Journal of Dentistry and Oral Biology

Review Article
Published: 19 Feb, 2024

Role of the Maxillofacial Prosthetic Treatment in the Rehabilitation of Post-Surgical Defects in Patients Who Underwent Surgical Oncology

Vivek M[1], Karthik S[2], Karthi Kumar M[3], Shyam Sundar B[4] and Dhinakaran EC[5]*

[1]Department of Oral and Maxillofacial Surgery, Sree Balaji Dental College and Hospital, India

[2]Department of Dentistry and Oral and Maxillofacial Pathology, PSP Medical College Hospital and Research Institute, India

[3]University of Science and Technology in Fujairah, India

[4]Department of Oral and Maxillofacial Pathology, Kalinga Institute of Dental Sciences, Kalinga Institute of Industrial Technology (KIIT) Deemed to be University, India

[5]Department of Pathology, Sree Balaji Medical College and Hospital, India

Abstract

Post-surgical defects and loss leads to physiological and functional disturbances. Therapeutic need can be attained by accurate rehabilitation which is determined by anatomy, magnitude and deformity. Above mentioned algorithm in conjunction with supplementary management especially in patients after triad of surgery, radiotherapy followed by chemotherapy play a vital role in the quality of life with respect to function, aesthetics and social responsibility.

Keywords: Oral; Prosthodontics; Faciomaxillary; Pathology; Oncology

OPEN ACCESS

Correspondence:
Karthik Shunmugavelu, Department of Dentistry and Oral and Maxillofacial Pathology, PSP Medical College Hospital and Research Institute, Tambaram, Oragadam Panruti Kanchipuram District, Tamilnadu 631604, India, Tel: 9789885622/9840023697

Received Date: *25 Jan 2024*
Accepted Date: *14 Feb 2024*
Published Date: *19 Feb 2024*

Citation:
Vivek M, Karthik S, Karthi Kumar M, Shyam Sundar B, Dhinakaran EC. Role of the Maxillofacial Prosthetic Treatment in the Rehabilitation of Post-Surgical Defects in Patients Who Underwent Surgical Oncology. J Dent Oral Biol. 2024; 9(1): 1226.

ISSN: 2475-5680

Introduction

Maxillofacial prosthetic treatment plays a crucial role in the rehabilitation of patients who have undergone surgical oncology procedures, especially those involving the head and neck region. Surgical interventions for oncological reasons can result in significant facial and oral defects, affecting both function and aesthetics. Maxillofacial prosthetics aims to restore the lost or compromised structures, enhancing the overall quality of life for these patients.

Maxillofacial prosthetic treatment in post-surgical oncology rehabilitation encompasses intricate facets such as meticulous facial and oral reconstruction, targeted speech and swallowing rehabilitation, the provision of dental prostheses, eye and ear prostheses, dedicated psychosocial support, close collaboration with surgical teams, individualized customization and precision in prosthetic design, and vigilant follow-up care to ensure the holistic well-being of patients.

When strategizing for cases in advance of surgery, it is imperative to seek the expertise of a maxillofacial prosthodontist to contribute insights into a patient's potential for functional rehabilitation. Individuals seeking evaluation for head and neck concerns should undergo a meticulous assessment of their presenting condition to attain a precise diagnosis. This assessment typically involves a comprehensive examination, potentially complemented by radiological imaging, diagnostic tests, and other pertinent diagnostic records [1].

Broadly speaking, maxillofacial prostheses fall into two main categories: Restorative and complementary. Restorative prostheses serve to replace bone loss or address facial contour deformities, and they can be situated either internally within the tissue or externally as oral, ocular, or facial prosthetics. On the other hand, complementary prostheses are instrumental in plastic surgery, assisting in the pre-, trans-, or postoperative phases, as well as during radiotherapy sessions [2].

It is extremely essential for the prosthetic planning to begin prior to surgery and requires a systematic approach. In most situations an immediate postoperative surgical prosthesis is required followed by definitive prosthesis after complete healing and such require meticulous planning and thorough follow ups (Figure 1) [3].

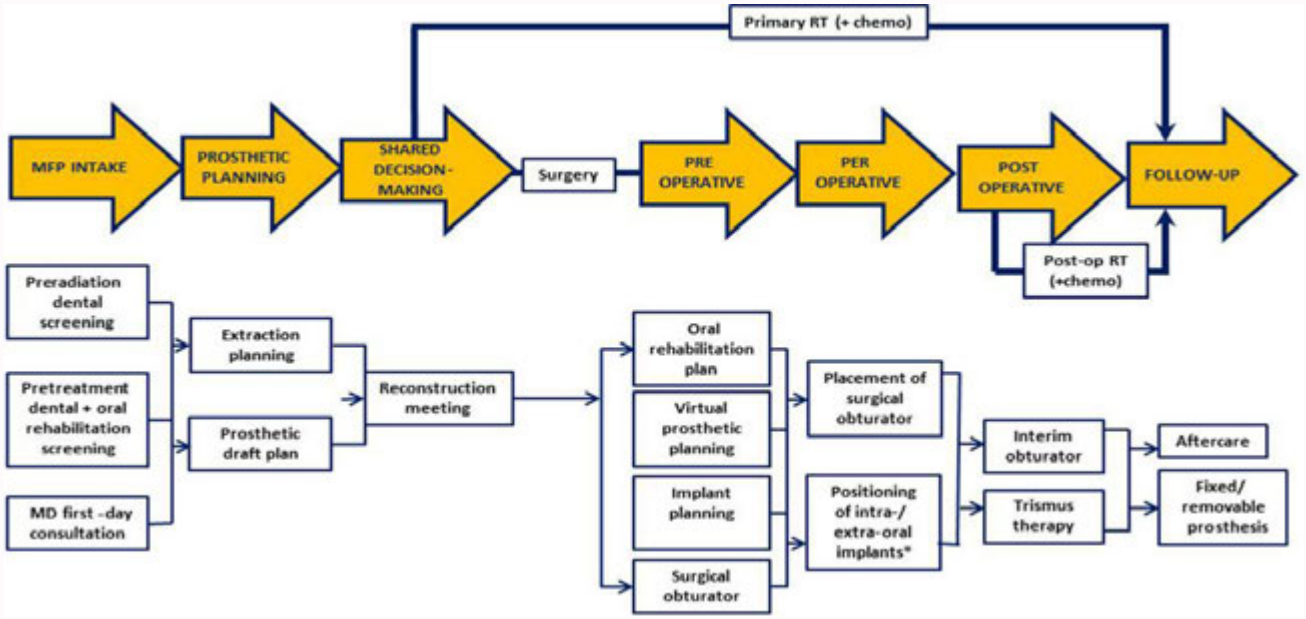

Figure 1: The participation of the maxillofacial prosthodontist in the treatment planning and recovery process for patients with head and neck cancer is centered on ablative surgery, chemotherapy (chemo), and multidisciplinary Medical Care (MD). Maxillofacial Prosthodontics (MFP) plays a crucial role in postoperative (post-op) care, particularly in conjunction with Radiotherapy (RT).

Facial and Oral Reconstruction

Aesthetic rehabilitation

Maxillofacial prosthetics helps in restoring facial aesthetics by designing prostheses that mimic the natural appearance of the patient's face. This is particularly important for patients who may have lost parts of their nose, ears, or other facial structures.

Restoration of oral structures

Prosthetics can replace missing or damaged oral structures such as the palate, mandible, or maxilla. This is vital for functions like speaking, swallowing, and mastication. Referred patients undergoing assessment receive a comprehensive oral examination, meticulously documenting all soft tissues, bone, and teeth. Additionally, the measurement of mandibular opening is imperative for the maintenance of oral health and nutrition. Abrupt reductions in mandibular opening may serve as a crucial indicator of recurrent disease. It is paramount to evaluate patients for caries and periodontal disease, as these conditions are associated with an increased risk of osteoradionecrosis of the jaw [4,5]. Teeth with uncertain prognoses should be evaluated for extraction at least 14 days prior to the commencement of radiation therapy to the underlying bony structures, as this precaution can minimize the risk of osteoradionecrosis lesions [4]. Following extraction, it is crucial to consider alveoloplasty and primary mucoperiosteal flap closure to promote expeditious healing, particularly in areas where the alveolus has been expanded to facilitate the removal of divergent root tips. Additionally, regions characterized by thin, friable mucosa overlying bony prominences, such as tori or exostoses, may serve as potential sites for chronic wound-healing issues [1].

Anticipating head and neck radiation, the creation of a custom radiation stent for immobilizing the mandible and adjacent structures is advisable to ensure consistent positioning during treatment. Considering the impact of ionizing radiation on salivary quality and quantity, it is recommended to provide patients with a means of daily fluoride treatment for their teeth. Typically, this involves custom fluoride trays for the application of prescription fluoride gel, aiming to diminish the occurrence of radiation-induced caries [6,7]. Typically, this involves the utilization of personalized fluoride trays designed to administer prescription fluoride gel, thereby mitigating the likelihood of radiation-induced caries [1].

Speech and swallowing rehabilitation

Swallowing is recognized as an intricately orchestrated physiological process, delineated into three pivotal phases: Oral, pharyngeal, and esophageal. The oral phase commences with lip seal and progresses through the oral preparatory subphase, inclusive of mastication [8]. Competent tongue movement is imperative for adept manipulation of the food bolus, facilitating effective comminution. Upon contact with the palatoglossal arch, the involuntary pharyngeal phase is initiated. Given that the resection of certain tumors can impact these critical areas, a thorough evaluation of swallowing is essential both pre- and post-surgery.

Utilizing a modified barium swallow provides valuable insights into the disability or efficiency of the swallow, particularly for patients undergoing resection of the maxilla, tongue, and soft palate. The information gleaned from such studies proves instrumental, guiding the redesign of prostheses to enhance swallowing efficiency based on individualized patient data [9].

For patients who have undergone surgical procedures affecting the palate (roof of the mouth), maxillofacial prosthetics can provide obturators. These devices help in restoring proper speech and prevent nasal regurgitation during swallowing.

Dental prostheses

Maxillofacial prosthetics includes the fabrication of dentures or dental implants to replace missing teeth. This not only improves aesthetics but also aids in proper oral function. Even though the full extent of the oncologic treatment plan may not be clear during the initial consultation, maxillofacial prosthodontists must assess

whether patients require simultaneous prosthetic rehabilitation with reconstructive surgery or if it should be deferred until after completing cancer therapy, considering the patients' preferences. Integrating the outcomes of pre-treatment screening into the prosthetic workflow ensures that all relevant information is collected to develop a personalized draft plan for prosthetic rehabilitation. In certain situations, careful consideration of prosthetic retentive factors is crucial to achieve successful prosthetic rehabilitation. Factors such as the size of the defect and the number of remaining critical teeth that can serve as anchors for a conventional clasp-supported removable partial denture framework pose challenges for maxillofacial prosthodontists. They must gain insight into the intended therapeutic fields in relation to strategically important teeth. This sometimes leads to a thoughtful decision to retain teeth that may be considered an oral focus of infection, including a thorough discussion of the risk of developing osteoradionecrosis [3].

Early decision-making regarding the need for implant placement is crucial for future prosthodontic rehabilitation in head and neck patients. This enables the preferred prosthodontic rehabilitation approach, involving choices in planning, positioning, and the number of endosseous oral implants or oncology zygomatic implants, which are critical factors for retaining the prosthetic construction [10,11]. Literature underscores the significance of an immediate implant procedure, as studies show that placing mandibular implants in edentulous patients during ablative surgery leads to a higher number of patients with functioning mandibular dentures after completing oncologic therapy [12]. Moreover, there is a growing trend towards early completion of prosthodontic rehabilitation, with an immediate implant procedure often being a prerequisite. When implants are placed post-radiation, the implant survival rate seems to be influenced by the anatomical site, with higher rates in the mandible compared to the maxilla and grafted bone Therefore, implant placement during ablative surgery is preferred, at least in selected cases [10].

Ocular prostheses (artificial eyes)

For patients who have lost an eye due to surgery, maxillofacial prosthetics provides artificial eyes that closely resemble the natural eye, promoting a more natural appearance. The correction of an ocular impairment through the use of a personalized ocular prosthesis not only ensures a superior fit but also enhances comfort, delivering superior aesthetic outcomes when contrasted with standard eye prosthesis [13].

Patients who have lost part or their entire ear can benefit from auricular prostheses, improving both appearance and hearing protection.

Enhancing self-esteem and confidence

Maxillofacial deformities can be a source of embarrassment for patients, impacting both their physical and psychological well-being. This may lead to significant psychiatric, familial, and social challenges, underscoring the profound repercussions these deformities can have on various aspects of their lives [14]. The restoration of facial features through maxillofacial prosthetics can have a significant impact on a patient's self-esteem and overall psychological well-being. Maxillofacial prostheses play a pivotal role in significantly influencing the quality of life and self-esteem of patients. This is achieved by promptly addressing the post-surgical defects, providing immediate correction and restoring a sense of normalcy [2,15]. Prosthetic devices facilitate the seamless reintegration of individuals into their social and familial circles, fostering heightened happiness and bolstered confidence levels [2].

Collaboration with surgical teams

Interdisciplinary approach: Maxillofacial prosthetists work closely with surgical oncologists and other members of the healthcare team to ensure comprehensive and coordinated care for the patient. In the past, prosthodontic rehabilitation within the oncological treatment pathway used to be a distinct and final procedure following the completion of oncological therapy. In contemporary practice, the approach has evolved to include the planning of surgical reconstruction, commencing with occlusion of teeth to ensure proper dental rehabilitation. This method advocates for a comprehensive adjustment of both surgical and prosthetic planning and treatment before the initiation of oncologic treatment [16,17]. During a reconstruction meeting, the head and neck team can explore various options for surgical, prosthetic, or combined reconstruction. The involvement of maxillofacial prosthodontists in such meetings ensures the feasibility from a prosthetic standpoint, guided by a prosthetic draft plan that also considers potential implant placement requirements. The integration of 3D planning and Computer-Aided Design (CAD) assistance, along with preoperative virtual augmented models provided by medical engineers, proves to be a valuable asset in these meetings. They significantly aid the surgical team and contribute to informed decision-making regarding the most favorable reconstruction option after oncology treatment [3]. Prosthetic devices are customized to the individual patient's needs, ensuring a precise fit and optimal function.

Maintenance and adjustments: Maxillofacial prosthetists provide ongoing care, including adjustments and maintenance of prosthetic devices, to ensure long-term functionality and comfort.

Utilizing removable prostheses in head and neck cancer patients provides a significant advantage by facilitating tumor surveillance. Given the rising overall survival rate of head and neck cancer, currently standing at approximately 52%, there exists a crucial timeframe for monitoring local recurrence. The use of prostheses allows for direct visualization of recurrent areas, a capability extending from the perioperative period to the third year of follow-up. In cases where these areas undergo tissue reconstruction, the ability to conduct surveillance is considerably diminished. Maxillofacial prosthetics, as a dedicated subspecialty, offers a treatment avenue for individuals dealing with head and neck defects, whether acquired or congenital. The interdisciplinary approach to addressing head and neck defects commences with a comprehensive consultation involving all team members. Following a thorough assessment by each member, decisions are made based on the patient's best interests and the benefit-to-risk ratio. Shared decision-making plays a pivotal role in ensuring that patients understand and actively participate in choosing the most suitable treatment path [1].

Diagnosis and Treatment Planning in Patients Undergoing Radiation and Resection

Dysphagia, indicative of impaired swallowing, can stem from various sources, including altered anatomy or neuropathic conditions. It may arise post-tumor ablative surgery, head and neck radiation therapy, or demyelinating diseases. Recognizing this symptom is crucial during the final treatment planning phase. For some dysphagic patients, consideration of an augmentative oral appliance may enhance deglutition within the oral cavity. However,

caution is warranted, as in cases of an incompetent swallowing reflex, such appliances may heighten the risk of aspiration, complicating management [1].

Xerostomia, characterized by reduced salivary quantity, often follows head and neck radiation or is linked to chemotherapy, aging, or Sjögren's disease. Consequences of xerostomia, including increased susceptibility to caries and periodontal disease, may progress to osteomyelitis, predisposing to osteoradionecrosis and localized infectious processes. Preventive measures, such as regular dental evaluations, custom fluoride carriers, and pre-emptive removal of questionable teeth before radiation therapy, are pivotal in averting dental caries [1].

Mucositis, an inflammation of oral mucous membranes, is a common side effect of head and neck radiation therapy and chemotherapy. Management is predominantly palliative, emphasizing infection prevention. Agents like Carafate may be recommended to discourage colonization of denuded oral mucosa [1].

Osteoradionecrosis of the jaw, associated with head and neck radiation, has identified exacerbating factors. Although its incidence has decreased with modern radiation planning, severe cases may necessitate microvascular reconstruction. Bisphosphonate-associated osteonecrosis, resulting from medications for bone density deficiency, often requires reconstructive intervention when bone exposure and destruction are substantial, with hyperbaric oxygen proving ineffective in such cases [18].

Restoration of Intraoral Defects

Maxillary tumors are frequently addressed through resection to manage disease progression, involving the hard palate, and in extensive cases, the infraorbital rim and orbit contents. Traditionally employed for tumor control, this procedure is followed by the use of removable obturator prosthesis. While the primary aim is tumor control, the presence of more hard palates enhances prosthesis stability during swallowing, speech, and mastication. Multiple prostheses are often crafted due to changing defects during the perioperative period and after radiotherapy if required. Documented studies affirm the measurable enhancement in the quality of life for these patients. Whether anchored to teeth, osseointegrated implants, or an edentulous jaw, the prosthesis plays a pivotal role in a patient's function related to speech and swallowing [1].

For minor oronasal fistulas resulting from tumor resection, surgical reconstruction using soft tissue flaps alone can yield excellent functional and aesthetic outcomes, provided that prosthetic retention for teeth replacement is assured [19]. In cases of larger maxillary defects, the traditional standard of care involves prosthetic rehabilitation with obturator prostheses. However, challenges such as discomfort, poor retention, and the need for frequent adjustments limit the effectiveness of this method in restoring speech and mastication. Implant-supported obturator prostheses offer improved retention and functional benefits, enhancing masticatory and oral function while minimizing discomfort during food intake. Studies suggest that, compared to prosthetic obturation, reconstructing palatomaxillary defects has advantages in terms of quality of life, comfort, convenience, and self-consciousness. Despite advancements in digital techniques and surgical reconstruction options, the obturator prosthesis remains a standard care option in low-income and middle-income countries. In certain cases, especially in medically compromised and older patients, implant-supported obturator treatment serves as a viable alternative to surgical reconstruction after maxillectomy. With the use of zygomatic implants and innovative techniques like the Rohner technique, combining surgical reconstruction with dental rehabilitation can be preferred for larger defects, providing predictable support for prosthetic rehabilitation [20,21]. Digital advancements allow for the preoperative production of surgical obturator prostheses, facilitating a precise fit and minimizing the need for postoperative adjustments [22]. When defects extend beyond manageable size with prosthetic management alone, a combination of surgical reconstruction and dental rehabilitation, such as the zygomatic implant perforated flap procedure or the Rohner technique with VSP, may be recommended [3,21].

Mandibular resections are employed in treating benign and malignant diseases affecting the floor of the mouth, tongue or the mandible itself. Traditional resections preserve approximately 10 mm of superior/inferior mandible height to maintain continuity, while more extensive resections may create a discontinuity between the temporomandibular joint, ramus, and body. Reconstruction with osteomyocutaneous flaps significantly improves function, especially when combined with osseointegrated implants, enhancing masticatory potential [1].

Smaller head and neck tumors may require soft tissue resection and primary closure, managed surgically. Individualized adapted prostheses are needed to address potential issues like a lack of vestibule or compromised neutral zone, allowing oral function to approach near-normal levels post-ablative surgery and prosthetic rehabilitation [23]. Advanced tumors can lead to large defects requiring surgical reconstruction, resulting in unfavorable anatomical alterations due to flap positioning and scar tissue. These conditions may impair speech, mastication, and swallowing, compounded by sensory loss, shallow or absent buccal vestibule, radiation-induced hyposalivation, and trismus. Bone resection in advanced tumor surgery can further compromise oral function by disrupting mandibular continuity, causing tooth loss, and severe deformities. Tongue mobility challenges the fabrication of functional mandibular resection prostheses, impacting stability during speech and mastication [3].

Many of these challenges can be mitigated by using endosseous oral implants to retain prostheses, contributing to stabilization and reducing loading on compromised soft tissues and underlying bone [24]. Implant-supported removable partial dental prostheses or implant-retained mandibular overdentures can achieve near-normal masticatory function, maximizing dental rehabilitation and significantly improving oral functioning, dietary achievements, and oral health-related quality of life [25-27]. However, a relatively low percentage of reconstructed patients complete prosthetic rehabilitation, with factors such as a vertical discrepancy between the graft and the remaining mandible, leading to an unfavorable implant-crown ratio, poor quality of soft tissues, and the type of prosthesis influencing non-completion [28,29]. Implant placement during primary reconstruction shortens the interval between surgery and dental rehabilitation, potentially increasing the number of orally rehabilitated patients [3,10,28].

Soft palate resections pose unique considerations as they impact speech and swallowing dynamics. Treatment often involves removing a portion of the soft palate, affecting the range of motion for velopharyngeal closure. This may be further influenced by neurophysiological factors like bulbar paralysis or demyelination

diseases. In cases of cleft palate patients, prosthetic reconstruction, such as a speech appliance anchored to remaining dentition, aids in speech and swallowing [1,30].

Aggressive treatment of tongue resections is essential for tumor control, considering their local metastatic potential to the neck. The absence of the tongue, crucial for swallowing and speech, creates a deficiency compensated by prosthetic augmentation of the palate [31]. This prosthesis, lowering the hard palate vault, facilitates contact with remnants of the tongue or the constructed floor of the mouth, aiding in food bolus propulsion and consonant articulation [32]. Its use has demonstrated a reduction in oral transit times for glossectomy patients [1].

Restoration of Extraoral Defects

Auricular anomalies, such as those associated with congenital conditions like Treacher-Collins syndrome resulting in microtia, or instances of traumatic avulsion or tumor removal, may necessitate intervention. Plastic surgical reconstruction or the use of an epithesis can be considered for auricular defects. Indications for prosthesis treatment depend on the extent of the defect, with larger areas posing challenges for surgical reconstruction. When prosthesis is deemed suitable, preserving the tragus can help conceal the anterior margin [1]. Prosthetic retention can be achieved with medical-grade adhesive or, more reliably, through the use of osseointegrated implants, particularly successful in the temporal bone [33].

In cases of microtia with healing deficits, the use of a bone-anchored hearing aid can enhance auditory perception through bone conduction. Implants strategically placed at the 1, 3, and 5 o'clock positions of the left ear and 7, 9, and 11 o'clock positions of the right ear have shown success [1].

Orbital defects are optimally addressed through obliteration with a microvascular flap, but prosthetic treatment is also a viable option. Adequate space for restoration should precede the referral for prosthesis fabrication. Preservation of eyebrow position symmetry is crucial, and osseointegrated implants may be considered in the frontal bone, albeit with noted long-term survival challenges [34].

Nasal defects can be reconstructed using regional flaps, but aesthetic concerns may arise due to skin texturing and color disparities. Prosthetic intervention becomes advantageous in such cases to restore symmetry and blend skin tones inconspicuously. Retention of nasal prostheses should be carefully considered due to the moisture-laden air exchange in this area, limiting the effectiveness of adhesives [1].

Facial prostheses, covering defects in the cheek, nose, or forehead, involve meticulous planning to avoid placing margins over movable tissue, utilizing engageable undercuts, and incorporating skin grafts for stabilizing reciprocating surfaces [1].

In summary, maxillofacial prosthetic treatment plays a vital role in rehabilitating patients who have undergone surgical oncology procedures, addressing both functional and aesthetic aspects of the head and neck region. The goal is to enhance the patient's overall quality of life by restoring lost or compromised structures and functions.

References

1. Salinas T. Prosthetic rehabilitation of defects of the head and neck. Semin Plast Surg. 2010;24(03):299-308.
2. de Caxias FP, Dos Santos DM, Bannwart LC, de Moraes Melo Neto CL, Goiato MC. Classification, history, and future prospects of maxillofacial prosthesis. Int J Dent. 2019;2019:8657619.
3. Vosselman N, Alberga J, Witjes MHJ, Raghoebar GM, Reintsema H, Vissink A, et al. Prosthodontic rehabilitation of head and neck cancer patients-Challenges and new developments. Oral Dis. 2021;27(1):64-72.
4. Beumer J, Harrison R, Sanders B, Kurrasch M. Preradiation dental extractions and the incidence of bone necrosis. Head Neck Surg. 1983;5(6):514-21.
5. Galler C, Epstein JB, Guze KA, Buckles D, Stevenson-Moore P. The development of osteoradionecrosis from sites of periodontal disease activity: Report of 3 cases. J Periodon. 1992;63(4):310-6.
6. Hastreiter RJ. Is 0.4% stannous fluoride gel an effective agent for the prevention of oral diseases? J Am Dent Assoc. 1989;118(2):205-8.
7. Zlotolow IM. Clinical manifestations of head and neck irradiation. Compend Contin Educ Dent. 1997;18(2 Spec No):51-6.
8. Logemann JA. Swallowing disorders. Best Pract Res Clin Gastroenterol. 2007;21(4):563-73.
9. Martin-Harris B, Logemann JA, McMahon S, Schleicher M, Sandidge J. Clinical utility of the modified barium swallow. Dysphagia. 2000;15(3):136-41.
10. Alberga JM, Vosselman N, Korfage A, Delli K, Witjes MJH, Raghoebar GM, et al. What is the optimal timing for implant placement in oral cancer patients? A scoping literature review. Oral Dis. 2021;27(1):94-110.
11. Hackett S, El-Wazani B, Butterworth C. Zygomatic implant-based rehabilitation for patients with maxillary and mid-facial oncology defects: A review. Oral Dis. 2021;27(1):27-41.
12. Wetzels JGH, Meijer GJ, Koole R, Adang EM, Merkx MAW, Speksnijder CM. Costs and clinical outcomes of implant placement during ablative surgery and postponed implant placement in curative oral oncology: A five-year retrospective cohort study. Clin Oral Implants Res. 2017;28(11):1433-42.
13. Khan F, Aras M, Chitre V, Coutinho I. Fabrication of a non-integrated hollow ocular prosthesis using soap spacer - A case report. Clin Case Rep Int. 2020;4:1164.
14. Goiato MC, Dos Santos DM, Bannwart LC, Moreno A, Pesqueira AA, Haddad MF, et al. Psychosocial impact on anophthalmic patients wearing ocular prosthesis. Int J Oral Maxillofac Surg. 2013;42(1):113-9.
15. Ackerman AJ. Maxillofacial prosthesis. Oral Surg Oral Med Oral Pathol. 1953;6(1):176-200.
16. Witjes MJH, Schepers RH, Kraeima J. Impact of 3D virtual planning on reconstruction of mandibular and maxillary surgical defects in head and neck oncology. Curr Opin Otolaryngol Head Neck Surg. 2018;26(2):108-14.
17. Seikaly H, Idris S, Chuka R, Jeffery C, Dzioba A, Makki F, et al. The Alberta reconstructive technique: An occlusion-driven and digitally based jaw reconstruction. Laryngoscope. 2019;129:S1-14.
18. Melo MD, Obeid G. Osteonecrosis of the jaws in patients with a history of receiving bisphosphonate therapy: Strategies for prevention and early recognition. J Am Dent Assoc. 2005;136(12):1675-81.
19. Aramany MA. Basic principles of obturator design for partially edentulous patients. Part II: Design principles. J Prosthet Dent. 1978;40(6):656-62.
20. Butterworth CJ. Primary *vs.* secondary zygomatic implant placement in patients with head and neck cancer-A 10-year prospective study. Head Neck. 2019;41(6):1687-95.
21. Rohner D, Bucher P, Kunz C, Hammer B, Prein J, Schenk RK. Treatment of severe atrophy of the maxilla with the prefabricated free vascularized fibula flap. Clin Oral Implants Res. 2002;13(1):44-52.

22. Bartellas M, Tibbo J, Angel D, Rideout A, Gillis J. Three-dimensional printing: A novel approach to the creation of obturator prostheses following palatal resection for malignant palate tumors. J Craniofac Surg. 2018;29(1):e12-5.

23. Tang JAL, Rieger JM, Wolfaardt JF. A review of functional outcomes related to prosthetic treatment after maxillary and mandibular reconstruction in patients with head and neck cancer. Int J Prosthodont. 2008;21(4):337-54.

24. Schoen PJ, Reintsema H, Raghoebar GM, Vissink A, Roodenburg JLN. The use of implant retained mandibular prostheses in the oral rehabilitation of head and neck cancer patients. A review and rationale for treatment planning. Oral Oncol. 2004;40(9):862-71.

25. Kumar VV, Srinivasan M. Masticatory efficiency of implant-supported removable partial dental prostheses in patients with free fibula flap reconstructed mandibles: A split-mouth, observational study. Clin Oral Implants Res. 2018;29(8):855-63.

26. Korfage A, Schoen PJ, Raghoebar GM, Bouma J, Burlage FR, Roodenburg JLN, et al. Five-year follow-up of oral functioning and quality of life in patients with oral cancer with implant-retained mandibular overdentures. Head Neck. 2011;33(6):831-9.

27. Kansara S, Wang T, Koochakzadeh S, Liou NE, Graboyes EM, Skoner JM, et al. Prognostic factors associated with achieving total oral diet following osteocutaneous microvascular free tissue transfer reconstruction of the oral cavity. Oral Oncol. 2019;98:1-7.

28. Urken ML, Buchbinder D, Weinberg H, Vickery C, Sheiner A, Biller HF. Primary placement of osseointegrated implants in microvascular mandibular reconstruction. Otolaryngol Head Neck Surg. 1989;101(1):56-73.

29. Anne-Gaëlle B, Samuel S, Julie B, Renaud L, Pierre B. Dental implant placement after mandibular reconstruction by microvascular free fibula flap: Current knowledge and remaining questions. Oral Oncol. 2011;47(12):1099-104.

30. Yoshida H, Michi K, Yamashita Y, Ohno K. A comparison of surgical and prosthetic treatment for speech disorders attributable to surgically acquired soft palate defects. J Oral Maxillofac Surg. 1993;51(4):361-5.

31. de Carvalho-Teles V, Sennes LU, Gielow I. Speech evaluation after palatal augmentation in patients undergoing glossectomy. Arch Otolaryngol Head Neck Surg. 2008;134(10):1066-70.

32. Marunick M, Tselios N. The efficacy of palatal augmentation prostheses for speech and swallowing in patients undergoing glossectomy: A review of the literature. J Prosthet Dent. 2004;91(1):67-74.

33. Eriksson E, Brånemark PI. Osseointegration from the perspective of the plastic surgeon. Plast Reconstr Surg. 1994;93(3):626-37.

34. Toljanic JA, Eckert SE, Roumanas E, Beumer J, Huryn JM, Zlotolow IM, et al. Osseointegrated craniofacial implants in the rehabilitation of orbital defects: An update of a retrospective experience in the United States. J Prosthet Dent. 2005;94(2):177-82.