Complications, Morbidity, and Rehabilitation After Treatment of Gingivobuccal Cancers

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KEYWORDS

• Gingivobuccal cancer • Complications following treatment of gingivobuccal cancer • Osteoradionecrosis • Trismus • Plate-related complications • Oral incompetence

KEY POINTS

- Posttreatment complications in gingivobuccal cancer significantly affect quality of life.
- Trismus, osteoradionecrosis, plate-related complications, oral incompetence, and xerostomia are common complications, especially after adjuvant therapy.
- Rehabilitation should start at diagnosis to mitigate complications and improve outcomes.
- Multidisciplinary care is crucial for addressing both oncologic and rehabilitative needs.

INTRODUCTION

Gingivobuccal (GB) cancers, a major subset of oral squamous cell carcinoma (OSCC), necessitate aggressive multimodal therapy including surgery, radiotherapy, and chemotherapy. While survival outcomes have improved, posttreatment morbidity remains a major challenge. The GB complex includes cancers affecting the buccal mucosa, upper and lower GB sulcus, upper and lower alveolus, and retromolar trigone area. The proximity of the sites to muscles of mastication, Infra temporal fossa, and overlying skin make it difficult to restore functionality after resection, which often burdens the patient with severe morbidity. In this article, we will discuss delayed and long-term complications, morbidity, and rehabilitation. Acute complications arising out of surgical and adjuvant radiation will be discussed in relevant chapters.

COMPLICATIONS & MORBIDITY

Trismus

Trismus is defined as tonic contraction of muscles of mastication resulting from any abnormal condition or disease, which restricts mouth opening less than 35 mm.[1] Trismus may be present before surgery because of underlying premalignant conditions such as oral submucosal fibrosis or involvement of masticator space by the tumor. Restricted mouth opening hampers essential functions such as speech, mastication, oral hygiene, and social interaction, and frequently contributes to nutritional deficiencies and psychological distress (**Fig. 1**). The prevalence of trismus is approximately 17.3% before treatment. This prevalence rose to 44.1% at 6 months posttreatment and stabilized around 32% at 12 months.[2]

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Abbreviations	
BMI	body mass index
GB	gingivobuccal
HBO	hyperbaric oxygen therapy
IMRT	intensity-modulated radiation therapy
NRI	nutritional risk index
OSCC	oral squamous cell carcinoma
OCF	orocutaneous fistula
ORN	osteoradionecrosis
PNI	prognostic nutritional index
RT	radiation therapy

Pathophysiology of trismus

Postsurgical trismus Postsurgical fibrosis occurs after excision of lesions involving the buccal mucosa, retromolar area, and/or tonsillar fossa. In such conditions, the pterygoid muscles and pterygomandibular ligament are caught up in the healing process because of their proximity to these structures, resulting in their progressive shortening. Trismus is noted specially in maxillectomy with infratemporal fossa clearance. The formation of a hematoma in the area around the coronoid process or ascending ramus sometimes allows fibrosis to develop, which leads to progressive decrease in its motion.[3] Reconstructive options also influence development of postoperative trismus. Reconstruction using soft-tissue free flaps and local flaps improve trismus as compared to Split thickness Skin Graft or primary closure.

Surgical steps to reduce trismus

1. If preoperatively mouth opening is reduced, reconstruction using soft-tissue free flaps should be considered
2. In complex resection with loss of outer skin cover and ITF clearance, there is a requirement for adequate soft tissue volume replacement to prevent fibrosis posttreatment. This may necessitate reconstruction using 2 separate free flaps to use as cover for outer skin and inner mucosa. Though this may be extensive, good outcomes can be achieved in the postoperative period. The complete flap survival rate reported in literature for such cases was 87.5%[4]
3. Inset of flap should be done with mouth opening in maximal interincisal distance, so that adequate volume replacement is achieved
4. Release of fibrous bands on contralateral side can be done to improve postoperative mouth opening

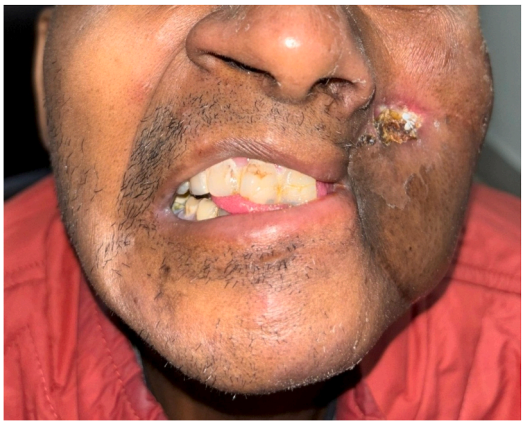

Fig. 1. Trismus in a treated case of right buccal mucosa cancer.

Postirradiation trismus Radiation damages tissues through the release of high-energy particles causing DNA damage and the generation of reactive oxygen species. Radiation also causes microvascular damage, initiating a cascade of inflammatory responses, beginning with neutrophil infiltration, progressing to proinflammatory macrophages, which secrete platelet-derived growth factor and transforming growth factor-beta, promoting angiogenesis and the recruitment of fibroblasts. Growth factor-beta plays a central role in radiation-induced fibrosis by driving fibroblast differentiation into myofibroblasts.[5]

A study by Kraaijenga and colleagues examined the relationship between radiation dose to masticatory muscles and the development of trismus. Their findings showed a strong correlation between radiation dose to the ipsilateral masseter muscle and medial pterygoid muscle and the risk of trismus. The probability of developing trismus increases by 24% for every additional 10 Gy of radiation delivered to medial pterygoid muscle.[6]

Impact on quality of life Trismus adversely affects nutrition, communication, and social interaction, often causing significant weight loss (>10% body weight) during cancer recovery. Social eating difficulties contribute to isolation and reduced psychosocial well-being. The Mandibular Function Impairment Questionnaire is a validated tool to assess functional limitation and severity.[7]

Treatment strategies

Management includes surgical and nonsurgical approaches.

Nonsurgical Includes jaw mobilization devices (eg, Therabite), microelectric therapy, and steroids.

Surgical Reserved for severe or refractory cases; techniques such as coronoidectomy, masseter and pterygoid myotomy, and immediate reconstruction may reduce recurrence.[8]

To summarize, trismus is a multifactorial condition requiring early conservative management to prevent progression, with surgical release reserved for advanced cases after adequate disease control. Timely, individualized intervention optimizes functional outcomes and quality of life.

Orocutaneous Fistula

Orocutaneous fistula (OCF) is an abnormal connection between oral cavity and skin. It is a commonly dreaded complication following surgery for OSCC as it predisposes the patients to infection and leads to exposure of vessels, making them vulnerable for vascular complications. It also delays wound healing and subsequently the initiation of adjuvant treatment, thus having an impact on the oncological outcomes (**Fig. 2**A and B). The incidence of OCF reported in literature is 8.8% to 20%.[9,10] Various factors related to development of OCF have been given in **Table 1**.

In some studies, positive surgical margins and prior RT/CTRT were recognized risk factors for fistula formation.[11,12] However, in the study by Girkar and colleagues, these factors did not significantly increase the risk of OCF. The only tumor-specific factor that showed a significant association with OCF was the tumor's subsite. Tumors located on the tongue or floor of the mouth were more likely to lead to fistula formation compared to those in the buccal mucosa, gingivobuccal sulcus, or other locations (15% vs 7%).[13] Several surgical variables have been assessed for their role in OCF development, but surgical site infection and bilateral neck dissection emerged as a significant predictor of OCF. In their study, Girkar and colleagues[13] noted that bilateral neck dissections resulted in a higher OCF rate than unilateral ones *(23% vs 6%)*.

Treatment

The treatment of OCF is often time-consuming, usually requiring 4 weeks or longer. Currently, there are 2 kinds of management for OCF.

Medical management Treating underlying surgical site infection with antibiotics and conventional wound care is the most common form of management. Numerous studies have demonstrated the reliability of negative pressure wound therapy. Tian and colleagues[14] reported successful closure in 90% of OCFs *via* this method with a median time of 19 days. It has been demonstrated that conventional wound care was achieved at a success rate of 86.2%.[15]

Surgical management Secondary surgery is usually reserved for those cases in which medical management has failed. The repair must be carried out once the local infection is under control. Loco-regional flaps such as Pectoralis Major Myocutaneous Flap may be useful in cases of persisting OCF.

Tips to reduce orocutaneous fistula

1. Surgical planning to reduce devascularization of skin flaps
2. Proper inset of free flaps during reconstruction to prevent dehiscence during recovery
3. Isolation of neck from oral cavity by strapping
4. Saline washes of infected site to reduce inflammation and bacterial load
5. High protein high-calorie diet

Microstoma and Oral Incompetence

Microstomia and oral incompetence are a result of extensive resection and inadequate reconstruction of the oral aperture. Microstomia is defined as an abnormally small mouth opening (**Fig. 3**). Oral incompetence refers to the inability to properly retain oral contents within the mouth, leading to drooling or leakage (**Fig. 4**). Both these conditions lead to difficulty in eating, poor oral hygiene, and reduced quality of life.

Excision performed for squamous cell carcinoma of buccal mucosa may involve excision of a minor or major part of the upper and the lower lip and/or oral commissure along with the buccal

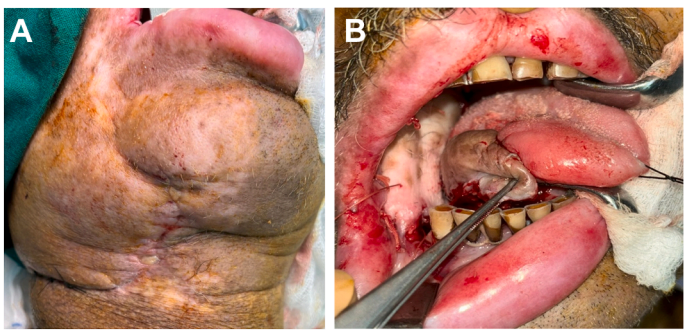

Fig. 2. (*A*, *B*) (*A*) Posttreatment orocutaneous fistula; (*B*) Surgical exploration and closure of orocutaneous fistula.

Table 1
Factors related to development of orocutaneous fistula

Patient Related	Tumor Related	Treatment Related
• Low hemoglobin • Low albumin	• Location of tumor • Previous RT/CTRT	• Development of SurgicalSite Infection • Faulty surgical technique • Improper flap design • Bilateral neck dissection

Abbreviation: RT/CTRT, radiotherapy or chemoradiotherapy.

mucosa and cheek skin. This leads to discontinuity of the orbicularis orris muscle and its attachment to the modiolus. Oral competence depends on orbicularis oris, with most of its fibers aligned horizontally. Preserving the nerves (marginal mandibular) is essential in reforming the sphincter.[16]

Oral competence can be achieved by coaptation of the residual lip edges in defects up to one-third of the total lip length. The commissure is often reconstructed using sling of Tensor Fascia Lata or Palmaris Longus. The fascial sling is a static sling with no contractile ability; the onus of competence is on the residual muscle (Fig. 5A and B).[16] If lip resection is extensive and the patient has preoperative trismus, it is better to err toward wider mouth opening, even if it risks mild oral incompetence. In such cases, hitching lower lip higher on the flap at the level of contralateral commissure can help reduce drooling. The final reconstruction should aim to keep a balance between minimizing oral incompetence and avoiding microstomia.

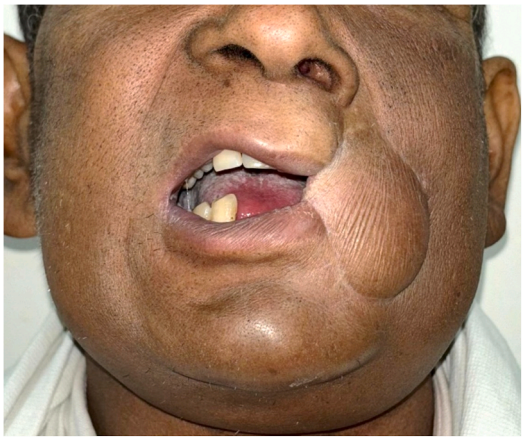

Fig. 3. Microstomia.

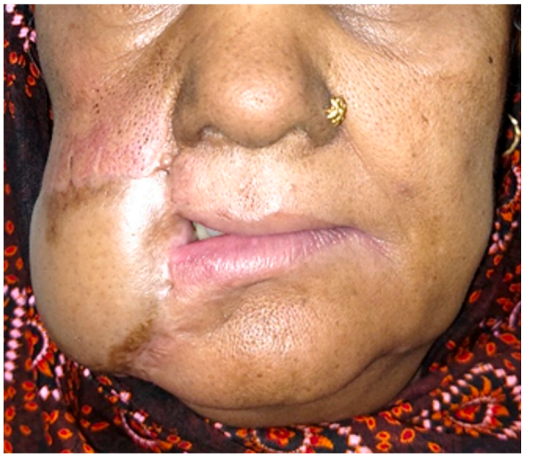

Fig. 4. Oral incompetence.

Surgical tips to reconstruct the oral commissure

1. Myomucosal advancement and hitching the remnant lip higher
2. Facilitate competence by preserving sensory and motor function
3. Consider dynamic or static slings when possible
4. Consider using 2 separate flaps/chimeric flaps in case of large tissue deficits

Osteoradionecrosis and Hardware-Related Complications

Osteoradionecrosis in gingivobuccal cancer

According to the ISOO-MASCC-ASCO Guidelines, osteoradionecrosis (ORN) of the jaw should be operationally characterized as radiographic lytic or mixed sclerotic lesion of bone and/or visibly exposed bone and/or bone probed through a periodontal pocket or fistula occurring within an anatomic site previously exposed to a therapeutic dose of head and neck radiation.[17]

Plate osteosynthesis is a widely used technique in head and neck reconstructive surgery. The study by Sharan and colleagues established that plate and osteosynthesis-related complications occurred in 10.5% of patients in surgery-alone group, 28.6% in surgery with postoperative radiation group, and 63.2% in surgery with postoperative concurrent CTRT group. Postoperative concurrent CTRT was seen to significantly increase plate and osteosynthesis-related complications in oral cancer.[18]

Treatment-related factors

ORN is more common in the mandible than the maxilla, owing to the mandible's dense cortical

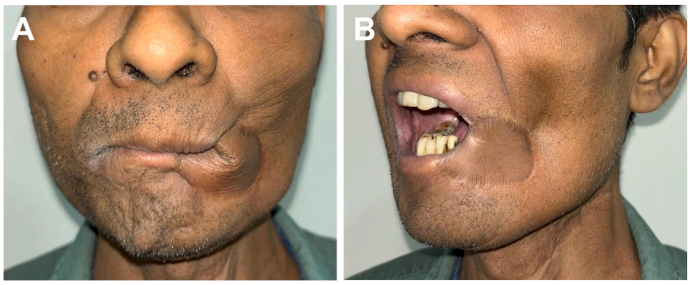

Fig. 5. (*A, B*) (*A*) Oral competence following commissure reconstruction with palmaris sling (*B*) Oral competence following commissure reconstruction-mouth opening.

bone and limited blood supply—particularly in the posterior regions (premolar, molar, and retromolar), which rely mainly on the inferior alveolar artery (**Figs. 6–8**).[19,20] Estimated risk of ORN in segmental mandibulectomy 7% to 17% whereas marginal mandibulectomy has a lower risk of 9%.[18,19] Periosteal resection has a higher rate of ORN than segmental mandibulectomy (39% vs 17%).[21] Preradiotherapy extractions carry approximately 4.16% ORN risk (0%–17.65%). A 10-day to 14-day healing period before RT is recommended.[22,23] postradiotherapy extractions nearly double ORN and extractions should be avoided from 2 weeks before until 3 months after RT.[24]

Measures during surgery to reduce osteoradionecrosis

1. Reduce periosteal stripping.
2. If marginal mandibulectomy is being performed, if possible, the bone should be cut above the level of the inferior alveolar canal to preserve the vascularity.
3. Unnecessary stripping of muscle from mandible during marginal mandibulectomy should be avoided to preserve the vascularity of the bone.

Radiotherapy and osteoradionecrosis risk

Radiotherapy is a major risk factor for ORN. Historically the risk of ORN post-RT was 15% to 30%, but now it has reduced to ~5% with intensity-modulated radiation therapy (IMRT).[25,26] ORN correlates with mandibular radiation dose, especially volumes receiving ≥50 Gy. Limiting radiation to ≤30% of mandibular volume at ≥42 Gy reduces ORN less than 5% in patients without prior dental extractions.[27]

Clinical presentation and staging

ORN ranges from asymptomatic bone exposure to severe destruction. Many staging systems have been proposed in the past to classify ORN of the jaw. However, the *Notani and colleagues classification* is the most frequently used system in recent clinical studies because of its simplicity and clinical relevance. Class I and II are usually managed conservatively, whereas Class III requires aggressive surgical management (**Table 2**).[28]

Diagnosis

Initial diagnosis of ORN is generally clinical and radiological by orthopantomogram of mandible. The gold standard imaging technique to diagnose ORN is CT scan. In a posttreatment scenario positron emission tomography–computed tomography (PET-CT) aids in differentiating ORN from tumor recurrence.[29,30] Biopsy is typically reserved for cases where malignancy cannot be

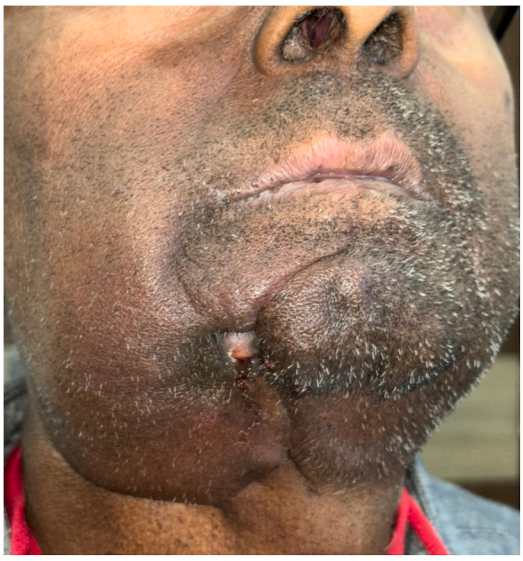

Fig. 6. Osteoradionecrosis of mandible.

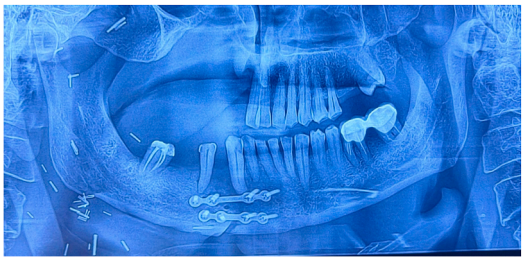

Fig. 7. Orthopantomogram (OPG) of mandible.

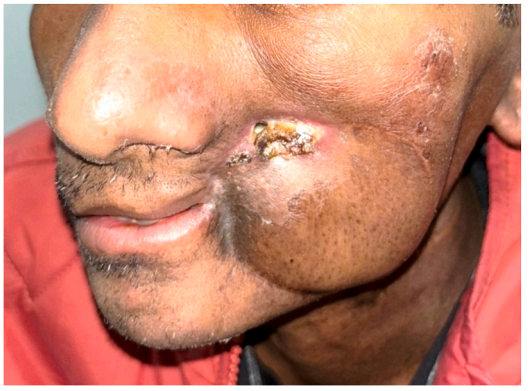

Fig. 8. Osteoradionecrosis of maxilla.

excluded. Characteristic histopathological features include empty osteocyte lacunae, absence of osteoblasts and osteoid matrix, marrow fibrosis, fatty infiltration, hypocellularity, and hypovascularity. These findings are indicative of radiation-induced vascular injury and compromised bone regeneration.[31]

Best practices for prevention of osteoradionecrosis in head and neck radiation therapy

- Advanced radiation planning techniques (eg, IMRT and intensity-modulated proton therapy [IMPT]) should be employed to reduce radiation dose to the jaw at risk as much as possible
- The mean dose to the jaw and the volume of bone receiving greater than 50 Gy, whenever possible should be reduced
- Dental extraction, if clinically indicated, should occur at least 2 weeks before commencement of RT. In the setting of rapidly progressing tumor, extractions should be deferred
- Patients at risk of radiation-induced salivary hypofunction should be instructed to use prescription strength topical fluoride applied to the teeth daily to reduce the risk of postradiation caries
- It is recommended that patients should receive oral antibiotics before and after invasive dental procedures, such as dental extraction and/or implant placement
- It is recommended that pentoxifylline (400 mg twice daily) and tocopherol (1,000 IU once daily) be prescribed for at least 1 week before and 4 weeks after invasive dental procedures

Table 2
Osteoradionecrosis classification

Classification	Stage	Criteria
Notani et al,[28] 2003	I	Involves alveolar bone only
	II	Extends above the inferior alveolar canal
	III	Extends below canal or has fistula/fracture

Conservative management Conservative management is recommended for early-stage osteoradionecrosis (ORN) presenting with localized bone exposure and no evidence of fistula, trismus, or fracture. Treatment involves saline irrigation, topical antiseptics, antibiotics for infection, analgesics, gentle sequestrectomy, and strict oral hygiene.[32]

Adjunctive therapies

Hyperbaric oxygen therapy Hyperbaric oxygen therapy (HBO) enhances tissue oxygenation, neovascularization, fibroblast activity, and wound healing.

- *Prophylactic use: Nabil and colleagues* reported a reduction in ORN incidence from 7% to 4% following HBO after dental extractions. A prospective study of 40 patients undergoing HBO before and after extractions showed 98.5% healing at 1 year.[33,34]
- *Therapeutic use:* The *HOPON trial* found no significant benefit in established mandibular ORN; recovery rates were lower in the HBO group versus placebo, leading to early trial termination for futility.[35] HBO may be effective prophylactically but lacks robust support for treating established ORN.

Pharmacologic therapy — pentoxifylline-tocopherol-clodronate combination protocol The pentoxifylline-tocopherol-clodronate combination protocol combines pentoxifylline, which exhibits anti–TNF-α activity and improves microcirculation; tocopherol (vitamin E), which reduces fibrosis by downregulating procollagen gene expression; and clodronate, a bisphosphonate that inhibits osteoclastic bone resorption. Delanian and Lefaix[36] reported an 89% healing rate in 16 of 18 patients after 6 months. Furthermore, Delanian and colleagues[37] documented 100% healing in a cohort of 54 refractory ORN patients within 9 months. These findings support pentoxifylline-tocopherol-clodronate combination as a promising noninvasive therapeutic approach for refractory ORN.

Surgical management

Surgical intervention for ORN in GB cancer is indicated in advanced cases. The surgical approach involves radical debridement or segmental resection of all necrotic and nonviable bone tissue to control infection and remove the source of chronic

inflammation (Fig. 9).[32] The extent of bone resection is determined by the severity and spread of necrosis. Marginal mandibulectomy may be performed when limited bone involvement exists, whereas segmental mandibulectomy is necessary for extensive necrosis compromising mandibular integrity.[38] These resections aim to achieve clear margins of healthy tissue to prevent disease recurrence. Reconstruction of the resulting mandibular defect is critical and uses vascularized-free flaps, such as fibula or radial forearm free flaps, which provide well-vascularized bone and soft tissue.

Fracture of Mandible and Hardware Complications

Pathologic mandibular fracture

Pathologic mandibular fractures occur through pre-existing lesions or compromised bone.[39] The leading causes are ORN (49%), infections (19%), malignancy (19%), and iatrogenic factors (61%)[40]. Fractures predominantly localize to the posterior molar and angle region (65%), followed by the mandibular body (22%) and symphysis (13%). Vulnerability arises from reduced cortical thickness and elevated occlusal stress. Following marginal mandibular resection, fracture rates of 9% to 13.5% have been reported.[39,41]

Key risk factors include residual bone height $\leq$10 mm, presence of $\geq$20 teeth and inferior alveolar canal exposure. Marginal resection disrupts occlusal load distribution despite masticatory muscle symmetry, increasing fracture susceptibility, particularly in dentate or prosthetically rehabilitated patients. Finite element analysis demonstrates that preserving residual bone height $\geq$10 mm is critical for mandibular integrity, with curvilinear resections better maintaining postoperative strength than angular resections.[42]

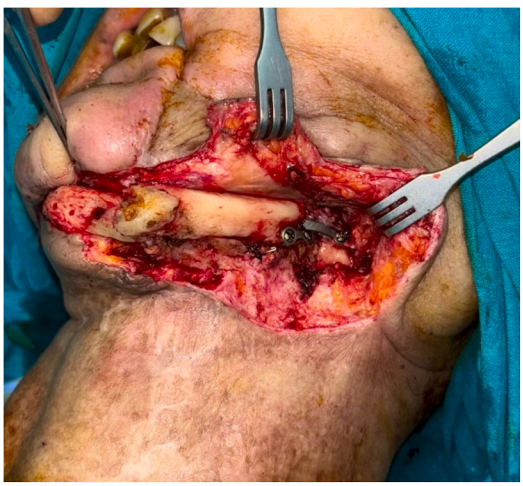

Fig. 9. Osteoradionecrosis, plate exposure, nonunion and mini plate fracture of neomandible being treated surgically by removing dead sequestra, bone graft, replating and deltopectoral flap cover.

Radiation therapy

Radiotherapy significantly elevates fracture risk. ORN develops in 2.6% of irradiated patients, with 23% of these progressing to fracture.[43] Post-ORN fracture rates reach 25.7%, correlating with dentition and periodontitis severity.[44] While no direct correlation exists between postoperative radiation and fractures after marginal mandibulectomy, the advent of IMRT has reduced mandibular osteonecrosis by enabling targeted irradiation.[39,41]

Hardware-related complications

In mandibular reconstruction, miniplates and reconstruction plates are key to graft stability, with comparable overall complication rates but distinct biomechanical and clinical profiles. Miniplates ($\leq$2.0 mm) offer better contouring and minimal vascular pedicle disruption, making them suitable for free flap cases. However, they are more susceptible to mechanical issues such as fracture, nonunion, and increased hardware removal.[45,46] Reconstruction plates provide greater structural support but can cause stress shielding, reducing physiologic loading on the grafted bone, and potentially leading to resorption or ORN, especially postradiotherapy.[47,48] Incidence of plate fracture is around 10% to 14% in miniplate versus 0% in reconstruction plate, but ORN happens in approximately 38% in reconstruction plates versus 5% in miniplates (Figs. 10 and 11). To summarize, both miniplates and reconstruction plates are viable options, but plate selection should be tailored to patient-specific anatomy, defect type, and risk profile.

Postradiotherapy Soft Tissue Fibrosis

Late effects of adjuvant RT on soft tissues can lead to hair loss, pigmentary changes, loss of tissue volume, and fibrosis, which appear months to years after the treatment. These changes are often progressive. Tissue hypoxia may be compounded by subclinical infection following minor trauma, exposed hardware, or associated ORN. The combined effect of these factors causes significant deformities in soft tissue, affecting both function and appearance. Such changes are also seen in primarily transferred flaps, which have been radiated, resulting in severe, progressive soft tissue fibrosis, compromising function and esthetics (Fig. 12). Patients seek medical attention only when there is a breach, discharging

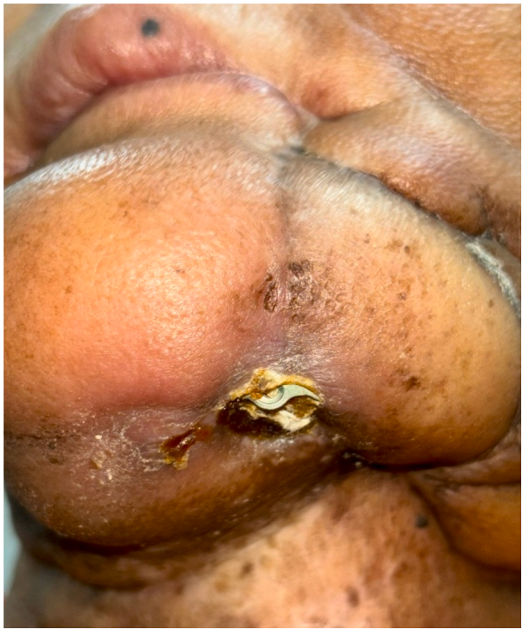

Fig. 10. Plate exposure.

sinus with exposed hardware or bone or when fistulas develop.

In a study by Biswas and colleagues,[49] 21 such patients who had received external beam radiation, using IMRT with photon beams, delivering, a total of 60 Gy over 30 fractions to the tumor (flap) bed followed by disfiguring fibrosis, were treated with a second surgical procedure including free soft-tissue flap with acceptable cosmetic results.

Xerostomia

Xerostomia following treatment of GB cancer is multifactorial in origin. Surgical resection of the primary tumor often necessitates ligation or sacrifice of the ipsilateral Stenson's duct. In addition, ipsilateral neck dissection typically involves removal of the submandibular gland. As a result, most patients retain only the contralateral parotid and

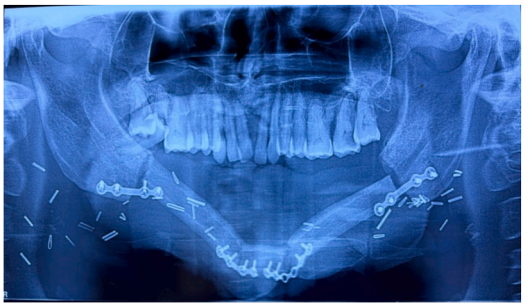

Fig. 11. Orthopantomogram of mandible.

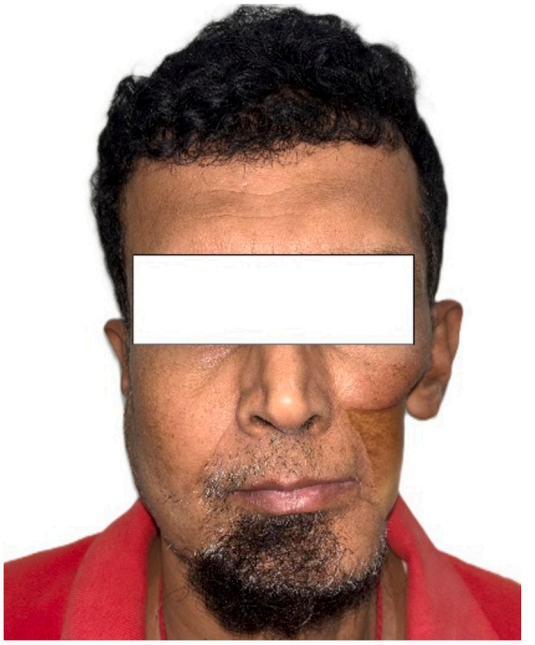

Fig. 12. Soft tissue fibrosis postsurgery and adjuvant radiation.

submandibular glands for salivary function, leading to unilateral xerostomia. This condition is often exacerbated at night when patients sleep on the contralateral side, as gravitational effects further reduce salivary pooling, intensifying the sensation of oral dryness.

When adjuvant radiotherapy is indicated, careful radiation planning is essential. Preserving the contralateral parotid and submandibular glands from high-dose radiation exposure, whenever feasible, is crucial to minimize long-term salivary dysfunction and improve posttreatment quality of life.

Rehabilitation

Rehabilitation of patients treated for oral cancer does not begin after treatment completion, but in fact it must be integrated into the treatment plan from the moment of diagnosis.

Nutrition The patients suffering from advanced lesions of the GB complex have reduced intake of food because of trismus and pain. A meta-analysis by Giulia and colleagues identified that malnutrition at the time of diagnosis is present in 20% to 40% of the patients. Prerehabilitation is a term that indicates a p*rocess of continuum of care that occurs between the time of cancer diagnosis and onset of acute treatment*.[50] The method of nutritional prerehabilitation commonly includes nutritional counseling, speech and swallow exercises, and dietary modifications.

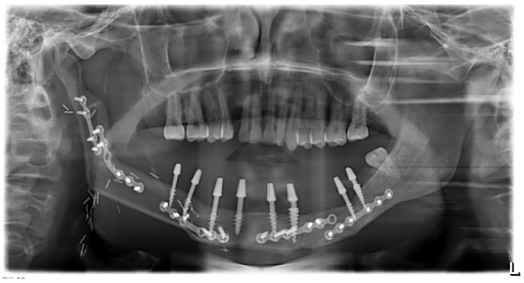

Fig. 13. Secondary dental implant—OPG.

Nutritional status is assessed by multiple modalities including hemoglobin, serum albumin, body mass index (BMI), midarm circumference, nutritional risk index (NRI), prognostic nutritional index (PNI) and so forth. In patients with cachexia, Capuano and colleagues found a significant correlation between weight loss, systemic inflammation, and hemoglobin levels. This suggests a possible mechanism in which both weight loss and anemia are driven by cytokine-related processes stemming from tumor–host.[51] George and colleagues[52] showed that ow PNI (<49) significantly correlated with feeding procedure requirement and treatment breaks, thus compromising treatment completion.

Nutritional risk index NRI, which combines weight, height and serum albumin levels, has also been reported as simple but sensitive methods that can objectively assess the nutritional status of patients with cancer. Malnutrition was defined by NRI less than 97.5, whereas normal nutrition status was defined by NRI $\geq$97.5. Bao and colleagues[53–55] found that BMI, ALB, PNI, and NRI are of prognostic value in patients with oral cancer and the prognostic performance of NRI was superior to BMI or ALB or PNI.

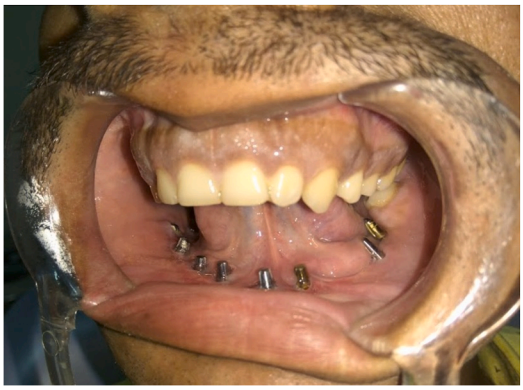

Fig. 14. Secondary dental implant for dental rehabilitation.

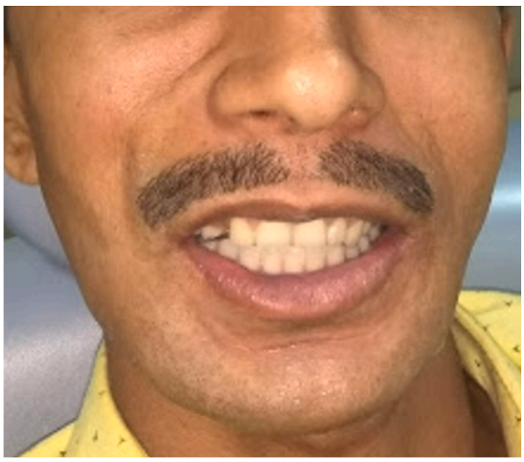

Fig. 15. Dental Rehabilitation final.

Trismus rehabilitation Rehabilitation of trismus begins postsurgery and must be carried out during adjuvant RT/CTRT. Rehabilitation strategies for trismus include the following.

Jaw mobilization devices These devices, such as the TheraBite, OraStretch, or Dynasplint systems, help to gently stretch and mobilize the jaw muscles.

Exercise therapy A variety of jaw exercises are prescribed, including active range of motion and stretching exercises, both with and without jaw mobilization devices.

Physical therapy techniques Physical therapists may use techniques like manual therapy, massage, heat therapy (eg, ultrasound and moist hot towels), and other modalities to reduce pain, inflammation, and improve muscle relaxation and flexibility.

Speech-language pathology intervention Speech-language pathologist plays a vital role in assessing and treating the impact of trismus on communication and swallowing. They can provide exercises, strategies, and counseling to help patients manage these difficulties.

Adherence to therapy Consistent and regular adherence to the prescribed exercises and rehabilitation regimen is essential for successful outcomes and improved mouth opening.

Pain management Pain is perhaps the most crippling of all the symptoms of oral cavity cancer. Pain assessment in clinical practice is often performed using questions describing the location, intensity, and quality of pain. Pain can be broadly classified as follows *Nociceptive:* Caused by

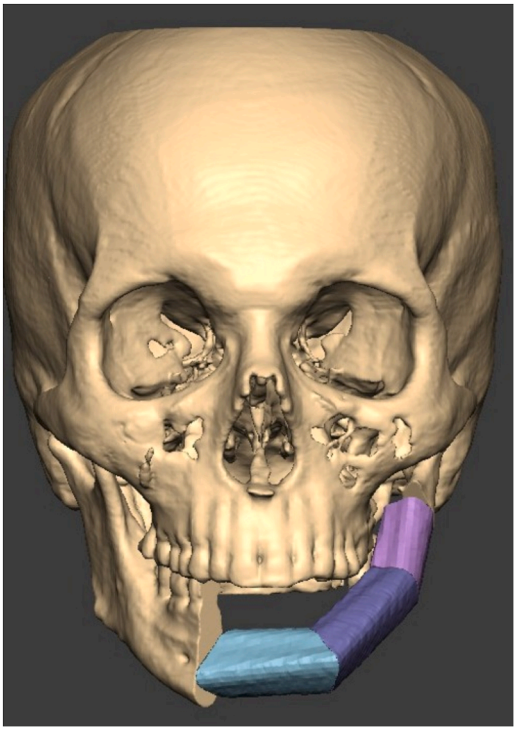

Fig. 16. Virtual planning of reconstruction-front view.

inflammation and tissue damage; *Neuropathic:* Caused by nerve damage and *Nociplastic*: Caused by dysfunction in the processing of pain signals within the nervous. For nociceptive pain, treatment

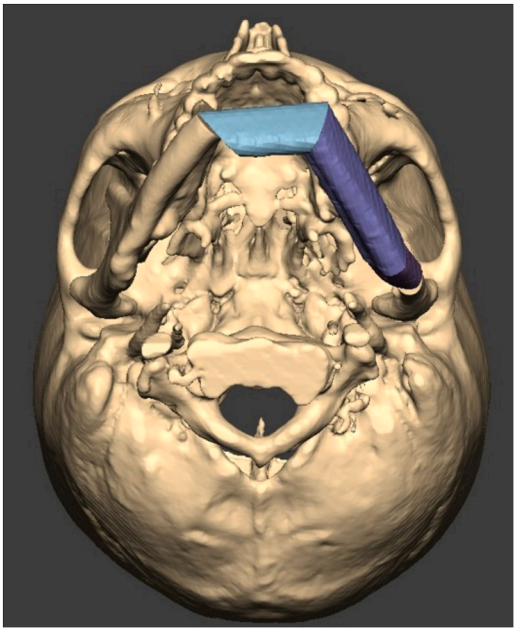

Fig. 17. Virtual planning of reconstruction-inferior view.

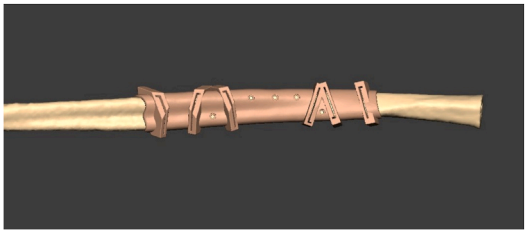

Fig. 18. Planning done virtually on fibula bone.

should address the source of the pain, if possible. If pain is caused by lymphedema or skeletal muscle tightness, for instance, treatments should focus on relieving lymphatic congestion or improving the range of motion through physical therapy. These therapies should be supplemented with nonsteroidal anti-inflammatory drugs, acetaminophen, neuromodulatory agents, or opioids per the World Health Organization (WHO) pain ladder (WHO 2019). Neuropathic pain tends to respond better to neuromodulatory agents such as gabapentin, pregabalin, selective serotonin reuptake inhibitors, or tricyclic antidepressants. In contrast, nociplastic pain is most likely to be refractory to medical therapy and may require nonpharmacologic treatments such as exercise therapy, cognitive behavioral therapy, or other multidisciplinary management approaches.[56]

Dental rehabilitation For patients treated for oral cancer, major concerns may include their ability to masticate, speak and swallow and if these issues are not addressed this may lead to psychological difficulties. Implant-based dental rehabilitation is an effective treatment modality (**Figs. 13–15**). Surgery leads to malocclusion, reduced occlusal force and loss of ability to take solid food resulting in a poor quality of life.

Jaw in a day In 2007, British surgeon Iain Hutchison and prosthodontist Andrew Dawood treated a facial gunshot wound using a scapula free flap with immediate implants and immediate teeth. Since then, the concept of Jaw in a day has been implemented in different clinical conditions,

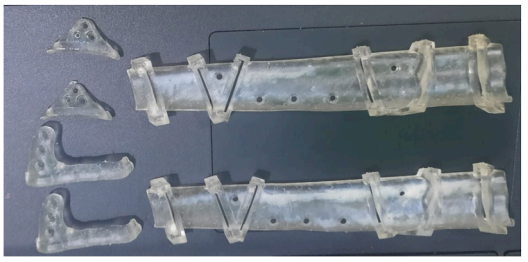

Fig. 19. Cutting guides for mandible and fibula.

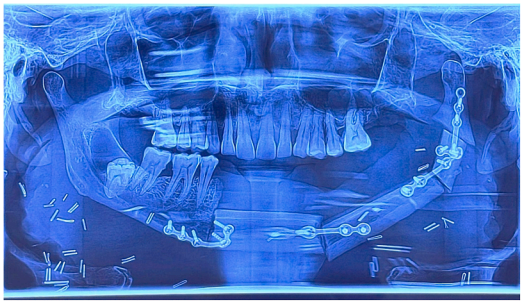

Fig. 20. Final outcomes postsurgery—OPG.

including rehabilitation of patients undergoing treatment of oral cancer.[57] At present reconstruction with free fibula osteo-cutaneous flap is done using predesigned Computer-Aided Design/Computer-Aided Manufacturing models and cutting guides. The fibula often is allowed to heal and form a bony union with the adjacent mandible before proceeding with the placement of dental implants, or they may be placed primarily (**Figs. 16–21**). This technique allows for early restoration of form and function, giving patients a sense of normalcy. Another advantage is the decrease in the number of procedures and general anesthetics required to obtain the final result. The excellent access to the fibula at the time of harvest combined with guided implant placement is likely to provide the surgeon the best opportunity to position these implants in the proper position and optimal angulation.

Maxillary rehabilitation depends on defect size. When surgical reconstruction is not feasible, obturator prostheses remain the standard and provide acceptable restoration of function and facial form. Patient-specific implants improve rehabilitation after mandibular/maxillary resection for GB cancer by enabling precise jig and wax trials that restore occlusion and bone alignment. Integrated abutments expedite dental prosthesis placement, facilitating early functional recovery. Computer-aided design/Computer-aided manufacturing fabrication ensures accurate fit, reducing surgery time and supporting prompt prosthetic loading. These advances enhance mastication, speech, and facial symmetry, leading to better overall rehabilitation outcomes compared to conventional methods.[58,59]

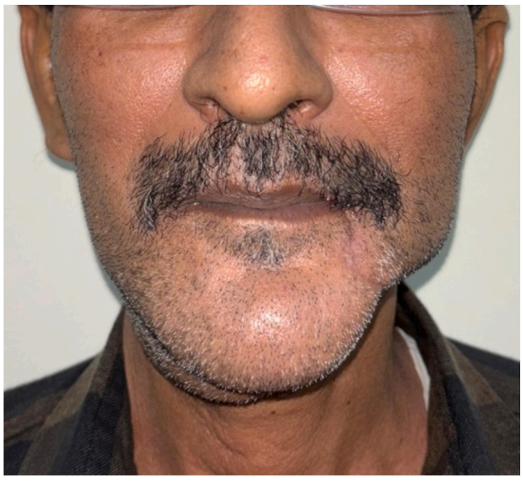

Fig. 21. Final outcomes postsurgery cosmesis.

SUMMARY

The management of GB cancers has advanced significantly, leading to improved survival outcomes. However, these treatments often result in a high burden of complications and long-term morbidity. The complexity of these outcomes underscores the necessity for involvement of a multidisciplinary team. Furthermore, rehabilitation is not a one-time intervention but a continuous and dynamic process. Critically, early intervention in rehabilitation can mitigate complications and enhance outcomes. Following treatment, structured rehabilitation programs significantly improve speech intelligibility, nutritional status, psychosocial adaptation, and overall reintegration into daily life and society. In conclusion, while curative treatment of GB cancers is achievable, the real measure of success lies in restoring function, form, and quality of life. Ensuring access to integrated, patient-centered rehabilitative care is therefore as important as the oncologic treatment itself in the journey toward full recovery.

CLINICS CARE POINTS

- To reduce post-treatment trismus in gingivobuccal cancer, the flap planned for reconstruction should have adequate soft-tissue volume, and inset must be done with the mouth opened to its maximum position.
- To prevent orocutaneous fistula, good nutrition, proper surgical planning, and proper inset of the soft-tissue flap are required.
- During reconstruction, there should be a balance between microstomia and an incompetent oral commissure to achieve a good functional result and improve quality of life.
- To prevent osteoradionecrosis (ORN), extensive periosteal stripping of the remnant mandible should be avoided, and supracanal marginal mandibulectomy should be considered whenever oncologically feasible.
- To prevent hardware-related complications, the reconstruction plate should be covered with adequate soft tissue.

- Recent developments in radiation therapy have resulted in fewer post-treatment complications and improved quality of life.

DISCLOSURE

The authors have nothing to disclose.

REFERENCES

1. Dijkstra PU, Kalk WW, Roodenburg JL. Trismus in head and neck oncology: a systematic review. Oral Oncol 2004;40(9):879–89. PMID: 15380165.
2. Watters AL, Cope S, Keller MN, et al. Prevalence of trismus in patients with head and neck cancer: a systematic review with meta-analysis. Head Neck 2019;41(9):3408–21. Epub 2019 Jun 19. PMID: 31215723.
3. Raj R, Thankappan K, Janakiram C, et al. Etiopathogenesis of trismus in patients with head and neck cancer: an exploratory literature review. Craniomaxillofac Trauma Reconstr 2020;13(3):219–25. Epub 2020 Apr 27. PMID: 33456691; PMCID: PMC7797966.
4. Balasubramanian D, Thankappan K, Kuriakose MA, et al. Reconstructive indications of simultaneous double free flaps in the head and neck: a case series and literature review. Microsurgery 2012;32(6): 423–30.
5. Wu H, Zhou Z, Zhang C, et al. The progress of post-treatment restricted mouth opening in oral and maxillofacial malignant tumor patients. Front Oral Maxillofac Med 2021;3. https://doi.org/10.21037/fomm-20-52.
6. Kraaijenga SA, Hamming Vrieze O, Verheijen S, et al. Radiation dose to the masseter and medial pterygoid muscle in relation to trismus after chemoradiotherapy for advanced head and neck cancer. Head Neck 2019;41(5):1387–94.
7. Stegenga B, de Bont LG, de Leeuw R, et al. Assessment of mandibular function impairment associated with temporomandibular joint osteoarthrosis and internal derangement. J Orofac Pain 1993;7(2):183–95.
8. Sharma S, Upadhyay AK, Prakash A, et al. Treatment complications of head and neck cancers and rehabilitation measures: a narrative review. Cureus 2024;16(5).
9. Chaukar DA, Deshmukh AD, Majeed T, et al. Factors affecting wound complications in head and neck surgery: a prospective study. Indian J Med Paediatr Oncol 2013;34:247–51.
10. Nair D, Singhvi H, Mair M, et al. Outcomes of surgically treated oral cancer patients at a tertiary cancer center in India. Indian J Cancer 2018;54:616–20.
11. Paydarfar J, Birkmeyer NJ. Complications in head and neck surgery: a meta-analysis of postlaryngectomy pharyngocutaneous fistula. Arch Otolaryngol Head Neck Surg 2006;132:67–72.
12. Khanh NT, Iyer NG. Management of post-operative fistula in head and neck surgery: sweeping it under the carpet? World J Otorhinolaryngol 2017;5(4):93.
13. Girkar F, Thiagarajan S, Malik A, et al. Factors predisposing to the development of orocutaneous fistula following surgery for oral cancer: experience from a tertiary cancer center. Head Neck 2019;41-(12):4121–7.
14. Tian B, Khoo D, Tay AC, et al. Management of orocutaneous fistulas using a vacuum-assisted closure system. Head Neck 2014;36:873–81.
15. Fang Q, Yuan J, Du W, et al. Orocutaneous fistula formation in free flap reconstruction for oral squamous cell carcinoma. Front Oncol 2022;12:887118.
16. Neligan PC. Strategies in lip reconstruction. Clin Plast Surg 2009;36(3):477–85.
17. Peterson DE, Koyfman SA, Yarom N, et al. Prevention and management of osteoradionecrosis in patients with head and neck cancer treated with radiation therapy: ISOO-MASCC-ASCO guideline. J Clin Oncol 2024;42(16):1975–96.
18. Sharan R, Iyer S, Chatni SS, et al. Increased plate and osteosynthesis related complications associated with postoperative concurrent chemoradiotherapy in oral cancer. Head Neck 2008;30:1422–30.
19. Renda L, Tsai TY, Huang JJ, et al. A nomogram to predict osteoradionecrosis in oral cancer after marginal mandibulectomy and radiotherapy. Laryngoscope 2020;130(1):101–7.
20. Chang CC, Cheng MH, Hao SP, et al. Osteoradionecrosis with combined mandibulotomy and marginal mandibulectomy. Laryngoscope 2005;115(11):1963–7.
21. Studer G, Zwahlen RA, Graetz KW, et al. Osteoradionecrosis of the mandible: minimizing risk using intensity-modulated radiation therapy. Strahlenther Onkol 2006;182(11):635–40.
22. Jiang YM, Zhu XD, Qu S. Incidence of osteoradionecrosis in patients who have undergone dental extraction prior to radiotherapy: a systematic review and meta-analysis. Journal of Oral and Maxillofacial Surgery, Medicine, and Pathology 2014;26(3):269–75.
23. Lee J, Hueniken K, Cuddy K, et al. Dental extractions before radiation therapy and the risk of osteoradionecrosis in patients with head and neck cancer. JAMA Otolaryngol Head Neck Surg 2023;149(12): 1130–9.
24. Huang YF, Liu SP, Muo CH, et al. The association between dental therapy timelines and osteoradionecrosis: a nationwide population-based cohort study. Clin Oral Invest 2020;24:455–63.
25. Balermpas P, van Timmeren JE, Knierim DJ, et al. Dental extraction, intensity-modulated radiotherapy of head and neck cancer, and osteoradionecrosis : a systematic review and meta-analysis. Strahlenther Onkol 2022;198(3):219–28.

26. Aarup-Kristensen S, Hansen CR, Forner L, et al. Osteoradionecrosis of the mandible after radiotherapy for head and neck cancer: risk factors and dose-volume correlations. Acta Oncol 2019;58(10):1373–7.
27. van Dijk LV, Abusaif AA, Rigert J, et al. Normal tissue complication probability (NTCP) prediction model for osteoradionecrosis of the mandible in patients with head and neck cancer after radiation therapy: large-scale observational cohort. Int J Radiat Oncol Biol Phys 2021;111(2):549–58.
28. Notani K, Yamazaki Y, Kitada H, et al. Management of mandibular osteoradionecrosis corresponding to the severity of osteoradionecrosis and the method of radiotherapy. Head Neck 2003;25(3):181–6.
29. Alhilali L, Reynolds AR, Fakhran S. Osteoradionecrosis after radiation therapy for head and neck cancer: differentiation from recurrent disease with CT and PET/CT imaging. AJNR Am J Neuroradiol 2014; 35(7):1405–11.
30. He Y, Ma C, Hou J, et al. Chinese expert group consensus on diagnosis and clinical management of osteoradionecrosis of the mandible. Int J Oral Maxillofac Surg 2020;49(3):411–9.
31. Raj R, Nair AH, Krishnan NA, et al. Advances and controversies in the management of osteoradionecrosis after head and neck cancer treatment: a narrative review. J Maxillofac Oral Surg 2022;21(3):836–44.
32. Oh HK, Chambers MS, Martin JW, et al. Osteoradionecrosis of the mandible: treatment outcomes and factors influencing the progress of osteoradionecrosis. J Oral Maxillofac Surg 2009;67(7):1378–86.
33. Nabil S, Samman N. Incidence and prevention of osteoradionecrosis after dental extraction in irradiated patients: a systematic review. Int J Oral Maxillofac Surg 2011;40(3):229–43.
34. Chavez JA, Adkinson CD. Adjunctive hyperbaric oxygen in irradiated patients requiring dental extractions: outcomes and complications. J Oral Maxillofac Surg 2001;59(5):518–24.
35. Shaw RJ, Butterworth CJ, Silcocks P, et al. HOPON (hyperbaric oxygen for the prevention of osteoradionecrosis): a randomized controlled trial of hyperbaric oxygen to prevent osteoradionecrosis of the irradiated mandible after dentoalveolar surgery. Int J Radiat Oncol Biol Phys 2019;104(3):530–9.
36. Delanian S, Depondt J, Lefaix JL. Major healing of refractory mandible osteoradionecrosis after treatment combining pentoxifylline and tocopherol: a phase II trial. Head Neck 2005;27(2):114–23.
37. Delanian S, Chatel C, Porcher R, et al. Complete restoration of refractory mandibular osteoradionecrosis by prolonged treatment with a pentoxifylline-tocopherol-clodronate combination (PENTOCLO): a phase II trial. Int J Radiat Oncol Biol Phys 2011; 80(3):832–9.
38. Marx RE. A new concept in the treatment of osteoradionecrosis. J Oral Maxillofac Surg 1983;41(6):351–7.
39. Sukegawa S, Saika M, Tamamura R, et al. Risk factors for mandibular fracture after marginal mandibular resection. J Craniofac Surg 2020;31(5):1430–3.
40. Coletti D, Ord RA. Treatment rationale for pathological fractures of the mandible: a series of 44 fractures. Int J Oral Maxillofac Surg 2008;37(3):215–22. Epub 2007 Nov 26. PMID: 18023145.
41. Okuyama K, Michi Y, Yamashiro ML, et al. Clinical study on mandibular fracture after marginal resection of the mandible. J Oral Maxillofac Surg 2014;72.
42. Murakami K, Sugiura T, Yamamoto K, et al. Biomechanical analysis of the strength of the mandible after marginal resection. J Oral Maxillofac Surg 2011; 69:1798–806.
43. Epstein JB, Wong FL, Stevenson-Moore P. Osteoradionecrosis: clinical experience and a proposal for classification. J Oral Maxillofac Surg 1987;45(2):104–10.
44. Ohori H, Iwata E, Takeda D, et al. Risk factors for pathological fracture in patients with mandibular osteoradionecrosis. Sci Rep 2023;13(1):5367.
45. Liu SP, Cai ZG, Zhang J, et al. Stability and complications of miniplates for mandibular reconstruction with a fibular graft: outcomes for 544 patients. Br J Oral Maxillofac Surg 2016;54(5):496–500.
46. Robey AB, Spann ML, McAuliff TM, et al. Comparison of miniplates and reconstruction plates in fibular flap reconstruction of the mandible. Plast Reconstr Surg 2008;122(6):1733–8.
47. Zhang ZL, Wang S, Sun CF, et al. Miniplates versus reconstruction plates in vascularized osteocutaneous flap reconstruction of the mandible. J Craniofac Surg 2019;30(2):e119–25.
48. Al-Bustani S, Austin GK, Ambrose EC, et al. Miniplates versus reconstruction bars for oncologic free fibula flap mandible reconstruction. Ann Plast Surg 2016;77:314–7.
49. Biswas G, Mathew JG, Kaur A, et al. Utilizing a second flap to address the effect of postradiotherapy soft tissue fibrosis in head and neck malignancy. Indian J Plast Surg 2024;57(01):031–8.
50. De Pasquale G, Mancin S, Matteucci S, et al. Nutritional prehabilitation in head and neck cancer: a systematic review of literature. Clinical Nutrition ESPEN 2023;58:326–34.
51. Capuano G, Gentile PC, Bianciardi F, et al. Prevalence and influence of malnutrition on quality of life and performance status in patients with locally advanced head and neck cancer before treatment. Support Care Cancer 2010;18(4):433–7.
52. George A, Ponni T. Prognostic nutritional index - a predictive tool for treatment tolerance in head and neck radiotherapy. Journal of Cancer Research and Practice 2022;9(4):135–9.
53. Yamaguchi S, Toyama N, Kaminogo K, et al. Preoperative controlling nutritional status (CONUT) is a predictor of short-term outcomes in patients with oral cancer. Oral Oncol Rep 2023;8:100119.

54. Buzby GP, Knox LS, Crosby LO, et al. Study protocol: a randomized clinical trial of total parenteral nutrition in malnourished surgical patients. Am J Clin Nutr 1988;47(2 Suppl):366–81.
55. Bao X, Liu F, Lin J, et al. Nutritional assessment and prognosis of oral cancer patients: a large-scale prospective study. BMC Cancer 2020; 20(1):146.
56. Byrd HF, Kohutek ZA. Painful realities: navigating the complexities of head and neck cancer pain. Oral Dis 2024.
57. Runyan CM, Sharma V, Staffenberg DA, et al. Jaw in a day: state of the art in maxillary reconstruction. J Craniofac Surg 2016;27(8):2101–4.
58. Dos Santos DM, de Caxias FP, Bitencourt SB, et al. Oral rehabilitation of patients after maxillectomy. A systematic review. Br J Oral Maxillofac Surg 2018; 56(4):256–66.
59. Pai A, Prabhu S. Patient-specific implants for intraoral and maxillofacial reconstruction: a scoping review on customization and fabrication methods. Maxillofac Plast Reconstr Surg 2025;47:28.