Approach Towards Oral Cavity Cancers

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5.1 Introduction

Oral cavity malignancies are one of the most common cancers of the head and neck region with an estimated incidence of 377,713 cases in 2020 [1]. India alone contributes to more than a third of this global burden followed by China and the United States [2]. Oral cancer is also more prevalent among men because of the heavier tobacco and alcohol consumption among them [3]. The global incidence has seen a rise across all age groups in the last decade, especially in young men [3]. Much information is now present to indicate a rise in mortality due to oral cancer in many parts of the world with some of the highest increases in countries of Central and Western Europe. Generally, a modest 5-year survival rate of 50% is seen among patients with oral cancer [4].

Majority of oral cancers are epithelial in origin with 90% comprising squamous cell carcinoma (SCC) [5]. Other tumours that are known to occur in the oral cavity include those from a salivary gland origin, bone and dental structures, and mesenchymal tumours of the soft tissue, nerves, etc. The oral cavity boundaries include the point of contact of the opposed lips anteriorly, the hard palate superiorly, the circumvallate papillae inferiorly and the anterior pillar of the tonsils laterally. Within this, the sites assessed include the wet mucosa of both lips, oral tongue, upper and lower alveolar ridges, retromolar trigone (RMT), floor of the mouth, buccal mucosa and hard palate. Anything beyond the cutaneous portion of the vermilion of the lip is considered a disease of the skin [6]. In the Indian subcontinent and parts of South Asia, the most common site affected is the gingivobuccal complex (GBC), i.e. at the sulcular junction of the buccal mucosa and alveolar gingiva. This is also the most common site of quid/smokeless tobacco placement in these users and occurs due to a direct-contact carcinogenic effect [7]. The mucosal epithelium harbours cells that are the origin of oral SCC. They can either occur de novo or in a background of pre-malignant changes such as those seen in oral submucosal fibrosis, erythroplakia, leukoplakia and less commonly oral lichen planus [8–10]. Once invasion of the basement membrane is established, they become locally aggressive infiltrating the underlying structures and rich lymphatics of the region. Due to this, all subsites of the oral cavity have a propensity of regional spread, with up to 45% of cases presenting with cervical metastasis at the time of diagnosis [11].

This chapter provides an overview regarding the principles of managing oral cavity cancers and the fundamentals of surgical resection highlighting the key steps in surgery.

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5.2 Principles of Management

The management of oral cavity cancers follows the basic principles of treatment of most malignancies. Priority should always be towards locoregional control and prevention of distant metastasis. Another equally important factor that needs to be considered is the quality of life of the patients being subjected to a sometimes rigorous treatment schedule. Hence, a dilemma exists on the acceptable definition of operable tumours that can achieve safe oncologic margins along with acceptable functional and aesthetic morbidity. Early-stage cancers are usually managed by a single-modality therapy in the form of surgery or radiotherapy, whereas advanced cancers are treated by a combination therapy, involving surgery followed by adjuvant radiotherapy (RT) alone or in combination with chemotherapy (CTRT) [12]. When multiple modalities are available, the treatment schedule with the maximum chance of cure should be considered. When the different modalities show comparable cure rates, the treatment option providing the best functional outcome should be considered. The choice between radiation or surgical resection for early-stage cancers mainly depends on the site tumour. Cancers of the buccal mucosa, tongue and floor of mouth are usually considered for surgical resection as these tumours are easily accessible and can be excised without considerable functional and cosmetic morbidity, and radiotherapy can be reserved to intensify management if needed or as a salvage treatment option. Managing the primary tumour by radiotherapy alone, in the form of conventional RT, brachytherapy or surface mould, is only considered for small superficial lesions on the lip and hard palate where excision is associated with poor aesthetic and functional outcomes (Key Point 1). Chemotherapy alone is currently being used either in trial settings or as a part of palliative treatment [12].

Key Point 1

- Surgery for early and advanced oral cancer delivers best survival outcomes as it is quick and cost effective with minimal morbidity.
- Quality of life is equally important and needs to be considered when planning treatment.
- Radiotherapy is considered for superficial lesions in sites associated with poor aesthetic and functional outcomes. For example, brachytherapy is used for superficial palatal lesions (surface mould) and for small tumours (≤1.5 cm depth) that are away from bone (Figs. 5.1 and 5.2) [13].

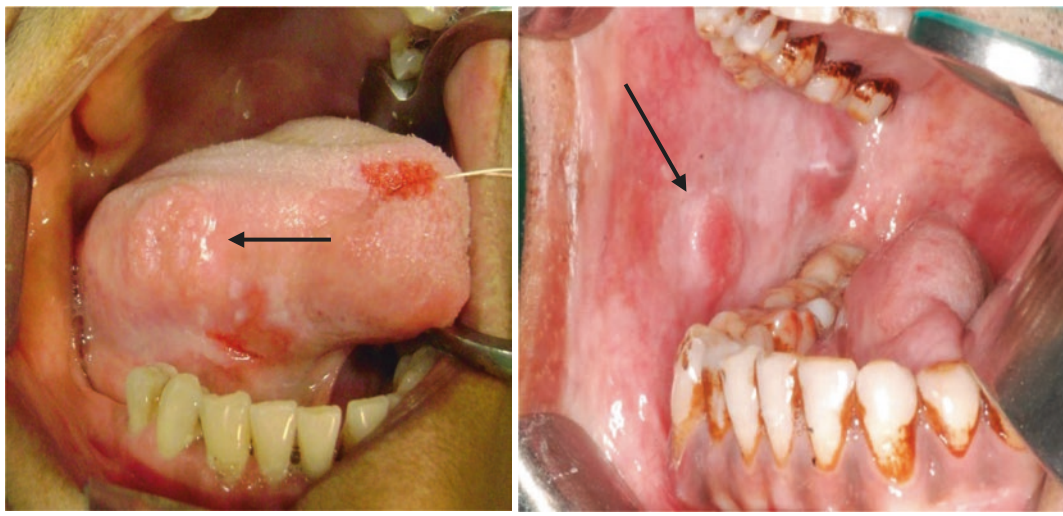


Fig. 5.1 Small tumours less than 1.5 cm in depth

Fig. 5.2 Small and superficial T1 tumours of lip and hard palate

5.2.1 Role of Neoadjuvant Chemotherapy

Neoadjuvant chemotherapy (NACT) was initially used to intensify treatment for oral cancers. The early randomized trials by Licitra and Zhong et al. demonstrated no improvement in overall survival or disease-free survival for operable oral cancers [14, 15]. A later meta-analysis demonstrated similar results but showed benefit in only patients with clinically N2 nodal status. Following this, Patil et al. used NACT in 721 borderline operable oral cancers. They defined borderline operable oral cancers as diseases where the extent would result in an inadequate or involved margin. They found that 43% had sufficient reduction in tumour size that made them operable and gave them a significant survival advantage [16]. Another setting that is gaining traction is the use of NACT for organ preservation of the oral cavity structures. Chaukar et al. demonstrated a 48% mandible preservation rate with no inadequate margins using NACT in operable oral cancers, and equal survival rates compared to the arm that did not receive NACT [17]. Currently, NACT is still being used in a trial setting, and more evidence is needed to substantiate its use in gaining survival advantage (Key Point 2).

Key Point 2 Indications for NACT Based on Current Evidence

Borderline operable disease

- Disease reaching up to the zygoma and/or soft-tissue swelling up to the zygoma
- Extensive soft-tissue involvement reaching up to the hyoid
- Extensive skin infiltration
- Involvement of the infratemporal fossa
- Extensive disease reaching vallecula

Organ preservation

- Paramandibular soft-tissue disease without bone erosion

5.3 Diagnostic Evaluation

A comprehensive history, physical examination and preoperative imaging are vital to form an appropriate diagnosis and treatment plan. The clinical staging of the AJCC classification takes into account all these parameters and helps in determining the extent of the primary tumour and cervical lymph node metastasis. The history of patient should comprise certain pointers that can help formulate the diagnosis. This includes questions regarding the presence of comorbidities and general condition, possible etiological agents and social habits focusing on the use of tobacco and alcohol, clinical progression of the disease and history of any prior cancer-related treatment. The estimate of clinical progression can be made by the duration of the disease, rate of progression and history relating to locoregional spread in the form of complaints such as trismus of recent onset, otalgia, dysarthria, odynophagia, facial numbness and severe weight loss.

The physical examination should be performed to accurately map the extent of the primary tumour and the presence of lymph node metastasis [18, 19]. A Hopkins rod or flexible endoscopy examination should be performed to rule out the presence of synchronous malignancies in the oropharyngeal, laryngeal and hypopharyngeal regions of the head and neck. Involvement of skin and bone is assessed by palpation and imaging. Induration or puckering palpable in the skin, along with *peau d'orange* appearance, should be suspicious of skin involvement (Fig. 5.3). The assessment of paramandibular disease is determined through palpation. This can be supplemented with additional imaging. The examination can be carried under topical or local anaesthesia. General anaesthesia is preferred if the patient is in intolerable pain, lesions that are difficult to assess such extension into the tonsil, lateral and posterior pharyngeal wall, base of tongue, vallecula and proximity to the hyoid bone.

All clinical interpretations need to be confirmed with an accurate representative biopsy. Histopathological diagnosis not only confirms the clinical diagnosis, but also helps in distinguishing the grade and variant of SCC predicting the nature of disease [14]. Punch biopsy of the mucosal regions of the oral cavity should be taken from the most representative part of the ulcer avoiding areas of necrosis. Widespread mucosal lesions entail a biopsy from multiple sites to ensure accurate assessment of the pathology [20–24].

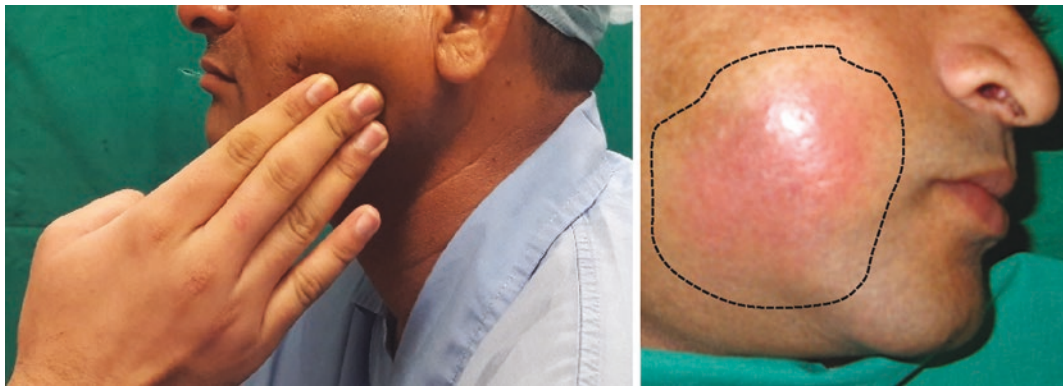


Fig. 5.3 Palpation of the skin to evaluate involvement and *peau d'orange* appearance

5.4 Principles of Imaging Techniques

The main aim of using imaging as a diagnostic tool is to study the spread of the tumour beyond the clinically discernible areas with respect to the involvement of the third dimension and adjoining spaces, i.e. masticator space, infratemporal fossa, and parapharyngeal and retropharyngeal space. The imaging modality to guide treatment plan is based on the site of the primary tumour involvement. The most common imaging modalities used are the contrast-enhanced (CE) CT scan and MRI. The role of the CECT has been described in demonstrating bone erosion of the mandible, maxilla or skull base [25]. A study comparing the different imaging modalities, namely the OPG, CECT, DentaScan and SPECT, to assess for mandibular involvement was undertaken, in which CT scan showed the highest accuracy [26].

CEMRI has been known to have superior soft-tissue delineation as compared to CECT, especially in lesions of the oral tongue, oropharynx and floor of mouth. The main factors that need to be studied in an MRI include the invasion of the extrinsic muscles of the tongue, spread into the sublingual and submandibular space; lesions crossing beyond the midline raphe; and the posterior extent of the disease onto the tongue base. The extent of involvement of the neurovascular bundle in malignancies involving the substance of the tongue, bone marrow and floor of mouth is of vital importance [27]. The features that need to be studied in any preoperative imaging based on the site of involvement are summarized below (Key Points 3 and 4, Fig. 5.4).

Key Point 3 Principles of Imaging Oral Cavity Cancers

Site of involvement	Characteristics	Features to study	CECT	CEMRI	Treatment decisions
RMT, GBC, hard palate	Higher chances for bone involvement (14–72%) [28, 29]	ITF involvement—supranotch or infranotch disease [30] Bone involvement—cortical erosion vs. extension into medullary canal Perineural spread Gross ENE	High specificity for detecting bone erosion (87–90%) [31] Detecting perineural spread and extension of nerve involvement, possible extension to foramen [31] Extent of marrow involvement	High sensitivity and negative predictive value and low sensitivity Inferior as compared to CECT for Buccal mucosal, RMT and GBC [31] Considered in cases where CT shows gross marrow involvement to accurately assess spread and perineural spread	Main decision regarding marginal vs. segmental mandibulectomy Predicting routes of tumour entry and possible spread [26] Segmental mandibulectomy—extent of bone resection if disease invading deeply into mandible having gross paramandibular disease [26, 32] Supranotch disease—poorer outcomes with increased chances of recurrences [29, 33]. Unresectable disease if PTF and lateral pterygoid plate involved

Site of involvement	Characteristics	Features to study	CECT	CEMRI	Treatment decisions
Tongue and floor of mouth	Spread of posteriorly located lesions to the tonsil and the base of tongue and vallecula Floor-of-mouth lesions abutting the mandible have a propensity for cortical erosion of the mandible Proximity of locally invasive cancers with the hyoid bone	Extent of the tumour and infiltration across the tongue musculature Proximity of the tumour to the mandible and possible involvement Involvement of the neurovascular bundle Deep infiltration and proximity with the hyoid	Preferred to assess for cortical erosion in floor-of-mouth cancers [34–36]	Superior to CECT Can be considered to assess suspicious marrow invasion in locally advanced tongue/floor-of-mouth carcinomas. However, possibility of overestimation of disease due to associated inflammation or periodontal disease [37]	Extent of resection—to consider reconstruction options if resection crossing midline, or there is breach of floor of mouth Lesions crossing midline—need to address the contralateral neck [38] Composite resection with a marginal or segmental mandibulectomy depending on the lesion abutting/involving the mandibular cortex Lesion in proximity to the hyoid bone—to consider options for neoadjuvant chemotherapy [16, 39] Extensive NV bundle involvement—to consider compartmental resection [40, 41]

5.5 Assessment of Depth of Invasion

The assessment of depth of invasion (DOI) has now become the standard as per the recommendations of the eighth AJCC staging. The role of MRI in assessing the depth of invasion of tumour has been reported extensively across literature. Most studies have accepted the use of MRI in assessing the depth of invasion in early oral tongue cancers. This use of MRI in assessing the depth of invasion has also been regarded as a prognostic marker for oral cancers reporting poor overall survival and disease-free survival with the DOI more than 8 and 11 mm, respectively [42]. The role of ultrasound-guided assessment in assessing tumour depths has also been highlighted with its ability to distinguish tumour interface with the surrounding tongue musculature leading to comparable accuracy between radiological and pathological reporting of depth of invasion. A recent meta-analysis has shown similar accuracy comparing MRI and ultrasound in assessing tongue cancers [43]. However, the presence of inter-observer variability and operator dependence makes the use of ultrasound less preferable as compared to the MRI. Based on the depth of invasion, it is essential to achieve an adequate three-dimensional margin with an adequate base. This is important for buccal mucosa and tongue cancers where a soft-tissue cuff of at least 5–10 mm is needed around the tumour (Fig. 5.5, Key Point 5).

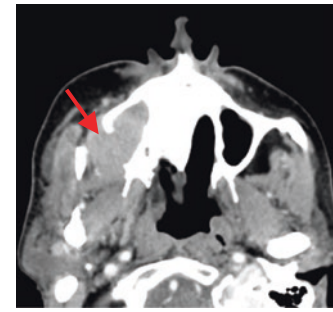
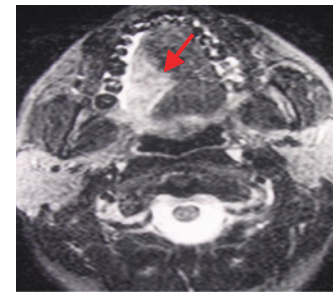
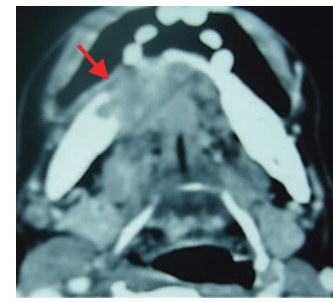
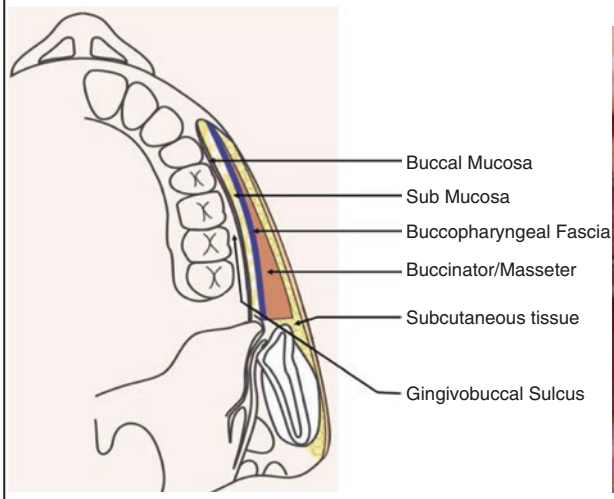
Key point 4 Common scenarios and imaging needed	
Clinical scenario	Imaging done to assess
1.  RMT: To assess for ITF invovlemnt—CECT/CEMRI	
2.  Tongue: To assess for depth of lesion—CEMRI	
3.  Lesion juxtaposed to bone: To assess for paramandibular disease and bone involvement—CECT	
4.  Mandible: To assess for extent of bone erosion and inferior alveolar canal invasion—CECT To assess for extent of marrow invasion and perineural spread—CEMRI	

Fig. 5.4 Subsites of oral tongue carcinoma and imaging findings of structural involvement

Key point 5

- 80% of the margin failure is at the base or deep margins
- Base for buccal mucosa is buccinator/masseter and then skin
- Based on the depth of resection
    - D1 – Mucosal and submucosal not reaching buccinators
    - D2 – Extending to the buccinators, but not breaching its continuity
    - D3 – Breaching buccinator



- Lesion breaching buccinators will mandate skin excision in most cases
- Base for alveolar lesions is underlying bone

- Base for tongue is deep musculature

Fig. 5.5 Critical points for consideration for margin resection

5.6 Imaging for Cervical Metastasis

The evaluation of regional spread is vital in the preoperative assessment of oral cancers. The presence of lymph node metastasis reduces the survival by 50%, and the presence of extranodal extension reduces it further by half. The extent of neck dissection depends on the site of the primary and the level of the positive lymph node [44]. The most likely site of lymph node drainage for oral cavity cancers is at levels I, II and III [45]. The presence of multiple cervical lymph nodes, presence of extranodal extension and encasement of soft tissue and vasculature of the neck significantly affect survival rates [46]. The

presence of above-mentioned features also forms an indication for adjuvant chemotherapy [47–49]. The imaging of choice to assess regional lymphadenopathy is a CECT due to its high specificity [50]. After the recent randomized trial that has shown a significant survival advantage when neck dissection is performed, imaging the neck purely to determine the nodal status has lost its significance.

5.7 Imaging for Distant Metastasis

The most common site for distant metastasis for oral carcinomas is the lung. Therefore, in majority of the cases, the preoperative workup of the patient should be accompanied with a plain CT thorax. The incidence of distant metastasis increases when patients present with large bulky nodal disease, multiple bilateral neck nodes and level III/IV lymph node involvement [12, 29]. A PET-CECT is considered as the imaging modality of choice for the detection of distant metastasis for most cancers [51]. However, for oral cancers, no significant difference has been observed in detecting distant metastasis between a plain CT thorax and a PET-CECT [51]. Therefore, the use of PET-CECT can be limited to recurrent oral cavity cancers or patients with suspected synchronous malignancies [52].

5.8 Approaches to Surgical Resection

5.8.1 Principles of Resection

Surgery is considered as the primary treatment modality for early and locally advanced oral cancers. Trials in the past have shown superior outcomes of surgical intervention as compared to primary radiotherapy in terms of overall survival and disease-free survival. One of the earliest randomized trials attempted to compare the survival outcomes in patients undergoing surgery followed by post-operative radiotherapy versus primary radiotherapy for oral cavity carcinomas. The trial was closed within less than 2 years of accrual due to marked difference in the overall survival favouring combination therapy of surgery with adjuvant therapy [52].

The surgical approach towards tumours of the oral cavity depends on the location of the tumour, depth of invasion and proximity of the lesion to bone, i.e. the buccal or lingual surface of the mandible, upper alveolus and hard palate. Furthermore, attention needs to be drawn to the size and depth of infiltration along with the presence of any other malignant or premalignant lesions in the oral cavity. The presence of any other suspicious lesion which has an area of intervening normal mucosa must be biopsied to confirm diagnosis. This will rule out the presence of a synchronous malignancy, which may affect the surgical plan. Other associated factors that need to be taken into consideration include the presence of trismus due to either pain, inflammation, masticator space involvement, prior surgery or chemoradiation.

5.8.2 Extent of Resection and Margins

The primary tumour management entails wide excision with adequate margins. The current accepted standard involves a minimum 5 mm margin to be considered during resection of the primary tumour [53]. The assessment of margins can be either specimen driven or defect driven. The specimen-driven approach has been reported to increase the rate of adequate resections and is considered superior to the defect-driven approach. However, intraoperatively, a margin of a minimum of 1 cm is considered adequate taking into account some degree of mucosal shrinkage after tissue resection and pathological processing [54]. Several studies have questioned the use of frozen section for intraoperative margin assessment, its benefit and cost-effectiveness [55]; however, its use can be considered in select situations such as recurrent tumours or those subjected to surgery after neoadjuvant chemotherapy where the clinico-radiological assessment of the margin status might be questionable.

5.8.2.1 Access-Incision Planning

Various incisions have been described based on the required access and extent of the primary tumour. When the skin is not involved, it is important to design the incision in a way that preserves vascularity of the native skin flap and provide adequate access at the same time. The incision is based on the proximity of the tumour with the oral commissure. The key principle is to preserve the vasculature around the oral commissure and lips (Fig. 5.6, Key Point 6).

If the skin resection is planned, the area to be resected is first marked keeping adequate margins around the involved area (Fig. 5.7). This is then connected to the neck incision by a perpendicular line. To gain further access to the oral cavity, the same principles highlighted in Fig. 5.6. Key Point 7 should be followed.

5.8.3 Surgical Techniques

5.8.3.1 Anaesthesia Considerations

General anaesthesia is preferred for oral cancer resection procedures. A nasotracheal intubation using a north pole-facing endotracheal tube is used so that the oral cavity is freely accessible. In case the mouth opening is restricted, a fibre-optic-assisted intubation or tracheostomy is performed. If the surgery entails resection of any part of the swallowing mechanism, an elective tracheostomy is performed. The patient is positioned supine with minimal neck extension, if required, for the primary resection. Nasogastric feeding tube is inserted and confirmed under direct visualization.

Approach	Indications
Peroral approach	Good mouth opening, anteriorly placed T1–T2 lesions
Lower cheek flap	Posteriorly placed lesions, lesions involving the RMT, gross paramandibular disease
Upper cheek flap	Tumours of the hard palate, upper GBS, upper alveolus
Pull-through visor approach	Anterior 2/3rd tongue lesions, lesions involving the entire dorsum of tongue, posteriorly located lesions (lesions at post 1/3rd of tongue, lesions involving BOT)
Mandibulotomy	Posteriorly located oropharyngeal and oral cavity lesions (requiring access for lateral soft-tissue margin and base), inaccessible lesions due to trismus

5.8.4 Early Tongue Carcinoma (T1 and T2 Tumours or T3/T4 Tumours That Are Completely Visualized)

5.8.4.1 Peroral Wide Local Excision

Once the patient is adequately anaesthetized, a mouth gag is inserted, and a visual and palpable examination confirms the extent of lesion. A traction stitch is taken at the planned anterior margin edge about 1 cm from the tumour followed by another stitch adjacent to it through the uninvolved substance of the tongue. Adequate mucosal margins are marked around the clinically discernible and palpable tumour (Fig. 5.8).

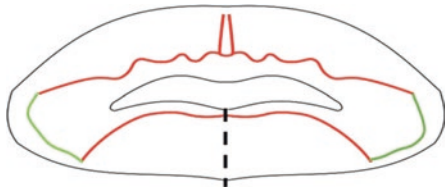
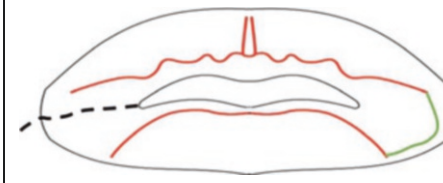
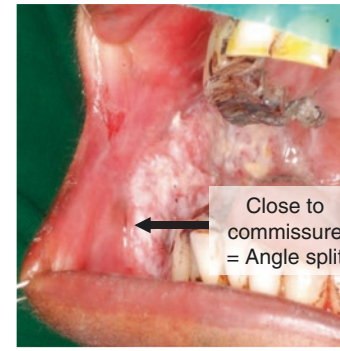
These markings are then deepened to include the tongue musculature always keeping in mind to palpate the adequacy of soft tissue resected for the third dimension, i.e. the base. As the resection continues posteriorly, the intramuscular branches or the terminal portion of lingual vascular bundle might be encountered deep to the sublingual gland. These vessels are meticulously ligated to achieve appropriate haemostasis (Fig. 5.9).

Once the specimen is removed, the mucosal and soft-tissue margins are assessed for adequacy (Fig. 5.10). Appropriate reconstruction is carried out based on the size of the defect and the functional requirement.

5.8.5 Advanced Tongue Carcinoma (T3 and T4 or Posteriorly Based T1 and T2 Tumours)

Once the patient is adequately anaesthetized, a mouth gag is inserted, and a visual and palpable examination confirms the extent of lesion. Nasogastric feeding tube is then inserted and confirmed under direct visualization. To achieve

Key Point 6 Midline Lip Versus Angle Split Incision

Midline lip split	**Angle Split**
 Midline Lip Split	 Angle Split
• When the tumour is present posteriorly and the facial vessels around the oral commissure can be preserved, a midline lip split is preferred.	• When the tumour or margin involves the commissure and its vessels, angle split is preferred.
Away from commissure = Midline split	
• The two halves of the lower lip obtain their blood supply from the upper lips through the communication at the commissures.	• The vascularity of the lower lip is preserved through the midline revascularization

Modifications of the above have been suggested to improve aesthetics:


Roux - Vertical


McGregor- Chin sparing


Robson – Angle split


Rassekh – Modified zig zag

Fig. 5.6 Types of lip split incision

Key Point 7 When and how to resect skin?

When to resect skin?

- Look out for induration or puckering of skin by palpation
- Unhealthy inflamed skin not lifting from underlying tumour needs to be removed
- Tumour can be palpated through the skin

How to mark the skin?

- The skin should be marked prior to initiation of surgery
- Adequate margin of 1cm should be resected around the clinically discernible tumour
- A perpendicular is dropped from the lower edge so as to maintain adequate vascularity at the edge
- If the skin resection is less than 5-4cm, a cervical rotation flap can be planned

Fig. 5.7 Designing a skin incision to get adequate margin

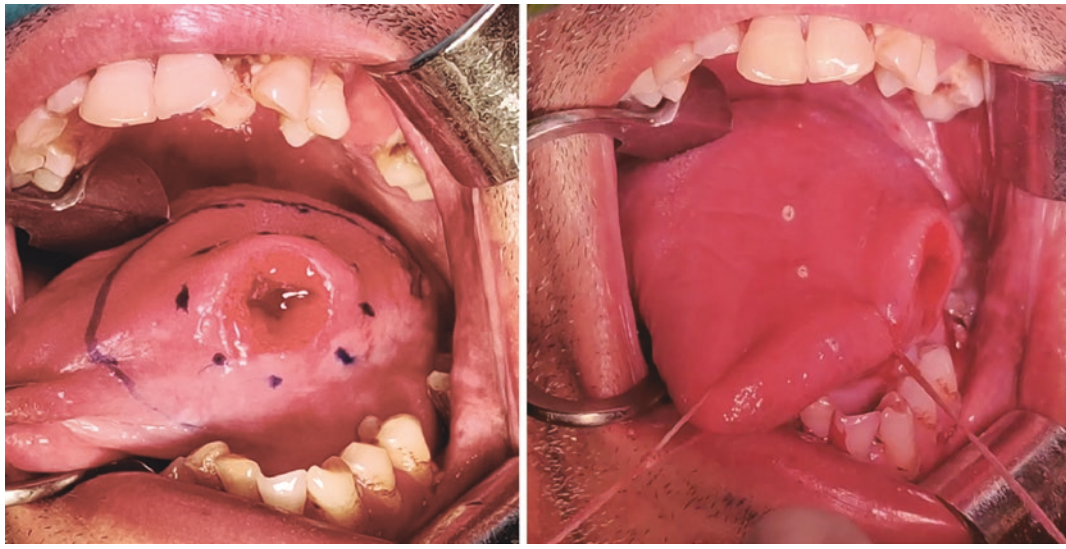


Fig. 5.8 Mucosal markings of the margin around the tumour

adequate margins, access to the posterior portion of the base tongue can be challenging in some T3 and T4 tumours. Few techniques have been described to aid in this situation that include:

1. Access osteotomy through mandibulotomy
2. Pull-through technique
3. Lateral pharyngotomy
4. Endoscope assisted

5.8.5.1 Access Osteotomy Through Mandibulotomy

This technique is usually performed for posteriorly based tumours involving the oropharyngeal area where accessing the posterior margin is difficult [56, 57]. There are various types of mandibulotomies described in literature; however, the paramedian type with mental nerve preservation is the most preferred. Certain factors need to be taken into consideration when planning a mandibulotomy like prevention of tooth injury and mental or inferior alveolar nerve damage. These are summarized as below [58] (Key Point 8).

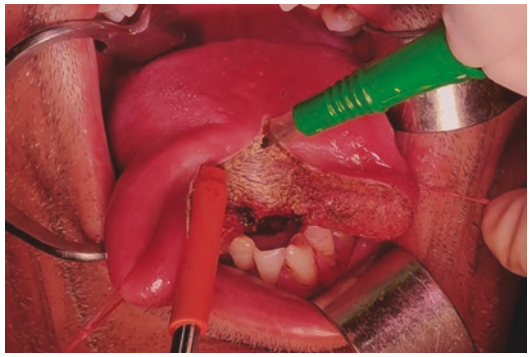


Fig. 5.9 Mucosal markings deepened to obtain adequate base

Key Point 8 Types of Mandibulotomies and Its Characteristics

Median	Osteotomy is between the central incisors Advantages: • Less risk of occlusal derangements • Good mechanical stability and exposure • Preservation of inferior alveolar nerve • Outside radiation portals Disadvantages • Division of genial muscles leading to delay in swallowing • Unaesthetic appearance if extraction of central incisor is needed

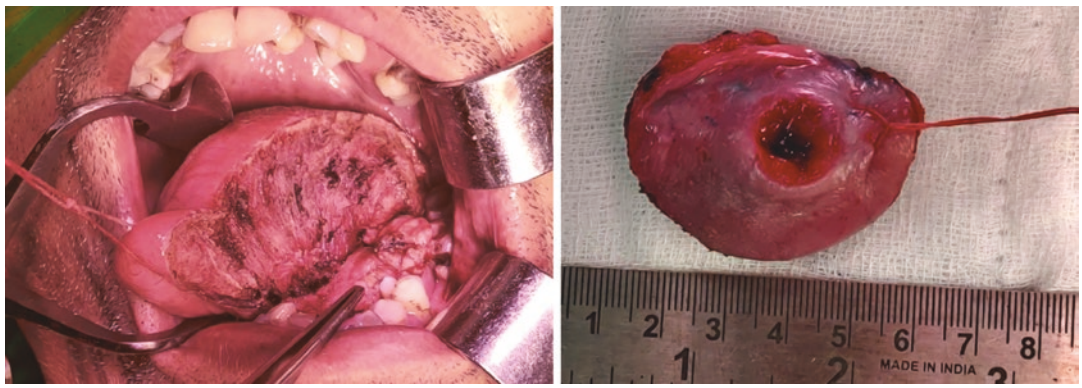


Fig. 5.10 Defect after resection and resected specimen

Paramedian	Osteotomy is between lateral and canine, most popular Advantages: • Might not need to extract teeth as canine root is tilted laterally • Good exposure • Mental nerve spared so lower lip innervation preserved Disadvantages: • Difficulty swallowing due to detachment of swallowing musculature • If adjuvant radiotherapy is planned, osteotomy site might be directly in the portals leading to poor healing

Lateral	Osteotomy through the body of the mandible, not currently in use Advantages: • Best access for posteriorly placed lesions Disadvantages: • Osteotomy site is under uneven muscular effects and might lead to delayed/non-union • Transection of inferior alveolar nerve causes devitalization of teeth and de-innervation of lower lip • If adjuvant radiotherapy is planned, osteotomy site will be directly in the portals leading to poor healing

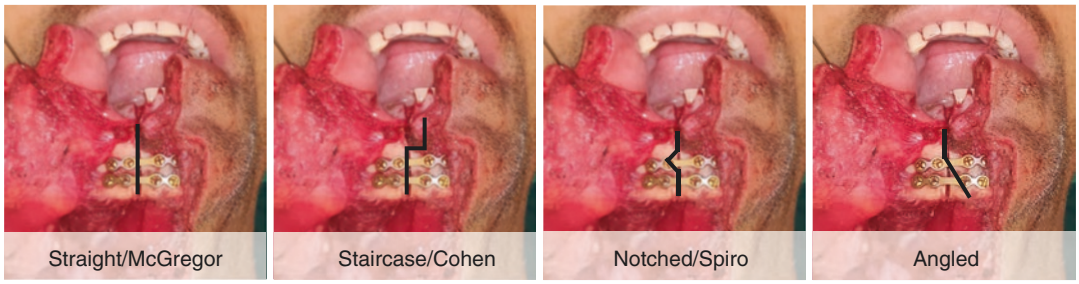


Fig. 5.11 Various designs of mandibulotomies

The osteotomy design of the mandibulotomy has various types. This can be divided into straight, stepped and notched [59, 61]. Of these, a stepped or notched mandibulotomy is usually preferred as it prevents the vertical movements of the mandible and facilitates fixation. Alternatively, a straight osteotomy shows more occlusal derangement, and the rearrangement of the fracture segments is difficult [59, 60] (Fig. 5.11).

5.8.5.2 Surgical Steps

A midline lip split is planned to gain access to the lateral surface of the mandible. Osteotomies can be planned either lateral, median or paramedian, with most commonly preferred being the lateral. These should be planned on the side of disease where the access is required. Once the lip is split, adequate mucosa and soft tissue of the gingivobuccal sulcus should be maintained on the mandible to aid in closure. Supra-periosteal flaps are raised so as to maintain adequate blood supply to the mandible. Once the site of osteotomy is confirmed, the periosteum is sharply dissected off the bone to expose the planned osteotomy line. Pre-plating is done by contouring the fixation plates across the planned osteotomy and drilling bur holes in their final position. The plates and corresponding screws are then set aside. The lingual mucoperiosteal flap is sharply raised across the planned osteotomy line.

Traction sutures are taken across the substance of the tongue. Once the osteotomy is performed, the floor of the mouth is incised close to the lingual plate and the tumour is accessed by pulling the oral tongue forward and outward. Adequate mucosal margins are marked around the tumour

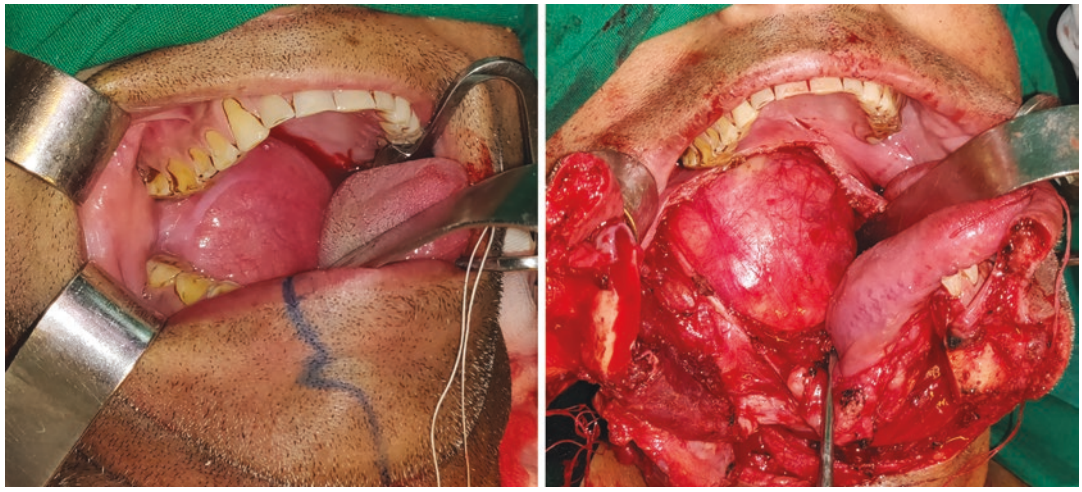


Fig. 5.12 Poor access for a posteriorly based lesion that improves once a mandibulotomy is performed

Fig. 5.13 Difficult-to-access bulky anterior lesions and posteriorly based lesion near the base tongue

with adequate visualization for the posterior margins (Fig. 5.12).

These markings are then deepened to include the tongue musculature always keeping in mind to palpate the adequacy of soft tissue resected for the base. Once the specimen is delivered and the reconstruction completed, fixation of the mandible is performed using the pre-contoured hardware, confirming that the occlusion is maintained.

5.8.5.3 Pull-Through Approach

This is usually done for bulky anterior tumours where posterior extent is difficult to access (Fig. 5.13).

The tongue is attached to the hyoid inferiorly, palate superiorly and mandible laterally and its own musculature makes up the bulk medially. For the resection of this compartment as a whole, these attachments need to be released.

5.8.5.4 Oral Component

A visor incision is planned to gain access for delivering the tongue in the neck. Traction sutures are taken across the substance of the tongue. A knife is used to sharply cut the periodontal attachments of the lingual aspect of gingiva across the extent of the tumour, usually from the ipsilateral

Fig. 5.14 Mucoperiosteal flap elevated from lingual alveolus

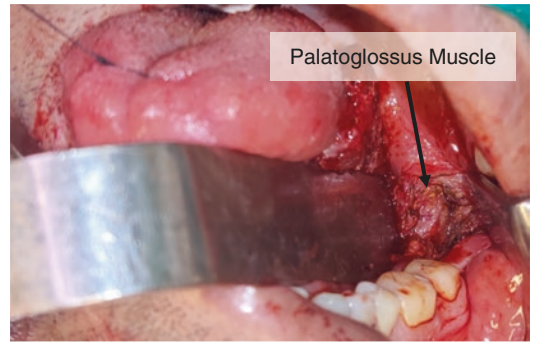


Fig. 5.15 Palatoglossus muscle visualized after mucosal incision

to the contralateral third molar region. Subperiosteal sharp dissection is performed to elevate the entire mucoperiosteal lingual gingiva from the lingual cortex, reaching up to mylohyoid line (Fig. 5.14).

Posteriorly mucosal incisions are continued on to ipsilateral tonsillolingual sulcus. Depending on the extent of disease, this incision continues to include the ipsilateral tonsil as a margin as well. Once this mucosal incision is deepened, the palatoglossus muscle is visualized medially and the medial pterygoid muscle laterally. The palatoglossus muscle is cut to release the palatal attachment and drop the tongue in the neck (Fig. 5.15).

On the contralateral side, the mucosal incision is continued on to the floor of the mouth and the dorsal surface of the uninvolved tongue. This incision is dictated by the extent of disease. If the extent requires a wider margin, a similar procedure is performed at the contralateral tonsillolingual sulcus as the ipsilateral side. The aim is to preserve as much of the oral or base tongue on the contralateral side as is oncologically feasible.

5.8.5.5 Neck Component

The neck dissection specimen is kept attached to the mandible at level Ib. Incision is given on the lower border of mandible corresponding to the intraoral mucosal incisions. Subperiosteal sharp dissection is continued elevating the periosteum off on the lingual surface of mandible laterally releasing the mylohyoid muscle from its origin. In the midline, the mandibular origin of both the anterior belly of digastric is released, followed by detaching the geniohyoid and genioglossus muscles from the genial tubercle. This will release the tongue from the mandible and result in a communication between the oral cavity and the neck. At the hyoid bone, the insertion of the tendon of the digastric, mylohyoid and hyoglossus is released. Once completed, the lingual neurovascular bundle is identified in close proximity to the lesser cornua of hyoid where it is ligated. Occasionally, the lingual artery might arise from a common faciolingual trunk and will need to be ligated in the tongue musculature. Proceeding laterally, the hypoglossal nerve is clipped and transected close to the external carotid so as to incorporate all contents of the tongue compartment. The posterior belly of digastric and styloglossus muscle is then cut cranially to include an adequate cuff of muscle with the specimen. At this time, the lingual nerve is encountered closer to the mucosa, which is also transacted. The tongue is then delivered into the neck to gain access to the posterior base tongue area. Once this is done, the ipsilateral mucosal incision is continued from the tonsillolingual sulcus onto the tongue base (Fig. 5.16).

As the mucosal incisions are deepened around the tumour, the tongue falls further into the neck

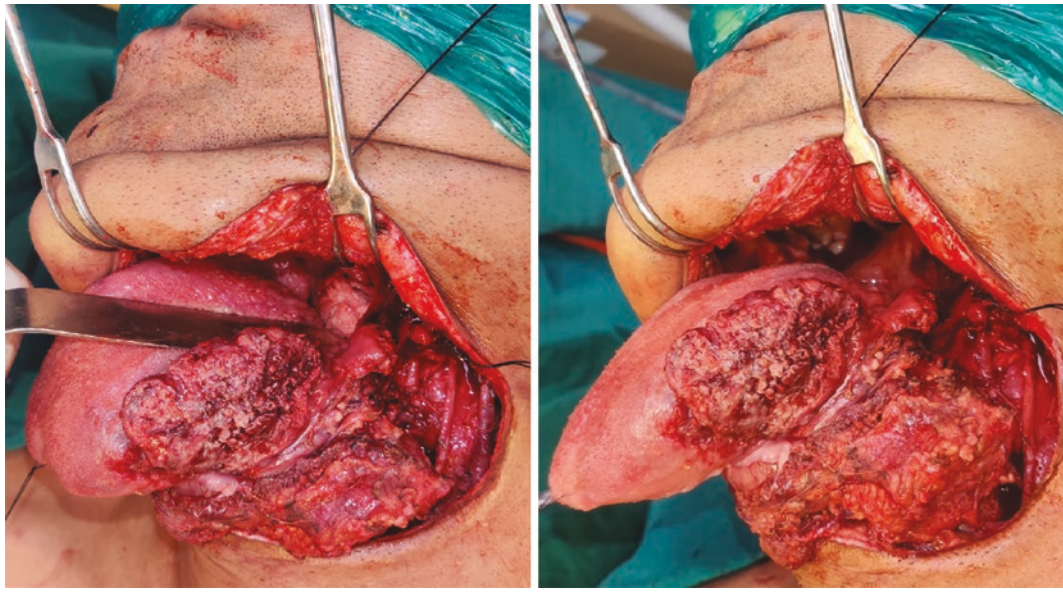


Fig. 5.16 Tongue being delivered in the neck to mark the posterior mucosal margins under adequate visualization

to continue the incision towards the contralateral uninvolved tongue.

These mucosal incisions are gradually deepened keeping in mind to palpate for the adequacy of soft-tissue margin around the tumour and avoiding inadvertent entry into the pre-epiglottic space. The mucosal incision is then continued onto the uninvolved portion of the base tongue to connect with the contralateral side. As the muscles are cut, the contralateral lingual neurovascular bundle and lingual nerve might be encountered that need to be ligated and transected, respectively. Once the specimen is removed, the mucosal and soft-tissue margins are assessed for adequacy, and appropriate reconstruction is carried out. The hyoid bone is hitched to the mandible to aid swallowing.

5.8.6 Early Buccal Mucosa (T1 and T2)

5.8.6.1 Peroral Wide Local Excision

Once the patient is adequately anaesthetized, a mouth gag is inserted and a visual and palpable examination confirms the extent of lesion. Adequate mucosal margins are marked anteriorly around the clinically discernible and palpable tumour. These markings are then deepened to include the buccinator musculature always keeping in mind to palpate the adequacy of soft tissue resected for the third dimension, i.e. the base. Once the buccinator is cut, the resection continues posteriorly in the subcutaneous plane, being observant for occasional hair follicles. Since the buccal mucosa is not very thick, infiltrative tumours, even if small in size, need to be resected along with a cuff of outer skin so that an adequate base can be obtained (Fig. 5.17).

The facial vessels are ligated both superiorly and inferiorly, and the length of the vessel should be included in the specimen to ensure adequacy of deep base if the skin is not planned to be removed. The mucosal incisions are continued posteriorly to reach the anterior border of masseter muscle. The Stenson's duct is ligated if it is part of the resection or margin. Postero-superiorly, the buccal fat pad can be preserved with its capsule if the tumour is superficial. Just before the final incisions are given to release the specimen,

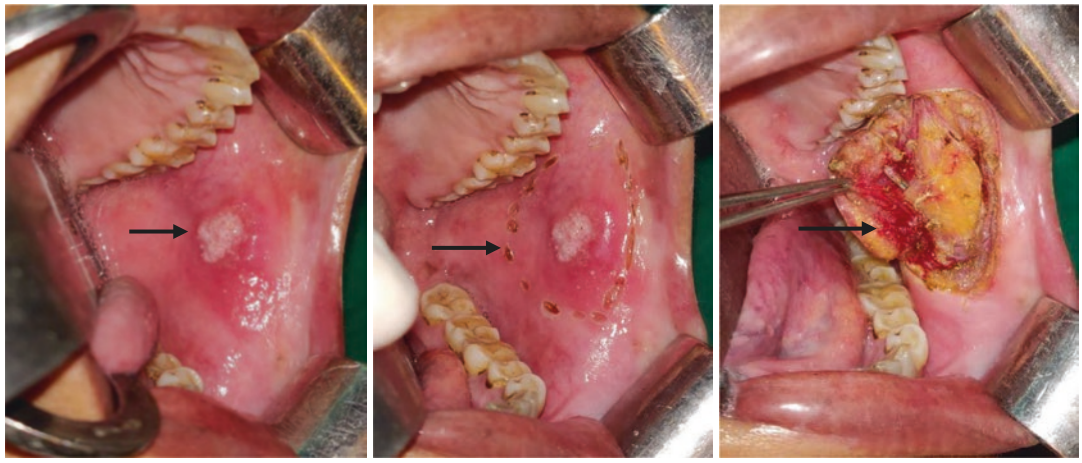


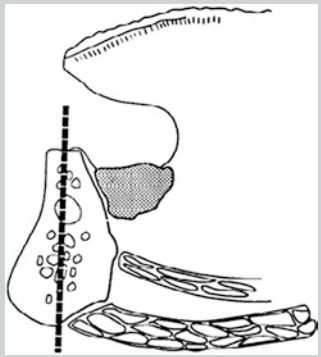
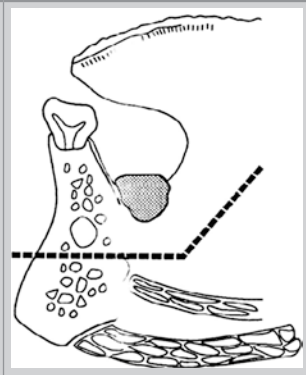
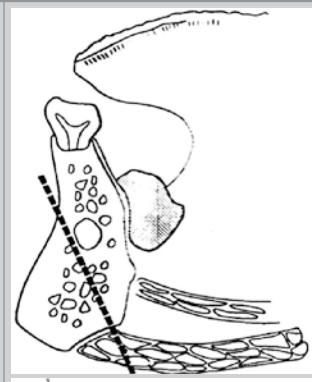
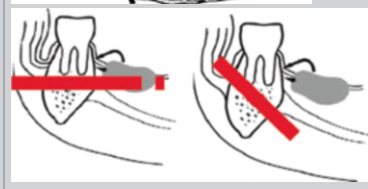
Fig. 5.17 Mucosal incisions deepened to include the underlying muscle as an adequate base in the specimen

orientation sutures are taken anteriorly and superiorly. Once the specimen is removed, the mucosal and soft-tissue margins are assessed for adequacy. Appropriate reconstruction is carried out based on the size of the defect and the functional requirement.

5.8.6.2 Wide Local Excision with Marginal Mandibulectomy

Tumours of the oral cavity involving or in close proximity to the mandible necessitate some form of mandibular resection. The extent of resection is decided by a combination of imaging, astute clinical judgment and a thorough knowledge of the pathophysiology of routes of tumour entry. For tumours juxtaposed with or superficially eroding the alveolus, marginal resection is an oncologically feasible option. To withstand the forces of mastication, a minimum residual height of 1 cm is required. It is contraindicated in the presence of gross bony erosion; in extensive soft-tissue disease, which precludes adequate soft-tissue margins; and in an edentulous and pipestem mandible where achieving a centimetre of residual bone is not possible. Prior radiotherapy is a relative contraindication as the periosteum loses its function as a protective barrier and tumour can enter the mandible at multiple points. The routes of tumour entry dictate the type of marginal resection to be performed. Brown et al. [62] demonstrated the point of abutment at the level of the attached and reflected mucosa to be the preferred point of entry for tumours of the floor of the mouth. Chaukar et al. in their study of buccal cancers reported the occlusal surface as the preferred method for buccal cancers [26] (Key Point 9).

Key Point 9 Types of Marginal Mandibulectomies

Vertical	Horizontal	Oblique
		
• Performed in a vertical plane in the intradental sockets • For floor-of-mouth or tongue cancers by removing the lingual plate • Removal of the buccal plate has been described in literature but is not performed as it leaves behind the weaker lingual plate, which is unable to withstand the forces of mastication • The soft-tissue attachments are mainly on the buccal side (better blood supply) and are sparse on the lingual side making it prone to injury	• Done for cancers of the buccal mucosa as tumours are closer to the occlusal surface permitting adequate soft-tissue and bony margins	 • point of abutment at the level of the attached and reflected mucosa mandates an oblique resection to achieve a good soft-tissue resection

5.8.6.2.1 Surgical Steps

Once the patient is adequately anaesthetized, a mouth gag is inserted, and a visual and palpable examination confirms the extent of lesion. Intraoral mucosal incisions are given keeping adequate margins from the tumour on the buccal aspect of the mandible (Fig. 5.18).

These cuts are deepened incising the buccinator muscle till subcutaneous tissue. Midline lip split incision is taken depending on the relationship of the tumour to the oral commissure as discussed in Key Point 6. Cheek flap is raised preserving adequate soft tissue over the tumour. Soft tissue over the mandible is incised to expose the proposed site of bone resection. Periosteum of the inferior rim is preserved to prevent the

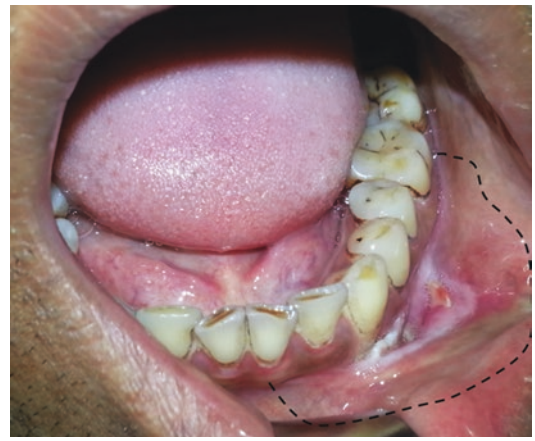


Fig. 5.18 Mucosal incision given around tumour from the anterior to the posterior planned site of osteotomy site on the buccal aspect of the mandible

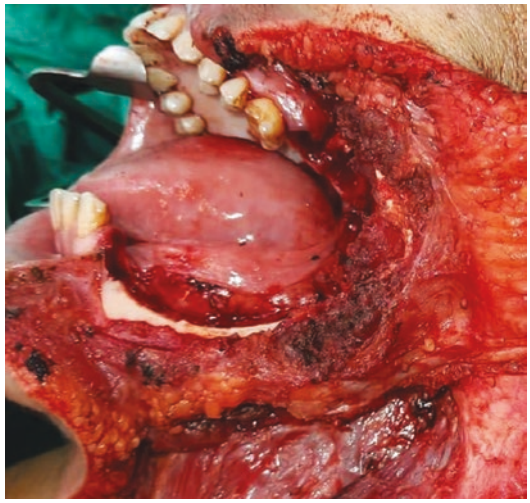


Fig. 5.19 Final resection bed after tumour removal. Periosteum and soft tissue should be maintained on the remaining mandible to maintain vascularity and avoid osteoradionecrosis if adjuvant radiotherapy is indicated

necrosis of the remaining bone. Teeth are extracted at the planned site of osteotomy, which is made at least 1 cm or two teeth away from the tumour. Anterior and posterior osteotomies are defined using powered instruments/reciprocating saw under continuous irrigation with saline to minimize thermal damage to the bony edges. These are connected across the body of the mandible maintaining a smooth curvilinear fashion, classically described as boat or canoe shape, avoiding any sharp angles. Height of the remaining mandible should be at least 1 cm to avoid the risk of stress fractures. It is important to engage both buccal and lingual cortices to obtain a uniform defect. The specimen is then swung laterally, and incision is given on the floor of the mouth keeping adequate margins. The lingual nerve will be encountered posteriorly and can be preserved if the disease is well away. Haemostasis is achieved by using bone wax or cauterizing the bleeding points over the cut surface of the bone (Fig. 5.19). Once the specimen is removed, the mucosal and soft-tissue margins are assessed for adequacy, and appropriate reconstruction is carried out.

5.8.7 Buccal Mucosa Composite Resection (T3 and T4)

Gross bony invasion or presence of paramandibular soft-tissue disease requires segmental resection of the bone. The extent and location of resection have a bearing on aesthetic and functional outcome. A simple classification proposed by Brown et al. [63] groups mandibular defects into four categories with increase in morbidity in terms of aesthetic and functional outcome from class I to IV. The extent of mandibular resection is guided by the extent of cortical erosion and/or medullary involvement in imaging and extent of soft-tissue disease [17].

5.8.8 Buccal Mucosa Composite Resection with Posterior Segmental Mandibulectomy

Once the patient is adequately anaesthetized, a mouth gag is inserted, and a visual and palpable examination confirms the extent of lesion. The planning for skin resection is done as previously discussed in Key Points 6 and 7. The area of the skin to be resected is marked after bimanually palpating the tumour, and a perpendicular incision is dropped from the lower skin edge connecting it to the neck crease incision. Intraoral mucosal incision is marked anteriorly keeping adequate margins around the tumour, extending to the planned osteotomy site. The incision extends posteriorly keeping adequate margins around the tumour to end short of the retromolar region. Teeth are extracted at the planned site of osteotomy on the mandible. The mucosal incisions are deepened to cut the buccinator and/or orbicularis oris till the subcutaneous tissue. The skin incision is then completed by bevelling away from the skin and communicated anteriorly with the oral cavity. At the lower border of mandible, platysma is sharply incised, and the cheek flap is raised keeping the buccinator and masseter on the specimen. The Stenson's duct is identified at the anterior border of masseter and ligated. The parotid gland is raised along with the

cheek flap without breaching its capsule till the posterior border of the mandible is reached. The stylomandibular ligament is then cut posteriorly. The masseter muscle is cut caudal to the zygomatic arch to expose the ramus of the mandible and the sigmoid notch. The rest of the muscle can be raised subperiosteally off the mandible to expose the entire condyle head and the coronoid process. With this, the capsule of the temporomandibular joint is separated from the specimen along with the insertion of the lateral pterygoid. Once this is done, the temporalis muscle is identified by the direction of its fibres, and its insertion is released from the coronoid process. The mandibular osteotomy is defined till the lower border of the mandible. Once the osteotomy is completed, the specimen is rotated downward and laterally to complete the mucosal incisions on the floor of the mouth. The specimen is gradually released deepening this lingual incision to include adequate cuff of mylohyoid muscle. The lingual nerve is encountered here and transected if the disease involves the retromolar trigone. This gives further access to complete the incision along the tonsillar pillar or tonsil and communicate it with the incision across the retromolar region (Fig. 5.20).

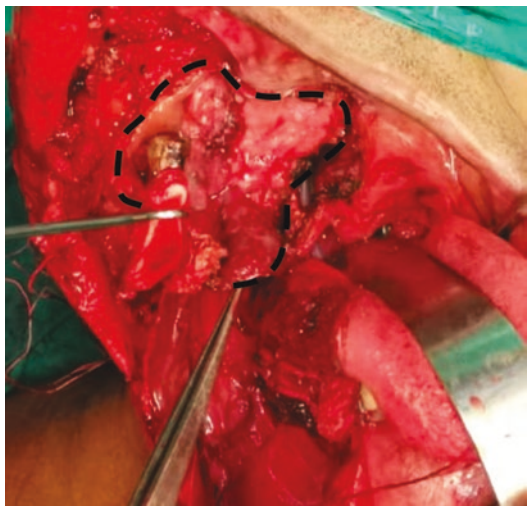


Fig. 5.20 Mucosal incision is continued along the tonsillar pillar or tonsil and communicate it with the incision across the retromolar region

As the mucosa is cut, the medial pterygoid muscle is identified due to the direction of the fibres and cut at an appropriate level keeping adequate cuff of medial soft-tissue base. As this muscle is cut, the mandibular nerve is identified and transected as cranially as possible. Lastly, the insertion of the lateral pterygoid muscle is released in a subperiosteal plane from the head and neck of the condyle by rotating the specimen counterclockwise. The maxillary artery and its branches can be encountered at this step and need to be ligated. Once the specimen is removed, the mucosal and soft-tissue margins are assessed for adequacy. Appropriate reconstruction is carried out based on the size of the defect and the functional requirement.

5.8.9 Modifications for Segmental Mandibulectomy

In case the disease is not extending posteriorly and infiltrating through the medullary canal, the posterior segmental of bone can be preserved to aid in reconstruction. The mucosal incision and extent of bone planning will be slightly different than the posterior segmental mandibulectomy.

- Teeth need to be extracted on both the anterior and posterior sites of osteotomy.
- Mucosal incisions are keeping adequate margins given around the tumour connecting these two osteotomy sites.
- The lateral soft tissue, or base, needs to be adequately assessed after raising the cheek flap.
- Once osteotomies are completed, the floor-of-mouth mucosal and soft-tissue incisions are given to deliver the specimen.

5.8.10 Modifications for Bite Composite Resection with/Without Infratemporal Fossa Contents

This is planned when the upper gingivobuccal sulcus or maxillary alveolus is involved. The

Fig. 5.21 Segmental mandibulectomy planned from the anterior to the posterior tooth extraction site

mucosal incision and extent of bone planning will be similar to the posterior segmental mandibulectomy and will include the upper alveolus (Figs. 5.21 and 5.22).

- Intraoral mucosal incisions are marked as per posterior segmental mandibulectomy, except that the posterior incision is carried to the site of osteotomy on the upper alveolus.
- Teeth are extracted at the planned site of osteotomy on the maxilla and mandible.
- The palatal mucosal cuts are taken extending from the site of extraction till the junction of hard and soft palate.
- The temporalis muscle is identified, its insertion is released from coronoid process and access to the posterolateral wall of the maxilla is obtained after the buccal fat pad is displaced inferiorly.
- The osteotomy is marked from the extraction socket, across the antero- and posterolateral maxillary walls till the pterygomaxillary fissure. The mandibular osteotomy is also defined till the lower border of the mandible.
- Once the mandibular, maxillary and palatal osteotomies are completed, the specimen is rotated downward and laterally to complete the mucosal incisions on the floor of the mouth.
- The specimen is gradually released deepening the lingual incision to include adequate cuff of mylohyoid muscle.
- This mucosal cut is continued posteriorly along the tonsillar pillar or tonsil and communicated upwards with the palatal incision (Fig. 5.16).

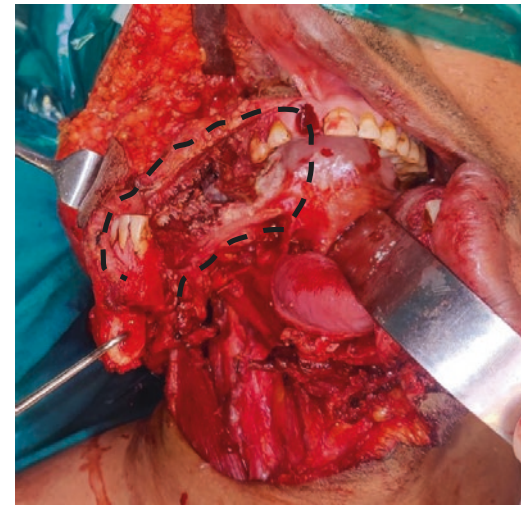


Fig. 5.22 Mucosal incision carried upward from the floor of the mouth towards the palate to include the maxillary alveolus in the specimen

- As the specimen is rotated further downward and laterally, the origin of the medial pterygoid muscle will need to be separated from the pterygoid plates and the insertional fibres of the lateral pterygoid muscle from the medial surface of the condylar head. The maxillary artery and its branches can be encountered here that need to be ligated. Alternatively, this vessel can be ligated at the posterior border of the neck of the condyle early on, adding to the haemostasis.
- Lastly, the specimen will hang on the mandibular nerve, which is transected as cranially as possible (Figs. 5.23 and 5.24).

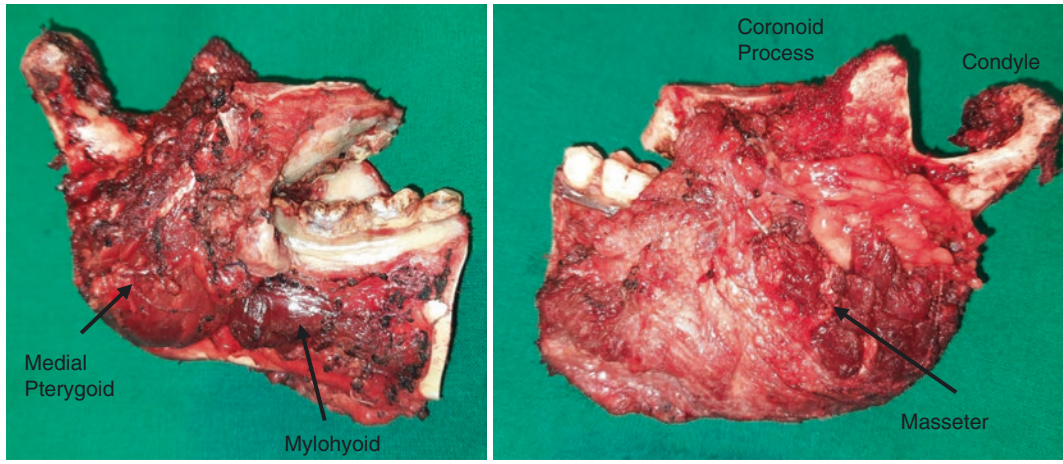


Fig. 5.23 Resection specimen of a bite composite resection

Fig. 5.24 Resection bed after tumour removal

In case the disease extent requires resection of the infratemporal fossa, the following modifications are required:

- The masseter muscle is cut at its attachment at the zygomatic arch, the glenoid fossa is identified and the temporalis muscle is cut as cranially as possible in the infratemporal fossa. It is important to follow the greater wing of sphenoid subperiosteally so that most of the contents can be included with the specimen. Harmonic or any other thermal instrument can be used for this step.
- The maxillary osteotomy is marked from the extraction socket, across the antero- and posterolateral maxillary walls and across the pterygomaxillary fissure to include the lower third of the pterygoid plates.
- After the mandible and maxillary osteotomies are performed, more access is gained to the infratemporal fossa and the remaining fibres of the temporalis are cut.
- Just after this, the mandibular nerve and vessels are identified at the foramen ovale, which are clipped and transected. Haemostasis can be achieved by packing the foramen with bone wax.
- Few fibres at the lateral pterygoid muscle origin need to be separated from the greater wing of sphenoid to deliver the specimen (Fig. 5.25).

Once the specimen is removed, the mucosal and soft-tissue margins are assessed for adequacy and appropriate reconstruction is carried out. Nasogastric feeding tube is then inserted and confirmed under direct visualization.

5.8.11 Hard Palate (T1–T2 Lesion)

5.8.11.1 Upper Alveolectomy

Once the patient is adequately anaesthetized, a mouth gag is inserted, and a visual and palpable examination confirms the extent of lesion. Teeth

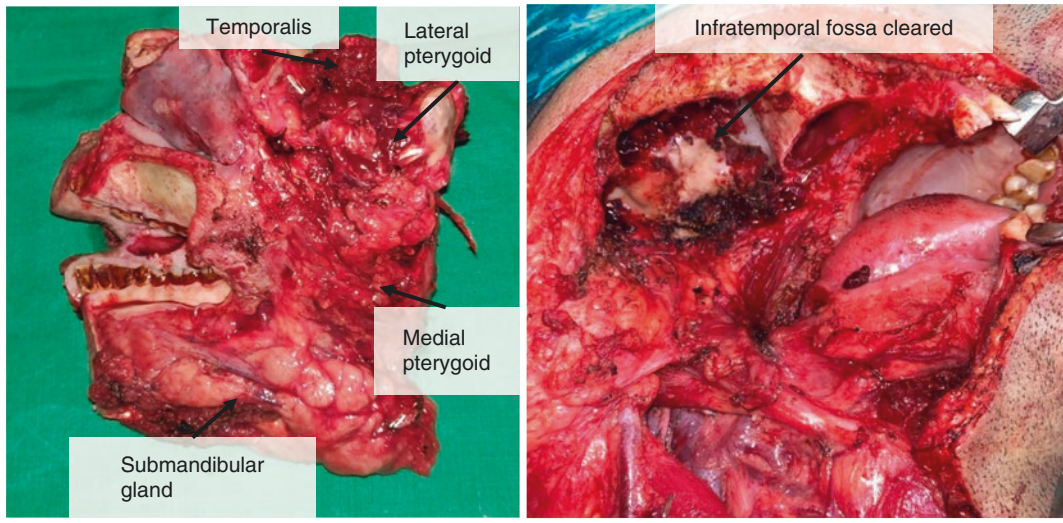


Fig. 5.25 Resection specimen and bed of a bite composite resection with infratemporal fossa clearance

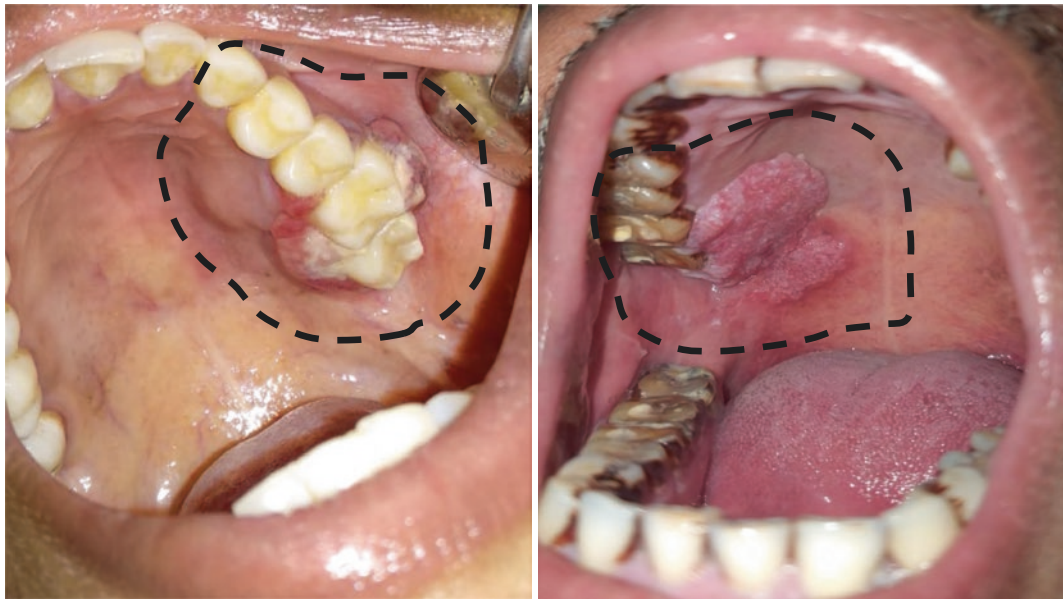


Fig. 5.26 Mucosal margins and extent of resection for an upper alveolus and hard palate lesion

are extracted at the site of planned osteotomies. Mucosal incisions are marked from these extraction sockets into the gingivobuccal sulcus keeping an adequate margin around the tumour. These are deepened to cut the buccinator, masseter and/or orbicularis oris till the subcutaneous fat. The resection then continues supero-medially keeping adequate soft tissue around the tumour to define the bone cuts on the antero- and posterolateral maxillary walls. The palatal mucosal incision is then given keeping adequate margin from the tumour (Fig. 5.26).

The osteotomies are performed on the palatal, medial and antero- and/or posterolateral wall of the maxilla. The specimen is delivered after releasing any mucosal attachments with the max-

Fig. 5.27 Posteriorly based lesions might require a upper philtrum split without/with lateral rhinotomy extension for accessing the tumour

illary sinus and/or nasal cavity. Nasogastric feeding tube is then inserted and confirmed under direct visualization.

For posteriorly placed lesions, few modifications might be needed:

- For access, an upper philtrum split incision along with a lateral rhinotomy incision may be planned. The cheek flap is raised in the supraperiosteal plane until the planned osteotomy site (Fig. 5.27).
- The palatal incision is given till the junction of soft and hard palate, connecting it with the gingivobuccal incision across the retromolar trigone. The posterior limit of maxillary cut will be the maxillary tuberosity. As the incision continues posteriorly, the greater palatine vessels might need to be cauterized to achieve haemostasis.

Once the specimen is removed, the mucosal and soft-tissue margins are assessed for adequacy and appropriate reconstruction is carried out. Nasogastric feeding tube is then inserted and confirmed under direct visualization.

5.9 Broad Tips for Reconstruction

1. Every defect in oral cavity is three dimensional, has multiple functional tissue elements and is often odd shaped. All this should be respected in planning reconstruction.
2. Head is at one end of the body; free flaps are as important as pedicle and local in a reconstructive surgeon's armamentarium.
3. Free, pedicle and local flaps complement, supplement and complete each other, with the surgeon's preference for one over the other being the only impediment!
4. Lip and lid should be closed up to third defect, shared for next third and reconstructed for anything more.
5. Buccal mucosa defects need generous flap replacement, especially at RMT, with marginal mandibulectomy and with associated skin defect.
6. Any mandible defect with two bony ends available for fixation deserves a consideration for bony reconstruction. All bone defects come with a soft-tissue deficit which needs equal attention.
7. The tongue remnant determines the functional outcome after resection. All reconstruction should be aimed at facilitating its freedom to move.
8. Maxilla defects are heterogenous. Obturator, bone and soft-tissue reconstruction options should be weighed carefully before choice is made.
9. Mouth opening, dentition and mucosal fibrosis should be factored in before any reconstructive decision for the oral cavity.

10. Slight overcorrection of volume deficit is always preferred over undercorrection.
11. Time, radiation and gravity affect all reconstruction, and severity may vary from one tissue to another.
12. Most problems attributed to radiation have their genesis in some deficiencies in surgical planning and execution.

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