Principles of Surgical Management of Oral Cancer

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82.1 Introduction

Management of oral cavity cancers in a curative intent setting mainly involves surgery. The other treatment modalities such as radiotherapy and chemotherapy are most commonly used as adjuvant treatment based on the histopathological features. However, it is to be noted that surgery alone is insufficient to treat oral cancer. Chemotherapy is either concurrent with radiotherapy or in very rare scenario used as induction therapy. The primary cancer treatment and risk factor reduction are of utmost importance to improve effectiveness of the primary treatment and to prevent development of second-primary cancers.

Ablative surgery has evolved over the years with the attempt to extirpate the tumor in its entirety with the understanding of the molecular tumor biology, pattern of tumor invasion of the tumors, as well as availability of better instrumentations.

With the advent of endoscopic assisted and robotic-assisted neck dissection, the branch of oral oncology has truly made progress, thus improving visualization and three-dimensional navigation; however it is still in its infancy and needs further research to understand the benefits over the conventional methods.

This chapter outlines details of ablative surgery and rationale for addressing neck (node positive/node negative) in patients with oral cavity cancers.

82.2 Initial Evaluation and Staging

Initial evaluation as for any other medical condition includes history, a clinical examination and investigations to form a diagnosis. The other two important aspects influencing management of oral cavity cancer (mainly squamous cell carcinoma) are habit history and performance status. Table 82.1 describes the performance status scales.

Staging of the disease is particularly important as it helps the clinicians in better communication in a scientific forum and forming a treatment plan for a patient. Various phases in management of oral cancer include accurate diagnosis, appropriate treatment plan, and execution of the advised treatment with relevant reconstruction, rehabilitation, and surveillance. So, to help clinicians in decision-making, there are several guidelines that exist. As these guidelines have a more generalized approach, it is the clinician's knowledge

Table 82.1 Performance status scale: Zubrod scale and Karnofsky scale

Performance Status Scales [1]	
Zubrod scale	Karnofsky scale
"0" normal activity	"100" normal; no evidence of disease
	"90" able to perform normal activities with only minor symptoms.
"1" symptomatic and ambulatory cares for self	"80" normal activity with effort; some activities
	"70" able to care for self but unable to do normal activities
"2" ambulatory >50% of the time; occasional assistance	"60" requires occasional assistance; cares for most needs
"3" ambulatory ≤50% of the time; nursing care needed	"50" requires considerable assistance
	"40" disabled; requires special assistance
	"30" severely disabled
"4" bedridden	"20" very sick; requires active supportive treatment
	"10" moribund

Electronic Supplementary Material The online version of this chapter (https://doi.org/10.1007/978-981-15-1346-6_82) contains supplementary material, which is available to authorized users.

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K. Bonanthaya et al. (eds.), *Oral and Maxillofacial Surgery for the Clinician*, https://doi.org/10.1007/978-981-15-1346-6_82

and understanding and experience which will help in tailoring the treatment plan to each individual distinctly. This individualized approach cannot be implemented unless there are multidisciplinary tumor board meetings, which are crucial for clinicians practicing oncology and hence provides team-based practice keeping the patient in mind [2–4]. This is best done before initiating the treatment.

To be able to know the extent of disease and decide the intent and modality of treatment, imaging plays a very important role. Precise imaging information is needed to determine the locoregional extent, erosion, and involvement of underlying bone and marrow space, lymph node involvement and to rule out distant metastasis—especially to the lungs. However the dilemma that most clinicians face is which is the imaging modality of choice for different clinical scenarios. In the following section, we attempt to provide indications of each imaging type available, which probably will help the clinicians in deciding what suits their needs.

Plain radiography is restricted to evaluation of pathological fractures or initial benign lesions. Contrast-enhanced computed tomography (CECT) is considered as the most popular, easily available, and cost-effective diagnostic imaging. It is the imaging modality of choice to know the presence of bone erosion and lymph node characteristic. Bony expansion is usually a feature of slow-growing/benign disease process; however destruction of bone and replacement by the tumor depicts the aggressiveness and hence is a feature of malignant process (Figs. 82.1, 82.2, 82.3 and 82.4).

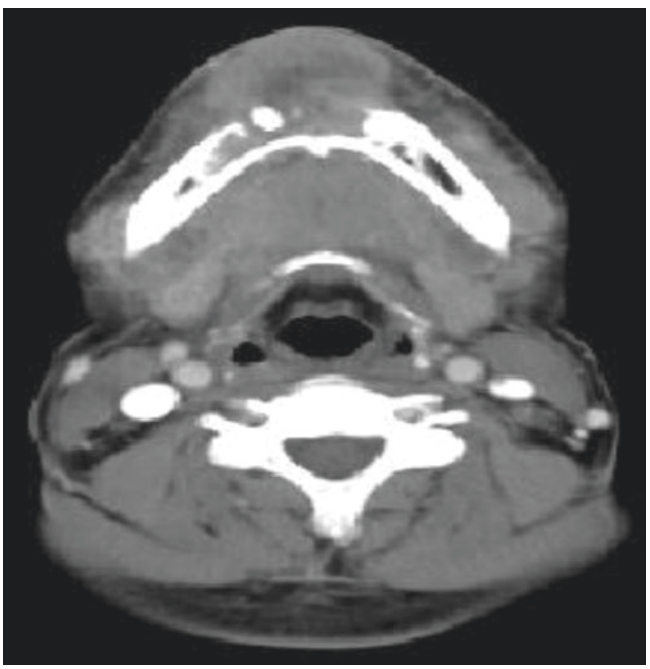


Fig. 82.1 Axial section of contrast enhanced CECT showing an ill-defined heterogeneously enhancing mass lesion along the mandibular alveolus involving the central lateral incisors and canines with erosion of body of mandible

Fig. 82.2 Sagittal section of the patient same as Fig. 82.1 to depict the extent of bony erosion and involvement providing a guide for the osteotomy

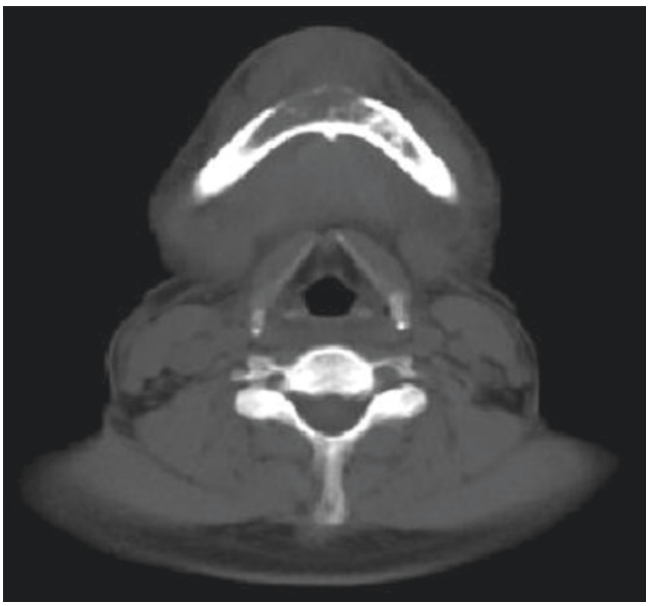


Fig. 82.3 This is axial section in bony window for exact extent of bony erosion

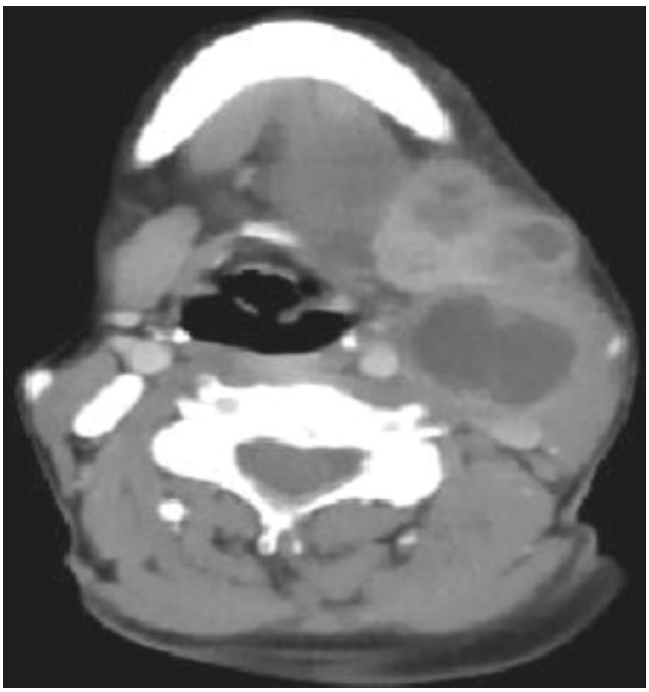


Fig. 82.4 Axial section—contrast-enhanced computed tomography. A heterogeneously enhanced conglomerate of the lymph nodal mass at left level II with cystic areas highly suspicious of metastatic lymphadenopathy. The mass has partially compressed internal jugular vein and pushed it posterolaterally

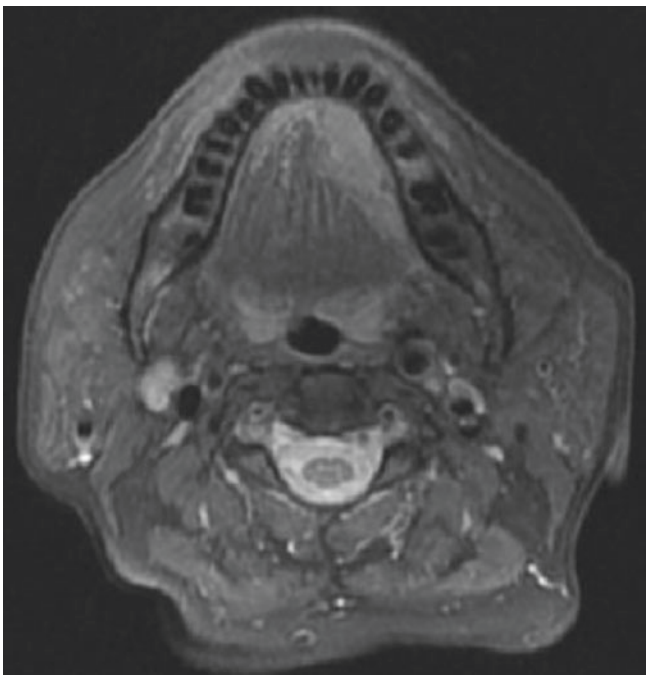


Fig. 82.5 The contrast-enhanced T1-weighted MRI images depicting hyperintensity involving the left lateral tongue with extension till the midline and involving tip of the tongue

Magnetic resonance imaging (MRI) is usually indicated as an adjunct as it has better soft tissue delineation. It is also used for assessing dural invasion (linear or nodular), medullary bone involvement, and perineural invasion. Radiographic assessment of tumor extent is invaluable for treatment planning. In case of tongue cancers, MRI has gained popularity for assessment of tongue cancer especially as it is helpful in identifying tumor thickness, involvement of the contralateral side, and involvement of extrinsic muscles. With recent addition of depth of invasion in the AJCC classification for staging, MRI has proven its role. As for buccal mucosa tumors, assessment of masticatory muscles involvement is crucial because it has historically been considered unresectable. However, according to Liao, infranotch lesions are still amenable for resection with favorable oncological outcome.

As oral cancers usually metastasize first to the lung, preoperative chest imaging is a part of initial pre-operative work-up. This can be in the form of either plain film or 3D imaging such as computed tomography (CT). Fluorodeoxyglucose positron emission tomography (FDG-PET) scan has emerged as the imaging modality of choice in patient with recurrence and high clinical suspicion for distant metastasis (Figs. 82.5, 82.6, 82.7 and 82.8).

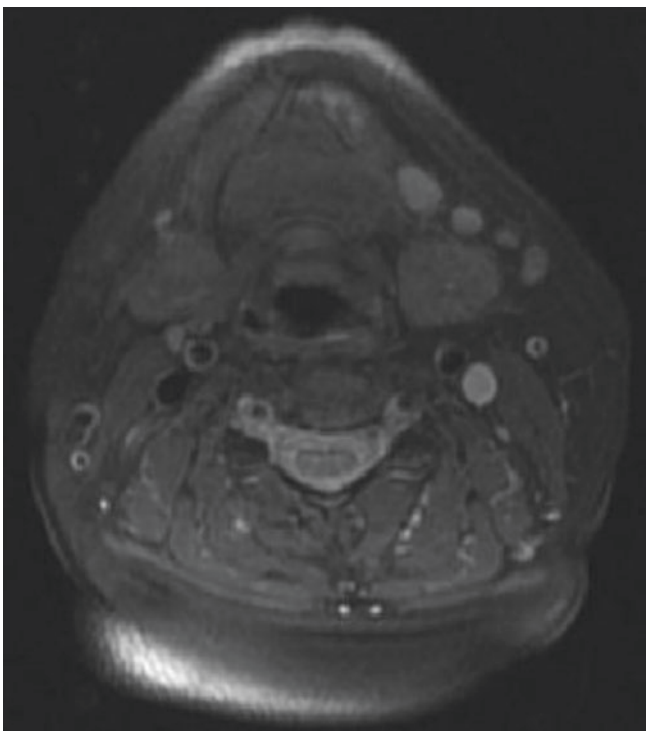


Fig. 82.6 Axial section of an MRI (T2-weighted) showing multiple lymph node metastasis at level IB

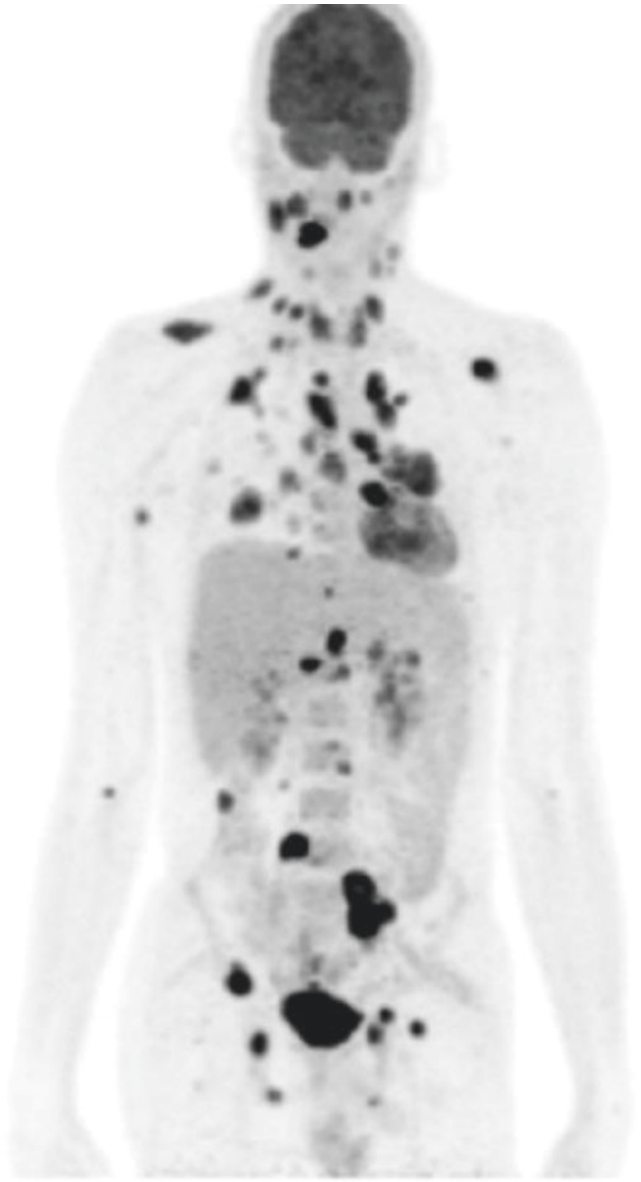


Fig. 82.7 This is the whole body image of PET-CT scan depicting uptake in the multiple areas suggestive of metastatic disease

It is to be noted that any suspicious lesions in PET-CT scan needs to be corroborated with tissue diagnosis (direct or guided) as there are a subset of lesions with false-positive findings; however, PET-CT is considered to have the highest negative predictive value approaching 100%. Although as per the NCCN guidelines, PET-CT has to be advised for all stage III and IV disease, it is usually reserved for patients with recurrent or second primary disease in a resource-constrained setting [5, 6]. Tables 82.2 and 82.3 provide imaging considerations in oral cavity tumors.

Baseline follow-up imaging is usually done after 3 months, and CECT has established its role in ruling out recurrence/residual disease. To avoid misinterpretation, it is important that the concerned imaging radiologist is familiarized with postoperative sequelae of tissue changes or changes that occur following radiotherapy such as nonspecific tissue thickening, edema, or fibrosis and various bony and soft tissue reconstruction methods to facilitate interpretation.

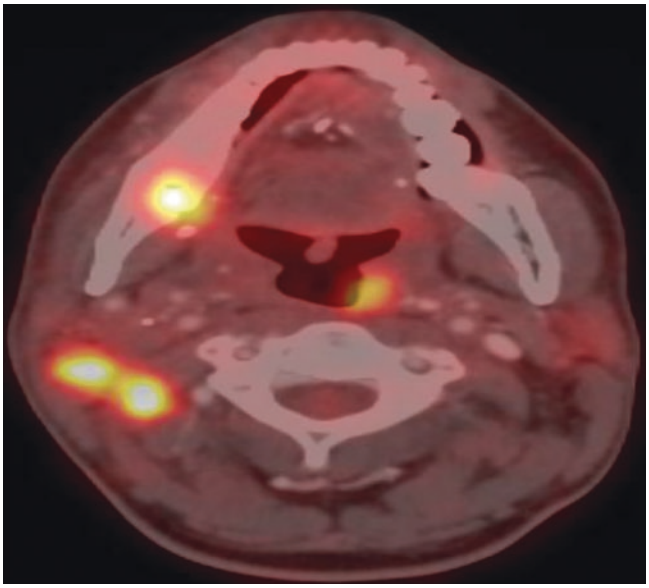


Fig. 82.8 FDG PET-CT images to show FDG avid lesion in the right lower alveolus and ipsilateral level II lymph nodes along with uptake in the right nasopharynx. All the lesion have a similar standard uptake value (SUV) of 15 corresponding to the metabolic activity

Staging the disease is developed to provide ease of communication and helps in understanding the prognosis and planning the treatment. AJCC staging system has been followed for years and provides concise information on size characteristics and extent of primary tumor and involvement of lymph nodes. The recent eighth edition has features like tumor thickness, depth of invasion, and extranodal extension (clinical and pathological).

82.3 Category for Oral Cavity Cancer, Eighth Edition Staging Manual

Table 82.4 provides the categorization for oral cavity cancer [6].

82.4 Principles of Surgical Management

In majority of oral cavity squamous cell cancers, surgery has been the mainstay of treatment, and hence, the need to know intricate surgical aspects has to be emphasized. As there has been improved understanding of disease pattern, biologic behavior of the disease at the molecular level, and the poten-

Table 82.2 Imaging in oral cavity tumors

Radiological means	Indications	Advantages/ Challenges
Computed tomography (CT)	Mainstay for imaging primary disease.	• Bone details. • Obscured to dental artifacts. • Early perineural spread can be missed [7].
Magnetic resonance imaging (MRI)	• Assessment of primarily oral tongue, floor of mouth, and hard palate lesions or bone marrow involvement along with assessment of nasopharyngeal, parotid, sinonasal tumors. • Useful in providing information on encasement of carotid arteries. • Promising results in early detection of perineural extension and detection of dural involvement or intracranial extension.	• Better contrast resolution. Superior detection of tumor spread into bone marrow. • Swallowing artifacts [8].
Ultrasonography (USG)	• To identify lymph node metastases. • For assessment of tumor spread in tongue carcinoma, when MR imaging is contraindicated or unavailable [9].	
Positron emission tomography (PET)	• Diagnosis of an unknown primary tumor, assessment of distant metastasis, response to therapy, surveillance/ detection of recurrence. • Limited role in neck node evaluation.	• Better localization of activity to normal vs abnormal structures, better identification of inflammatory lesions [5].

Table 82.3 Imaging considerations for various sites

Neck nodes	USG-guided FNAC—100% specificity [10, 11]
RMT	• To look for bone erosion—Cortical bone or marrow involvement. • To detect spread of lesion along pterygomandibular raphae.
Palate	• To assess invasion of maxillary sinus, palatal bone, and nasal vault. • Depth of invasion dictates extent of resection.
Infratemporal fossa	• Pterygomandibular raphae provides pathway of spread of lesion into ITF. • CT & MRI are useful.
Tongue	• MRI is preferred; surrounding structure involvement will help in deciding the extent of resection [12, 13].
Bone invasion	• MRI is superior for evaluating medullary space of mandible but inadequate for assessing cortical invasion.

Table 82.4 Category for oral cavity cancer, eighth edition staging manual [6]: Definition of primary tumor (T)

T category	T criteria
TX	Primary tumor cannot be assessed
Tis	Carcinoma in situ
T1	Tumor ≤2 cm with depth of invasion (DOI)* ≤ 5 mm
T2	Tumor ≤2 cm with DOI* > 5 mm Or tumor >2 cm and ≤ 4 cm with DOI* ≤ 10 mm
T3	Tumor >2 cm and ≤ 4 cm with DOI* > 10 mm Or tumor >4 cm with DOI* ≤ 10 mm
T4	Moderately advanced or very advanced local disease
T4a	Moderately advanced local disease Tumor >4 cm with DOI* > 10 mm Or tumor invades adjacent structures only (e.g., through cortical bone of the mandible or maxilla or involves the maxillary sinus or skin of the face) Note: Superficial erosion of bone/tooth socket (alone) by a gingival primary is not sufficient to classify a tumor as T4
T4b	Very advanced local disease Tumor invades masticator space, pterygoid plates, or skull base and/or encases the internal carotid artery
*DOI is depth of invasion and not tumor thickness	
T suffix	Definition
(m)	Select if synchronous primary tumors are found in single organ
Definition of regional lymph node (N) clinical N (cN)	
cN	Category cN criteria
NX	Regional lymph nodes cannot be assessed
N0	No regional lymph node metastasis
N1	Metastasis in a single ipsilateral lymph node, 3 cm or smaller in greatest dimension ENE(−)
N2	Metastasis in a single ipsilateral node larger than 3 cm but not larger than 6 cm in greatest dimension and ENE(−) Or metastases in multiple ipsilateral lymph nodes, none larger than 6 cm in greatest dimension and ENE(−) Or in bilateral or contralateral lymph nodes, none larger than 6 cm in greatest dimension, and ENE(−)
N2a	Metastasis in a single ipsilateral node larger than 3 cm but not larger than 6 cm in greatest dimension, and ENE(−)
N2b	Metastases in multiple ipsilateral nodes, none larger than 6 cm in greatest dimension, and ENE(−)
N2c	Metastases in bilateral or contralateral lymph nodes, none larger than 6 cm in greatest dimension, and ENE(−)
N3	Metastasis in a lymph node larger than 6 cm in greatest dimension and ENE(−); Or metastasis in any node(s) and clinically overt ENE(+)
N3a	Metastasis in a lymph node larger than 6 cm in greatest dimension and ENE(−)
N3b	Metastasis in any node(s) and clinically overt ENE(+)
Note: A designation of "U" or "L" may be used for any N category to indicate metastasis above the lower border of the cricoid (U) or below the lower border of the cricoid (L). Similarly, clinical and pathological ENE should be recorded as ENE(−) or ENE(+)	
N suffix	Definition
(sn)	Select if regional lymph node metastasis identified by SLN biopsy only
(f)	Select if regional lymph node metastasis identified by FNA or core needle biopsy only
U	Metastasis above the lower border of the cricoid

(continued)

Table 82.4 (continued)

N suffix	Definition
L	Metastasis below the lower border of the cricoid
Pathological N (pN)	
pN category	pN criteria
NX	Regional lymph nodes cannot be assessed
N0	No regional lymph node metastasis
N1	Metastasis in a single ipsilateral lymph node, 3 cm or smaller in greatest dimension and ENE(−)
N2	Metastasis in a single ipsilateral lymph node, 3 cm or smaller in greatest dimension and ENE(+) Or larger than 3 cm but not larger than 6 cm in greatest dimension and ENE(−); Or metastases in multiple ipsilateral lymph nodes, none larger than 6 cm in greatest dimension and ENE(−) Or in bilateral or contralateral lymph node(s), none larger than 6 cm in greatest dimension, ENE(−)
N2a	Metastasis in single ipsilateral node 3 cm or smaller in greatest dimension and ENE(+) Or a single ipsilateral node larger than 3 cm but not larger than 6 cm in greatest dimension and ENE(−)
N2b	Metastases in multiple ipsilateral nodes, none larger than 6 cm in greatest dimension and ENE(−)
N2c	Metastases in bilateral or contralateral lymph node(s), none larger than 6 cm in greatest dimension and ENE(−)
N3	Metastasis in a lymph node larger than 6 cm in greatest dimension and ENE(−); Or metastasis in a single ipsilateral node larger than 3 cm in greatest dimension and ENE(+) Or multiple ipsilateral, contralateral, or bilateral nodes, any with ENE(+); Or a single contralateral node of any size and ENE(+)
N3a	Metastasis in a lymph node larger than 6 cm in greatest dimension and ENE(−)
N3b	Metastasis in a single ipsilateral node larger than 3 cm in greatest dimension and ENE(+) Or multiple ipsilateral, contralateral or bilateral nodes any with ENE(+); Or a single contralateral node of any size and ENE(+)
Note: A designation of "U" or "L" may be used for any N category to indicate metastasis above the lower border of the cricoid (U) or below the lower border of the cricoid (L). Similarly, clinical and pathological ENE should be recorded as ENE(−) or ENE(+)	
N suffix	Definition
(sn)	Select if regional lymph node metastasis identified by SLN biopsy only
(f)	Select if regional lymph node metastasis identified by FNA or core needle biopsy only
U	Metastasis above the lower border of the cricoid
L	Metastasis below the lower border of the cricoid

Definition of distant metastasis (M)	
M category	M criteria
cM0	No distant metastasis
cM1	Distant metastasis
pM1	Distant metastasis, microscopically confirmed

tial aggressive nature, the need has arisen for several technical modifications in this era. Hence as surgeons, we have to evolve and adapt to the required changes to improve outcomes of ablative surgery (oncological and functional) in patients with squamous cell carcinoma of oral cavity.

For early-stage oral cavity cancers, especially tongue, it has been proven that both surgery and radiotherapy/brachytherapy offer similar outcome (single modality). For advanced lesions with extensive disease, multimodality treatment is required; surgery being the primary modality and followed by adjuvant radiotherapy +/− chemotherapy (depending on the histopathological evaluation) has been the standard of care.

82.5 Treatment Decision Algorithm [14]

Critical decisions which have to be made are as follows:

1. Intent of treatment—curative vs. palliative treatment.
2. Primary modality—surgical vs. non-surgical treatment.
3. Need for addressing neck in clinically node-negative patients.
4. Type of neck dissection in patients with metastatic lymph nodes.
5. Need for adjuvant treatment.
6. Type of adjuvant treatment.
7. Best supportive care.

Decision 1 Primary intent of treatment: This is the first and most critical decision-making point. All patients other than those with technically unresectable tumors, distant metastasis, poor performance status, and major comorbidities precluding surgery must be considered for treatment with curative intent. However, it is to be noted that surgical excision with positive margins portends poor prognosis. Palliative care is usually when patient has distant metastasis and given only to relieve symptoms and control spread. This is in the form of chemotherapy, radiotherapy or metronomics.

Decision 2 Curative modality of treatment: The primary treatment for patients with oral cavity cancers is surgery. However, in selected scenarios, non-surgical treatment may be considered. This includes primary radiotherapy for tumors of the commissure of mouth and lip tumors where surgery can cause significant esthetic and functional disability. In addition, significant comorbidities that preclude long anes-

thesia may necessitate the need for primary radiotherapy or chemoradiotherapy. However primary chemoradiotherapy has very limited role in treatment of oral cancers.

Decision 3 Management of neck in N0 stage: Even with no radiographic evidence of significant suspicious lymph-nodes, rate of occult metastasis reaches up to as high as 30% [15]. Presence of lymph node metastasis and the number of lymph nodes involved have a direct relation with the prognosis of the disease; decreasing the overall survival rate by 50%. Moreover, a significant subset of metastatic nodes of less than 1 cm can have extranodal extension [16]. This further worsens the prognosis. There is now level I evidence from a randomized control trial, that addressing the neck surgically irrespective of the lymph node status improves overall survival to about 84% when compared to 69% in patients who were selected for wait-and-watch policy [17]. Therefore, almost all the patients with oral cavity cancer should undergo elective neck dissection. A subset analysis of the same study did not show benefit for primary tumors of depth less than 3 mm. This may be considered in selected patients with cancers of lower nodal metastatic prevalence such as lip and buccal mucosa.

Decision 4 Extent of neck dissection in N+ve oral squamous cell carcinoma: Conventional teaching is that any patients with N+ve neck should undergo modified radical neck dissection covering levels 1–5. This has been questioned by several observational studies. Large cohort of patients who have undergone radical neck dissection for N+ve disease has showed less than 3% incidence of level V nodes [17]. This also was observed only when there were pathologically positive level IV nodes [18]. There are reports of oncologic safety for clearing level I–III lymph nodes for alveolus and buccal mucosal cancers and to clear level IV in addition to levels I, II, and III lymph nodes in patients with oral tongue cancers as they bore high risk of skip metastasis [19]. It is to be noted that when a patient is found to have pathological nodal metastasis, in general, it is recommended for adjuvant radiation that covers all levels of the neck with additional boost in the levels which are positive for metastasis.

Decision 5 Indication for adjuvant radiotherapy: Any patients with more than one of the high risk features should be considered for adjuvant radiotherapy.

> This includes (1) nodal metastasis without extracapsular extension, (2) perineural invasion, (3) lymphovascular invasion, (4) poor differentiation, (5) close margin (1–5 mm), and (6) depth of invasion over 1 cm.

But the absolute indication for radiotherapy is stage III and IV disease.

Decision 6 Indication for adjuvant chemoradiotherapy: Meta-analysis of two randomized trials has suggested that in patients with positive surgical margin (<1 mm) and neck nodes with extranodal extension would benefit from adjuvant chemoradiotherapy.

Decision 7 Best supportive care options: This is an important and critical decision. Once the decision for treatment with palliative intent is arrived at, the goal should be made clear with the treating team of doctors and the patient/patient attenders. Ambiguity at this stage may result in loss of trust between the treating team and the patient, causing delay in treatment and possible increase in morbidity. Although this decision is made in the multidisciplinary tumor board, it requires series of meetings with the family to convey the treatment goals. It is also essential to appreciate by treatment group that lack of active treatment does not mean stoppage of care, which needs to be provided by the same team till the end. The quality of death is equally important as quality of life.

The role of best supportive care is to palliate the symptoms the patients may have. In this situation, it is essential to balance the morbidity of treatment versus potential benefit the patient may receive. Often one may have ethical dilemma when faced with young patients with locoregionally advanced tumors. In this situation, temptation of surgery should be tempered. One should consider surgery as palliation to alleviate fungating ulcers or to close a cutaneous fistula. The goal of this surgery must be made very clear to the family. It is essential not to give false hope to the family, which will have deleterious consequence in the patient-physician relationship. In patients with good performance status, especially those who have not received previous radiotherapy, one may consider chemoradiotherapy with curative dose, with the goal to obtain durable palliation. In doubtful situations, induction chemotherapy followed by chemoradiotherapy could also be considered. Local radiation or re-radiation to a limited field may be considered for fungating ulcers. The dose, fractionation, and volume of radiation field need to be tailored for palliative purpose.

In patients with advanced metastatic disease, one needs to be very selective in recommending systemic therapy as the benefit is doubtful. Chemotherapy with targeted anti-EGFr treatment has shown improved survival up to 4 months, with significant morbidity associated with the regimen [20]. An alternate approach is chemotherapy at metronomic dosing regimen, especially the use of methotrexate and celecoxib [21]. Recent evidence of nivolumab, a checkpoint inhibitor, showing improved survival of about 3 months, and acceptable morbidity, is to be considered. However the cost of the treatment is a major deterrent for its wider application. Table 82.5 provides the indications for adjuvant RT and adjuvant CT + RT.

Table 82.5 Indications for adjuvant RT and adjuvant CT + RT

Indications for adjuvant RT		Indications for adjuvant CT + RT
Tumor factors	Nodal factors	
• Perineural invasion. • Lymphovascular invasion +pT3/T4 primary tumor.	• Multiple positive nodes (without ECE). • Positive level IV/V nodes.	• Extra-capsular nodal spread. • Positive margins.
• Bernier J et al. [22]		

82.6 Indications for Adjuvant RT and Adjuvant CT + RT

After various comparative studies, it has been concluded that in adjuvant setting, postoperative IMRT has to be given at dose of 60 Gy in 30 fractions to surgical bed and first echelon nodal stations and the high-risk regions receive a total dose of 66 Gy. It has to be remembered that for salvage surgery cases, concept of re-irradiation should be explained to the patient. A minimum of 12-month duration gap is required prior to re-irradiation to allow for the spinal cord recovery.

In cases with postoperative histopathological features like extranodal extension or positive surgical margins, patients are treated with concurrent chemoradiation (usually 100 mg/m^2 of cisplatin for a maximum of 6 cycles in India). Indication of chemotherapy as described is usually in adjuvant setting in oral cavity cancers.

However role of chemotherapy as induction therapy is evolving. Chemotherapy usually exerts its cytotoxic effects systemically and hence associated with side effects. The major drawbacks of chemotherapeutic agents used commonly are the adverse toxicities and cellular resistance. In an induction setting, most commonly taxanes, platinum, and 5FU are used as 3 cycle regimen (also refer Chap. 84 of this book on Adjunctive therapy in Oral Cancer).

Tumors of oral cavity which are considered technically unresectable are as follows:

- Erosion of skull base, sphenoid bone, and widening of foramen ovale.
- Encasement of internal carotid artery, >270 degree.
- Involvement of mediastinal structures.
- Involvement of prevertebral fascia or cervical vertebrae.

These are considered unresectable not due to surgical technicality but because of the inability to get negative margins and to achieve R0 resection. However, with the superior skills such as endoscopic-assisted surgeries which are associated with less morbidity, and better adjuvant treatment including chemotherapy, an attempt has been made to consider resection of tumors involving muscles of mastication and pterygoid plates especially with the anterior infratemporal fossa involved. Recent studies have shown that surgical resection of these tumors along with adjuvant treatment has shown survival benefit. Also studies from Tata Memorial Hospital, India have shown better outcome in patients who have undergone surgical resection following neoadjuvant chemotherapy.

82.7 Principles of Ablative Surgery

1. Adequate access to the tumor.
2. To achieve negative surgical margins.
3. Utilization of intraoperative frozen section for margin assessment.
4. Wide excision versus compartment resection.

The surgical approaches for tumors of oral cavity depends primarily on the site of tumor (anterior versus posterior), its size, and its proximity to bone (maxilla or mandible). The various approaches frequently used for oral cavity cancers are shown in Figs. 82.9, 82.10, 82.11, 82.12, 82.13, and 82.14 (Also refer Chap. 85 of this book on Access Surgeries and Osteotomies of the Maxillofacial Region).

Types of mandibulotomy is shown in (Figs. 82.15, 82.16a, b) shows marginal mandibulectomy and segmental mandibulectomy.

82.8 Sub-Site-Wise Surgical Management

82.8.1 Tongue and Floor of Mouth

The tongue is a muscular organ which is composed of intrinsic and extrinsic muscles and divided anatomically into the oral tongue (falls in oral cavity cancers) and base of tongue (BOT, sub-site of oropharynx). The tongue is innervated by the hypoglossal nerve, and vascularity is by lingual artery (branch of external carotid artery). Pathway of tumor spread from the oral tongue can be into the floor of mouth, mandible, or/and base of tongue via local extension, the lingual septum being the barrier to tumor spread. For tumors abutting the mandible, marginal mandibulectomy is indicated for negative surgical margin encompassing the tumor and at the same time preserving the mandibular continuity. Segmental mandibulectomy is usually done when there is mandibular erosion or paramandibular spread. Anterior segmental mandibulectomy is more commonly indicated in floor of the mouth cancers.

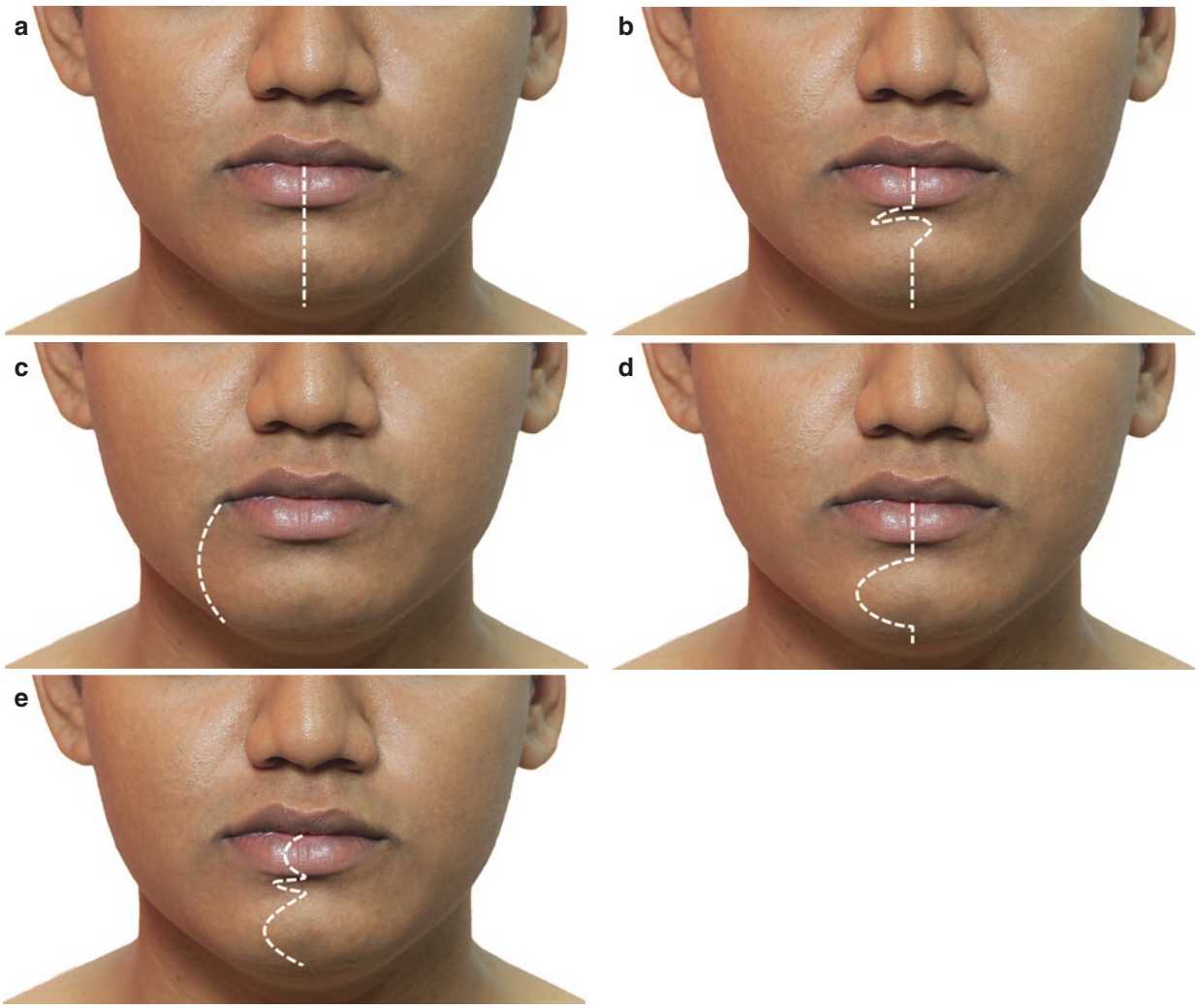


Fig. 82.9 Lip split incisions; (**a**) midline lip split (straight), (**b**) midline lip split with Z-plasty; (**c**) angle/commissure lip split; (**d**) straight midline with chin contour; (**e**) straight midline with chin contour and Z-plasty at vermilion and submental region

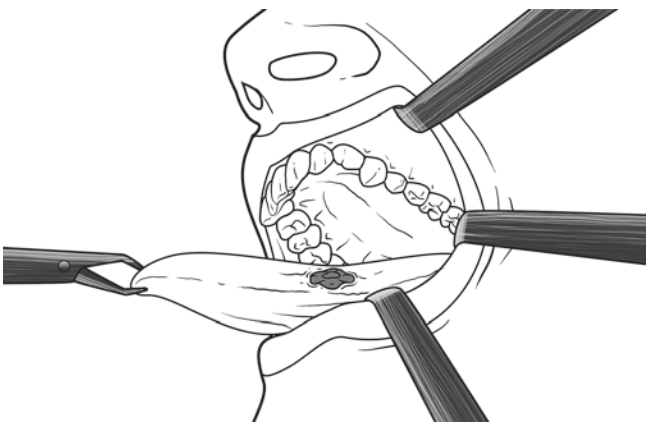


Fig. 82.10 Pictorial representation of excision of lesionally per-orally. This is usually indicated for T1–2 lesion in patients with adequate mouth opening

Lingual artery is an end artery, and hence clinicians have to be careful in resections involving more than two-thirds of tongue mass as this may jeopardize the vascularity and utmost care to be taken to preserve the neurovascular bundle.

There is a recent concept of compartment resection in patients with infiltrative disease where the adjacent extrinsic musculature and neurovascular bundle is excised in continuity to ensure negative margins. This was proposed by Calabrese [23], and all cases underwent access mandibulotomy; hence it is not commonly followed. Tumors of floor of the mouth are usually infiltrative and lymph node metastasis is seen bilaterally. According to Byers, the rate of lymph node skip metastasis at level IV is observed in about 10–15% cases. According to the study by Kowalski [24], tumors of floor of the mouth, tongue cancers crossing the midline, and advanced stage of the disease have a propensity of developing contralateral lymph node metastasis.

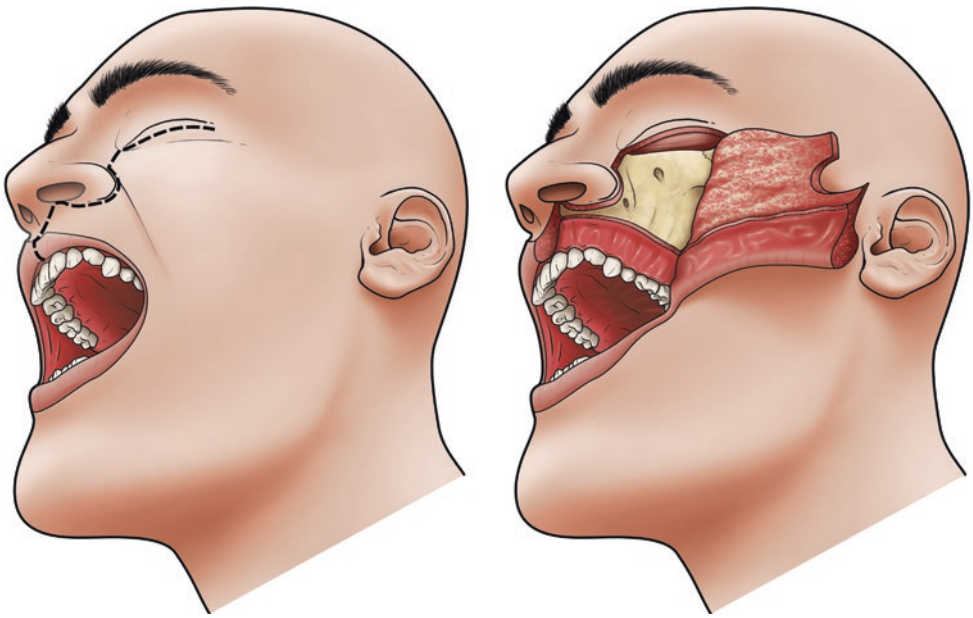


Fig. 82.11 Weber-Ferguson incision for tumors of maxilla not amenable to per-oral excision and not requiring infratemporal fossa access. The upper cheek flap is raised as shown

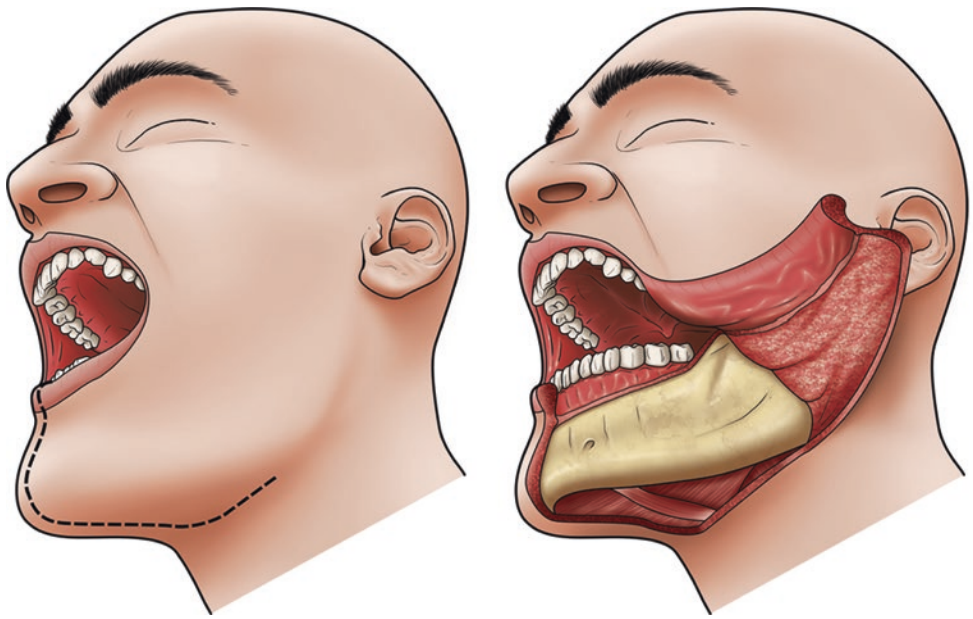


Fig. 82.12 A lower midline lip split incision continued and transverse neck skin crease incision followed by raising of a lower cheek flap. This gives the best access to infra-temporal fossa. The periosteum to be left on the mandible to preserve its periosteal blood supply. The mental neurovascular bundle has to be sacrificed

82.8.1.1 Surgery

Wide local excision (WLE)/adequate glossectomy procedure with adequate surgical margins has been the procedure of choice for early tongue cancers, and this is amenable with per-oral approach. Before planning resection, thorough knowledge about the extent of lesion is important, and palpation of induration provides a guide for the same. Ideal margin for resection of tumour is all 1–1.5 cm all around. Usually it is the deep soft tissue margin which is prone for being close or positive, and this can be avoided by palpation method. In many institutions, it is a useful practice to ligate the lingual artery in the neck before performing WLE for

Fig. 82.13 This picture depicts access mandibulotomies for tumors situated in the posterior tongue. The other alternative is pull through approach

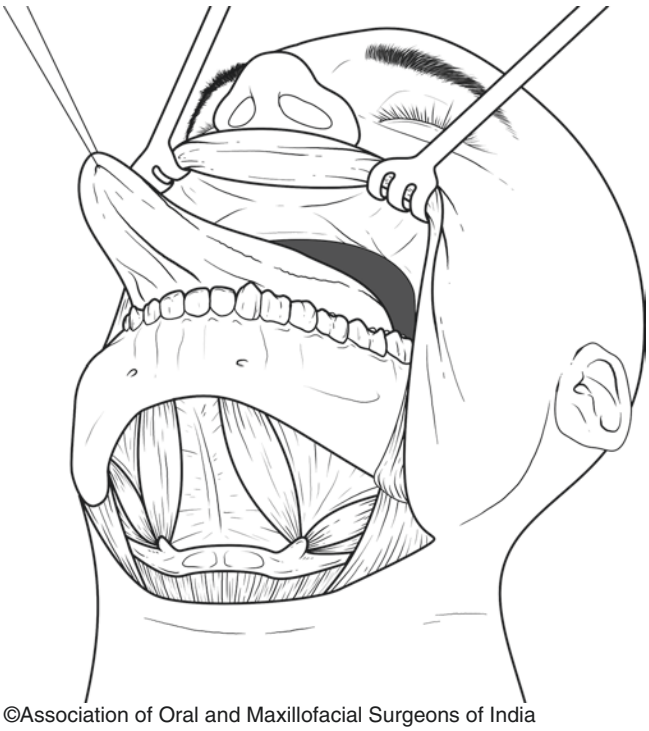
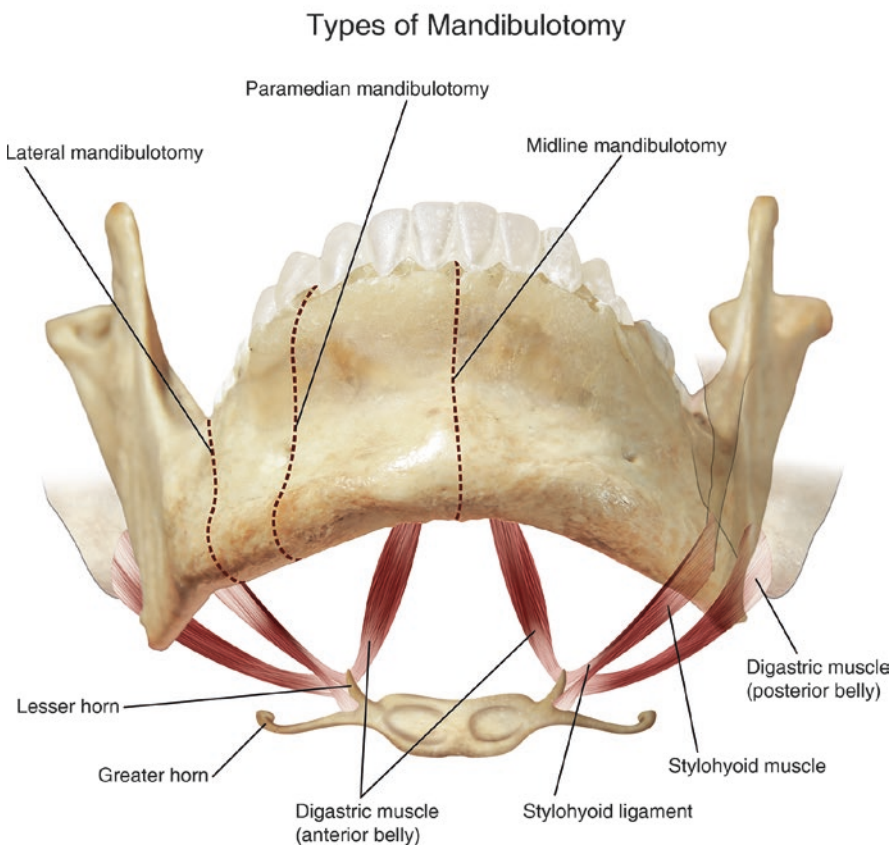


Fig. 82.14 Visor flap provides best access for total and subtotal glossectomy

Fig. 82.15 Depiction of various types of access mandibulotomies



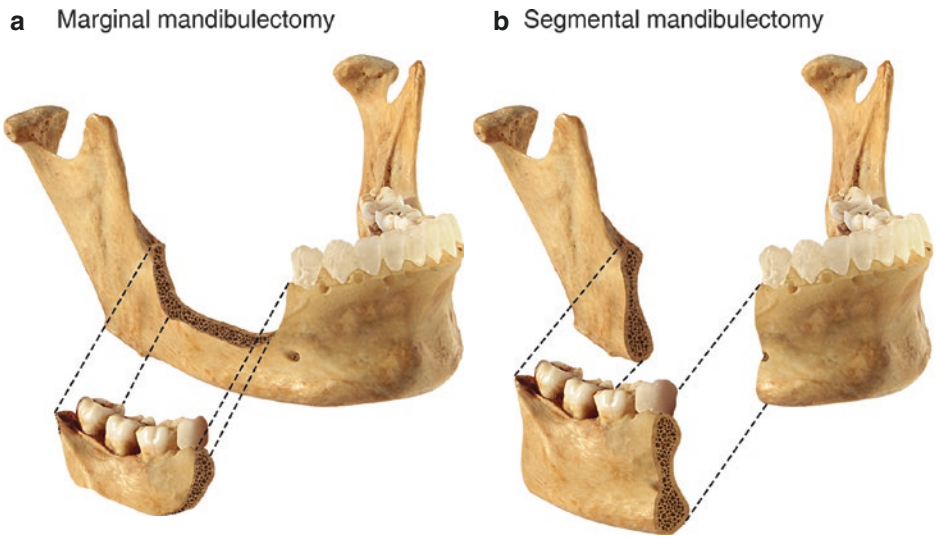


Fig. 82.16 Types of mandibulectomies (**a**) marginal and (**b**) segmental

adequate bleeding control and clean surgical field. The resulting defects of adequate glossectomy for early lesions are usually closed primarily avoiding tethering of the tongue. Excisional biopsy for suspicious lesions is highly discouraged even if the lesion is about 1 cm.

Moderately advanced cancers of the tongue and floor of the mouth (T2–T3) warrant classical hemiglossectomy which sacrifices the tip jeopardizing the tongue mobility resulting in compromised speech and swallowing. Majority of these tumors are excised by combinations of per-oral and pull-through approaches, without the actual need for lip-split or access mandibulotomy. The pull through technique helps in avoiding positive posterior margins as the resection is done under direct vision. All these patients require reconstructive surgery (lining or bulk), along with long-term tracheostomy and feeding tube (ryles tube/PEG) dependence. Free-flap reconstructions have become inevitable following resection of tongue cancers. Locally advanced (T4a) cancers (tumor depth > 20 mm, restricted mobility and hypoglossal palsy) of tongue warrant total glossectomy or near-total glossectomy. Standard total glossectomy procedure involves complete removal of anatomical tongue from mandible to hyoid and from the tip of the tongue upto the vallecula.

The following a is brief outlay of surgical steps: anterior belly of digastric muscle is first divided through the cervical neck incision followed by intra-oral crevicular incision. Then the genioglossus, geniohyoid is divided from the genial tubercle and mylohyoid muscle from the mylohyoid line from the mandible. At the contralateral retromolar region come the division of buccopharyngeal fascia, styloglossus muscle, and the palatoglossus muscle and incision at the vallecula. The same steps are repeated on the other side for total glossectomy. However in near-total/subtotal glossectomy, base of the tongue of uninvolved side is preserved. It is the extent of excision of the base of tongue which determines the postoperative swallowing function.

Tongue and the FOM lesions involving or abutting mandible pose a unique challenge. Resecting the segment of mandible increases morbidity and reconstructive challenge by many times. In such situations an attempt should be made to preserve the mandible whenever possible.

Removal of the level V lymph node is reserved in situations when level IV or V is involved or in N3 nodal disease. According to Kowalski et al., the indications for addressing contralateral lymph nodes are lesions of the tongue crossing the midline, floor of the mouth tumors, and locally advanced T3 and T4 tumors [24].

Reconstruction of the tongue requires a soft tissue flap with large volume to provide the adequate bulk which in turn is believed to aid in swallowing. The drawback of a reconstructed tongue is the impaired mobility resulting in compromised speech. The most commonly used flap is radial forearm free flap and anterolateral thigh free flap. The other uncommon examples for free tissue transfer are lateral arm flap, gracilis flap, and local flap such as FAMM flap and submental flap.

Reconstruction of tongue defect using radial forearm free flap (Figs. 82.17, 82.18, 82.19, 82.20 and 82.21).

Reconstruction of tongue defect with local flap: facial artery myomucosal flap (Figs. 82.22, 82.23, 82.24 and 82.25).

Fig. 82.17 Squamous cell carcinoma of left lateral border of the tongue with induration extending 1 cm short of midline not involving floor of mouth

Fig. 82.19 Completed left modified radical neck dissection

Fig. 82.18 Post-surgical defect following left hemiglossectomy and left marginal mandibulectomy

Fig. 82.20 Left radial artery forearm free flap harvested for the defect

Fig. 82.21 Radial forearm free flap inset into defect and anastomosed to left facial artery and tributory of left internal jugular vein

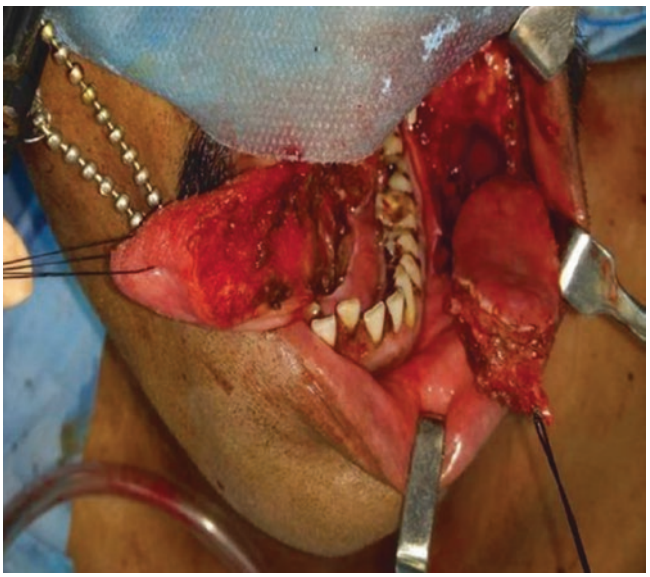


Fig. 82.22 Tongue defect following wide local excision of left lateral border tongue squamous cell carcinoma

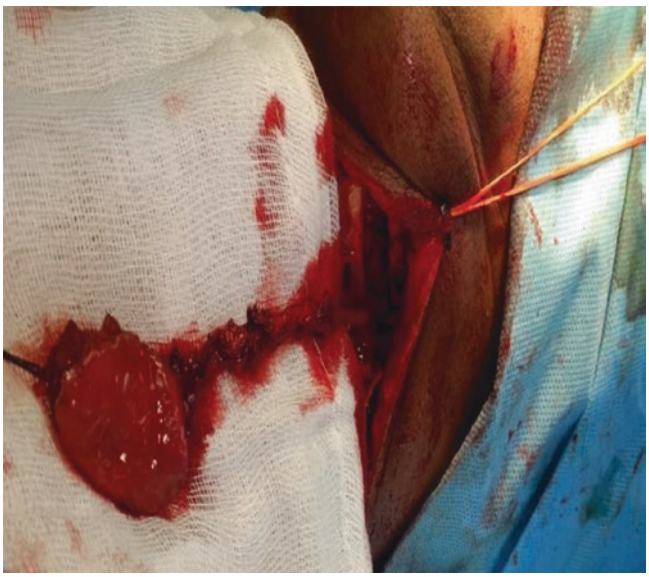


Fig. 82.23 Harvesting of facial artery myomucosal flap (FAMM)

Fig. 82.24 FAMM flap tunneled into the defect and reconstructed

82.8.2 Buccal Mucosa

82.8.2.1 T1/T2 Lesions

Surgical Steps: For Early Buccal Cancer Per-oral approach is adequate. It is important to ensure oncologic completeness and appreciate depth. Inadvertent injury to the buccal branch of facial nerve and to the parotid duct should be avoided. Facial artery, facial vein, and parotid duct (if encountered or injured) should be ligated. Mucosal incision around the lesion, with adequate margin, taking the buccinator muscle in specimen forms the deep soft tissue margin. These defects can be reconstructed with split thickness skin grafts/buccal pad of fat/local flaps such as nasolabial flap.

Fig. 82.25 Closure of the donor site

Fig. 82.26 Locally advanced T4a, left buccal mucosa lesion requiring composite resection with excision of the overlying involved skin

Advanced T3/T4 Lesions (Lesions with Skin Involvement/Bone Involvement/Involvement of Muscles of Mastication) Pre-operative clinical examination revealing a subtle skin puckering and imaging studies shows stranding of subcutaneous fat that is the early sign of skin involvement. If buccal space involvement is suspected, then buccal fat pad should be included in the specimen.

Fig. 82.27 Defect following composite resection and modified radical neck dissection; this defect was reconstructed with anterolateral thigh free flap

These advanced lesions require full-thickness cheek resection. The planning of incision may be a midline lip split or angle split, both of which will help in raising a lower cheek flap or when overlying skin is involved, an incision around the skin involved in continuity with the neck dissection incision. The muscle of mastication involvement warrants infratemporal fossa clearance (Figs. 82.26, 82.27 and 82.28).

82.8.3 Gingivobuccal Sulcus

Gingivobuccal sulcus (GBS) tumors are tumors occurring in the upper or lower GBS, usually seen to abut the bone adjacent (Fig. 82.29). These occur almost exclusively in Southeast Asia due to high incidence of chewing tobacco use. Due to the high propensity for local invasion and close proximity of bone, skin, and masticator space, presentation is often advanced, and outcomes are poor. If there is superficial erosion of bone or if the lesion is abutting the mandible, then the resection should include marginal mandibulectomy. Superficial cortical erosion in alveolar tumors is not considered as T4 lesion, and marginal mandibulectomy may still suffice. Although MRI is consid-

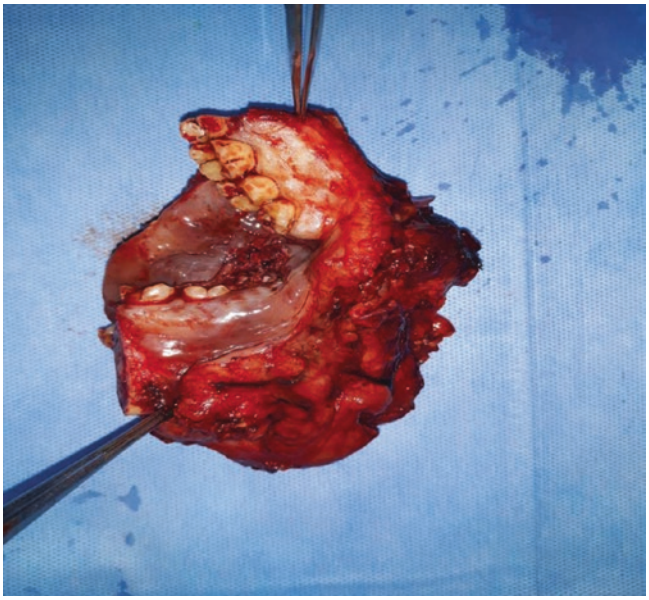


Fig. 82.28 Excised specimen in toto (Same case shown in Figs. 82.26 and 82.27)

ered most sensitive imaging modality to determine extent of bony involvement, periosteal stripping is by far the best method to determine extent of bony erosion and helps in decision-making regarding extent of mandibulectomy. GBS tumors usually present at an advanced stage with gross mandibular erosion, paramandibular spread, or overlying skin involvement (skin involvement is never seen in the masseter region as it is a tumor barrier). These findings preclude the use of marginal mandibulectomy, and hence patients often require segmental mandibulectomy and bony reconstruction.

82.8.4 Retromolar Trigone Carcinoma

Retromolar trigone tumors are rare but more aggressive malignancies with poorer outcome. Higher incidence of local recurrence has been reported in squamous cell carcinoma of the retromolar trigone (RMT) and posterior GBS carcinomas. This is attributed to to its higher propensity of infratemporal fossa (ITF) and pterygomandibular fissure involvement. Due to restricted mouth opening at the time of presentation, thorough clinical examination is hindered. For both oncologic and anatomic reasons, tumors with mandibular invasion are best managed surgically by segmental mandibulectomy including coronoid process of the mandible.

The reason to preserve condyle is as follows: (a) it may be used for secondary reconstruction, and (b) as the condyle lacks medullary bone, it does not act as a pathway of spread and hence can be oncologically safe to preserve it.

Fig. 82.29 Classic example of a gingivo buccal tumor abutting the adjacent mandible

As a large proportion of the RMT tumors involve both the upper and lower jaw (Fig. 82.30), excision of ramus of mandible in the form of subsigmoid marginal mandibulectomy with at least an upper alveolectomy and ITF clearance (anterior ITF comprising masseter and medial pterygoid with or without pterygoid plates) is required. Selective neck dissection comprising of level I–V lymph nodes is usually performed electively for all stage cancers for purpose of staging.

82.8.5 Hard Palate

Tumors of the hard palate are less common when compared to tumors of the mandible, tongue, or buccal mucosa and are often of minor salivary gland etiology. Premaxilla provides support for the nose and midface; lesions involving anterior alveolus and hard palate will require bony reconstruction to prevent midface deformity. Lesions of the posterior alveolus and hard palate have a higher tendency to locally invade the orbital floor and skull base or through various neurovascular bundles (greater palatine foramen, sphenopalatine foramen, palatovaginal canal).

Lymph node involvement is very rare for salivary neoplasm of the palate, and neck dissection is reserved only for node-positive disease. However, maxillary alveolar carcinoma has a high propensity for occult lymph node metastasis

Fig. 82.30 Left retromolar trigone squamous cell carcinoma extending to involve lingual surface of mandible, soft and hard palate ipsilaterally

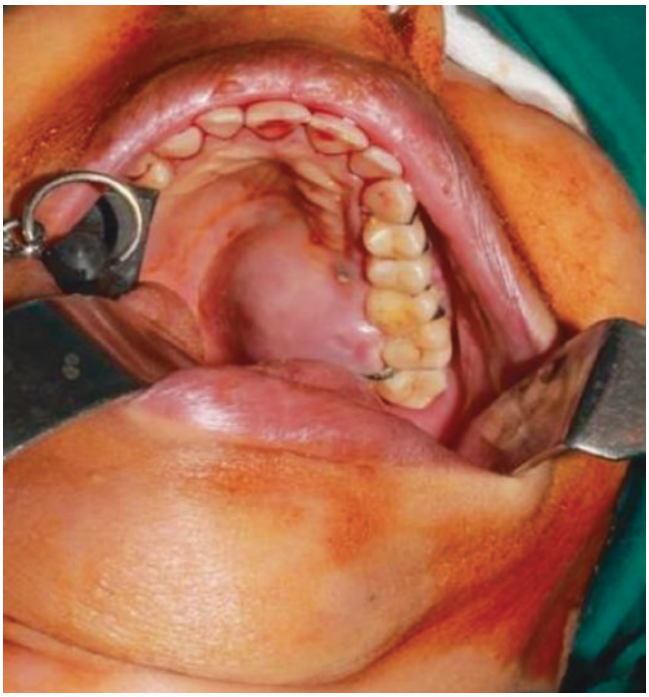


Fig. 82.31 Minor salivary gland tumour of the hard palate

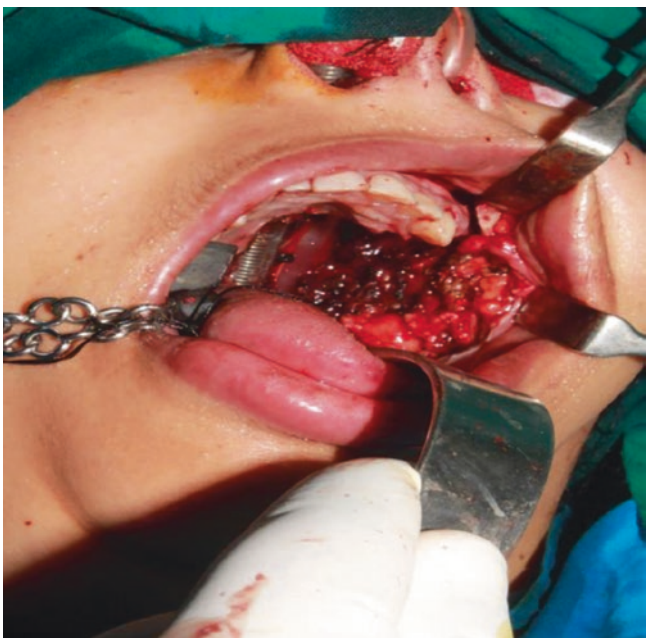


Fig. 82.32 Defect following partial maxillectomy

(15–20%), and also in patients where neck is not addressed, they tend to present with nodal recurrences which are not salvageable in two-thirds of the cases; hence it is wise to consider elective neck dissection. The other point worthwhile and to be noted is that perifacial group of lymph nodes have to be cleared for effective disease control for the upper alveolus (Figs. 82.31, 82.32, 82.33 and 82.34).

82.8.5.1 Brown's Classification System for Maxillary Defects [25] (Fig. 82.35)

Vertical Component

- Class I, maxillectomy with no oroantral fistula.
- Class II, low maxillectomy.
- Class III, high maxillectomy.
- Class IV, radical maxillectomy.

Horizontal Component I, unilateral alveolar maxilla and resection of the hard palate;

(a) resection of less than or equal to half of the alveolar and hard palate, not involving the nasal septum or crossing the midline;

(b) resection of the bilateral alveolar maxilla and hard palate, including a smaller resection that crosses the midline of the alveolar bone, including the nasal septum; and

(c) removal of the entire alveolar maxilla and hard palate.

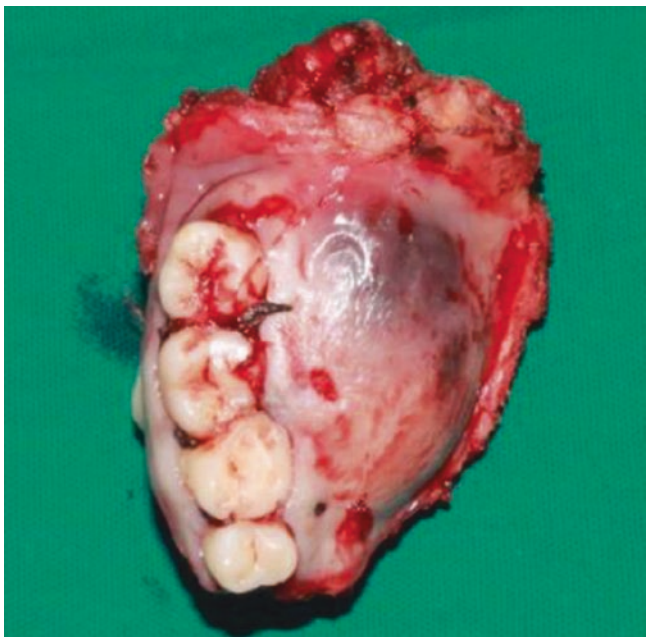


Fig. 82.33 Specimen in toto

Fig. 82.34 Defect reconstructed with conventional obturator placement

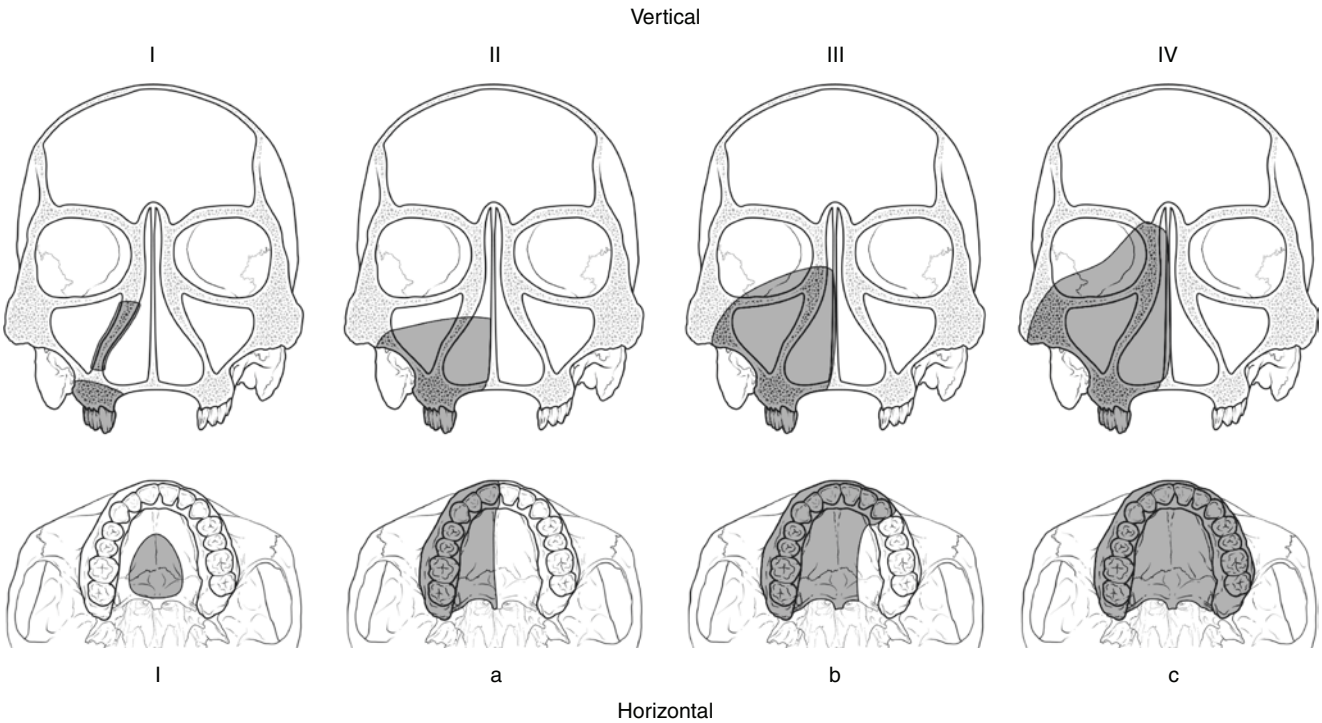


Fig. 82.35 Brown's classification for maxillectomy defects

82.8.6 Lip Carcinoma

Squamous cell carcinoma of the lip is most frequently associated with sun exposure as the risk factor. Lower lip is more commonly involved than the upper lip. Submental and submandibular nodal basins are the primary echelon drainage pathways; regional nodal metastasis occurs in only 10% of patients. Full-thickness excision with up to 1 cm margin is necessary. Lesions that involve less than one-third of the lip are managed with simple wedge excision and primary closure and hence offer acceptable oncologic and reconstructive results. For lesions larger than one-third but less than two-thirds, Abbe-Estlander or

Table 82.6 Treatment modalities of use in oral cancer

T1/T2 N0	Radiotherapy/brachytherapy vs. surgery
T3/T4 N0/N+	Surgery is mainstay of treatment followed by adjuvant therapy

Karapandzic flap can be utilized (refer Chap. 86 on Soft tissue reconstruction of the Maxillofacial Region). For defects more than two-thirds, free tissue transfer is preferred to achieve better cosmetic result and avoid microstomia and oral incompetence. To ensure oral competence, adjunctive procedures such as fascial sling, palmaris longus sling, or temporalis muscle sling can be used along with the adynamic soft tissue flap.

Table 82.6 describes the treatment modalities of use in oral cancer.

82.8.6.1 Management of the Neck in Oral Cavity

Introduction

Although skip metastasis can occur, lymph node metastasis usually follows a predictable fashion from the first echelon nodes to the second echelon nodes. Tumors of the oral cavity most commonly drain to levels I (submental and submandibular group) and level II (upper jugular group) in the neck. Level IA is between the two anterior belly of digastric muscle, and level IB is between anterior and posterior belly of digastric muscle on either side. The submental triangle drains the anterior portion of the oral cavity and hence can get involved in the tumors of the incisor region, the anterior floor of mouth, or anterior mandibular gingival/alveolar cancers. The level II nodes are found between the level of the hyoid bone inferiorly and anteriorly, the posterior belly of the digastric muscle superiorly, and the posterior border of the sternocleidomastoid muscle (SCM) posteriorly. In the jugular chain, the level III lymph node station is demarcated inferiorly by the omohyoid muscle as it crosses the internal jugular vein (IJV) and contains the mid-jugular lymph nodes particularly the prominent omohyoid node lying in close relationship to the muscle. Level IV (between the omohyoid muscle and the transverse cervical vessels, medially bound by the IJV) and V (between the posterior border of SCM and anterior border of trapezius muscle, further divided into levels A and B by the spinal accessory nerve) nodes are very rarely directly involved by early initial spread of oral SCC. In addition to these classical patterns of spread, buccal cancers may present with parotid nodes, and the posterior maxillary alveolus/hard palate may spread initially to retropharyngeal nodes. Tumors involving/crossing midline and tumors of the floor of the mouth generally require bilateral neck dissection.

82.9 Evaluation and Diagnosis

Evaluation of neck disease for the purpose of staging is best done by USG-guided FNAC, it being both highly sensitive and specific, simple, and cost-effective but observer dependent. Although palpation is most commonly employed, it has a very low accuracy ranging between 50 and 65%. The limitations of palpation method are obese patients or patients with previously treated necks; examination is more difficult. Imaging with CT scan or MR has been said to improve accuracy for metastatic neck disease to approximately 90%. Chaukar et al. found contrast-enhanced CT to give better concordance with histology in the N0 neck than either US or PET/CT.

82.10 Management

Evolution of neck dissection [26, 27]:

- 1906—George Crile described the classic radical neck dissection (RND).
- 1933 and 1941—Blair and Martin popularized the RND.
- 1967—Bocca and Pignataro described the "functional neck dissection" (FND).
- 1975—Bocca established oncologic safety of the FND compared to the RND.

Technique:

- The incision is made through the skin and deepened to divide subcutaneous tissues. Thus exposing the platysma (Thin pink muscle layer) which is incised in a single stroke.
- This is followed by raising of the subplatysmal flaps with the superior limit being the lower border of the mandible; anteriorly it is extends to the midline, posterior border of sternocleidomastoid (SCM) muscle posteriorly, and inferiorly till the clavicle [26].
- Neck dissection can be done either as an antero-posterior fashion or as a postero-anterior approach.
- Firstly the anterior belly of digastric muscle is identified, and mobilization of the fibrofatty tissue begins between the two anterior belly of digastric muscle and hyoid bone.
- In level IB dissection, marginal mandibular nerve is identified and preserved. The next step is to divide the fascia below the submandibular salivary gland, and the gland per se is retracted cephalad. This maneuver exposes the posterior belly of digastric muscle and helps in the identification of the facial artery. It is ligated close to the entry point at the posterior belly of digastric muscle and lower border of mandible. However full length of the facial artery may be preserved in case of full flap reconstruction [27, 28].
- The Sub mandibular gland (SMG), fibrofatty tissue, lymphatics and the prefacial LNs are mobilized off the mylohyoid and hence retracted it anteriorly.
- For the level II–IV lymph node dissection, the fascia over the SCM is raised till the posterior belly of digastric muscle superiorly. Level IIA dissection begins with identification of the Spinal accessory nerve (SAN) and Internal Jugular Vein (IJV) and removal of the LNs, lymphatics, and fibro-

fatty tissue between these structures, the deep limit of dissection being the prepectoral fascia. At any given point on time tractional injury to the SAN has to be avoided.

- This is followed by release of the fascia and tissue along the posterior border of SCM till the clavicle inferiorly; mylohyoid muscle retracted inferiorly and lateral border of IJV identified. Care is taken to preserve deep cervical plexus. Now the level II–IV tissue is retracted anteriorly and peeled off the IJV and continued in the anterior triangle of the neck till the midline, preserved the superior thyroid vessels and tributary of IJV.
- Level IIB is dissected between the posterior belly of digastric and postero-superior to the SAN, posterior limit being SCM.

This completes the selective neck dissection (Figs. 82.36, 82.37, 82.38, 82.39, 82.40, 82.41, 82.42, 82.43, 82.44 and 82.45).

Fig. 82.36 Incision marking for selective neck dissection

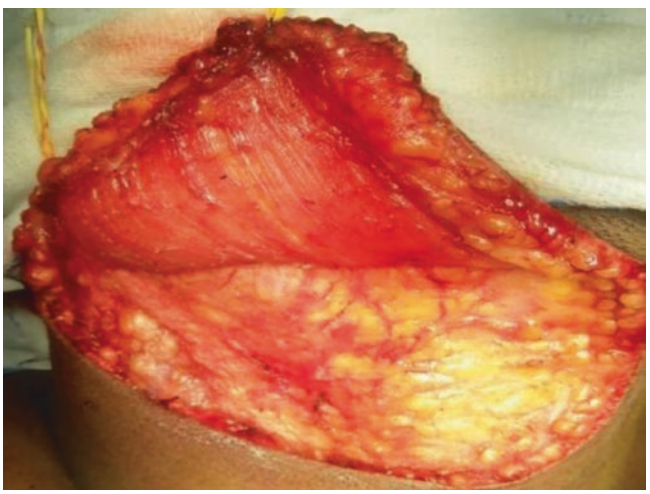


Fig. 82.37 Raising of subplatysmal flap

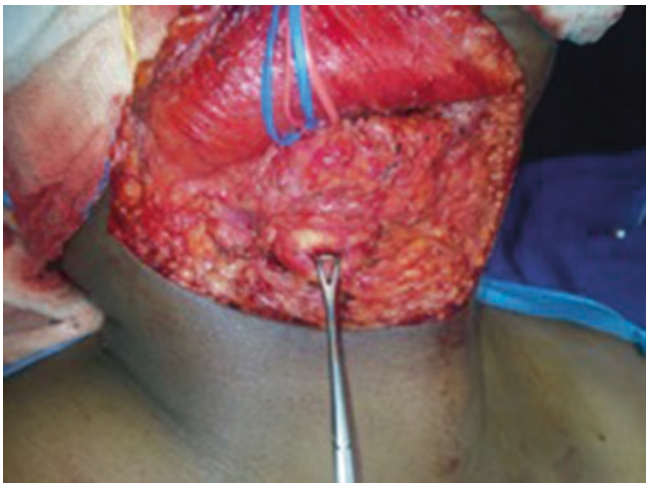


Fig. 82.38 Mobilization of submandibular salivary gland for level I dissection; also seen is isolation of facial vessels

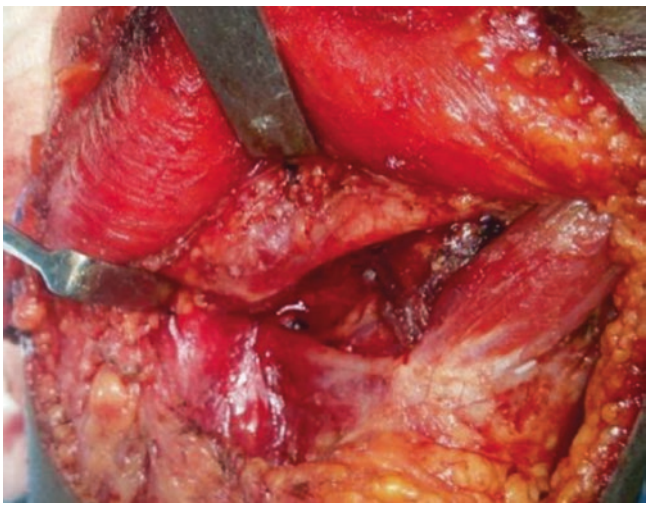


Fig. 82.39 Completed Level Ib dissection, boundaries well appreciated

Fig. 82.40 Exposed SCM, greater auricular nerve, and external jugular vein can be seen over the SCM

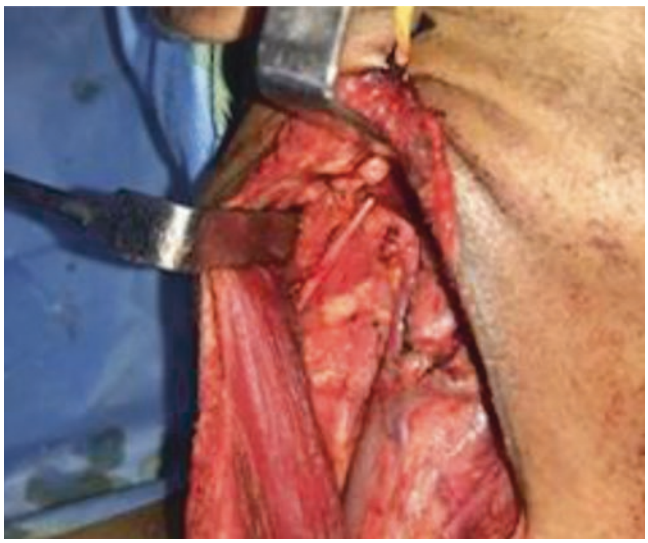


Fig. 82.41 Spinal accessory nerve exposed in level II region

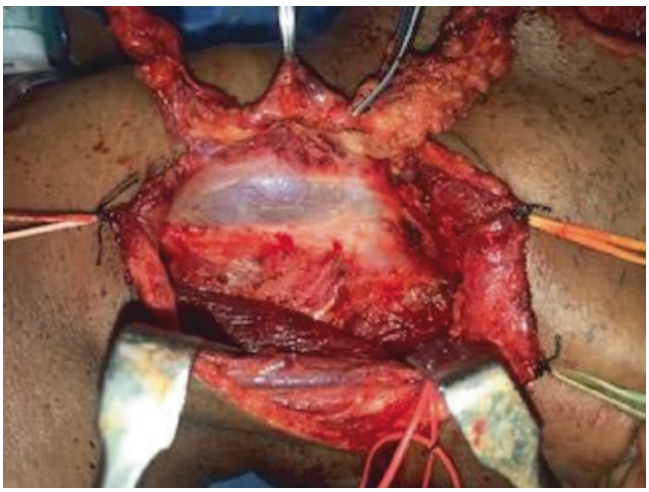


Fig. 82.42 Level II–IV Lymph node dissection mobilized over the IJV

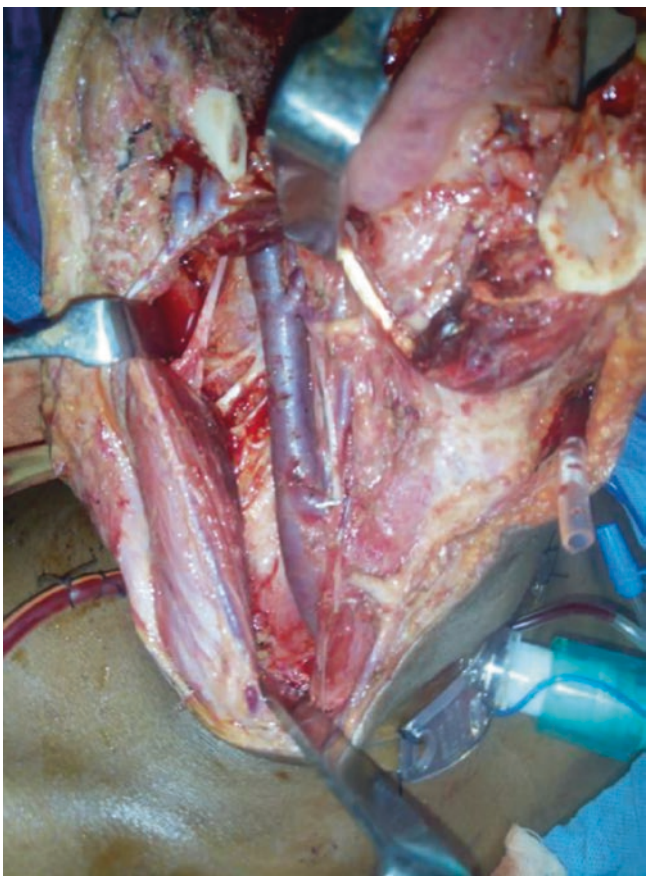


Fig. 82.43 Completed selective neck dissection (level I–IV) preserving sternocleidomastoid (SCM), spinal accessory nerve (SAN), internal jugular vein (IJV)

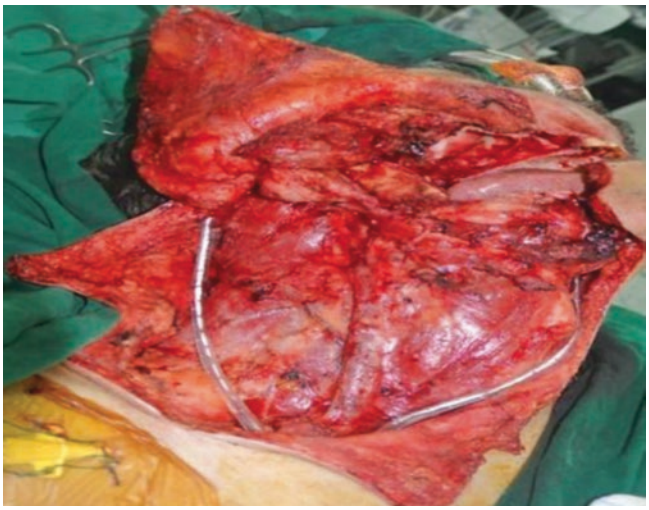


Fig. 82.44 Intraoperative picture depicting right infrastructure maxillectomy, right hemimandibulectomy, modified radical neck dissection (level I–V) preserving only internal jugular vein with suction drains in situ

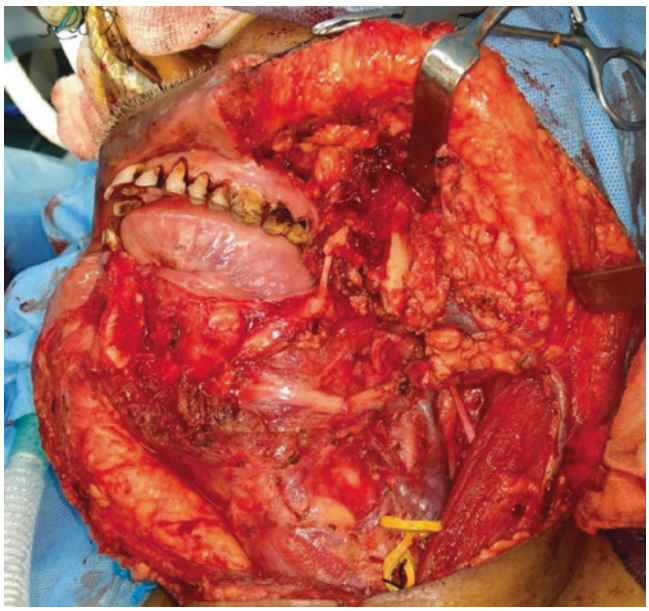


Fig. 82.45 Composite resection with left hemimandibulectomy and selective neck dissection (Level I–IV) preserving the non-lymphatic structure

Table 82.7 Complications of neck dissection [29]

Immediate complications and management	
Hemorrhage	Controlled by ligation or direct cauterization. If hematoma, "milking" the drains may result in evacuation. It is best to return the patient to the operating room and explore the wound if there is suspicion of active bleed and/or there is evidence of hypotension. Blood and blood products to be arranged for blood transfusions. Coagulation profile
Nerve injury	SAN in the level II may be injured either tractional or due to vascular compromise. Vagus, lingual, hypoglossal, and marginal mandibular branch of the facial nerves should be identified and preserved. All attempts should be made to preserve the greater auricular nerve too
Increased intra-cranial pressure	This usually occurs when the internal jugular vein is ligated. When one internal jugular vein is ligated, the pressure rises by three-fold and when both are ligated it increases by five-fold. This usually is temporary and will normalize in 24 h. If it persists, head end elevation, steroids, and mannitol can be used
Pneumothorax	Rare Any tears in the pleura should be identified and closed and their integrity tested
Intermediate complications and management	
Pulmonary	Basal atelectasis and bronchopneumonia may occur in patients who are smokers and have pre-existing chronic obstructive lung disease
Deep vein thrombosis	This is seen in patients in geriatric age group, prolonged duration of surgery, bedridden patients, and patients with previous history of deep vein thrombosis, pulmonary embolism, myocardial infarction and thrombophilia
Chylous fistula	Intra-operative identification can be aided by placing the patient in the Trendelenburg position or adopting a forced Valsalva maneuver. Postoperative leaks are usually identified when feeding is commenced. Multiple approaches to the treatment of an established leak have emerged including nutritional, surgical, and pharmacological therapy
Carotid blowout	Damage to the adventitial layer during surgery may be another contributory factor. If risk of exposure is anticipated, vessels should be covered, e.g., dermal graft, fascia lata or levator scapulae muscle flap. This is particularly important in the post-irradiation subject
Delayed complications and management	
Lymphedema	When both the internal jugular veins are ligated, lymphedema often follows owing to interruption of the lymphatic drainage channels. There are massages advocated as a temporary measure

82.11 Complications of Neck Dissection

Table 82.7 provides a comprehensive view of the complications arising from neck dissection [29].

Disclosure Authors have no conflicts of interest to disclose.

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