Principles and Outcomes of Compartmental Resection in Upper Gingivobuccal Cancers

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KEYWORDS

• Compartmental resection • Gingivobuccal cancer • Infratemporal fossa • Masticator space
• T4b oral cancer

KEY POINTS

- Gingivobuccal sulcus tumors are aggressive oral cancers with complex anatomic extension, often classified as T4b and historically deemed unresectable.
- Compartmental resection is an anatomically driven surgical approach that removes entire compartments at risk for microscopic disease, improving local control and outcomes.
- Tumors commonly spread through the masticator space, infratemporal fossa, and pterygopalatine fossa, exploiting fascial planes and neurovascular pathways.
- Conventional margin-based surgery often fails in these tumors, resulting in high rates of positive margins and recurrence; compartmental resection addresses these limitations.
- Advances in surgical and reconstructive techniques now allow resection of selected advanced tumors, challenging previous staging and management paradigms.

INTRODUCTION

Gingivobuccal sulcus tumors represent a challenging subset of oral cavity cancers due to their complex anatomic relationships and tendency for deep tissue extension. These malignancies frequently involve critical anatomic spaces including the masticator space, infratemporal fossa, and pterygopalatine fossa, leading to their classification as T4b disease according to the American Joint Committee on Cancer (AJCC) staging system.[1] Historically, such tumors were considered surgically unresectable, with treatment limited to palliative measures.[2] The anatomic complexity of the gingivobuccal region stems from its intimate relationship with multiple fascial spaces and neurovascular structures. Upper gingivobuccal sulcus tumors (Fig. 1) can extend to the upper alveolus and maxilla, subsequently spreading through the pterygopalatine fossa to reach the skull base. Lower gingivobuccal sulcus tumors commonly involve the masticator space, providing a pathway for skull base extension. These patterns of spread necessitate surgical approaches that extend beyond conventional margin concepts.

WHAT IS COMPARTMENTAL RESECTION?

Compartmental resection represents a paradigm shift from traditional margin-based surgery to anatomically driven tumor removal. This concept,

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Abbreviation	
AJCC	American Joint Committee on Cancer

initially described for oral tongue cancers[3] and subsequently adapted for gingivobuccal malignancies,[4,5] involves the en bloc resection of anatomic compartments that may harbor microscopic disease extension beyond conventionally defined margins. The fundamental principle underlying compartmental resection is the recognition that cancer cells can spread along anatomic planes, fascial boundaries, and neurovascular pathways in predictable patterns. Rather than relying solely on gross tumor margins with added clearance distances, compartmental resection removes entire anatomic units that may contain occult disease, thereby reducing the risk of incomplete excision and local recurrence. In the context of gingivobuccal cancers, compartmental resection encompasses 3 key components: soft tissue resection involving muscles of mastication from origin to insertion, bony resection including parts of the maxilla with pterygoid plates and potentially portions of the mandible, and neurovascular resection with proximal ligation of the maxillary artery and resection of the maxillary nerve at the foramen rotundum when indicated. The compartmental approach differs fundamentally from conventional wide local excision in its systematic, anatomically guided methodology (Figs. 2 and 3). The resection proceeds from posterior to anterior, with deeper structures addressed first. Proximal vascular control is achieved early in the procedure, and critical neurovascular structures are preserved when uninvolved by tumor. This methodical approach ensures complete clearance of potentially involved anatomic compartments while minimizing the risk of inadvertent injury to vital structures.

Fig. 1. Upper gingivo-buccal carcinoma involving the upper alveolus.

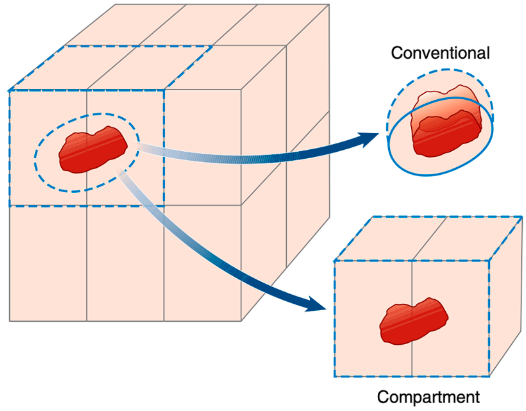

Fig. 2. Conventional versus compartment surgical approach. With permission to reuse Fig 1.4, Chapter "The Compartmental Surgical Approach" from the book *Atlas of Head and Neck Cancer Surgery- The Compartment Surgery for Resection in 3-D*. (Trivedi, N. (2015). Concepts for Three-Dimensional Resection. In: Atlas of Head and Neck Cancer Surgery. Springer, New Delhi. https://doi.org/10.1007/978-81-322-2050-3_1.)

CONCEPT AND RATIONALE OF COMPARTMENTAL RESECTION IN GINGIVOBUCCAL CANCERS

The rationale for compartmental resection in gingivobuccal cancers is based on several key observations regarding tumor behavior and anatomic spread patterns. Gingivobuccal malignancies especially those of the retromolar trigone and the posterior maxilla involve the masticator space early, which provides a pathway to reach the skull base. This pyramidal-shaped, fascia-enclosed space contains the muscles of mastication, mandibular nerve, and internal maxillary artery. The muscles that constitute the major content of this space lack facial barriers to tumor spread, making it ill-defined and en bloc resection difficult. These tumors also demonstrate a propensity for perineural invasion, particularly along the maxillary division of the trigeminal nerve and its branches.[6,7] This pattern of spread can result in skip lesions and microscopic disease extension far beyond the gross tumor margins, making conventional margin-based approaches inadequate.[8] The anatomic compartments surrounding the gingivobuccal region are interconnected through various foramina and fascial planes, creating potential pathways for tumor dissemination. The pterygopalatine fossa serves as a crucial crossroads, connecting the infratemporal fossa, orbit, nasal cavity, middle cranial fossa, and palate. Upper gingivobuccal tumors can access this space through perineural invasion along the posterior superior alveolar nerves or through direct maxillary

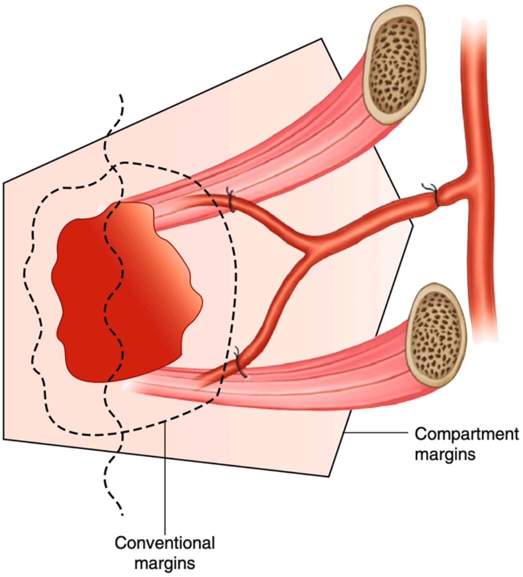

Fig. 3. The technical aspect of performing compartment surgery in the head and neck region. With permission to reuse Fig 1.5, Chapter "The Compartmental Surgical Approach" from the book *Atlas of Head and Neck Cancer Surgery- The Compartment Surgery for Resection in 3-D*. (Trivedi, N. (2015). Concepts for Three-Dimensional Resection. In: Atlas of Head and Neck Cancer Surgery. Springer, New Delhi. https://doi.org/10.1007/978-81-322-2050-3_1.)

erosion. Once within the pterygopalatine fossa, tumors can spread extensively through its multiple communications.

The conventional approach to these tumors, which relies on wide local excision with arbitrary margin distances, fails to account for these anatomic realities. Studies have demonstrated that conventional approaches result in positive deep margins in up to 40% of cases, with subsequent local recurrence rates exceeding 30%.[9,10] The poor outcomes have been attributed to inadequate clearance. Recurrences can occur locally at the margins of resection, in the infratemporal fossa or at the skull base (**Figs. 4–6**). Historically, T4b oral squamous cell carcinomas with masticator space involvement have been deemed technically unresectable due to multiple interrelated factors.[11,12] Clinically, patients frequently present with trismus secondary to pterygoid muscle involvement, which severely limits adequate clinical examination and assessment of tumor extension.[13] Cross-sectional imaging modalities, despite their utility, have inherent limitations in accurately delineating soft tissue involvement, with studies demonstrating significant false-positive rates (>25%) and measurement variations when assessing depth of invasion, particularly in detecting subtle involvement of muscles of mastication, maxillary artery, and inferior alveolar nerve.[14–16] MRI and computed tomography are essential for characterizing masticator space lesions, but masses in this deep anatomic location are difficult to evaluate clinically, and imaging interpretation requires familiarity with complex anatomic relationships.[17,18] Intraoperatively, the surgical approach to the masticator space is technically challenging due to limited surgical corridors, abundant bleeding from the pterygoid venous plexus which obscures the surgical field, and difficulty in determining adequate surgical margins in this complex 3 dimensional anatomic space.[19,20] Additionally, the historical lack of adequate reconstructive infrastructure and expertise in managing extensive defects following compartmental resection of the masticator space contributed to the designation of these tumors as unresectable.[12,21] However, with advances in surgical techniques, compartmental resection principles, and reconstructive capabilities, selected T4b tumors involving the masticator space are now being successfully resected with oncological outcomes comparable to T4a disease, leading to calls for reevaluation of the current staging system.[11,19,22]

Compartmental resection addresses these limitations by removing entire anatomic units that may

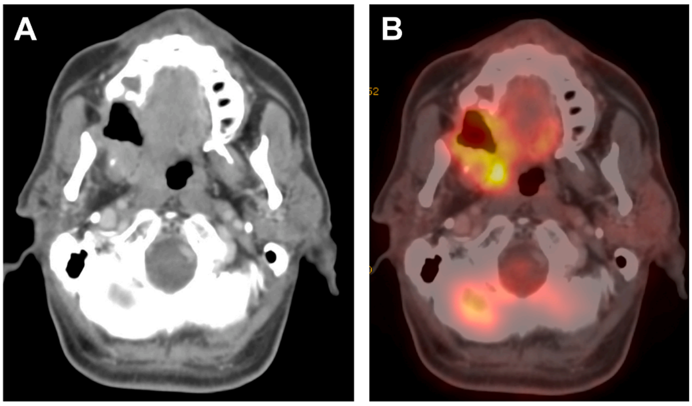

Fig. 4. (*A*, *B*) Imaging depicting pattern of failure after conventional resection and adjuvant treatment, local recurrence ([*A*] CT scan and [*B*] PET CT scan).

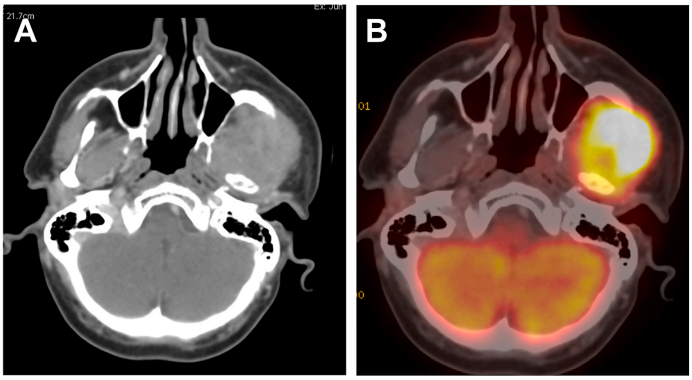

Fig. 5. (*A*, *B*) Imaging depicting pattern of failure after conventional resection and adjuvant treatment, infratemporal fossa recurrence ([*A*] CT scan and [*B*] PET CT scan).

harbor occult disease. This concept has been validated in other anatomic sites, including the tongue, where compartmental resection has demonstrated improved outcomes compared to conventional approaches.[3,23]

RELEVANT ANATOMY AND SPREAD OF CANCERS

Understanding the complex anatomy of the gingivobuccal region is essential for successful compartmental resection. The area encompasses multiple interconnected fascial spaces, each with distinct boundaries, contents, and communications that influence patterns of tumor spread.[24]

Masticator space is a crucial pyramidal, fascia-enclosed compartment for lower gingivobuccal tumors, extending from skull base to mandibular border. The investing cervical fascia splits at the mandibular border into superficial and deep layers. The superficial layer covers masseter and inferior temporalis tendon, while the deep layer passes medial to the medial pterygoid, attaching from medial pterygoid plate to sphenoid spine. The space contains 4 mastication muscles (masseter, temporalis, medial, and lateral pterygoids), mandibular nerve, internal maxillary artery, and pterygoid venous plexus. It can be subdivided into suprazygomatic and infrazygomatic components (based on zygomatic arch) or supranotch and infranotch regions (based on sigmoid notch). Trivedi and colleagues[4] classified masticator space involvement into 3 prognostically significant classes: Class I (low masticator space) involving medial pterygoids, masseter, and ascending ramus with high cure potential; Class II (intermediate) involving temporalis, lateral pterygoid, and lower pterygoid plates with potential for cure; and Class III (high) involving pterygomaxillary fissure and intracranial extension, typically requiring palliative treatment. Foramina ovale and spinosum in the masticator space roof provide critical neurovascular communications with middle cranial fossa, serving as potential intracranial extension pathways requiring careful surgical evaluation.

Infratemporal fossa represents a nonfascia-lined space that communicates directly with the masticator space and pterygopalatine fossa. Its boundaries include the posterior surface of the maxilla and inferior orbital fissure anteriorly, the mastoid and tympanic portions of the temporal bone posteriorly, and the inferior surfaces of the greater wing of sphenoid and squamous temporal bone superiorly. The medial pterygoid and tensor veli palatini

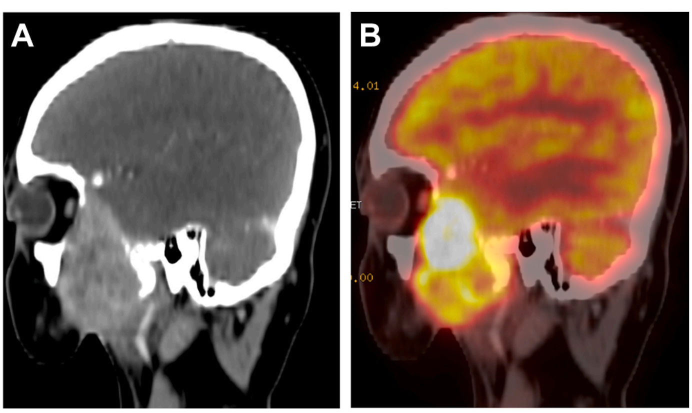

Fig. 6. (*A*, *B*) Imaging depicting pattern of failure after conventional resection and adjuvant treatment, infratemporal fossa recurrence ([*A*] CT scan, [*B*] PET CT scan).

muscles form the medial boundary, while the inner surface of the mandibular ramus and zygomatic arch provide lateral boundaries. The infratemporal fossa contains the lateral and medial pterygoid muscles, temporalis muscle, mandibular nerve with its branches, otic ganglion, chorda tympani nerve, maxillary artery, and pterygoid venous plexus. The maxillary artery, which provides the primary vascular supply to the region, follows a characteristic course between the pterygoid muscles before entering the pterygopalatine fossa.

Pterygopalatine fossa serves as a critical crossroads for tumor spread from upper gingivobuccal primaries. This cone-shaped depression lies between the posterior maxilla and pterygoid process of the sphenoid bone. Its boundaries include the posterior wall of the maxillary sinus anteriorly, the perpendicular plate of the palatine bone medially, and the pterygomaxillary fissure laterally. The fossa contains the pterygopalatine ganglion, maxillary artery with its terminal branches, and the maxillary division of the trigeminal nerve. Of particular oncological significance are the posterior superior alveolar nerves and the greater and lesser palatine nerves, which provide pathways for perineural tumor spread from gingivobuccal primaries. The pterygopalatine fossa communicates with multiple anatomic regions through various foramina and fissures, including the foramen rotundum (middle cranial fossa), vidian canal (foramen lacerum), palatine canals (hard palate), sphenopalatine foramen (nasal cavity), and pterygomaxillary fissure (infratemporal fossa). These communications explain the diverse patterns of spread observed in advanced gingivobuccal cancers.

Pathways of Tumor Spread

Gingivobuccal cancers demonstrate predictable patterns of spread that reflect the anatomic relationships described earlier. Upper gingivobuccal tumors more commonly involve the pterygopalatine fossa through perineural invasion along the posterior superior alveolar nerves or through direct maxillary bone erosion. Once within the pterygopalatine fossa, tumors can spread extensively through its multiple communications, potentially reaching the orbit, nasal cavity, middle cranial fossa, or contralateral side. This pattern is facilitated by the tumor's proximity to the retromolar trigone and the pterygomandibular raphe, which serves as a fibrous bridge between the pterygoid hamulus and the mylohyoid line of the mandible. Tumors can spread along the raphe to involve the infratemporal fossa. The masticator space and infratemporal fossa are particularly significant in the context of AJCC staging, as tumor involvement of these spaces classifies the cancer as T4b.[1] This classification has historically been associated with poor prognosis and limited surgical options, although recent evidence suggests that carefully selected cases can achieve favorable outcomes with appropriate surgical management.[11,22,25]

CONVENTIONAL APPROACH TO UPPER GINGIVOBUCCAL TUMORS

Conventionally, the upper gingivobuccal tumors are exposed through an upper cheek flap elevation with the buccal sulcus incision extending to the maxillary tuberosity. The skin incision may have extension laterally through subciliary or transconjunctival route. The excision involves an infrastructure or total maxillectomy. The approach is anterior to posterior. Following completion of the maxillectomy cuts, pterygoid dysjunction is performed, after which the infratemporal fossa is entered and a comprehensive soft-tissue clearance is carried out. This approach is suitable for smaller tumors with good mouth opening and limited deep extension. But in cases where the tumor is posteriorly placed or when there is associated trismus it fails to give a controlled and well visualized excision of the area where the main tumor bulk reside. This approach has further limitations. It often results in troublesome bleeding from the pterygoid venous plexus and maxillary artery, creating a challenging surgical field that impairs visualization. It is difficult to achieve good control of this bleeding. Furthermore, this approach frequently fails to provide adequate exposure of the superior boundaries of the infratemporal fossa, including the skull base attachments of the pterygoid muscles and the superior orbital fissure. Studies have demonstrated positive margin rates of 30% to 40% with conventional approaches, with the majority of positive margins occurring in the deep aspects of the resection.

APPROACHES FOR COMPARTMENTAL RESECTION

Compartmental resection as discussed earlier will address the shortcomings of incomplete resection. Mandibulotomy approach was the first attempt in addressing this problem. The authors developed a dual window approach to improve the deficiencies with the mandibulotomy approach. Both these techniques will be discussed in detail later.

Mandibulotomy Approach

The mandibulotomy approach has been practiced widely for compartmental resection of gingivobuccal cancers with infratemporal fossa extension.[26–28] This method was initially developed to address the limitations of conventional approaches by providing wide exposure and early vascular control through a posterior-to-anterior dissection strategy.[29,30] The procedure begins with a midline lip split incision extending through the lower lip and chin, followed by a gingivobuccal sulcus incision to the premolar region. A paramedian mandibulotomy is then performed, typically between the canine and first premolar, after mandibular mobilization, a lower cheek flap is elevated in the subperiosteal plane, and the mucoperiosteum is reflected from the lingual aspect of the mandible. This allows the mandible to be swung laterally and providing direct access to the infratemporal fossa. This exposure allows direct visualization of the medial pterygoid muscle at its attachment to the medial surface of the mandibular ramus. The muscle is then dissected from both its mandibular attachment and its skull base origin, maintaining its attachment to the tumor specimen. Early vascular control is achieved through identification and ligation of the internal maxillary artery, typically performed medial to the condylar process of the mandible. This proximal control significantly reduces bleeding and improves visualization during subsequent dissection. The lateral pterygoid muscle is then detached from both its skull base origin and its insertion on the condylar process, again maintaining its attachment to the specimen. Critical neurovascular structures, particularly the contents of the foramen ovale (mandibular nerve and its branches), are preserved when uninvolved by tumor. In cases of extensive disease, the posterior margin may extend to the internal carotid artery, requiring careful consideration of the risks and benefits of complete resection. This may be supplemented by an upper cheek flap that is elevated through an upper gingivobuccal incision, and the bone cuts for maxillectomy are completed. In appropriate cases, the maxillary cuts can be given perorally without elevating the upper cheek flap. The pterygoid plates are divided at their skull base attachments using a long fissure burr, staying below the skull base when oncologically appropriate to avoid inadvertent intracranial entry. Fig. 7A shows the surgical defect after resection, and Fig. 7B shows the surgical specimen with en bloc resection of infratemporal fossa. Good margin on the posterior soft tissue was obtained by dividing the pterygoid muscles from their insertions on the mandible.

The mandibulotomy approach offers several advantages, including wide exposure of the infratemporal fossa, early vascular control, and the ability to perform truly compartmental resection with complete clearance of potentially involved anatomic structures. The technique allows for systematic identification and preservation of uninvolved neurovascular structures while ensuring adequate oncological margins. However, the mandibulotomy approach is associated with several significant limitations and potential complications. The mandibular osteotomy introduces risks of osteoradionecrosis, particularly in patients who require postoperative radiation therapy.[27,30] Hardware-related complications, including plate infection, exposure, and failure, may necessitate additional procedures and prolonged healing times.[31] Occlusal disturbances and malocclusion can result from inadequate reduction or malunion of the mandibular segments. The most distressing sequelae is the development of significant trismus due to scarring and fibrosis of the masticatory muscles. This functional impairment can persist long-term and significantly impact quality of life. The exposure at the superior boundaries of the infratemporal fossa, while improved compared to conventional approaches, may still be suboptimal in some cases, particularly when dealing with extensive skull base disease.

Dual Window Approach

The dual window approach represents a novel surgical technique developed to address the limitations of the traditional mandibulotomy approach while maintaining the oncological advantages of compartmental resection.[32,33] This innovative method involves accessing the infratemporal fossa laterally through 2 carefully planned “windows”: the zygomatic window and the coronoid window (Fig. 8A, B). The procedure begins with lateral rhinotomy and upper lip split incisions, extended with a subciliary incision that extends 2 cm lateral to the lateral orbital commissure. An upper cheek flap is elevated, exposing the zygomatic process and its masseter attachment. The incision is continued along the upper gingivobuccal sulcus to reach the posterior maxillary tuberosity. The soft palate is detached while respecting the posterior mucosal extent of the tumor, and the masseter muscle is completely detached from the zygoma and retracted laterally and inferiorly. Removal of the buccal fat pad provides additional exposure. The first window, the zygomatic window (Fig. 9A), involves removal of a portion of the inferior border of the zygoma lateral to the proposed maxillary bone cut. This osteotomy provides direct lateral access to the infratemporal fossa and allows visualization of the pterygoid muscles from their lateral aspect. With the mouth opened using a bite block, the coronoid process and attached temporalis muscle are pushed forward, allowing delineation

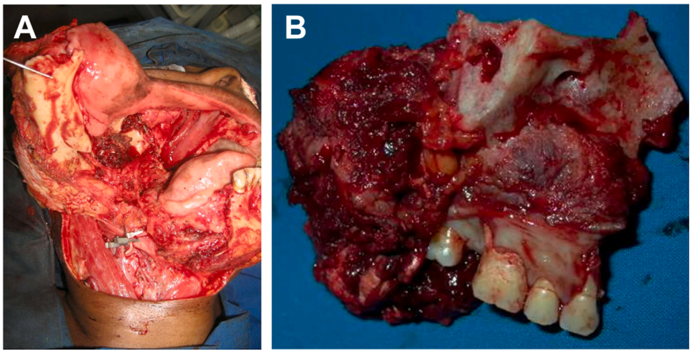

Fig. 7. (*A*) Mandibulotomy approach, the surgical defect and exposure. With permission to reuse. (*B*) Mandibulotomy approach, Resected specimen with margins. With permission to reuse. (Shilpa S. Chatni et al., Transmandibular approach for excision of maxillary sinus tumors extending to pterygopalatine and infratemporal fossae, Oral Oncology, 45 (8), 2009, 720-726, https://doi.org/10.1016/j.oraloncology.2008.11.005.)

of the medial pterygoid muscle and its attachment to the medial surface of the mandible. The lateral surface of the mandibular ramus and sigmoid notch are then defined and exposed. The second window, the coronoid window (Fig. 9B), involves coronoidectomy with a bone cut extending from the sigmoid notch to the anterior border of the ramus. Care must be taken to avoid injury to the inferior alveolar vessels during this osteotomy. The cut coronoid process is grasped with forceps and used to retract the temporalis muscle inferiorly. The temporalis muscle is systematically divided layer by layer using bipolar cautery, with the muscle and coronoid bone removed to serve as the lateral tumor margin. This approach provides excellent exposure of the pterygoid muscles and allows identification of the maxillary artery between them. Early vascular control is achieved through identification, clamping, and ligation of the maxillary artery at its proximal location. The lateral pterygoid muscle is then delineated, noting its lateral attachment to the condylar head. Before detaching the pterygoid muscles, the skull base attachments are carefully delineated using bipolar cautery, following the superior orbital fissure to expose the lateral pterygoid plate and its skull base attachment. The medial pterygoid muscle is detached from its mandibular insertion, and the lateral pterygoid is detached from its condylar attachment, both remaining attached to the specimen. The pterygoid base cut, detaching the pterygoid plates from the skull base, is performed using a long fissure burr or saw. Following completion of all maxillary bone cuts, the specimen (Fig. 9C) is removed en bloc, with the posterior limit at the foramen ovale (preserving the mandibular nerve when uninvolved) and the superior limit at the exposed skull base. Soft tissue clearance including the maxillary nerve up to the foramen rotundum can be achieved through this approach (Fig. 9D).

Clinical Results

Our institutional experience with the dual window approach encompasses 19 patients treated between 2019 and 2023. The cohort had a mean age of 52 years (range 33–71 years) and included 15 male individuals and 4 female individuals. Primary cases constituted the majority (16 patients), with the remaining 3 cases performed in the salvage setting following previous treatment failures. Eleven patients had high infratemporal fossa involvement above the sigmoid notch, while the remaining 8 patients had low infratemporal fossa

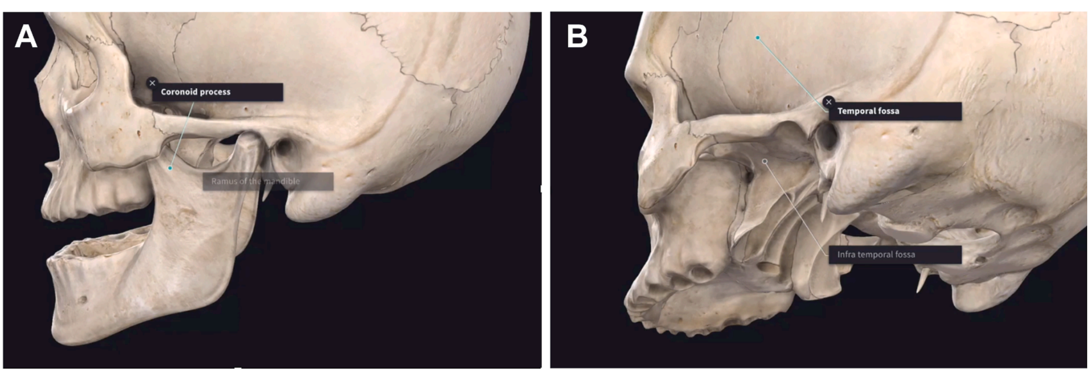

Fig. 8. (*A*) Dual window approach, showing the zygomatic window and the coronoid window. (*B*) Dual window approach, windows removed with exposure to the infratemporal fossa.

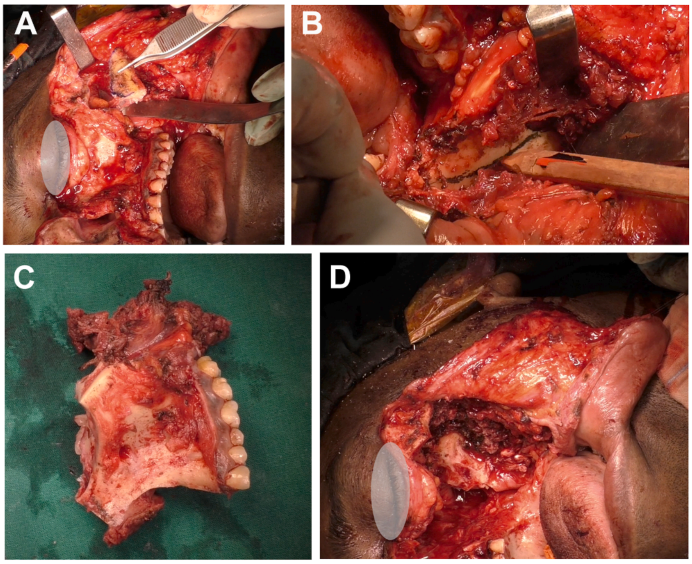

Fig. 9. (*A*) Dual window approach, surgical step, zygomatic window. (*B*) Surgical step, coronoid window. (*C*) Surgical specimen with margins. (*D*) Surgical defect after clearance showing skull base.

involvement below the sigmoid notch level. Squamous cell carcinoma was the most common pathology, occurring in 11 patients (58%), followed by adenoid cystic carcinoma in 4 patients (21%). The remaining cases included various other histologic subtypes. Negative margins were achieved in 12 patients (63%), while 7 patients (37%) had positive margins, with 3 of these occurring in adenoid cystic carcinoma cases. After a median follow-up of 14 months, 5 patients experienced recurrences, of which only 2 were local recurrences. Thirteen of the 19 patients (68%) are alive and disease-free at last follow-up.

Functional outcomes were generally favorable, with no patients experiencing significant trismus, which represents a major advantage over the mandibulotomy approach. Two patients developed subciliary incision-related complications, and 3 patients experienced minimal cosmetic deformity related to lateral zygomatic bone removal. Importantly, no patients experienced significant problems with speech or swallowing function.

The dual window approach offers several advantages over the traditional mandibulotomy technique. The wide exposure achieved through the 2 windows provides excellent visualization of the infratemporal fossa and skull base. Early vascular control through proximal maxillary artery ligation creates a relatively bloodless field that facilitates precise dissection. The approach avoids the morbidity associated with mandibular osteotomy, including risks of osteoradionecrosis, hardware complications, malocclusion, and trismus. The preservation of mandibular continuity also reduces the complexity of reconstruction and may improve long-term functional outcomes. However, the dual window approach does have some limitations. Cosmetic deformity may result from zygomatic bone removal. Prior preplating (**Fig. 10**) and detaching this bone segment attached to the masseter muscle and then replating it, after the tumor removal helped to circumvent this deformity in the latter 2 cases. The subciliary incision has to be made carefully or replaced by transconjunctival incision to avoid ectropion. The procedure has a long learning curve and requires significant experience with skull base anatomy and surgical techniques.

Evidence and Outcomes

Paradigm shift in the understanding of these cancers has happened in the last 2 decades. The evidence supporting compartmental resection for gingivobuccal cancers has evolved with multiple studies demonstrating superior outcomes compared to conventional approaches. Historically, oral squamous cell carcinoma with masticator space or infratemporal fossa involvement, classified as T4b according to AJCC staging, was considered surgically unresectable. However, multiple contemporary series have fundamentally challenged this paradigm by demonstrating that carefully selected infranotch T4b tumors, without carotid encasement or extensive skull base involvement, can achieve survival outcomes comparable to T4a disease when complete (R0) resection is achieved and appropriate adjuvant therapy is administered.[11,25,34,35]

The landmark study by Liao and colleagues[11] first challenged the conventional wisdom regarding T4b

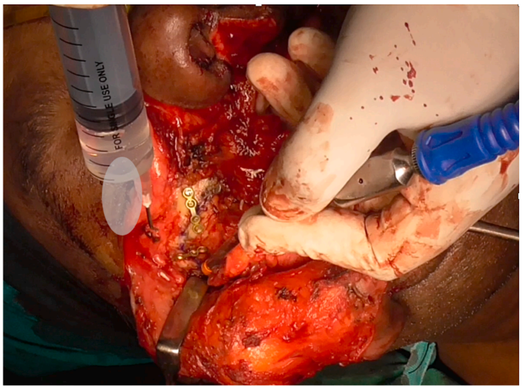

Fig. 10. Prior preplating the zygomatic window and replating after the tumor removal, to reduce the facial deformity.

unresectability by comparing outcomes between T4a and T4b oral cavity cancers. Their analysis of 103 patients (58 T4a and 45 T4b) who underwent curative intent surgery revealed no significant differences in 5 year overall survival (45% vs 49%), disease-free survival (66% vs 57%), and disease-specific survival (65% vs 60%) between T4a and T4b groups. This demonstrated that T4b classification based on masticator space involvement was more reflective of anatomic proximity rather than oncological aggressiveness. Subsequent studies have validated these findings across larger patient cohorts. A prospective study by Pillai and colleagues[10] comprising 277 patients with T4 disease showed similar oncological outcomes between T4a and T4b groups, with overall survival rates of 64% versus 58% and disease-free survival rates of 64% versus 61%, respectively. Multivariate analysis identified extranodal extension, lateral pterygoid involvement, and defaulting on adjuvant therapy as independent predictors of outcome in T4b disease. A recent meta-analysis by Rao and colleagues[35] of over 11,790 patients confirmed no significant differences in overall survival, disease-free survival, or local control between infranotch T4b and T4a at both 2 and 5 years. The pooled 5 year overall survival and disease-free survival rates were 53% and 48%, respectively, for T4b disease.

The consistent finding across multiple studies is that oncological outcomes in T4b disease are primarily determined by the ability to achieve complete (R0) resection with negative margins. Mair and colleagues[25] specifically emphasized that surgery with negative margins is the recommended treatment modality for T4b tumors to ensure oncological safety. Studies have consistently demonstrated that adequate deep margin clearance, often requiring distances of 1 to 2 cm from the skull base, neutralizes the prognostic disadvantage traditionally associated with T4b classification. The importance of anatomically driven resection techniques has been highlighted by pathology-based mapping studies of advanced buccal cancers.[9,36] These studies reveal frequent involvement of both pterygoid muscles and the masseter, with the pterygomaxillary fissure emerging as a key margin-risk zone linked to skull base recurrence.

Subclassification of T4b Disease

Recognition that T4b represents a heterogeneous group of tumors has led to efforts to subclassify this category. Liao and colleagues[34] introduced the concept of supranotch versus infranotch tumor classification based on the sigmoid notch of the mandible. Their analysis revealed that supranotch tumors had significantly higher rates of nodal metastasis (50% vs 31.6%) and extranodal extension (50% vs 21%) compared to infranotch tumors. More importantly, the oncological outcomes differed dramatically, with 5 year overall survival rates of 38.5% for supranotch disease compared to 83% for infranotch disease. Imaging-based subclassification of infratemporal fossa involvement has provided additional prognostic information. Studies have shown that low infratemporal fossa and anterior retro-antral fat involvement behave more favorably, while perineural/pterygopalatine extension carries the poorest prognosis. Technical refinements, particularly the adoption of en bloc “compartment surgery” with complete clearance of involved anatomic subunits, have been central to improving deep margin status and oncological outcomes.[4,19] Multiple studies have demonstrated that compartmental approaches result in higher rates of negative margins compared to conventional wide local excision techniques.[37–39]

Multi-institutional real-world series have demonstrated 5 year overall survival rates approaching 59% for surgically treated T4b buccal and gingivobuccal cancers, supporting curative-intent resection in appropriately selected patients.[35,40] These results have led some authors to advocate for downstaging infranotch T4b disease to T4a in future AJCC classifications.[41] The accumulating evidence has established that with meticulous preoperative imaging, anatomically driven resection techniques, and timely adjuvant therapy, selected infranotch T4b oral squamous cell carcinomas can achieve oncological outcomes approaching those of T4a disease. Further to this, the systematic, anatomically guided approach provides surgeons with a clear roadmap for resection, reducing uncertainty and improving reproducibility. The technique also facilitates teaching and quality assurance, as the extent of resection is defined by anatomic landmarks rather than subjective assessments of adequate margins.

SUMMARY

Compartmental resection has been an important milestone in the surgical management of gingivobuccal cancers, providing superior oncological outcomes compared to conventional wide local excision. This technique, based on anatomic principles accounting for predictable tumor spread patterns in fascial spaces, has changed the approach to T4b oral cavity cancers. Carefully selected patients can achieve survival outcomes comparable to T4a disease when complete resection with negative margins is accomplished. The dual window approach addresses limitations of the transmandibular approach while maintaining oncological advantages with reduced morbidity. Success requires meticulous preoperative planning with high-quality imaging, thorough anatomic understanding, systematic surgical technique with early vascular control, and appropriate patient selection focusing on infranotch disease without extensive skull base involvement or carotid encasement. Adjuvant therapy completion remains critical for optimal outcomes. Integration with modern adjuvant protocols offers the best cure potential for these challenging cancers. Compartmental resection should be considered standard of care for advanced gingivobuccal cancers with masticator space or infratemporal fossa involvement, provided complete resection can be achieved while preserving critical neurovascular structures. The technique requires significant surgical expertise and should be performed in experienced centers with appropriate resources.

CLINICS CARE POINTS

- Compartmental resection involves resection of he tumor along with the surrounding tissue more than conventional margins.
- The technique is based on anatomical principles accounting for the predictable tumor spread.
- Carefully selected upper gingivobuccal tumors classified as T4b can be resected using this approach.
- The dual window approach addressed the limitations of transmandibular approach for compartmental resection, while maintaining the oncological advantages with reduced morbidity.

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