Journal of Dentistry & Oral Disorders

Open Access

Austin Publishing Group

Research Article

Prosthetic Rehabilitation with Zygomatic Implants after Maxillectomy: A Systematic Review

Lacroix T[1], Jaby P[2], Nokovitch L[3] and Chaux-Bodard AG[1,3]*

[1]Faculty of dentistry, University Claude Bernard Lyon I, France

[2]Maxillofacial Surgery Unit, Hôpital de la Croix Rousse, Hospices Civils de Lyon I, France

[3]Head and Neck Surgical Oncology Unit, Anticancer Center Léon Bérard, Lyon I, France

***Corresponding author:** Chaux Anne-Gaëlle, Head and Neck Surgical Oncology Unit, Anticancer Center Léon Bérard, Lyon I, France

Received: April 24, 2020; **Accepted:** May 12, 2020; **Published:** May 19, 2020

Abstract

Purpose: Due to their high osseointegration success rate, zygomatic implants (ZIs) have been proposed after maxillectomy for stabilizing either removable dentures or fixed prostheses in case of associated reconstructive surgery. The aim of this study was to collect the different studies and case reports published and to highlight what type of ZI-supported prosthesis can be proposed for maxillectomy patients.

Methods: An electronic search was performed in PubMed via Medline, Scopus, the Cochrane Central Register of Controlled Trials and in gray literature from January 1999 to June 2019. The number of implants placed, the age and sex of the patients, the type of reconstruction (free flap or other), the type of attachments and prostheses, and a history of previous irradiation, were assessed.

Results: Fifteen studies were included, resulting in a total of 35 patients, in whom 86 ZIs were placed. Reconstruction was performed in 8 patients, and radiotherapy was performed in 17 patients. A maxillary obturator prosthesis was placed in 12 patients, a fixed prosthesis in 10 patients and a removable denture in 4 patients.

Conclusion: In nonreconstructed patients, ZI-supported obturator prostheses remain a valuable therapeutic option. For reconstructed patients, fixed or removable dentures can be proposed, depending on: the number and repartition of implants, the oral hygiene of patients, patients' sleight, and aesthetic considerations. The use of ZIs in maxillectomy patients should be considered a reliable technique in patients for whom immediate reconstruction with a microvascular free flap cannot be performed.

Keywords: Zygomatic implants; Maxillectomy; Prosthesis

Introduction

The use of Zygomatic Implants (ZIs) for the prosthetic rehabilitation of maxillectomy patients has been recently proposed. Due to their high osseointegration success rate [1,2], ZIs have been proposed for use after maxillectomy to overcome bone unavailability for stabilizing either removable dentures (comprising obturator prostheses) or fixed prostheses in cases of associated reconstructive surgery. Nonetheless, only a few studies have reported on the rehabilitation of maxillectomy patients with ZIs, regardless of whether surgical reconstruction was performed. The aim of this study was thus to collect the different studies and case reports published and to highlight what type of ZI-supported prosthesis can be proposed for maxillectomy patients according to the literature.

Methods

An electronic search was performed in PubMed via Medline, Scopus, and the Cochrane Central Register of Controlled Trials, andin gray literature from January 1999 to June 2019. The keywords used were "maxillectomy" or "hemimaxillectomy" or "partial maxillectomy" or "subtotal maxillectomy" or/and "tumor resection" and "maxilla" and "obturator prosthesis" or "maxillary obturator" and "zygoma implants" or "zygomatic implants". Manual revision of the references of the selected studies was also performed.

The inclusion criteria were as follows: articles in English; case reports, case series, and literature reviews; and full-text availability. The PICOS criteria were as follows: the "population" was maxillectomy patients, with or without surgical closure of the defect; the "intervention" was prosthetic rehabilitation with ZIs; the "comparison" was the type of prosthesis performed; the "outcomes" were both the number of ZIs used and prosthetic rehabilitation; and the "study design" included case reports and case series. Systematic reviews and meta-analyses were also included.

The selection criteria included maxillectomy reports (due to oncologic resection, trauma or other etiology), the presence or not of surgical reconstruction, the use of ZIs for oral rehabilitation and reports of the type of prosthesis and implant-prosthesis connection used. When possible, Pellegrino's classification was used for the classification of the maxillectomy defect (available in the articles or conversion from the classification used) [3].

Articles were read by 2 independent reviewers and selected following the use of a standardized form, which is presented in Table 1. For each article, the number of implants placed, the age and sex of the patients, the type of reconstruction (free flap or other), the type of

Chaux-Bodard et al. © All rights reserved

Citation: Lacroix T, Jaby P, Nokovitch L and Chaux-Bodard AG. Prosthetic Rehabilitation with Zygomatic Implants after Maxillectomy: A Systematic Review. J Dent & Oral Disord. 2020; 6(3): 1132.

Table 1: Standardized form for study selection.

Eligibility criteria		yes	no	Secondary criteria	yes	no	Type if available
Topic	Maxillectomy			Reconstructed			
				Nonreconstructed			
	Use of zygomatic implants			Number			
				Localization			
				Diameter and length			
				Combined with standard implants			
	Prosthetic rehabilitation			Fixed			
				Removable			
				Obturator			
Radiotherapy							

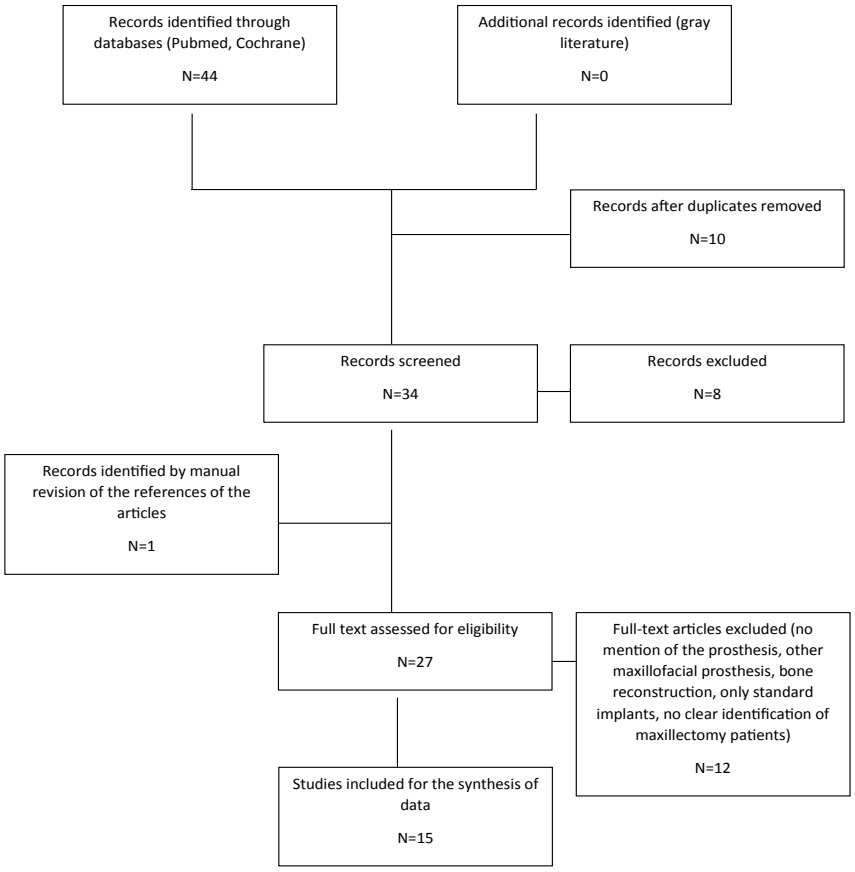

Figure 1: Flow diagram: studies were identified through searching databases and gray literature and by the manual revision of the references of the selected studies.

attachments and prostheses, whether there was a history of previous irradiation, and the specific features of the cases reported were studied. Additionally, a quality analysis of the selected articles was performed (bias and level of evidence) using the modified ROBIN's tool [4] for each included study (Table 2).

Results

Number of studies

Forty-five articles were identified: 44 through database searching and 1 by manual revision of the references of the selected articles. Duplicates were removed; after reading the abstracts, 8 articles were excluded (due to a lack of prosthetic information, a lack of ZI use, and different topic of the article). Twelve articles were excluded after reading the full-text articles (due to a lack of prosthetic parts, the use of a conventional obturator prosthesis without a ZI, the presence of bone reconstruction, the use of conventional implants only, a lack of clear separation between severe atrophy of the maxilla and maxillectomy patients…). The flow diagram is presented in Figure 1.

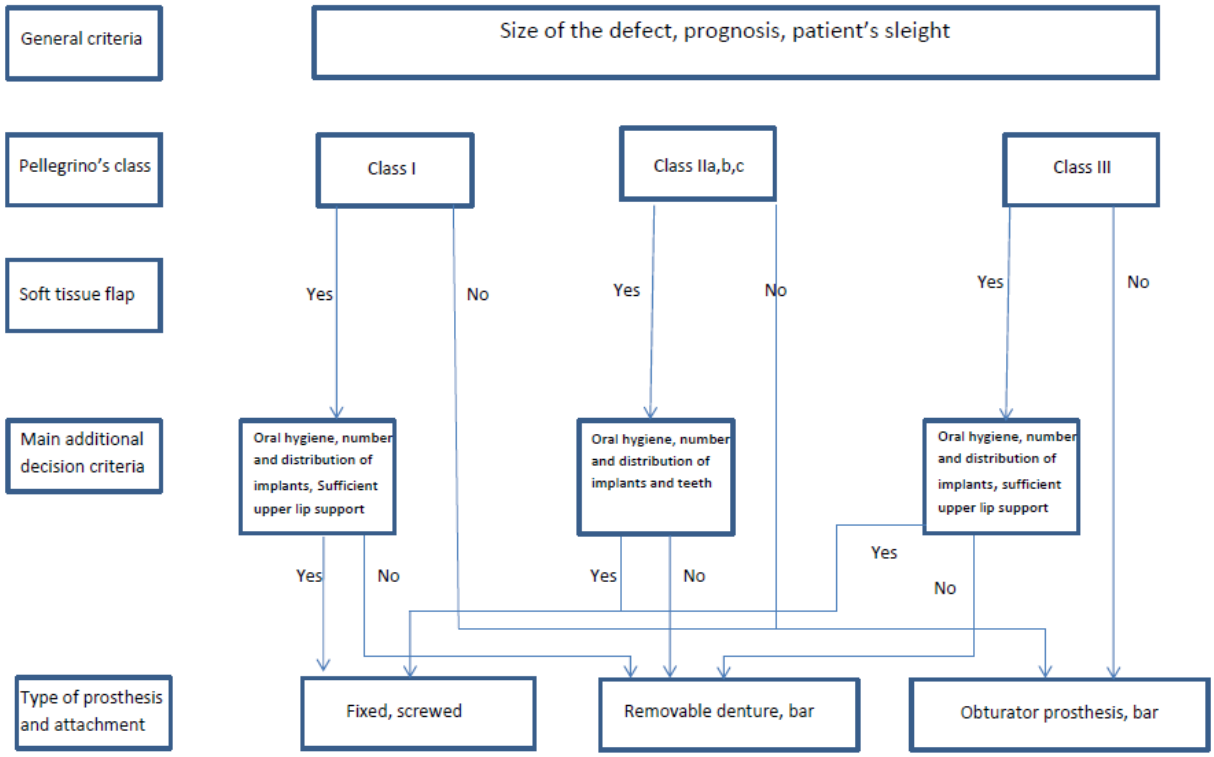

Figure 2: Decision tree for prosthetic treatment regarding general and secondary criteria and Pellegrino's classification.

Table 2: Modified Robin's tool for the risk of bias assessment, adapted for case reports and case series.

Simplified form modified from ROBIN's tool			
Publication number:			
Authors:			
Title:			
Type of study:	Series	Case report	
Confounding factors	Yes	No	No
Selection bias	Yes	No	NA
Information bias	Yes	No	NA
Performance bias	Yes	No	NA
Missing data	Yes	No	

Population

Of the 15 remaining studies, all included maxillectomy patients, with or without reconstruction (with soft-tissue flaps), who underwent rehabilitation with zygomatic implants bearing a fixed or removable denture (obturator prosthesis or not) [3,5-18]. The results of the studies are presented in Table 3. None of the meta-analyses or literature reviews were found to have sufficient clinical precise data, so they were excluded from the review. The review ultimately included 35 patients (1 patient was described twice in Ozaki's 2016 and 2018 papers) (Table 3). The studies involved nine women and 12 men. Sex was not reported for 14 patients. The age ranged from 13 to 85 years old (mean: 61.13 years old); age was not reported for 1 patient. Regarding Pellegrino's classification, 9 patients presented with class I maxillectomy, 10 to 15 patients with class IIa, 1 to 5 patients with class IIb, 3 patients with class IIc, 5 patients with class II (a, b or c) and 3 patients with class III.

Surgery

Reconstruction was performed in 8 patients and consisted of the use of soft-tissue flaps (temporalis muscle: 2; latissimus dorsi: 1; fasciocutaneous radial forearm: 1; fat pad: 2; skin flap: 1; and type not available: 1). For 9 patients, the type of flap was not clearly stated.

Radiotherapy

Radiotherapy was performed after implant placement in 17 patients, with radiation doses ranging from 50 to 63 Gy, when available. For the 16 remaining patients, there no radiotherapy was provided, or it was not mentioned in the articles.

Number of implants

Eighty-six ZIs were placed on the resected side of the maxilla; 8 ZIs were lost; and 1 ZI was associated with biomechanical complications. Of the 78 remaining implants, 4 [11] were custom-made subperiosteal implants supported by the zygoma, and 2 were placed using a "reverse" technique [7].

Type of prosthesis

A maxillary obturator prosthesis was placed in 12 patients, a fixed (screwed) prosthesis in 10 patients and a removable denture in 4 patients. The type of prosthesis was unclear in 10 patients (removable or obturator prosthesis). The types of attachments used for patients who underwent rehabilitation with removable dentures (obturator or not) were screws for fixed prostheses or a prosthetic bar (combined or not with Locator®) in 11 patients, a specific anchoring system in 1

Table 3: Details of the included studies.

Author, year (number of references)	sex	age	Pellegrino's classification (conversion from the original classification used if possible)	Flap (Yes/no) (type)	Number of zygomatic implants used (combined with classic implants)	attachment	prosthesis	Loading (time interval – months)	Radiotherapy – dose when available	Additional information
Ugurlu 2013 [5]	M	42	IIA	Yes (NA)	1(1)	screws	Fixed (bridge)	5	NA[1]	
Pia 2012 [6]	F	77	IIb	Temporalis muscle	2(1)	Bar + locators on the bar	removable	2 weeks	Yes (dose NA[1])	
Dawood 2015 [7]	F	NA[1]	I	Latissimus dorsi	2	Bar + locators	removable	rapid	50 Gy[2]	Reverse placement + custom made
Dattani 2017 [8]	M	13	IIA	No	2	Bar + locators	obturator	4	0	
Ozaki 2018 [9]	F	76	IIC	No	2	Magnetic	Obturator	8	0	
Ozaki 2018 [9]	M	81	IA	NA[1]	1(1)	Magnetic	Removable	6	0	
Ozaki 2018 [9]	F	83	IIC	No	2 (2)	Magnetic	Obturator	8	50 Gy[2] + chemotherapy	
Butterworth 2017 [10]	M	66	II a or b (=2b (Brown))	Fasciocutaneous radial forearm	4	screw	fixed	1 (immediate fixed provisory prosthesis)	63 Gy[2]	
Vosselman 2019 [11]	F	74	I (= Bilateral subtotal mx[3])	NA[1]	4 (custom made)	bar	removable	Immediate (temporary prosthesis)	60 Gy[2]	Custom made ZI like plates (subperiosteal)
Salvatori 2017 [12]	M	76	IIA	Buccal fat pad	2	screw	fixed	3	0	

patient, and magnetic attachments in 3 patients.

Quality of the studies-risk of bias

The level of evidence of the articles was low, as only case reports or short case series were included. Therefore, no meta-analysis could be performed. Nonetheless, as the aim of the study was to collect data for therapeutic decisions, the review resulted in a more consistent series.

Several biases were identified. First, the number of patients had to be reinterpreted, as Ozaki published twice the same case (in 2016 and 2018) [9,13]. In one study [14], some patients were treated with zygomatic implants due to an extremely resorbed maxilla and were not after maxillectomy, so the number of ZIs had to be cautiously interpreted. In 2 studies [14,16], the types of prostheses and attachments remained unclear, as the authors mentioned either obturation of the defect by a flap or by an obturator prosthesis. However, these factors have little influence on the ZI success rate, occlusal force and prosthetic durability. Some missing data could have influenced the interpretation of the results: there was a lack of data concerning radiotherapy; a lack of data concerning the time of radiotherapy (before or after ZI placement, time interval between radiotherapy and ZI placement); and a lack of data concerning the types of prostheses or attachments. In these cases, photos of the patients had to be used when available to assess the types of attachments used. Additionally, data regarding oral hygiene (which might have compromised the ZI success rate) were not reported.

Conclusion

Number of implants required

In this study, Pellegrino's classification was preferred for the classification of defects because it proposed a defect classification related to prosthetic rehabilitation with zygomatic implants, depending on the size of the defect [3]. Pellegrino proposes a 3-class classification system with 3 subclasses. Class I represents a bilateral maxillectomy, requiring 4 ZIs. Class IIA represents a partial maxillectomy with remaining dentures, requiring 1 or 2 ZIs on the resected side and 1 on the contralateral side. Class IIB represents a partial maxillectomy in an edentulous patient, requiring 2 ZIs in the resected part and 2 conventional implants contralaterally. Class IIC represents a partial maxillectomy in edentulous patients with bone atrophy, requiring 2 ZIs on the resected side and 1 ZI on the opposite side. Class III represents an anterior maxillectomy, requiring either ZIs if there is bone atrophy or conventional implants if the bone volume is sufficient [3]. This classification and recommendation system for ZIs has also been preferred by Salvatori [12]. For classes IIa and b, the lack of precision in the number of patients is due to a lack of precision regarding the remaining dentures in the study by Atalay [14] and of the conversion between Brown's and Pellegrino's classifications in the study by Butterworth [10].

Success rate and specific risks of failure

The ZI success rate ranges from 95.8% to 99.9% [2]. In this review, the success rate was 96.38%, but the follow-up times differed from one study to another.

Most ZI failures appeared within the 6-month surgical period, which occurs during the second-stage period, consistent with the results of Chranovic [2]. The main features of conventional ZIs are sinusitis, fistula, soft-tissue infection, paresthesia, and oroantral fistula, leading to loss of osseointegration. Smoking, radiotherapy, and cantilever force also increase the failure risk [19]. In this series, 39 ZIs were reported to be immediately placed at the time of reconstruction and 19 ZIs with secondary placement. There were 4 ZI failures: 3 in the 6-month postoperative period and 1 at a later time. Immediate placement seemed to be preferred.

Overloading of zygomatic implants could be one of the causes of implant loss [13,14]. Special care regarding biomechanical forces is required [5], especially in maxillectomy patients where no alveolar bone anchor is available. Akay [20], in a finite element analysis study, highlighted that the placement of 2 ZIs on each side of the maxilla was better than using conventional implants on the nonoperated side. Furthermore, increasing the number of implants was not mandatory. Occlusal forces should be given great attention on the nonoperated side [20]. In contrast, Atalay [14] preferred using conventional implants on the nonresected side.

External radiotherapy is also known to increase the risk of implant failure [16]. Schmidt [16] proposed ZI placement at the time of resection and at the beginning of radiation therapy within 2 to 3 weeks. In cases of secondary placement, implant loading often has to be delayed. In this series, 6 of 28 cases of ZI placement failed, of which 5/6 implants were placed in irradiated patients. Boyles-Varley [21] reported a series of 20 ZI patients in which 6 patients were irradiated without any cases of failure after an 18-month follow-up. The optimal time interval between implant placement and the beginning of radiotherapy ranges from 2 to 3 weeks [16] to 8 weeks [21]. Analysis of the cases following Pellegrino's classification and recommendation was performed and showed some differences between Pellegrino's recommendations and the number of implants placed. In most cases, the authors tried to remain in accordance with Pellegrino's recommendations. Differences could be explained by local constraints such as the number of remaining teeth, patient's sleight, or anatomical constraints. One author [16] who published results before Pellegrino seemed to have placed more implants than the number found in recent studies. It has been proven that the number of implants is not a major biomechanical factor for implant survival [20].

Flap closure

Using flap closure allows the closure of the defect and isolates zygomatic implants from the oral cavity [6]. Local or locoregional flaps such as temporalis muscle flaps or fasciocutaneous free flaps such as radial forearm flaps [10] allow separation between the sinus and the oral cavity, restoring etancheity [3,12]. Soft-tissue flaps can be placed in vascular compromised patients and/or in elderly patients [10]. Nonetheless, conventional implants cannot be placed with these flaps. Butterworth [10] suggested a ZI-perforated microvascular soft-tissue flap for the rehabilitation of maxillectomy patients, which is of great interest by Brown for class 2B patients [9] – i.e., class IIa or b according to Pellegrino's classification. No correlation could be found between reconstruction (or not) and the type of defect or between the type of flap and the type of defect. Flap overgrowth (over ZI emergence) was observed, and Butterworth [10] proposed the placement of a small polythene disk around the ZI to prevent this overgrowth. Without flap closure, ZIs allow simple postoperative observations [13].

Chronology of the treatment

Despite some heterogeneity in the different studies, the immediate placement of zygomatic implants during resection and flap reconstruction seemed to allow a better success rate [10,19], especially if postoperative radiotherapy was mandatory. Indeed, placement allowed primary osseointegration before radiotherapy [12], which limited the possible adverse effects of implant placement on osseointegration. Furthermore, placement of the zygomatic implants when performing the maxillectomy allowed direct vision of the zygoma, thus making it easier to place the implants [12]. The use of computer-aided systems and planification remain mandatory for better predictability [3]. Immediate loading is possible due to the high initial stability of ZIs. Immediate versus secondary loading is controversial; some authors think that it is preferable, whereas others [14] admit that the relationship between the loading and success rates is unclear. It seems that immediate loading is preferable in cross arch rehabilitations, with solidarization of the ZI, whereas it must be discussed in unilateral rehabilitations [8], especially in oncologic patients.

Screwed retention bars can be associated with fasteners [8]. Between ZI placement and loading, small polyethylene disc cuts surrounding the implants can be placed to prevent flap overgrowth [9].

Prosthetic considerations

Prosthetic management depends on the number of implants placed, the presence or absence of reconstruction, the number of residual teeth, and the type of bone defect. A trapezoid prosthesis basal design should be preferred [22]. Obturator prostheses may have a high score in terms of quality of life and functional results [9]; however, the results highly depend on the extent of the resection, particularly in its horizontal component, which influences the stabilization and retention of the prosthesis [8] and on the eventual remaining teeth needed to support the prosthesis [9]. The use of implants and ZIs has dramatically increased the effectiveness of the prosthesis in these cases.

Different attachments are described in the literature: magnetic, telescope or screwed prostheses [19]. To overcome the increased failure risk due to overloading, the use of magnetic attachments with weak forces can be proposed [9,13]. Maintenance is easier than with ball attachments, with however the remaining problem of the lateral forces that may mobilize the prosthesis. Thus, magnetic attachments can be used in cases of obturator prostheses because the obturator provides lateral stabilization of the prosthesis. Stabilization of the obturator prosthesis with ZIs avoids the superior displacement of the prosthesis in the maxillectomy cavity [19]. However, the risks of implant fracture and peri-implantitis remain.

Temporary prostheses are often necessary because of the need for flap monitoring in the immediate postoperative period [10,21]. Fitting is recommended during a 4- to 6-week postoperative period [10].

Quality of life

Quality of life seems to be comparable between ZI-supported obturator prostheses and fixed prostheses [19]. Primary closure of the defect should be preferred over obturator prostheses [12]. Obturator prostheses are easy to remove and allow easy local follow-up [11]; cleaning of the flap and prosthesis is easier. For conventional implants, the surgeon must keep in mind the final goal, which is the prosthesis, and thus place "prosthesis-driven implants "[11]. Several quality of life studies have compared obturator prostheses and free flap reconstruction and have not shown any significant differences

[23,24].

Outcomes

Regarding the review of the literature, in maxillectomy patients who are noncandidates for free flap reconstruction, the rehabilitation proposal should first answer the following question: is the patient a candidate for soft-tissue rehabilitation? In addition to surgical criteria, the size of the defect, patient prognosis and patient sleight can help answer this question. Depending on the decision of soft-tissue defect closure, additional criteria should be considered for the prosthetic decision: the number of implants and their distribution, which allows different biomechanical conditions; the number of remaining teeth; oral hygiene, which is more difficult in cases of fixed prostheses; and aesthetic considerations, especially in cases of anterior defects (class III of Pellegrino's classification). Figure 2 summarizes the different prosthetic treatments proposed in the case of maxillectomy regarding Pellegrino's classification.

The use of ZIs in maxillectomy patients should be considered a reliable technique in patients for whom immediate reconstruction with a microvascular free flap cannot be performed [3,5]. Nonetheless, these data should be cautiously interpreted, as long-term follow-up periods are lacking in the studies. Soft-tissue flaps are safe to perform in elderly or medically compromised patients [10]. Thus, the combination of both types of flaps may be an alternative to free flap reconstruction. Nonetheless, risk factors such as those of radiotherapy should be carefully assessed before a decision is made, as well as the number of mandatory ZIs, which remains unclear [9]. Some authors have even proposed one-stage reconstruction plus prosthetic rehabilitation for maxillectomy patients [25]. Furthermore, increased quality of life and the durability of the rehabilitation render ZI-supported prostheses a valuable technique to consider for maxillectomy patients.

References

1. Aparicio C, Manresa C, Francisco K, González-Martín O, Albrektsson T. Zygomatic implants: indications, techniques and outcomes, and the zygomatic success code. Periodontol. 2014; 66: 41-58.
2. Chranovic BR, Albrektsson T, Wennerberg A. Survival and complications of zygomatic implants: an updated systematic review J Oral Maxillofac Surg. 2016; 74: 1949-1964.
3. Pellegrino G, Tarsitano A, Basile F, Pizzigallo A, Marchetti C. Computer-Aided Rehabilitation of Maxillary Oncological Defects Using Zygomatic Implants: A Defect-Based Classification J Oral Maxillofac Surg. 2015; 73: 2446.
4. Schmucker C, Meerpohl JJ, Blümle A. Risk of bias in controlled clinical trials. Radiologe. 2019.
5. Ugurlu F, Yildiz C, Sener BC, Sertgoz A. Rehabilitation of posterior maxilla with zygomatic and dental implant after tumor resection: a case report Case Reports in Dentistry. 2013.
6. Pia F, Aluffi P, Crespi MC, Arcuri F, Brucoli M, Benech A. Intraoral transposition of pedicled temporalis muscle flap followed by zygomatic implant placement. J Craniofac Surg. 2012; 23: 463-465.
7. Dawood A, Collier J, Darwood A, Tanner S. The reverse zygomatic implant: a new implant for maxillofacial reconstruction. Int J Oral Maxillofac Implants. 2015; 30: 1405-08.
8. Dattani A, Richardson D, Butterworth CJ. A novel report on the use of an oncology zygomatic implant-retained maxillary obturator in a paediatric patient. Int J Implant Dent. 2017; 3: 9.
9. Ozaki H, Sakurai H, Yoshida Y, Yamanouchi H, Iino M. Oral Rehabilitation of Oral Cancer Patients Using Zygomatic Implant-Supported Maxillary Prostheses with Magnetic Attachment: Three Case Reports. Case Rep Dent. 2018; 16: 1694063.
10. Butterworth CJ, Rogers SN. The zygomatic implant perforated (ZIP) flap: a new technique for combined surgical reconstruction and rapid fixed dental rehabilitation following low-level maxillectomy Int J Implant Dent. 2017; 3: 37.
11. Vosselman N, Merema BJ, Schepman KP, Raghoebar GM. Patient-specific sub-periosteal zygoma implant for prosthetic rehabilitation of large maxillary defects after oncological resection Int J Oral Maxillofac Surg. 2019; 48: 115-117.
12. Salvatori P, Mincione A, Rizzi L, Costantini F, Bianchi A, Grecchi E, et al. Maxillary resection for cancer, zygomatic implants insertion, and palatal repair as single-stage procedure: report of three cases. Maxillofac Plast Reconstr Surg. 2017; 39: 13.
13. Ozaki H, Ishikawa S, Kitabatake K, Yusa K, Sakurai H, Iino M. Functional and aesthetic rehabilitation with maxillary prosthesis supported by two zygomatic implants for maxillary defect resulting from cancer ablative surgery: a case report/technique article Odontology. 2016; 104: 233-38.
14. Atalay B, Doğanay Ö, Saraçoğlu BK, Bultan Ö, Hafiz G. Clinical Evaluation of Zygomatic Implant-Supported Fixed and Removable Prosthesis J Craniofac Surg. 2017; 28: 185-89.
15. Mittal S, Agarwal M, Chatterjee D. Rehabilitation of posterior maxilla with obturator supported by zygomatic implants. Case Reports in Dentistry. 2018; 3437417.
16. Schmidt BL, Pogrel MA, Young CW, Sharma A. Reconstruction of extensive maxillary defects using zygomaticus implants. J Oral Maxillofac Surg. 2004; 62: 82-89.
17. Shirota T, Shimodaira O, Matsui Y, Hatori M, Shintani S. Zygoma-implant supported prosthetic rehabilitation of a patient with a maxillary defect Int J Oral Maxillofac Surg. 2011; 40: 113-17.
18. Kreissl ME, Heydecke G, Metzger MC, Schoen R. Zygoma-implant supported prosthetic rehabilitation after partial maxillectomy using surgical navigation : a clinical report J Prosth Dent. 2007; 97: 121-28.
19. Butterworth CJ. Primary vs secondary zygomatic implant placement in patients with head and neck cancer-A 10-year prospective study Head Neck. 2019; 41: 1687-95.
20. Akay C, Yalug S. Biomechanical 3-dimensional finite element analysis of obturator prostheses retained with zygomatic and dental implants in maxillary defects. Med Sci Monit. 2015; 21: 604-11.
21. Boyes-Varley JG, Howes DG, Davidge-Pitts KD, McAlpine JA. A protocol for maxillary reconstruction following oncology resection using zygomatic implants Int J Prosth. 2007; 20: 521-31.
22. Landes CA, Paffrath C, Koehler C, Thai VD, Stübinger S, Sader R, et al. Zygoma implants for midfacial prosthetic rehabilitation using telescopes: 9-year follow-up. Int J Prosthodont. 2009; 22: 20-32.
23. Dos Santos DM, De Caxia FP, Bitencout SB, Turcio KH, Pesqueira AA, Goiato MC. Oral rehabilitation of patients after maxillectomy A systematic review Br J Oral Maxillofac Surg. 2018; 56: 256-66.
24. Brandao TB, Vechiato Filho AJ, De Souza Batista VE, Querido de Oliveira MC, Santos-Silva AR. Obturator prostheses versus free tissue transfers : a systematic review of the optimal approach to improving the quality of life for patients with maxillary defects. J Prosth Dent. 2016; 115: 247-53.
25. Ekstrand K, Hirsch JM. Malignant tumor of the maxilla: virtual planning and real-time rehabilitation with custom-made R-zygoma fixtures and carbon-graphite fiber-reinforced prosthesis Clin Impl Dent Relat Res. 2008; 10: 23-29.