MedNEXT Journal of Medical and Health Sciences

RESEARCH ARTICLE

DOI: 10.34256/mdnt2137

Zygomatic Implant: State of the Art

Henrique Esteves Magalhães [1,2], Priscilla Janaína de Lima Borelli Bovo [1,2], Luciano Rodrigues Neves [1,2], Marcelo Henrique Batista Santos [1,2], Rogério Luiz de Araújo Vian [1,2,3], Elias Naim Kassis [1,2], Álvaro José Cicareli [1,2]

[1] University Center North Paulista (Unorp) - Sao Jose do Rio Preto, Sao Paulo, Brazil.
[2] Post graduate and continuing education (Unipos), Street Ipiranga, 3460, Sao Jose do Rio Preto, Sao Paulo, Brazil
[3] Santa Casa Hospital-Bucomaxillo Facial Traumatology Center- Ribeirao Preto, Sao Paulo, Brazil.

*Corresponding author Email: financeiro.integra.cco@gmail.com

DOI: https://doi.org/10.34256/mdnt2137

Received: 23-05-2021 ; Accepted: 06-06-2021; Published: 10-06-2021

Abstract: Introduction: In the dental implant scenario, the rehabilitation of the maxilla severely reabsorbed with endosseous implants remains a challenge. There are less aggressive alternatives, including short implants, inclined implants, and especially zygomatic (ZI) implants. In cases where the height and width of the residual bone do not allow the placement of conventional dental implants, the ZI can be considered. **Objective:** Conducted a concise systematic review to analyze the main literary findings on the use of the zygomatic implant as an important alternative for a dental implant, to present the state of the art to the dental community. **Methods:** The present study followed a concise systematic review model. The search was carried out in the PubMed, Embase, Ovid, Cochrane Library, Web Of Science, and Scopus databases. The quality of the studies was based on the GRADE instrument and the risk of bias was analyzed according to the Cochrane instrument. **Results and Conclusion:** Zygomatic implants appear to be a consolidated therapeutic option for significantly atrophic maxilla, offering a promising alternative to costly heavy bone graft techniques, fewer complications, less time for rehabilitation, less required prosthodontic work, and significantly higher survival rates. Thus, the zygomatic implant is revolutionizing the implant procedure in the posterior atrophic maxilla, eliminating the complications of bone augmentation and sinus elevation, with delayed healing, showing better clinical results compared to the bone graft, pointing to a possible gold standard for a dental implant.

Keywords: Zygomatic implantation, Dental Implants, Bone atrophy, Bone graft, Complications, Survival.

1. Introduction

In the dental implant scenario, the rehabilitation of the maxilla severely reabsorbed with endosseous implants remains a challenge [1,2]. Several surgical procedures have been advocated to treat the atrophic maxilla, including graft techniques (block, compound, interposition Le Fort I and the iliac crest and maxillary sinus grafts), elevation of the sinus floor, and guided bone regeneration [3–5]. However, there are less aggressive alternatives, including short implants, inclined implants, and especially zygomatic implants (ZI) [6,7].

In this sense, in cases where the height and width of the residual bone do not allow the placement of conventional dental implants, the ZI can be considered. In the last decades, different bone graft procedures have been advocated before or simultaneously with implant placement in routine treatments to increase the volume of bone load support [8]. Conventional grafting with autogenous bone has been considered the "gold standard" in the treatment of extremely atrophic jaws, but due to the high failure rates of 10-30%, additional time, and higher costs, the development and introduction of a new standard with results superior clinical trials is essential [9,10].

In this regard, the placement of ZI proves to be a reliable method to reconstruct severe maxillary atrophy and defects in the maxillary deficiency. The placement of ZI is more complex and more challenging than the placement of conventional oral implants, especially in the quadruple approach. The application of navigation surgery in complex craniomaxillofacial procedures has become very useful in transferring the surgical plan to the patient and in preventing adjacent anatomical injuries [11].

Also, in certain situations in which the placement of conventional implants is not possible without advanced surgical procedures, the ZI can be used as a preferable treatment option for completely

and partially edentulous jaws, with insufficient bone volume [12-15].

Thus, conventional treatment with implants cannot be performed on the edentulous maxilla in some patients due to advanced bone resorption and/or the presence of extensive maxillary sinuses, leading to inadequate amounts of bone tissue for anchoring the implants [16-18]. For more than three decades, bone grafting before or simultaneously with implant placement has become routine in oral rehabilitation [18].

Therefore, the present study carried out a concise systematic review to analyze the main literary findings on the use of the zygomatic implant as an important alternative for a dental implant, to present the state of the art to the dental community.

2. Methods

2.1. Study Design

This study followed a concise systematic review model, following the rules of systematic review - PRISMA (Transparent reporting of systematic reviews and meta-analysis-HTTP: //www.prisma-statement.org/) [19].

2.2. Search Strategy and Sources

The search strategy was carried out in the databases PubMed, Embase, Ovid, Cochrane Library, Web Of Science, and Scopus, using the keywords Zygomatic Implant. Dental Implants. Bone atrophy. Bone graft. Complications. Survival, and use of the Booleans "and" among descriptors and "or" among historical findings.

2.3. Study Quality and Bias Risk

The quality of the studies was based on the GRADE instrument [20] and the risk of bias was analyzed according to the Cochrane instrument [21].

3. Results And Discussion

After the literary search criteria, a total of 129 studies were found that were submitted to the eligibility analysis, and, after that, 53 studies of high to medium quality and with risks of bias were selected that do not compromise the scientific basis of the studies (Figure 1).

3.1 Risk of bias

Considering the Cochrane tool for risk of bias, the overall assessment resulted in 4 studies with a high risk of bias and 2 studies with uncertain risk. The domains that presented the highest risk of bias were related to the number of participants in each study approached, and the uncertain risk was related to the complications rate to zygomatic implants. Also, there was an absence of the source of funding in 3 studies and 2 studies did not disclose information about the conflict of interest statement.

After a thorough analysis of these selected studies, it was found that restoring the dentition of an edentulous patient is often a challenge. Endosseous dental implants have allowed for much more versatility in this area, but still require adequate maxillary and mandibular alveolar bone. Unless significant bone graft techniques are used, true dentition restoration may be impossible with traditional bone implants. The advent of zygomatic implants may provide a viable, predictable and stable alternative for restoring dentition in patients with the severe maxillary alveolar bone loss [22].

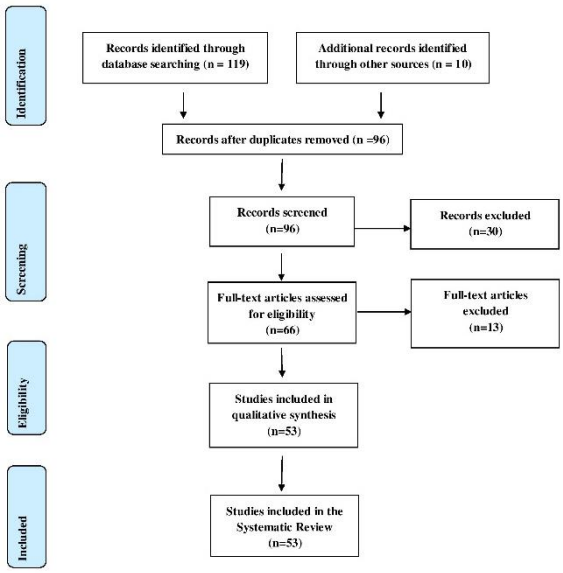

Figure 1. Flow Chart of Study Eligibility.

Also, prosthetic rehabilitation of the atrophic edentulous maxilla is a challenge for which ZI stand out from traditional techniques with reduced treatment duration and immediate loading [12,13]. Some studies showed that implant survival rate was 100.0 % over follow-up periods varying from 5 to 47 months [14-16].

During postoperative follow-up, two patients presented with slight palate inflammation [17]. The results obtained with ZI are satisfactory in terms of reproducibility and speed of rehabilitation of the maxillary. When the patient wishes a fixed prosthetic rehabilitation, the solution provided by the ZI becomes more common in the daily practice of the clinician [17,18].

According to the main guidelines for the placement of the ZI, in the appropriate bone zone 1 and the absence of bilateral bone in zones 2 and 3, two to four axial implants are indicated [23]. Typically, two to four conventional implants are distributed in the anterior maxilla plus a zygomatic implant on each premolar / molar side. In the appropriate bone zone 1 and absence of bone in zones 2 and 3 on only one side. A single zygomatic implant is placed and conventional implants are placed in the anterior maxilla and on the opposite side to the zygomatic implant. In the inadequate bone zone 1 and adequate immaculate bone in zones 2 and 3. An anterior zygomatic implant, together with conventional posterior implants, can solve the problem [24].

In the absence of bone in the three areas of the maxilla. Four zygomatic implants can be used for rehabilitation. In the presence of inadequate bone in zones 1, 2, or 3 in a partially edentulous patient, it is recommended to place three implants to support a partial denture. Also, the use of ZI in partially edentulous patients requires more clinical validation before widespread use can be advocated [25].

Thus, a study systematically reviewed and compared the survival rates (SR) of oral rehabilitation performed with 2 zygomatic implants (ZIs) combined with two regular implants (IR) versus 4 ZI [13]. The literature search resulted in a total of 417 studies, of which 6 were included in this study. For the control group (2 ZIs + 2 IR) and the test group (4 ZIs), the implant RS was 98.6% and 97.4%, respectively, with 95.0% CI. There were no statistically significant differences in terms of SR between the two groups, with $p = 0.286$. Therefore, the analysis of the data showed favorable results for the treatment with 4 ZIs. The results showed no statistical differences in the use of 1 or another treatment, in terms of survival and failure rates. The reduction in treatment time and morbidity related to regenerative approaches maybe its main advantage. In conclusion, ZI seems to be the treatment of choice for the rehabilitation of the severely atrophic maxilla.

Besides, a literature review study, with 32 analyzed articles, reported the current evidence for the use of ZI in head and neck cancer patients for prosthetic rehabilitation of midface and maxilla defects. Overall survival rates of 77% -100% were reported with few complications, although only four centers had data on 20 or more patients. Primary implant placement at the time of resection surgery is an effective means of accelerating rehabilitation along with early loading protocols. The role of radiotherapy in implant failure has not been fully elucidated, and ZI can be used successfully in the irradiated patient. Thus, ZI can provide remote anchorage for a variety of oral and facial prostheses that contribute to improving the function and quality of life of patients undergoing treatment of maxillary and midfacial tumors [26].

Also, a systematic review study with 12 scientific articles evaluated the accuracy and complications of dynamic navigation in the placement of ZI. According to the Joanna Briggs Institute tool, the average score for case reports (± standard deviation) was 6.4 (range, 9/9 to 8/9) and the average score for observational studies (± standard deviation) was 5.66 (variation, 5/9 to 7/9) as measured by the New Castle Ottawa tool. The materials included pointed out that greater precision and a drastic reduction in the risk of perioperative/postoperative complications were reported using the dynamic navigation system compared to placing freehand implants [27].

Also, although ZI presents a unique treatment option for patients with severe maxillary resorption, the palatine-positioned ZI platforms will result in significant buccal-palatal cantilever, speech disorders, and unhygienic prosthetic contours. Thus, a study presented a new preoperative workflow to help achieve predictable surgical and prosthetic results with ZI. With ZI, the application of a prosthesis-driven approach is possible. However, it involves a unique application of the traditional principles of biomechanics and soft tissues of implantology and the digital integration of prosthetic and surgical treatment plans. The objective of ZI placement should be the effort to obtain platforms as close as possible to the central fossae and cingulate of prosthetic teeth [28].

Besides, a study evaluated 141 ZI in 45 patients for reconstruction of severely atrophic jaws. The mean age of the patients was 51.76 (range: 23 to 72) years. Three patients were rehabilitated with removable prostheses, 19 patients with fixed prostheses, and 23 patients with hybrid prostheses. The overall complication rate was 5.67% (two

zygomatic implants developed infection [1.4%], one zygomatic implant developed peri-implantitis [0.7%], three zygomatic implants developed sinusitis [2.1%] and two zygomatic implants showed unsuccessful prosthetic rehabilitation [1.4%]). The follow-up period ranged from 6 to 36 months. The clinical complications of zygomatic ZI are acceptable and their survival rates are similar to those of endosteal implants. Also, the ZI can contribute to prosthetic rehabilitation [29].

Besides, another study included sixty-eight studies, comprising 4556 ZI in 2161 patients with 103 failures [14]. The cumulative 12-year survival rate was 95.21%. Most of the failures were detected within the 6-month post-surgical period. Studies (n = 26) that exclusively evaluated load showed a statistically lower rate of ZI failure than studies (n = 34) evaluating loading protocols (p = 0.003). Other studies (n = 5) evaluating IZ for the rehabilitation of patients after maxillary resections had lower survival rates. In this context, complications in the postoperative period were as follows: sinusitis, 2.4%; soft tissue infection, 2.0%; paresthesia, 1.0%; and oroantral fistulas, 0.4%. However, these numbers can be underestimated because many studies did not mention the prevalence of these complications.

Thus, the ZI has a high rate of survival accumulated in 12 years, with the majority of failures occurring in the early stages in the postoperative period. The main complication observed related to zygomatic implants was sinusitis, which can appear several years after implantation surgery [15]. The presence of increased maxillary sinus pneumatization with advanced resorption of the posterior alveolus may result in the insufficient bone to anchor the implant [15]. Bone augmentation is generally necessary under these conditions to allow the placement of a sufficient number and length of implants. Another more serious condition would be defects of maxillectomy, aplasia of the maxillary sinus, and cleft deformities [15].

In this sense, the ZI offers an effective alternative for the treatment of an atrophic jaw. Survival decreases during the first year after surgery and is more related to local infection than to the number of ZI. Also, the survival of osseointegrated implants can be related to the use of adequate pre-surgical exams and the parameters used during surgical procedures [16].

In this sense, the indications for ZI can be for the treatment of severely atrophic edentulous jaws without using any bone augmentation procedure [30]. There may be two different clinical situations involved, treatment of the partially edentulous jaw severely atrophic, avoiding breast elevation or other grafting procedures; maxillary reconstruction after partial or total maxillectomy, ZI can be used to fix maxillary obturators as an alternative to non-implanted obturators, local and regional flaps and microvascular free flaps [31-35].

Also, ZI can provide the only solutions for patients with the severely atrophic posterior maxilla, especially those that result from surgical removal of tumors, and for patients who cannot tolerate conventional removable prostheses [36-41]. These patients can be treated satisfactorily if a comprehensive preoperative evaluation is performed, followed by careful case planning, meticulous surgical technique, and appropriate biomaterial selection [42-47].

In cases where a ZI is considered for oral rehabilitation, a computerized surgical stent must be used, a delayed loading protocol must be in place, a rigid connector must be placed between the implant and the prosthesis for better distribution of occlusal loads [48 -51], and the implants must be placed in an arc shape to neutralize the flexing forces [52,53].

Besides, a systematic review study showed the result of ZI loaded immediately, with an average follow-up of 12 months. The survey provided 236 titles for immediately loaded zygomatic implants and resulted in 106 abstracts for analysis. Full-text analysis was performed on 67 articles, resulting in the inclusion of 38 articles for this systematic review. Therefore, it was shown that the immediate loading of zygomatic implants for the restoration of the severely atrophic maxilla presents a viable alternative for the treatment of the atrophic maxilla [15].

Finally, another systematic review study showed that the reliability of oral rehabilitation by four ZIs without previous support has yet to be determined [1]. The study evaluated the predictability of this approach to implant survival, technical and biological complications, and quality of life. Human clinical trials in which oral rehabilitation was performed using four ZI's without additional placement of standard implants were included. The weighted average of the ZI survival rate was 96.7%. Also, patient satisfaction levels were high. Therefore, rehabilitation of the maxilla by four zygomatic implants without previous support is a reliable approach.

4. Conclusion

Zygomatic implants appear to be a consolidated therapeutic option for a significantly atrophic maxilla, offering a promising alternative to costly heavy bone graft techniques, fewer complications, less time for rehabilitation, less required prosthodontic work, and significantly higher survival rates. Thus, the zygomatic implant is revolutionizing the implant procedure in the posterior atrophic maxilla, eliminating the complications of bone augmentation and sinus elevation, with delayed healing, showing better clinical results compared to the bone graft, pointing to a possible gold standard for a dental implant.

References

[1] B. Friberg, The posterior maxilla: clinical considerations and current concepts using Brånemark System implants, Periodontology 2000, 47 (2008) 67–78. [DOI] [PubMed]

[2] P.S. Petrungaro, G.M. Kurtzman, S. Gonzales, C. Villegas, Zygomatic implants for the management of severe alveolar atrophy in the partial or completely edentulous maxilla, Compend Contin Educ Dent 39 (2018) 636–645. [PubMed]

[3] T. Starch-Jensen, J.D. Jensen, (2017) Maxillary sinus floor augmentation: a review of selected treatment modalities, Journal of Oral & Maxillofacial Research, 8 (2017) e3. [DOI] [PubMed]

[4] S.A. Ali, S. Karthigeyan, M. Deivanai, A. Kumar, Implant rehabilitation for atrophic maxilla: a review, Journal of Indian Prosthodontic Society, 14 (2014) 196–207. [DOI] [PubMed]

[5] M. Merli, M. Moscatelli, U. Pagliaro, G. Mariotti, I. Merli, M. Nieri, Implant prosthetic rehabilitation in partially edentulous patients with bone atrophy, An umbrella review based on systematic reviews of randomised controlled trials, European Journal of Oral Implantology, 11 (2018) 261–280. [PubMed]

[6] E. Candel-Marti, C. Carrillo-Garcia, D. Penarrocha-Oltra, M. Penarrocha-Diago, Rehabilitation of atrophic posterior maxilla with zygomatic implants: review, Journal of Oral Implantology, 38 (2012) 653–657. [DOI]

[7] A. Jokstad, M. Sanz, T. Ogawa, F. Bassi, L. Levin, A. Wennerberg et al (2016) A systematic review of the role of implant design in the rehabilitation of the edentulous maxilla, International Journal of Oral and Maxillofacial Implants, 31(Suppl) s43–s99. [DOI] [PubMed]

[8] S.S. Jensen, H. Terheyden, (2009) Bone augmentation procedures in localized defects in the alveolar ridge: clinical results with different bone grafts and bone-substitute materials, International Journal of Oral & Maxillofacial Implants, 24 Suppl (2009) 218-236. [PubMed]

[9] C. Aparicio, C. Manresa, K. Francisco, P. Claros, J. Alandez, O. Gonzalez-Martin, T. Albrektsson, Zygomatic implants: indications, techniques and outcomes, and the zygomatic success code, Periodontology 2000, 66 (2014) 41–58. [DOI]

[10] S. Ramezanzade, J. Yates, F.J. Tuminelli, S.O. Keyhan, P. Yousefi, J. Lopez-Lopez, Zygomatic implants placed in atrophic maxilla: an overview of current systematic reviews and meta-analysis, Maxillofacial Plastic and Reconstructive Surgery, 43 (2021) 1. [DOI] [PubMed]

[11] Y. Wu, F. Wang, W. Huang, S. Fan, Real-Time Navigation in Zygomatic Implant Placement: Workflow, Oral and Maxillofacial Surgery Clinics of North America, 31 (2019) 357-367. [DOI] [PubMed]

[12] M. Merli, M. Moscatelli, U. Pagliaro, G. Mariotti, I. Merli, M. Nieri, Implant prosthetic rehabilitation in partially edentulous patients with bone atrophy. An umbrella review based on systematic reviews of randomised controlled trials, European Journal of Oral Implantology, 11 (2018) 261-280. [PubMed]

[13] S. Aboul-Hosn Centenero, A. Lázaro, M. Giralt-Hernando, F. Hernández-Alfaro, Zygoma Quad Compared With 2 Zygomatic Implants: A Systematic Review and Meta-analysis. Implant Dentistry, 27 (2018).

[14] A. Y Alqutaibi, A. Aboalrejal, Zygomatic Implants Are a Reliable Treatment Option for Patients with Atrophic Maxilla, Journal of Evidence-Based Dental Practice, 17 (2017) 402-404. [DOI] [PubMed]

[15] F.J. Tuminelli, L.R. Walter, J. Neugarten, E. Bedrossian, Immediate loading of zygomatic implants: A systematic review of implant survival, prosthesis survival and potential complications, European Journal of Oral Implantology, 10 Suppl 1 (2017) 79-87. [PubMed]

[16] P. Molinero-Mourelle, L. Baca-Gonzalez, B. Gao, L.M. Saez-Alcaide, A. Helm, J. Lopez-Quiles, Surgical complications in zygomatic implants: A systematic review, Medicina Oral, Patologia Oral, Cirugia Bucal, 21 (2016) e751-e757. [DOI] [PubMed]

[17] B.E. Petruson, W.C. Tan, M. Zwahlen, N.P. Lang, A systematic review of the success of

sinus floor elevation and survival of implants inserted in combination with sinus floor elevation, Journal of Clinical Periodontology, 35 Suppl. 8 (2008) 216–240. [DOI] [PubMed]

[18] F. Wang, A. Monje, G.H. Lin, Y. Wu, F. Monje, H.L. Wang, R. Davó, Reliability of four zygomatic implant-supported prostheses for the rehabilitation of the atrophic maxilla: a systematic review, International Journal of Oral & Maxillofacial Implants, 30 (2015) 293-298. [DOI] [PubMed]

[19] D. Moher, A. Liberati, J. Tetzlaff, D.G. Altman, The PRISMA Group Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLOS Medicine, 6 (2009) e1000097. [DOI]

[20] H. Balshem, M.Helfand, H.J.Schünemann, A.D. Oxman, R.Kunz, J.Brozek, G.E. Vist, Y.Falck-Ytter, J. Meerpohl, S. Norris, G. H. Guyatt, Grade guidelines: 3 ratng the quality of evidence, Journal of Clinical Epidemiology, 64 (2011) 401-406. [DOI] [PubMed]

[21] J. Higgins, S. Green, Cochrane Handbook for Systematic Reviews of Interventions. Version 5.1.0 [updated March 2011]. The Cochrane Collaboration, (2011).

[22] J. Rosenstein, H. Dym, Zygomatic Implants: A Solution for the Atrophic Maxilla: 2021 Update, Dental Clinics of North America, 65 (2021) 229-239. [DOI] [PubMed]

[23] C. Aparicio, C. Manresa, K. Francisco, P. Claros, J. Alández, O. González-Martín, T. Albrektsson, Zygomatic implants: indications, techniques and outcomes, and the zygomatic success code, Periodontol 2000, 66 (2014) 41-58. [DOI] [PubMed]

[24] M. Pineau, R. Nicot, L. Lauwers, J. Ferri, G. Raoul, Zygomatic implants in our daily practice. Part II: Prosthetic rehabilitation and effect on quality of life, Swiss Dental Journal, 128 (2018) 694-700. [PubMed]

[25] M. Pineau, R. Nicot, L. Lauwers, J. Ferri, G. Raoul, Zygomatic implants in our daily practice. Part I: Treatment Plan and Surgical Technique, Swiss Dental Journal, 128 (2018) 689-693. [PubMed]

[26] S. Hackett, B. El-Wazani, C. Butterworth, Zygomatic implant-based rehabilitation for patients with maxillary and mid-facial oncology defects: A review. Oral Dis. 27 (2021) 27-41. [DOI] [PubMed]

[27] S. Ramezanzade, S.O. Keyhan, F. J. Tuminelli, H.R. Fallahi, P. Yousefi, J. Lopez-Lopez, Dynamic-Assisted Navigational System in Zygomatic Implant Surgery: A Qualitative and Quantitative Systematic Review of Current Clinical and Cadaver Studies, Journal of Oral and Maxillofacial Surgery, 79 (2021) 799-812. [DOI] [PubMed]

[28] S. Ponnusamy, M. Miloro, A Novel Prosthetically Driven Workflow Using Zygomatic Implants: The Restoratively Aimed Zygomatic Implant Routine, Journal of Oral and Maxillofacial Surgery, 78 (2020) 1518-1528. [DOI] [PubMed]

[29] M. Yalçın, S. Can, M. Akbaş, G. Dergin, H. Garip, B.A. Aydil, A. Varol, Retrospective Analysis of Zygomatic Implants for Maxillary Prosthetic Rehabilitation, International Journal of Oral and Maxillofacial Implants, 35 (2020) 750-756. [DOI] [PubMed]

[30] Y. Wu, C. Zhang, C.H. Squarize, D. Zou, Oral Rehabilitation of Adult Edentulous Siblings Severely Lacking Alveolar Bone Due to Ectodermal Dysplasia: A Report of 2 Clinical Cases and a Literature Review, Journal of Oral and Maxillofacial Surgery, 73 (2015) 1733.e1-12. [DOI] [PubMed]

[31] L.F. Lopes, V.F. da Silva, J.F. Santiago Jr, S.R. Panzarini, E.P. Pellizzer, Placement of dental implants in the maxillary tuberosity: a systematic review, International Journal of Oral and Maxillofacial Surgery, 44 (2015) 229-238. [DOI] [PubMed]

[32] H. Ozaki, S. Ishikawa, K. Kitabatake, K. Yusa, H. Sakurai, M. Iino, 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, 104 (2015) 233-238. [DOI] [PubMed]

[33] N. Takamaru, H. Nagai, G. Ohe, T. Tamatani, K. Sumida, S. Kitamura, Y. Miyamoto, Measurement of the zygomatic bone and pilot hole technique for safer insertion of zygomaticus implants, International Journal of Oral and Maxillofacial Surgery, 45 (2015) 104-109. [DOI] [PubMed]

[34] D.R. Monteiro, E.V.F, Silva, E.P. Pellizzer, O.M. Filho, M.C. Goiato, Posterior partially edentulous jaws, planning a rehabilitation with dental implants, World Journal of Clinical Cases, 3 (2015) 65-76. [DOI] [PubMed]

[35] J.M. Yates, I.M. Brook, R.R. Patel, P. F Wragg, S.A. Atkins, A.El-Awa, I.Bakri, R.Bolt, Treatment of the edentulous atrophic maxilla using zygomatic implants: evaluation of survival rates over 5-10 years, International Journal of Oral and Maxillofacial Surgery, 43 (2014) 237-242. [DOI] [PubMed]

[36] M.C. Goiato, E.P. Pellizzer, A.Moreno,

H.Gennari-Filho, D.M. dos Santos, J.F. Santiago Jr, E.G. dos Santos, Implants in the zygomatic bone for maxillary prosthetic rehabilitation: a systematic review, International Journal of Oral and Maxillofacial Surgery, 43 (2014) 748-757. [DOI] [PubMed]

[37] Fernandez, H., et al. Zygomatic implants for the management of the severely atrophied maxilla: a retrospective analysis of 244 implants, International Journal of Oral and Maxillofacial Surgery, 72 (2014) 887-891. [DOI] [PubMed]

[38] C. Aparicio, C. Manresa, K. Francisco, P. Claros, J. Alández, O. González-Martín, T.Albrektsson, Zygomatic implants: indications, techniques and outcomes, and the zygomatic success code, Periodontol 2000, 66(2014) 41-58. [DOI] [PubMed]

[39] A. Sharma, G. R. Rahul, Zygomatic implants/fixture: a systematic review, Journal of Oral Implantology, 39 (2013) 215-224. [DOI] [PubMed]

[40] B.R. Chrcanovic, M.H. Abreu, Survival and complications of zygomatic implants: a systematic review, Journal of Oral and Maxillofacial Surgery, 17 (2013) 81-93. [DOI] [PubMed]

[41] F. Ugurlu, C. Yıldız, B.C. Sener, A. Sertgoz, Rehabilitation of posterior maxilla with zygomatic and dental implant after tumor resection: a case report, Case Reports in Dentistry, 2013 (2013) 930345. [DOI] [PubMed]

[42] T.J. Balshi, G. J. Wolfinger, N.J. Shuscavage, S.F. Balshi, Zygomatic bone-to-implant contact in 77 patients with partially or completely edentulous maxillas, Journal of Oral and Maxillofacial Surgery, 70 (2012) 2065-2069. [DOI] [PubMed]

[43] X. Rodriguez, V. Méndez, X. Vela, M. Segalà, Modified surgical protocol for placing implants in the pterygomaxillary region: clinical and radiologic study of 454 implants, International Journal of Oral & Maxillofacial Implants, 27 (2012)1547-1553. [PubMed]

[44] E. Candel, D. Penarrocha, M. Penarrocha, Rehabilitation of the atrophic posterior maxilla with pterygoid implants: a review, Journal of Oral Implantology, 38 (2012) 461-466. [DOI] [PubMed]

[45] G.N. Anandakrishna, G. Rao, Pterygomaxillary implants: a graftless solution to deficient maxillary bone, Journal of Indian Prosthodontic Society, 12 (2012) 182-186. [DOI] [PubMed]

[46] A.S. Bidra, G. Huynh-Ba, Implants in the pterygoid region: a systematic review of the literature, International Journal of Oral and Maxillofacial Surgery, 40 (2011) 773-781. [DOI] [PubMed]

[47] C. Aparicio, W. Ouazzani, A. Aparicio, V. Fortes, R. Muela, A. Pascual, M. Codesal, N. Barluenga, M. Franch, Immediate/Early loading of zygomatic implants: clinical experiences after 2 to 5 years of follow-up, Clinical Implant Dentistry and Related Research, 12 (2010) e77-82. [DOI] [PubMed]

[48] M. Stievenart, C. Malevez, Rehabilitation of totally atrophied maxilla by means of four zygomatic implants and fixed prosthesis: a 6-40-month follow-up, International Journal of Oral and Maxillofacial Surgery, 39 (2010) 358-363. [DOI] [PubMed]

[49] P. Malo, A. Nobre Mde, I. Lopes, A new approach to rehabilitate the severely atrophic maxilla using extramaxillary anchored implants in immediate function: a pilot study, Journal of Prosthetic Dentistry, 100 (2008) 354-366. [DOI] [PubMed]

[50] Rodríguez-Ciurana, XVN, V. Mendez, M.Segalá. Alternatives to maxillary sinus lift: posterior area of the atrophic maxilla rehabilitation by means pterigoideal implants, Revista Espanola de Cirugia Oral y Maxilofacial, 30 (2008) 412-419.

[51] S. Galan Gil, M. P. Diago, J. B. Martínez, Eva Marti Bowen Rehabilitation of severely resorbed maxillae with zygomatic implants: an update, Medicina oral, patologia oral y cirugia bucal, 12(2007) E216-220. [PubMed]

[52] L. Vrielinck, C. Politis, S. Schepers, M. Pauwels, I. Naert, Image-based planning and clinical validation of zygoma and pterygoid implant placement in patients with severe bone atrophy using customized drill guides. Preliminary results from a prospective clinical follow-up study, International Journal of Oral and Maxillofacial Surgery, 32(2003) 7-14. [DOI] [PubMed]

[53] Aparicio, C., P. Perales, and B. Rangert. Tilted implants as an alternative to maxillary sinus grafting: a clinical, radiologic, and periotest study, Clinical Implant Dentistry and Related Research, 3 (2001) 39-49. [DOI] [PubMed]

Acknowledgement

Nil

Funding

Not applicable

Data sharing statement

No additional data are available

Informed consent

Informed written consent obtained from the participant

Conflict of interest

The authors declare no conflict of interest.

About The License