Advances in Reconstructive Surgery for Gingivobuccal Cancers

Deepak Balasubramanian, MS, MCh[a,*], Tejal Patel, MCh[a], Arjun Krishnadas, BDS, MDS[b,c], Pramod Subash, BDS, MDS[c], Krishnakumar Thankappan, MS, DNB, MCh, PhD[a], Subramania Iyer, MBBS, MS, MCh[a,d]

KEYWORDS

• Tissue engineering • Mandible reconstruction • Virtual surgical planning • Implants • Recent advances

KEY POINTS

- Prevalence and Impact: Gingivobuccal cancers are common head and neck cancers and the surgical traetment often results in complex defects.
- Evolving Reconstruction Techniques: Reconstruction has progressed from primary closures and skin grafts to advanced local, regional, and free tissue transfers, tailored to defect size and anatomic involvement.
- Technological Innovations: Virtual surgical planning, 3D modeling, robotics, and bioactive scaffolds have enhanced reconstructive precision, reduced operative time, and minimized donor-site morbidity.
- Multidisciplinary and Multicomponent Approaches: Inverse occlusion-based planning, chimeric and composite flaps, and the use of iliac crest and scapular donor sites allow for restoration of complex, multidimensional defects.
- Regenerative Medicine and Prosthodontics: Advances in biomaterials, dermal substitutes, tissue engineering, and computer-aided dental implant placement support functional rehabilitation and improve long-term quality of life for patients.

INTRODUCTION

The mainstay of treatment of gingivobuccal complex cancers is surgery.[1] The defects after tumor extirpation can range from simple mucosal defects to defects involving the skin, mandible, palate, tongue and/or the infratemporal fossa. They jeopardize speech, swallowing, mastication, and facial aesthetics. The reconstruction of these defects has evolved from primary closures and skin grafting to local, regional, and free tissue transfers tailored to the defect size and the involvement of adjacent structures. Apart from advances in surgical techniques, technologies such as virtual surgical planning, three-dimensional (3-D) modeling, bioactive scaffolds, and robotics have also contributed to improving reconstructive precision, reducing operative time and hospital stay, and minimizing

[a] Department of Head and Neck Surgery and Oncology, Amrita Institute of Medical Sciences, Amrita Vishwa Vidyapeetham, Kochi, Kerala, India; [b] Department of Dentistry, Amrita School of Dentistry, Amrita Vishwa Vidhyapeetham, Kochi, Kerala, India; [c] Department of Cranio-Maxillofacial Surgery, Amrita Institute of Medical Sciences, Amrita Vishwa Vidyapeetham, Kochi, Kerala, India; [d] Department of Plastic and Reconstructive Surgery, Amrita School of Medicine, Kochi, Kerala, India
* Corresponding author. Department of Head and Neck Surgery, Amrita Institute of Medical Sciences, Kochi, Kerala, 682041, India.
E-mail address: deepakbala@live.com

Oral Maxillofacial Surg Clin N Am 38 (2026) 425–432
https://doi.org/10.1016/j.coms.2026.03.004
1042-3699/26/© 2026 Published by Elsevier Inc.

Abbreviations

ALT	anterolateral thigh
ART	Alberta Reconstructive Technique
DCIA	deep circumflex iliac artery
FOCFF	free osteocutaneous fibula flap
PSI	Patient-specific implants
SMART	Sydney modification of the Alberta Reconstructive Technique
STL	stereolithographic
TFL-IC	tensor fascia lata–iliac crest
TJR	total temporomandibular joint replacement
VSP	virtual surgical planning

donor-site morbidity. Within this rapidly developing landscape, advances in buccal reconstruction aim not only to restore continuity but to optimize oncologic safety, early rehabilitation, and long-term health-related quality of life.[2]

ADVANCES IN PRINCIPLES

Occlusion-Based Reconstruction: Traditionally, forward planning was employed to reconstruct mandibular defects associated with gingivobuccal cancers. This approach did not account for the patient's occlusion or future dental rehabilitation. It has since been replaced by inverse planning, wherein the free bone flap is planned only after occlusion has been corrected, either on the patient directly or on stereolithographic (STL) models used for plate contouring and osteotomy planning.[3] This approach facilitates improved masticatory function and enables prospective planning for dental rehabilitation. Inverse planning necessitates a collaborative team comprising surgeons, prosthodontists, and biomedical engineers, representing a truly multidisciplinary effort.

Virtual Surgical Planning and Reconstruction: Traditional reconstruction of the mandible and maxilla relied on preplating to ensure occlusion and successful bone reconstruction. However, this approach was time-consuming and often imprecise, particularly when tumor expansion precluded accurate preplating. Virtual surgical planning (VSP) emerged as a solution to these limitations. Initially, imaging data was used to create a virtual model of the mandible, following which the diseased segment was digitally resected and replaced with a mirror image of the contralateral mandible. These corrected images enabled the printing of STL models, allowing surgeons to prebend reconstruction plates in the laboratory while maintaining proper occlusion. The precontoured plates were then transferred to the operating room and applied to the patient, ensuring accurate adaptation and preserved occlusion. Subsequent advancements in VSP have enabled the printing of cutting and osteotomy guides that precisely direct bone cuts in the native mandible and osteotomies in the fibula, thereby simplifying the procedure and reducing operative time. More recently, the incorporation of implant guides has facilitated the placement of primary dental implants at the time of reconstruction. Thus, virtual surgical planning not only ensures optimal occlusion but also enables the fabrication of guides for the various steps of mandibular and maxillary reconstruction.[4] **Fig. 1** shows the virtual surgical planning for mandible defect using scapula osteocutaneous flap.

Multiple Subunit Reconstruction: Defects resulting from ablation of advanced gingivobuccal tumors are rarely small; they typically involve multiple subsites and are multidimensional. The defect components usually include skin, mucosa, and bone. The goals of reconstruction must be established at the outset. If soft tissue coverage alone is required, an anterolateral thigh (ALT) flap would suffice. However, the primary objectives in such resections are to restore bony continuity, establish occlusion, and provide both mucosal and cutaneous coverage. While the fibula free flap remains the workhorse for mandibular reconstruction due to its excellent characteristics, it offers limited soft tissue. The flexor hallucis longus and soleus muscles can be harvested with the flap, but these are useful only for resurfacing fixed mucosal defects or obliterating dead space. When the fibula is selected, a second flap is often necessary to address the external skin defect. Several options exist, including both free and regional flaps. The simplest approach is to use a deltopectoral flap for external skin coverage, which can be divided after 6 weeks. This flap obviates the need for an additional microvascular anastomosis and provides reliable vascularity when planned appropriately. The supraclavicular flap is another pedicled regional option. If a free flap is preferred for comprehensive reconstruction, the scapular flap is ideal for composite defects owing to its availability of bone, skin, and soft tissue. Although the length and caliber of bone may be limiting factors, the multiple components available make it a suitable choice for composite defects.[5] **Fig. 1**; **Figs. 2–6** shows Virtual surgical planning for mandible defect using scapula osteocutaneous flap including cutting guides.

Bone Reconstruction in the Absence of the Condyle: Inclusion of the condyle in the resection specimen presents a considerable challenge to the reconstructive surgeon. For young, dentate individuals without trismus, bony reconstruction remains the preferred approach. Techniques such as cantilevering the fibula with gap arthroplasty

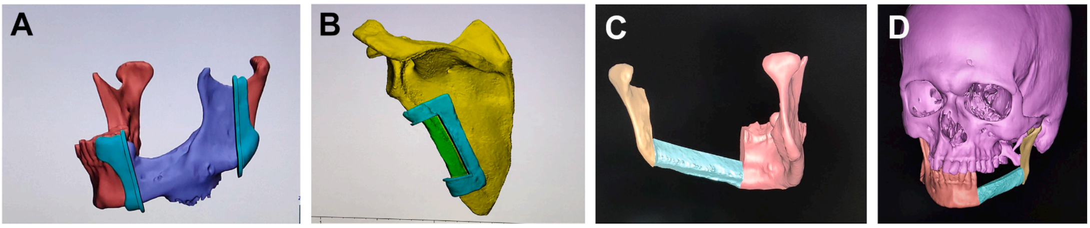

Fig. 1. (*A–D*) VSP for mandible defect using scapula osteocutaneous flap including cutting guides. (*A*) Planning the resection margins. (*B*) Planning the part of the lateral border of scapular to be harvested. (*C, D*) Performing virtual surgery and placing the scapula bone to reconstruct the defect.

have been employed; however, while these methods achieve acceptable aesthetic outcomes, functional results are often suboptimal. The ideal reconstruction for optimizing both function and appearance is total temporomandibular joint replacement (TJR). Nevertheless, primary TJR is not recommended due to the deleterious effects of postoperative radiation on the prosthesis. In the setting of secondary reconstruction, TJR may be considered with appropriate precautions (see Fig. 2).Temporomandibular joint prostheses are available in 2 configurations: patient-specific implants designed using virtual surgical planning, and stock implants available in various sizes with the best-fitting option selected intraoperatively.

ADVANCES IN FLAPS AND GRAFTS

Chimeric Flaps for Complex Defects: Gingivobuccal cancers can involve the mucosa, skin, mandible, palate, and infratemporal fossa. For patients in whom bony reconstruction is not contemplated, soft tissue flaps with multiple components are available. Examples include the ALT flap[6] and flaps based on the subscapular system.[7] Chimeric flaps circumvent the limitations of single-component flaps, such as the need to fold the skin paddle or deepithelialize portions when transitioning from the intraoral to the external surface. Folding a flap results in increased bulk, raises the risk of vascular compromise, and produces inferior esthetic outcomes compared to chimeric flaps, which can be designed to conform to the defect without manipulation. Additionally, muscle can be harvested with chimeric flaps for dead space obliteration, particularly in patients requiring reconstruction of the infratemporal fossa. The ALT flap may incorporate multiple skin perforators and muscle perforators, facilitating harvest of the vastus lateralis muscle. With the subscapular axis, skin components can be obtained from the scapular or parascapular territories, while skin and muscle can be harvested from the thoracodorsal axis. A notable advantage of the subscapular system is that it permits harvest of bone from the lateral border of the scapula, an option not available with the chimeric ALT flap. In cases where lip defects accompany complex gingivobuccal defects, the ALT flap may be extended; however, a second free flap, such as a radial forearm flap with a fascial sling, is often required for lip reconstruction.[8]

Iliac Crest as a Donor Site: The iliac crest offers several advantages as a donor site for free tissue transfer. The volume of bone stock available for harvest exceeds that of other osseous flaps, making it ideal for dental implantation. Drawbacks include a short pedicle, bulky skin if a cutaneous

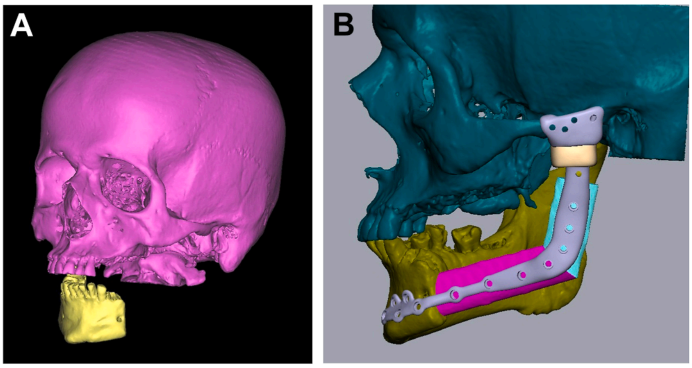

Fig. 2. (*A, B*) Secondary mandibular reconstruction in the absence of condyle using E-TJR (total joint replacement). (*A*) 3D reconstruction of the defect showing the absence of condyle. (*B*) TJR prosthesis along with free fibula osteocutaneous flap for reconstruction.

Fig. 3. (*A–C*) Outcome of DCIA osteocutaneous flap for mandible and buccal reconstruction. (*A*) Epithelialized lower alveolus and gingiva. (*B*) Dental rehabilitation. (*C*) Reconstructed contour of the jaw.

paddle is harvested, and donor site morbidity. However, the unique anatomy of the iliac crest permits the harvest of composite flaps. The first is the tensor fascia lata–iliac crest (TFL-IC)–internal oblique flap, which incorporates the iliac crest along with the tensor fascia lata and internal oblique muscles. This flap requires 2 anastomoses and is well suited for reconstruction of complex maxillary defects. The second is the TFL-IC flap, which can be used to reconstruct single-subunit defects in the maxillofacial region.[9,10] The surgical photographs of deep circumflex iliac artery flap (DCIA) flap are shown in chapter 9. **Fig. 3** shows the outcome of DCIA osteocutaneous flap for mandible and buccal reconstruction in a different patient.

Bone Substitutes: The cornerstone of dental rehabilitation following mandibular resection is the provision of adequate bone height. The free fibula osteocutaneous flap remains the standard for mandibular reconstruction; however, a major limitation is insufficient bone height for implant placement and prosthetic rehabilitation. One option for vertical bone augmentation is an onlay iliac crest bone graft, although this approach carries its own drawbacks, including donor site morbidity and rapid resorption. Nanotex bone is a synthetic biomaterial developed for vertical bone augmentation that is biomimetic, porous, mechanically stable, and biodegradable. It mimics native bone architecture and promotes cellular infiltration, neo-angiogenesis, and new bone formation.[11] Research in this area is ongoing, and similar materials are likely to be developed soon. **Fig. 4** shows bone substitute NANOTEX.[11]

Dermal Substitutes: Acellular dermal matrices are collagen-based scaffolds that are increasingly being used for reconstruction of small-to medium-sized thin mucosal defects of the buccal mucosa. The principal advantages of dermal substitutes are avoidance of separate flap harvest and the associated donor site morbidity and facial scarring. These matrices serve as scaffolds that facilitate mucosal ingrowth and neovascularization, which in turn reduces scarring and improves functional outcomes. A wide variety of dermal substitutes are commercially available, including Integra, MatriDerm, and biodegradable temporizing matrix, among others. The major drawback is cost. Consorti and colleagues performed a retrospective study in which dermal matrices were used in 47 patients with oral squamous cell carcinoma following resection. They concluded that dermal matrices represent a valid alternative in oncological reconstructive surgery for small-to medium-sized intraoral mucosal defects, as they facilitate reepithelialization of the wound bed.[12]

Regenerative Medicine and Tissue Engineering: Regenerative medicine is advancing at a rapid

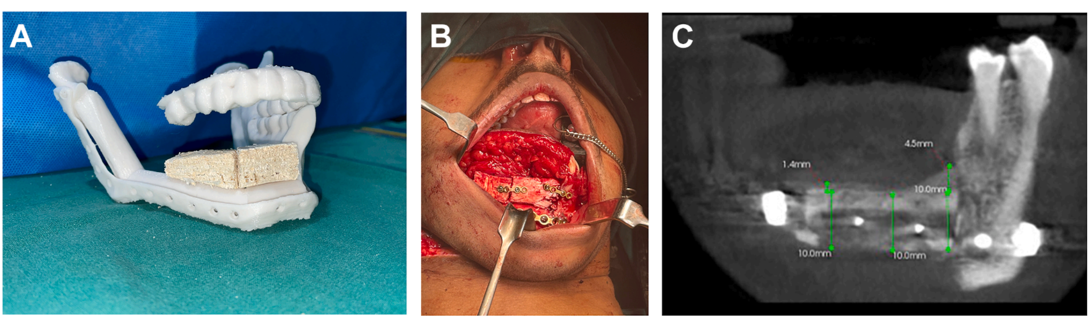

Fig. 4. (*A–C*) NANOTEX. (*A*) Bone Substitute Nanotex used for augmenting bone height. (*B*) Intraoperative picture demonstrating the use and how to fix the NANOTEX. (*C*) Postoperative radiograph demonstrating the increase in height achieved by the use of NANOTEX.[11]

Fig. 5. (*A–C*) Guiding flange prosthesis. (*A*) Guiding flange prosthesis. (*B*) Placement and use of the guiding flange. (*C*) Occlusion achieved by using the guiding flange.

pace, with its most significant applications in the head and neck region pertaining to bone regeneration. Although surgical reconstruction using grafts or flaps remains the current gold standard, it is associated with several drawbacks, most notably donor site morbidity. Furthermore, these conventional techniques fail to replicate the precise three-dimensional architecture of native tissues. These limitations can potentially be overcome through tissue engineering, which relies on 3 fundamental components: a scaffold, cells, and signaling molecules.[13] Warncke and colleagues[14] demonstrated a novel application of this approach by implanting growth factors into the latissimus dorsi muscle for flap prefabrication, subsequently using the engineered tissue to reconstruct a segmental mandibulectomy defect. Beyond bone regeneration, epithelial tissue, specifically oral mucosa, has also been an area of active investigation. Ex vivo produced oral mucosa equivalent preparations have been used for prelamination of radial artery free flaps, with subsequent transfer to the oral cavity resulting in accelerated wound healing.[15]

ADVANCES IN PROSTHODONTICS AND IMPLANTS

Prosthodontics in reconstruction: Guiding flange/guide plane prosthesis: Resection of a part of the mandible causes the mandible to drift to the ipsilateral side during mastication. This prevents optimal occlusion causing the patient to lose the ability of mastication. In turn, the patient cannot consume solid foods. A guide plane prosthesis or guiding flange is a training type of prosthesis. It engages the maxillary teeth during mandibular closure, thereby directing the mandible to an appropriate position. Early use of the guiding flange is associated with a higher success in achieving occlusion. The use of this prosthesis can often be discontinued once the patient has been trained.[16] **Fig. 5** shows the Guiding flange prosthesis.

Implant based prosthetic rehabilitation: Endosseous dental implants are considered a stable and reliable option for reconstruction with advantages such as increased chewing efficiency, preservation of the remaining bone height and width, and improved quality of life. Prosthetic rehabilitation options were originally proposed by Misch in 1989 and include implant assisted fixed dentures or removable implant assisted dentures.[17]

Advances in dental implants: Ideal implant placement optimizes long-term performance and avoids damage to critical anatomic structures. The traditional freehand approach to implant placement is associated with a considerable margin of error. With the rapid evolution of digital technology, these tools are increasingly being incorporated into treatment planning. Dynamic computer-aided implant surgery and robot-assisted implant surgery represent the latest advancements. These technologies offer significant advantages, including reduced deviation, greater stability, and improved accuracy by circumventing human factors such as limitations in hand–eye coordination, fatigue, and tremor.[18]

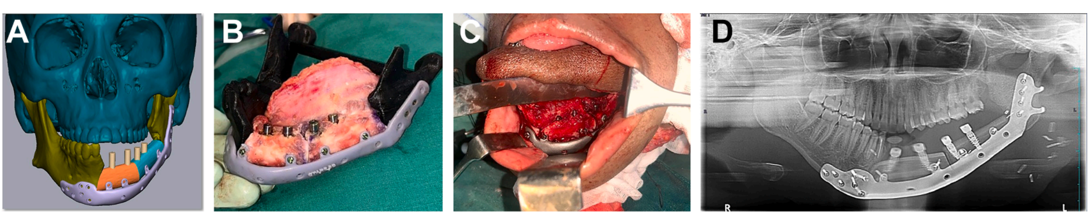

Fig. 6. (*A–D*) Secondary reconstruction of mandible using a PSI and FOCFF with dental implants. (*A*) VSP the use of PSI and dental implant. (*B*) Dental implant placement using the PSI model. (*C*) Intraoperative picture of the PSI and dental implants. (*D*) Postoperative orthopantamogram.

Rohner, ART, and SM-ART Techniques: The Rohner method and the Alberta reconstructive technique (ART) are established protocols for mandibular reconstruction that integrate virtual surgical planning with dental implant placement.[19,20] Building upon these approaches, a refined technique has been developed to optimize outcomes. The Sydney modification of the Alberta reconstructive technique (SM-ART) is a hybrid of the Rohner method and ART. SM-ART differs from ART in 3 key aspects: the use of patient-specific custom plates, intraoral placement of implants via 3-dimensionally printed guides, and a skin graft buried deep to the skin paddle of the fibula flap during the first stage of reconstruction.[21]

Patient-specific implants: Certain aspects of maxillary and mandibular reconstruction require custom implants to address defects for aesthetic purposes. Patient-specific implants (PSIs) are of 3 types: those used in conjunction with a microvascular bone flap, and those used to reconstruct the entire bony defect, typically reserved for select benign cases. When used with a fibula free flap for mandibular reconstruction, PSIs offer several advantages. The plate is designed specifically for the patient and arrives precontoured. Additionally, the PSI is engineered to serve as a trough for the fibula, with fixation points positioned away from planned dental implant sites. These implants provide excellent contour and highly stable fixation. However, they are larger than low-profile reconstruction plates and are generally suitable only for patients with benign pathology. Furthermore, as they are prefabricated, intraoperative adjustment is not possible should the resection margin need to be extended. For benign maxillary tumors, PSIs have been used to reconstruct the anterior wall of the maxilla and zygoma. Regardless of the site of application, adequate vascularized soft tissue coverage is essential to prevent implant extrusion.[22] **Fig. 6** shows a secondary reconstruction of mandible using a patient specific implant and free osteocutaneous fibula flap (FOCFF) with dental implants.

Jaw in a day: Conventionally, the dental rehabilitation of patients undergoing maxillary or mandibular reconstruction was in 2 stages. The first stage would be the fibula bone flap, and the second stage would include debulking of the flap, vestibuloplasty, and placement of the implants. This required a considerable amount of time for the dental rehabilitation and the addition of RT delayed the process longer and yielded poorer results. Levine and colleagues described a single stage technique to provide for immediate dental rehabilitation at the primary reconstruction itself. This development has been facilitated by computer-aided design and computer-aided manufacturing, which allows precise determination of osteotomy locations, design of reconstruction plates, and occlusion-driven installation of implants and prosthesis.[23]

Treatment and patient related factors: Advanced-stage cancers of the gingivobuccal complex frequently require adjuvant treatment in the form of radiation or chemoradiation. Indications for adjuvant therapy include T3/T4 disease, positive or close margins, nodal metastasis, and extranodal extension. The reconstructive method chosen must accommodate these treatment requirements. Several treatment related factors warrant careful consideration: the use of nonvascularized biological tissues, potential delays in initiating radiation due to poor tissue healing or flap failure, and the deleterious effects of external beam radiation on dental implant osseointegration. When operating in a previously treated or irradiated field, poor wound healing and the absence of viable recipient vessels for microanastomosis pose additional challenges. Patient specific factors that influence reconstructive choice include poor nutritional status, advanced age, and the presence of severe trismus. The reconstructive plan should be individualized based on these treatment-related and patient-related considerations to achieve optimal oncological and functional outcomes.

SUMMARY

Reconstruction of the gingivobuccal complex following cancer surgery has evolved from a largely empirical practice to a highly individualized, technology driven endeavor. Microvascular free flaps remain the cornerstone of defect reconstruction, while biomaterials and tissue engineering strategies hold considerable promise for augmenting current approaches. Technologies such as virtual surgical planning and robotic-assisted surgery have enhanced precision and minimized intraoperative errors. Emerging advancements, including stem cell therapy and allotransplantation, although currently in nascent stages, are poised to become integral components of the reconstructive armamentarium. Achieving reconstruction that optimizes function, aesthetics, and quality of life while minimizing morbidity necessitates a multidisciplinary approach. This collaborative model should encompass the head and neck oncosurgeon, reconstructive microsurgeon, oral and maxillofacial surgeon, prosthodontist, and biomedical engineer, each contributing specialized expertise toward comprehensive patient-centred care.

CLINICS CARE POINTS

- Inverse planning over forward planning restores occlusion and enables dental rehabilitation in mandibular reconstruction after gingivobuccal cancer resection.
- Virtual surgical planning with cutting guides improves osteotomy precision, reduces operative time, and facilitates primary dental implant placement during reconstruction.
- Chimeric flaps address multicomponent defects involving mucosa, skin and bone without flap folding, reducing bulk and vascular compromise.

DISCLOSURE

None.

REFERENCES

1. Gilbert RW. Reconstruction of the oral cavity; past, present and future. Oral Oncol 2020;108:104683. https://doi.org/10.1016/j.oraloncology.2020.104683. Epub 2020 May 20. PMID: 32446137.
2. Dandoulakis, Emmanouil, Reconstructive Strategies For Post-Oncological Oral And Maxillofacial Defects: A Systematic Overview Of Novel Techniques And Outcomes 2025. Available at: https://ssrn.com/abstract=5677983orhttps://doi.org/10.2139/ssrn.5677983. Accessed February 1, 2026.
3. Krishnadas A, Subash P, Iyer S. Inverse planning in maxillomandibular reconstruction. Int J Oral Maxillofac Surg 2017;46:184.
4. Barr ML, Haveles CS, Rezzadeh KS, et al. Virtual surgical planning for mandibular reconstruction with the fibula free flap: a systematic review and meta-analysis. Ann Plast Surg 2020;84(1):117–22.
5. Escobar-Domingo MJ, Bustos VP, Akintayo R, et al. The versatility of the scapular free flap: a workhorse flap? A systematic review and meta-analysis. Microsurgery 2024;44(5):e31203.
6. Liu WW, Yang AK, Ou YD. The harvesting and insetting of a chimeric anterolateral thigh flap to reconstruct through and through cheek defects. Int J Oral Maxillofac Surg 2011;40(12):1421–3.
7. Lee KT, Wiraatmadja ES, Mun GH. Free Latissimus dorsi muscle–chimeric thoracodorsal artery Perforator flaps for reconstruction of complicated defects: does muscle still have a place in the Domain of perforator flaps? Ann Plast Surg 2015;74(5):565–72.
8. Jeng SF, Kuo YR, Wei FC, et al. Reconstruction of extensive composite mandibular defects with large lip involvement by using double free flaps and fascia lata grafts for oral sphincters. Plast Reconstr Surg 2005;115(7):1830–6.
9. Iyer S, Thankappan K, Kuriakose MA, et al. Tensor fascia lata-iliac crest-internal oblique free flap for composite orbito-maxillary defect with orbital exenteration. J Plast Reconstr Aesthetic Surg 2013;66(4):e116–8. PMID: 23245756.
10. Iyer S, Chatni S, Kuriakose MA. Free tensor fascia lata-iliac crest osteomusculocutaneous flap for reconstruction of combined maxillectomy and orbital floor defect. Ann Plast Surg 2012;68(1):52–7.
11. Babu AS, Rashmi R, Manju V, et al. NANOTEX BONE graft along with fibula flap in the reconstruction of segmental mandibular defect: protocol for pilot clinical trial. Int J Surg Protoc 2023;27(1):90–6. PMID: 36818421; PMCID: PMC9912909.
12. Consorti G, Monarchi G, Paglianiti M, et al. Reconstruction of oral mucosal defects with regenerative dermal matrix after T1-T2 squamocellular carcinoma resection. J Stomatol Oral Maxillofac Surg 2024;125(4S):101911. https://doi.org/10.1016/j.jormas.2024.101911. Epub 2024 May 7. PMID: 38719193.
13. Lydia N. Melek, Tissue engineering in oral and maxillofacial reconstruction. Tanta Dental Journal 2015;12(3):211–23. ISSN 1687-8574.
14. Warnke PH, Springer IN, Wiltfang J, et al. Growth and transplantation of a custom vascularised bone graft in a man. Lancet 2004;364(9436):766–70. PMID: 15337402.
15. Hotta T, Yokoo S, Terashi H, et al. Clinical and histopathological analysis of healing process of intraoral reconstruction with ex vivo produced oral mucosa equivalent. Kobe J Med Sci 2007;53(1–2):1–14. PMID: 17579297.
16. Patil PG, Patil SP. Guide flange prosthesis for early management of reconstructed hemimandibulectomy: a case report. J Adv Prosthodont 2011;3(3):172–6. Epub 2011 Sep 25. PMID: 22053250; PMCID: PMC3204455.
17. Manju V, Krishnapriya VN, Babu AS, et al. Prosthetic rehabilitation options in post-ablative maxillomandibular microvascular reconstructions. J Maxillofac Oral Surg 2023;22(Suppl 1):10–9. Epub 2023 Mar 16. PMID: 37041947; PMCID: PMC10082883.
18. Xu Z, Zhou L, Han B, et al. Accuracy of dental implant placement using different dynamic navigation and robotic systems: an in vitro study. npj Digit Med 2024;7:182.
19. Rohner D, Bucher P, Hammer B. Prefabricated fibular flaps for reconstruction of defects of the maxillofacial skeleton: planning, technique, and long-term experience. Int J Oral Maxillofac Implants 2013;28(5).
20. Seikaly H, Idris S, Chuka R, et al. The Alberta reconstructive technique: an occlusion-driven and digitally based jaw reconstruction. Laryngoscope 2019;129:S1–4.
21. Johal M, Leinkram D, Wallace C, et al. The Sydney Modified Alberta reconstruction technique (SM-

ART) for dental rehabilitation following mandibulectomy or maxillectomy. Int J Oral Maxillofac Surg 2021;50(5):615–8.

22. Möllmann HL, Apeltrath L, Karnatz N, et al. Comparison of the accuracy and clinical parameters of patient-specific and conventionally bended plates for mandibular reconstruction. Front Oncol 2021; 11:719028.

23. Levine JP, Bae JS, Soares M, et al. Jaw in a day: total maxillofacial reconstruction using digital technology. Plast Reconstr Surg 2013;131(6): 1386–91.