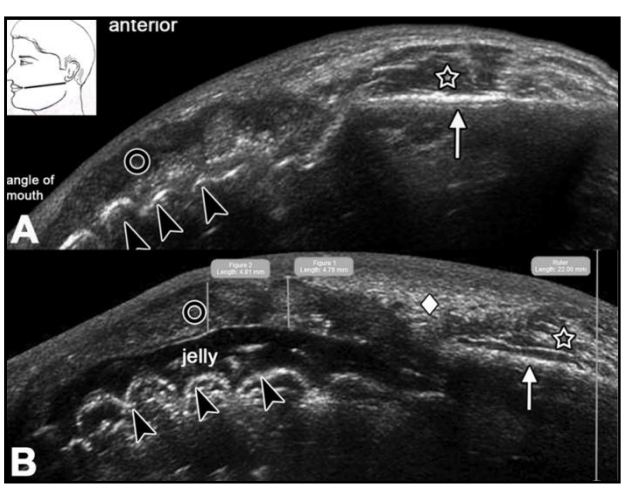

Fig. 16

Fig. 16: Squamous cell carcinoma of buccal mucosa in a 62 year old man unable to perform puff cheek. **A,** Axial panoramic view image of cheek reveals vague ill-defined area of hypoechogenecity (circle), its medial extent not made out. **B,** Post jelly technique scan reveals irregular growth involving the buccal mucosa measuring approximately 4.81mm thick; lesion is seen involving entire

antero-posterior extent (circle) extending into connective tissue (rhombus). (Masseter–Star,Mandible-Arrow, Alveolar sockets-Arrow heads), are not involved.

RESULTS: Extra oral approach provided better compliance to the patients and use of panoramic imaging gave larger field of view. Ultrasound was able to measure tumour thickness up to 2.5 mm, it was able to measure tumour thickness with equal efficacy as of CT and MRI in early stage cases. Jelly technique was useful in patients who were unable to open their mouth adequately especially people with submucous fibrosis and lesions in the anterior part of vestibule. Ultrasound was unable to image deep extensions, lesions located in posterior aspect of vestibule and those obscured by bone.

DISCUSSION:

Carcinoma of Buccal Mucosa: SCC of buccal mucosa accounts for 10% of oral cavity cancers in the US and around 41% of oral cavity cancers in India.[6] Over 650,000 new cases of head and neck cancer are added worldwide every year. Studies indicate that early detection of cancer improves prognosis, improves quality of life and increases 5-year survival rate with less aggressive treatment.[10] More than 50% of patients with oral cavity cancers develop regional or distant metastasis at the time of presentation.[11]

Imaging Modalities in Evaluating Pathologies of Oral Cavity: Ultrasound, CT, and MRI are the mainstay techniques for evaluating tumour and lymph nodes in oral cancer patients. Ultrasound is mainly used to evaluate lymph node status and to guide biopsies in head and neck cancer patients. The extent of the tumour is studied using CT or MRI, CT is the primary imaging modality to detect cortical invasion in bones and MRI is the modality of choice to appreciate bone marrow changes and perineural spread of the tumour.[12] CT and MRI images are of low quality in presence of metallic implants.[13] Bulky tumours are difficult to be imaged on a MRI due to long scan time.[14,12] In some cases, MRI over estimates the tumour or give false positive results while CT fails to demonstrate small invasion.[14]

Prognostic Factors in Carcinoma of Oral Cavity: Presence of cervical node metastasis is regarded as the single most important prognostic factor in head and neck carcinomas.[15] In patients with SCC of head and neck, the presence of metastatic node reduces the 5-year survival rate by 50% and the presence of contralateral node reduces it to 25%.[16]Sieczka et al. in their study concluded that T stage and negative histologic margins are unreliable indicators for treatment.[2] DNA ploidy, angiogenesis, and tumour infiltration depth were found to be predictors of biological aggressiveness and regional failure, while the former two are expensive, assessment of tumour thickness would be less expensive and widely available parameter.[1]

Tumour Depth or Thickness: Yeun et al. stated that tumour thickness was the only factor that could predict subclinical nodal metastasis, local recurrence, and survival.[17] Studies have shown increased mitosis at invasive tumour front in tumours with depth more than 5 mm, and tumour thickness was the only parameter to predict recurrence.[18,19] Melchers et al. stated that tumour infiltration was the only independent predictor of nodal metastasis in pT1-T2 cancers, they recommended that the infiltration depth of four mm to be used as an absolute indication for performing neck dissection in pT1c N0 squamous cell cancers.[20] Mishra et al stated that The TNM staging is not a reliable prognostic indicator for node negative SCC of the buccal mucosa, and a modification of TNM staging is now proposed to incorporate tumour thickness.[1]

Evaluation of Tumour Depth or Thickness: Tumour depth in previous studies were evaluated histologically and this information is not available preoperatively where critical decisions are taken.[21] Ultrasound, CT, and MRI are the modalities that are available to us to evaluate the tumour. However, CT and MRI were unable to differentiate tumour from surrounding normal tissue in patients with implants, and when tumour was less than 5 mm.[22] Taylor et al. found that the ultrasound-measured thickness was comparable to histologically measured thickness; between the two modalities, the difference was within one mm in 81% cases, and the difference was within two mm in 93% cases.[21] Tumours as small as one mm were detected and ultrasound could detect tumour shape and invasion, whereas tumour thickness measured on CT and MRI was more than that measured on ultrasound and histology.[22]

Evaluation of Lymph Nodes: Accurate evaluation of lymph nodes is important in predicting prognosis. Sumi et al. found that ultrasound showed greater sensitivity and specificity than CT in depicting metastasis of head and neck SCC.[23] In another study, the combination of size with the altered hilar flow on Doppler showed greater predictivity in depicting metastatic nodes, and found ultrasound accuracy equal or superior to CT or MRI.[24]

CONCLUSION: Carcinoma of the oral cavity is one of the most common neoplastic conditions seen in South East Asia and one of the cancers on the rise in the West. Early detection of such cancers improves prognosis, quality of life and increases five-year survival rate. Presence of cervical nodal metastasis is the single most reliable prognostic factor for patient survival, and tumour thickness is the most reliable factor related to presence of occult or clinically palpable nodes. Ultrasonography is an easily available, less expensive and reliable imaging tool with no risk of radiation, it can diagnose the presence of metastatic cervical nodes and measure tumour thickness with good accuracy in early stage cancer better than or equal to CT or MRI. Use of extra-oral panoramic imaging technique provides greater field of view so that status of adjacent structures can be assessed adequately with better patient compliance, and scan can be performed using any linear

transducer of 12 MHz and above, with panoramic imaging facility in the machine. In advanced cases with deeper extensions, involvement of deep nodes and in cases where lesions are obscured by bone it is of limited value and serves as an adjunct modality to CT and MRI in evaluation of the disease.

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