MDCT evaluation of gingivo-buccal cancers: What the clinician needs to know

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Learning objectives

- To describe the normal radiological anatomy of oral cavity & specifically of the gingivo-buccal region (vestibule) with the importance of "puffed-cheek" manouevre.
- To demonstrate the imaging appearances of various stages of squamous cancers of the gingivo -buccal region through a pictorial essay.
- To describe how imaging findings impact management.

Background

Squamous cell carcinomas account for greater than 90% of the malignant tumors that are found in the oral cavity. The lip and oral tongue are the commonest sites of cancer in the western world, however in Southeast Asia, buccal mucosa and the gingivobuccal (GB) sulcus tumors are more common. This is associated with the extensive usage of quid of tobacco with lime which is kept in the GB sulcus.

Patients generally present to the clinician with complaints of a nonhealing ulcer in the mouth, with halitosis, pain and trismus in later stages. Clinical history with examination and histopathology are used for the diagnosis.

Imaging does not have a role in the initial diagnosis of oral cancer, but is crucial for staging of the disease. Imaging with contrast enhanced MDCT using puffed cheek manouevre can depict these cancers with high degree of accuracy.

Management of these patients is dependent on disease stage, early stages being treated by surgery alone and advanced stages requiring multimodality treatment (chemoradiation in addition to surgery). Hence accurate preoperative staging is imperative.

Imaging findings OR Procedure details

Normal anatomy:

The oral cavity is divided into a central part called the oral cavity proper and a lateral part called the vestibule (Fig 1). Oral cavity proper is bounded by the inner aspects of the lips anteriorly, by the circumvallate papillae and anterior tonsillar pillar posteriorly, the inner aspects of upper and lower alveolus laterally and hard palate superiorly. The vestibule
is lined by the gingiva of the upper and lower alveolus medially and the buccal mucosa laterally and leads into the retromolar trigone posteriorly(Fig 2).

Lateral to the buccal mucosa is the buccal space and buccomasseteric region, which are relevant for the spread of gingivobuccal cancers. The buccal space is bounded by the buccinator medially and zygomaticus major laterally, while posteriorly the fascia between it and the masticator space is incomplete (Fig 3 & 4).

**Puffed cheek technique:**

Computed Tomography is a commonly used modality for evaluation of buccal cancers. At our institute, imaging of buccal cancers is done using 16slice MDCT following intravenous injection of 60-70cc of iodinated contrast and using "puffed cheek technique"(Fig 5).

This technique has been extremely useful in our practice to evaluate early buccal mucosal thickening and GB sulcus cancers. It involves blowing air uniformly through pursed lips during quiet breathing to distend the vestibule. It was first described by Weissman & Carrau. Keeping the tongue away from the hard palate further improves the image.

Subtle thickening of the buccal mucosa which can be missed on non puffed cheek scans can be picked up using this technique (Fig 6).

**AJCC 7th Edition TNM staging of buccal cancers.**

T-Primary:

T1 tumors are less than 2 cm

T2 tumors are more than 2 cm but less than 4 cm

T3 tumors are more than 4 cm

T4a tumors involve cortical bone, extrinsic muscles of the tongue, maxillary sinus, or skin

T4b tumors involve the masticator space, pterygoid plates, skull base or encase the carotid artery

N-Lymph Nodes:

N1-Metastasis in a single ipsilateral lymph node, 3 cm or less in greatest dimension

N2a-Metastasis in a single ipsilateral lymph node, more than 3 cm but not more than 6 cm in greatest dimension
N2b-Metastasis in multiple ipsilateral lymph nodes, none more than 6 cm in greatest dimension
N2c-Metastasis in bilateral or contralateral lymph nodes, none more than 6 cm in greatest dimension
N3-Metastasis in a lymph node more than 6 cm in greatest dimension

M-Metastases -
Mo-No distant metastases
M1-Distant metastases evident.

**SPREAD OF BUCCAL CANCERS:**

Spread can occur mainly by two routes-a) Direct spread and b) Lymphatic spread.

Spread along neurovascular bundles and via hematogenous route is not very common in buccal cancers.

**Direct spread:**

It is the most common route of spread of buccal cancers. Involvement of contiguous structures like retromolar trigone, buccal space, overlying subcutaneous tissue and skin, masticator space, infratemporal fossa, pterygopalatine fossa and base skull can occur. Osseous involvement includes erosion of mandible, maxilla and pterygoid plates.

Cases of buccal cancers representing T1, T2 and T3 stages are shown in Fig 6, 7 and 8 respectively. The treatment of choice for most of these cases is surgery upfront which may or may not be followed by chemoradiation.

Accurate assessment of advanced cases (i.e T4) by imaging plays an important role in the management of these cases since some of them might require multimodality treatment.

v Osseous Involvement:

Osseous involvement (mandible and maxilla) upstages the tumor to stage T4a.

Involvement of the mandible can be assessed using MDCT and multiplanar reformats. MDCT is the most accurate modality for detecting mandibular erosion. CT findings of osseous involvement include cortical erosion adjacent to the primary lesion, aggressive periosteal reaction, abnormal attenuation in bone marrow, and pathologic fractures.
Two important surgical procedures used for mandible are-

1) *Marginal mandibulectomy*- If the mandible is uninvolved or subtle cortical erosion is noted.

2) *Segmental mandibulectomy*- If there is gross erosion of the mandibular cortex. (Fig 9)

Hemimandibulectomy is a type of segmental mandibulectomy done only in cases where the tumor does not cross the midline.

Reconstruction procedures like a free fibular flap or a prosthesis needs to be done post mandibular surgery.

Involvement of the mandible also increases the chances of perineural spread via the inferior alveolar nerve which runs in the mandibular canal (Fig 10).

Involvement of the Maxillary Sinus---

*Involvement of only inferior wall can be treated by infrastructural partial maxillectomy while gross soft tissue within the sinus may require a total maxillectomy* (Fig 11).

Erosion of the pterygoid plates also represents T4b disease (very advanced) and should be looked for in the scan (Fig 12).

Thus, it is observed that accurate reporting of osseous component of the disease has a direct impact on patient management.

v Retromolar Trigone:

Involvement of the retromolar trigone should always be carefully searched for since it is an important site from which spread of tumor can occur to many other subsites.

*Anterior spread can occur along the alveolar ridge, and inferior spread along the mandible and inferior alveolar nerve. It may spread to the base tongue, tonsil and pterygomandibular raphe*. The pterygomandibular raphe provides access to the masticator space superolaterally and the floor of the mouth inferomedially. Fig 13 shows a soft tissue lesion involving the right retromolar trigone.

v Masticator space:

Masticator space involvement indicates very advanced disease and represents T4b lesion. (Fig 14). *Extent of disease whether below or above the mandibular notch is considered important and should be mentioned. If disease extends above the notch* (Fig 15 & 16) *getting a clear(negative) surgical margin might be difficult upfront and*
hence the patient might require neoadjuvant chemotherapy to downsize the tumor. This can be followed by a repeat imaging and then surgery if possible.

*Involvement of the skin* if present should always be mentioned (Fig 17) though clinical assessment is many times good enough to diagnose it. Skin involvement requires plastic reconstruction.

- **Carotid artery encasement:**

  Carotid encasement (rare) if occurs generally is due to large nodal mass which is adherent to the vessel. The circumferential contact (CC) of tumor with CCA if greater than 270 degrees makes it unresectable while tumor with CC with CCA less than 180 degrees is resectable.

- **Involvement of skull base:**

  Skull base involvement is possible either by direct route by a large mass or via the perineural route. Case with spread along the mandibular nerve via foramen ovale is shown in Fig 18.

  *If the lesion extends up to the skull base getting a negative surgical margin would be difficult and an extensive surgery in co-ordination with a skull base surgeon would be required.* Some of these patients might be put on neoadjuvant chemotherapy to downsize the tumor.

**Lymphatic Spread:**

Nodal involvement is one of the most important prognostic indicator in buccal cancers and hence an accurate assessment of all nodal chains should be performed. The spread of buccal cancers commonly occurs to the ipsilateral nodes and generally levels I and II are the ones commonly affected. (Fig 19, 20 & 21). Contralateral spread can also occur as shown in Fig 20.

Signs of metastatic nodal involvement include enlargement (greater than 10 mm in size for most nodes except level II which should be greater than 15 mm), necrosis (commonly seen in squamous cancers of oral cavity), round shape and features s/o extracapsular spread. Imaging features of extracapsular spread include poorly defined nodal margins and soft-tissue stranding around nodes.

**Spread along neurovascular bundle and via haematogenous route:**

Spread via hematogenous route is not very common and if occurs involves organs like the liver and lung. Perineural spread is commoner in cancers involving floor of the mouth and
is not commonly seen in buccal cancers. MRI can show enhancement along the nerve in cases of perineural spread.

**Checklist for structured reporting:**

- Lesion epicenter.
- Soft tissue extent including maximum size.
- Details of the osseous involvement- Which bone is involved? Is the involvement subtle or gross? Does the lesion cross the midline?
- Status of the retromolar trigone- Whether involved or not?
- Masticator space involvement- If yes then whether it extends above the mandibular notch or not?
- Nodal status- Details mentioning size, number, level, morphology, laterality (ipsilateral or contralateral). Angle of contact if close to carotid artery.
- Any obvious perineural spread or skull base involvement.

**Images for this section:**
Fig. 1: Coronal reformat on a 16 slice MDCT showing the vestibule (blue arrow), oral cavity proper (green arrow) and the lower gingivobuccal sulcus (red arrow)
Fig. 2: Oblique sagittal reformat on 16 slice MDCT showing the retromolar trigone
Fig. 3: Axial CT scan showing the buccal space (yellow shaded area). Yellow arrow points to the zygomaticus major muscle and white arrow to the buccinator muscle.
Fig. 4: Axial CT scan showing communication of the buccal space fat(*) with the masticator space fat(+). m=masster muscle.
Fig. 5: Axial CT scan at the level of lower alveolus with the puffed cheek manoeuvre showing bilateral symmetry.
**Fig. 6:** Axial CT scan acquired with the puffed cheek manoeuvre shows subtle thickening of the left posterior buccal mucosa measuring 1.8cm representing T1 disease.
Fig. 7: Coronal reformat on 16 slice MDCT showing thickening of the right buccal mucosa extending into the right lower gingivobuccal sulcus measuring 3.8cm representing T2 disease (Mandible is uninvolved)
Fig. 8: Axial CT scan showing an enhancing mass lesion measuring 4.2cm involving the left gingiva representing T3 disease.
Fig. 9: Axial CT scan bone window showing erosion of the outer cortex of the left hemimandible.
Fig. 10: Axial CT at the level of mandible showing spread of the tumor along the mandibular canal (arrow).
Fig. 11: Coronal reformat showing a right buccal cancer with gross soft tissue involving the right maxillary sinus.
Fig. 12: Axial CT bone window image showing erosion of the right pterygoid plates (arrow) with extension into the right maxillary sinus.
**Fig. 13:** Axial CT image showing soft tissue thickening involving the right retromolar trigone (arrow).
**Fig. 14:** Axial CT image showing a large mass involving the right masticator space and medial pterygoid muscle with destruction of the mandible.
Fig. 15: Coronal reformat showing extension of the left buccal mass lesion into the left masticator space above the mandibular notch with involvement of the left mandibular condyle (arrow).
Fig. 16: Oblique sagittal reformat bone window showing erosion of the mandible reaching up to the condyle.
Fig. 17: Axial CT scan showing a large left buccal mass with skin infiltration and ulceration.
**Fig. 18:** Coronal reformat showing enhancing right buccal mass lesion with involvement of the right lateral pterygoid muscle (*) and extending along the mandibular nerve to the skull base via foramen ovale (arrow). (+) shows normal left lateral pterygoid muscle.
Fig. 19: Axial CT showing necrotic level IA nodes
**Fig. 20:** Axial CT scan in a patient with left buccal cancer with contralateral right level IB necrotic node (white arrow). Ipsilateral left level IB node is also seen (yellow arrow). Also noted is involvement of the left hemimandible.
Fig. 21: Axial contrast enhanced CT shows a large necrotic right level II node in a case of right gingival cancer.
Conclusion

MDCT with puffed cheek technique is useful in the pretherapeutic evaluation of gingivobuccal cancers. Knowledge of the anatomic subsites and potential routes of spread is important in staging of this disease. Accurate reporting of key imaging findings allows referring physicians to choose the most appropriate treatment options and plan a correct surgical approach.

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