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Zygomatic Implants as an unconventional implant strategy in atrophic maxilla-A Systematic Review

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Abstract

Aim: This systematic review aims to identify and interpret results of studies that evaluated the success rate of zygomatic implants when placed by two stage protocol and immediate loading protocol in case of atrophic maxilla and the percentages of sinusitis as a postoperative complication after zygomatic implant placement.

Settings and Design: This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic reviews and Meta-Analyses guidelines (PRISMA).

Materials and methods: Relevant articles written in English only, from 2000 till march 2021 were identified using an electronic search in the PubMed/Medline, EMBASE conducted to identify pertinent articles. The relevancy of the articles was verified by screening the

title, abstract, and full text. A total of 37 articles satisfied the criteria, from which data were extracted for qualitative synthesis.

Results: The database search resulted in 120 studies, of which 50 articles were excluded due to lack of relevance, duplication of data. From remaining 70 articles, 49 were assessed for full text eligibility, out of which 21 articles were excluded on the basis of abstract screening. Total of thirty-seven studies were included in the present systematic review.

Conclusion: The placement of zygomatic implants requires skilful and experienced clinicians as it includes vital anatomic structures. There is an impending need for conducting randomized controlled clinical trials to test the efficacy of these implants in comparison with the other traditional techniques to treat the atrophic edentulous maxilla, although they have high survival rates.

Keywords: zygomatic implants, sinusitis, immediate loading, atrophic maxiila.

Introduction

Dental implants are a common mode of rehabilitation for partially and completely edentulous patients. Patients self-esteem affects by masticatory and phonetics limitations which are usually accompanied with esthetic alterations. Many restrictions have arised especially in the posterior maxillary region due to insufficient bone volume. Traditional treatment with fixed prosthesis and dental implant gets difficult due to the same.[1] Various techniques like sinus floor augmentation, onlay bone grafts, lefort I osteotomies associated with bone graft from iliac crest were the popular and common ones to enable placement and integration of implants. However these techniques require long treatment periods and are more prone to complications. Sinusitis, contamination of grafts, mobility, postoperative pain, neurosensory disturbances are some of the most common reasons of morbidity of these techniques.[2] Insufficient bone after healing period is one of the major drawback among them.

Materials and Methods

Focused question

This systematic review attempt to answer the focused questions “what is the success rate of zygomatic implants when placed by two stage protocol and immediate loading protocol in case of atrophic maxilla?” and “what are the percentages of sinusitis as a postoperative complication after zygomatic implant placement by two stage protocol and immediate loading protocol?”

Outcome measures

The primary outcome variable measured was the success rate of zygomatic implants placed by immediate loading protocol and two stage protocol. The secondary outcome variable was to measure incidences of sinusitis associated with zygomatic implant placement as a postoperative complication.

Search strategy

A comprehensive bibliographic electronic search was conducted in Medline/PubMed, EMBASE to collect relevant articles published from 2000 till march 2021. A PRISMA statement guideline with predetermined search strategy was used. The search strategies were based on population (partially or completely edentulous maxillary ridge), intervention (patients rehabilitated with zygomatic implants with two stage and immediate loading protocol), comparison (variations in success rate zygomatic implants placed by two different protocols and associated postoperative complication i.e sinusitis), outcome (success and failures associated with zygomatic implants placement), and a study design, i.e., PICOS framework. (Table:1)

Table 1: PICOS Fame work.

Population	Partially or completely edentulous maxillary ridge
Intervention	Patients rehabilitated with zygomatic implants with two stage and immediate loading protocol
Comparison	Variations in success rate zygomatic implants placed by two different protocols and associated postoperative complication i.e sinusitis
Outcome	Success and failures associated with zygomatic implants placement
Study design	Systematic review

Selection criteria

This review includes all the studies which were related with zygomatic implant placements with different surgical protocols and their comparisons also complications associated with it.

Inclusion criteria

All articles, including studies with few case reports, were considered for inclusion. All reference lists of the selected and review studies were hand-searched for additional papers that might meet the eligibility criteria. Simple case report articles were also included.

Exclusion criteria

The exclusion criteria were letters to the editor, case series, in vitro and laboratory simulations and dental implants associated to a bone regeneration/sinus augmentation procedure. Review articles without original data were excluded.

Screening and selection

Titles and abstracts were analyzed and then the full-text articles were selected and analyzed with careful and through reading based on the inclusion and exclusion criteria for future data extraction.

Data extraction

Data extraction procedure was carried out then redefined. It was done independently from each full-text articles met inclusion criteria. Information was classified under author/year, type of study, protocol used for implant insertion, complications associated with different surgical protocols for zygomatic implant placement and author conclusion. Quantitative data extracted from the included studies that provided data for the period of failure of zygomatic implants were used for the calculation of interval survival rate during each follow-up.

Results

Search and selection

Selection criteria were based on PRISMA statement flowchart. The database search (P) resulted in 120 studies, of which 50 articles were excluded as they were irrelevant, duplicates, and data were not available. 70 primary studies were included in which 49 assessed for eligibility and 21 were excluded on the basis of abstract screening. (Fig:1) 37 studies were included in qualitative synthesis in which 16 evaluated for zygomatic implants success when placed using the two-stage protocol, while 18 evaluated when placed with immediate loading protocols, 3 of them were evaluated for both. Postoperative complications reported were as follows: 13 sinusitis in case of 2 stage protocol while 7 cases of sinusitis reported when zygomatic implants were placed by immediate loading. However, this number may be underestimated, since most of the studies did not mention the presence or absence of these complications.

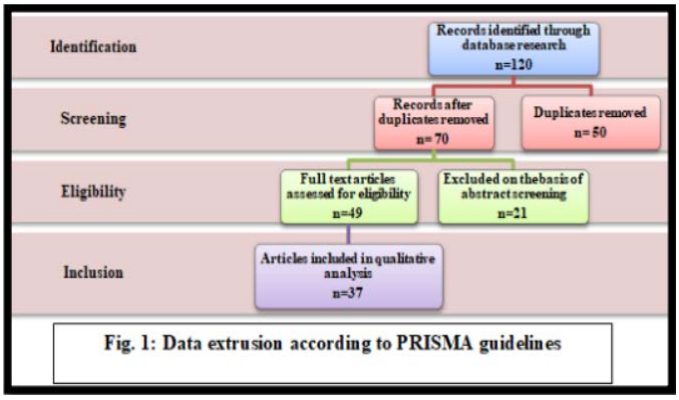

Fig. 1: Data extrusion according to PRISMA guidelines

Study characteristics

The publications reviewed for this article included 1146 patients and 2549 zygomatic implants with a follow-up period of 6 months to 18 years (table 2 and 3). In total, 41 implants were reported as failures, giving an overall survival rate of 98.36%. However, it should be noted that some studies, in part, covered the same patient groups and therefore the precise number of patients and implants is questionable. Nevertheless, the preliminary data show that the zygomatic implant technique is highly predictable and results in good clinical outcomes.

Table 2: success and failures of zygomatic implants.

Study	Follow up period	No. of patients	Zygomatic implants	Failed zygomatic implants
Parel et al.[2]	1–12 years	27	65	0
Bedrossian et al.[3]	2.8 years	22	44	0
Vrielinck et al.[4]	>2 years	29	46	3
Boyes-Varley et al.[5]	2.5 years	45	77	0
Malevez et al.[6]	0.5–4 years	55	103	0
Branemark et al [7]	1–10 years	81	164	4
Hirsch et al [8]	1 year	66	124	3
Branemark et al.[9]	5–10 years	28	52	3
Becktor et al.[10]	1–6 years	16	31	3
Penarrocha et al [11]	1–1.5 years	5	10	0
Farzad et al.[12]	1.5–4 years	11	22	0
Ahlgren et al [13]	1–4 years	13	25	0
Aparicio et al [14]	0.5–5 years	69	131	0
Bedrossian et al.[15]	1 year	14	28	0
Chow et al.[16]	10 months	5	10	0
Duarte et al [17]	2.5 years	12	48	2
Penarrocha et al [18]	3.5 years	21	40	0
Davo et al.[19]	2.5 years	18	36	0

Table 3: success and failures of zygomatic implants.

Study	Follow up period	No. of patients	Zygomatic implants	Failed zygomatic implants
Mozzati et al.[20]	2 years	17	14	0
Pi-Urgell et al.[21]	6 years	54	101	0
Davo et al.[22]	3.5 years	42	81	0
Malo et al.[23]	1.5 years	29	67	1
Balshi et al.[24]	5 years	56	110	4
Davo et al [25]	5 years	21	45	1
Aparicio et al.[26]	6-8 months	20	41	0
Aparicio et al.[27]	3 years	25	47	0
Stievenart et al.[28]	1 year	20	80	3
Davo et al.[29]	1 year	17	67	0
Migliorana et al.[30]	1 year	65	150	2
Agliardi et al.[31]	8 years	15	47	0
Butura et al. [32]	2 years	15	40	0
Chana et al.[33]	18 years	95	88	5
Coppede et al [34]	3 years	42	94	1
Degidi et al.[35]	1 year	10	20	0
Neugarten et al.[36]	4.5 years	28	105	4
Sartori et al.[37]	4 years	16	37	0
Zwahlen et al.[38]	8 months	18	34	2

Table 4: Sinus complications reported in different studies in which zygomatic implants were placed using the immediate function protocol.

Immediate function protocol	Total number of patients	Follow-up period (months)	Survival rate of zygomatic implants, %	Sinusitis (%)
Bedrossian et al.[15]	14	12-34	100	0
Chow et al.[16]	5	6	100	0
Duarte et al.[17]	12	6-30	97.9	0
Davo et al.[19]	18	6-29	100	1(5.5)
Mozzati et al.[20]	7	24	100	0
Davo et al [22]	42	12-42	100	1(2.4)
Malo et al [23]	29	6-18	98.5	4(13.8)
Balshi et al.[24]	56	9-60	96.4	0
Aparicio et al.[26]	20	6-48	100	0
Stievenart et al [28]	10	40	100	0
Davo et al.[29]	17	12	100	0
Miglioranca et al.[30]	65	>12	98.7	0
Aparicio et al.[31]	80	12-84	96.8	3(3.8)
Agliardi et al.[32]	15	79-97	100	0
Butura et al [33]	15	24	100	0
Coppede et al [35]	42	36	98.9	0
Degidi et al.[36]	10	12	100	0
Neugarten et al.[37]	28	54	96	0
Zwahlen et al.[38]	18	8	94.1	2(4.8)

Table 5: Sinus complications reported in different studies in which zygomatic implants were placed using the two stage protocol.

Two-stage protocol	Total number of patients	Follow-up period (months)	Survival rate of zygomatic implants(%)	Sinusitis (%)
Bedrossian et al.[3]	22	34	100	0
Vrielink et al.[4]	29	12-34	92	2 (6.9)
Boyes-Varley et al.[5]	45	6-30	100	0
Malevez et al [6]	55	6-48	100	5 (9)
Hirsch et al.[8]	76	12	98	3 (4)
Branemark et al.[9]	28	72-108	94	4 (14.3)
Becktor et al.[10]	16	9-69	90.3	6 (26.6)
Farzad et al.[12]	11	18-56	100	1 (9.1)
Ahlgren et al.[13]	13	12-56	100	0
Aparicio et al.[14]	69	6-60	100	3 (4.3)
Penarrocha et al.[18]	21	12-60	100	2 (9.5)
Pi-urgell et al.[21]	54	1-72	96	0
Stievenart et al.[28]	10	40	96.3	1 (1.3)
Aparicio et al.[31]	22	120	97.7	2 (9.1)
Chana et al.[34]	45	216	94.32	5 (11.1)
Coppede et al [35]	42	36	98.9	0
Sartori et al [37]	16	48	100	0
Zwahlen et al.[38]	18	6	94.4	1 (5.5)
Davo et al.[39]	24	60	97.4	5 (20.8)

Discussion

Zygomatic implants have enabled sufficient rehabilitation in patients with edentulous maxillary atrophic ridge, providing restored function and improved esthetics, and has given many patients back a normal social life. Bothur et al. [41] described a modification of the standard zygomatic implant placement technique, using more than three implants on each side of the upper maxilla to support the dental prosthesis, and thus obviating the bone graft procedures in the premaxillary zone.

According to Bedrossian et al. [42] the maxilla can be divided into three zones:

Zone 1: The Premaxilla

Zone 2: The Premolar Area

Zone 3: The Molar Area

The clinician should determine the availability of bone in all three zones. Cone beam computed tomography can be used to determine the amount of bone in these zones as well as in the zygomatic arch, in both horizontal and vertical dimensions. Moreover, any pathology in these areas, as well as in the maxillary sinuses, needs to be verified pre-operatively. In the presence of adequate bone in zones 1 and 2, the clinician can consider the use of four to six conventional implants, tilting the most distal one on each side to achieve good load distribution. As such, one can bypass the need for bone grafting. The anterior extent or position of the sinuses, as well as the slope of the anterior sinus walls, determine both the most posterior position of the distal implant as well as its angulation. Various techniques for the placement of zygomatic implants are documented in the literature.

Branemark technique suggested a proper axis path extends from the premolar region traversing the maxillary sinus, entering the mid portion of the zygomatic body.[9] Stella and Warner have described a simplified technique for installation of zygomatic implants. This technique uses a lateral slot outside of wall of the maxillary sinus, avoiding the contact of the implant with the sinuses membrane.[43] The zygomatic implant is installed outside the maxillary sinus, reducing surgical time and the risk of sinus adverse events, and improving surgical visualization.

The extra sinus technique for installation of zygomatic implants have been reported, with high success rates.[35] Generally, with standard end osseous implants, the occlusal force is parallel to the long axis of the implant. In zygomaticus implants, the implant is at a 30 ° to 60 ° angle relative to the occlusal force. These biomechanical requirements can contribute to zygomaticus implant failures in patients following extensive maxillectomy. The zygoma bone offers a solid and extended anchorage due to thick cortical layer, also it is situated at a large distance from the occlusal level that can support the masticatory forces applied to the occlusal level.[28] Non-traditional implant anchorage sites have been developed to circumvent compromised maxillary bone anatomy and volume. Such sites are pterygoid plates, zygoma and vomer. [33] Testori et al. [44] stated that tilting the most distal implants one can decrease the posterior maxillary implant length.

The development of zygomatic implants has allowed the reconstructive specialist to overcome the regional hard tissue deficiency by engaging bone at distant sites for increased stability/retention of a

maxillary obturator/prosthesis after maxillary resection. Maxillary rehabilitation can be further improved by using the vascularized bone graft and zygomatic implants or can mostly circumvent the need for vascularized osseo-myo-cutaneous grafts or these grafts in combination with non-vascularized free bone grafts. Sometimes, the implant placement at the time of initial resection surgery also allows for end osseous implant integration prior to commencement of postoperative radiotherapy, since irradiated tissues have impaired bone healing. Reconstitutions of the buttresses system ensure a stable base for occlusion, which is essential to optimal functional and esthetics maxillary rehabilitation. It was speculated that deficient osseointegration of the coronal part of the zygomatic implants results in the formation of an oroantral fistulae and infection. The problem may be due to lack of contact between the residual alveolar crest and the implant, thereby creating a communication between the oral and sinus cavities. Sartori et al. [38] stated that there was no case of loss of the zygomatic fixtures and conventional implants or fracture of the metallic bar of the fixed dentures among the 16 patients. Half of the patients returned for clinical evaluation, and 12.5% were treated more than 3 times to resolve the complication. According to stievenart et al. [28] 20 consecutive patients shows the benefits of inserting four zygomatic implants in the zygoma providing a steady anchorage for a fixed prosthesis and a prosthesis retained on a screwed fixed bar (table 4 and 5).

In the cases of sinusitis, the treatment is administration of antibiotics and/or meatotomies and repositioning the soft tissue without the removal of the stable zygomatic implants. If the infection does not resolve with one or two rounds of oral antibiotic therapy, there may be a concern that the implant is acting as a foreign body and is responsible in part for the persistence of the infection, and its removal may be indicated.

Branemark has demonstrated that zygoma is reliable site for implant placement and with the ability to control

occlusal platform immediate loading can be achieved. [9] The use of zygomatic implants reduces morbidity, shortens the treatment time and the number of implants required supporting fixed bridge prosthesis. It also reduces the expenses of treatment. The zygomatic implants technique is a complex surgical procedure which needs proper training and skill. The patient needs to be informed about the possible complications involved for eg: soft tissue complications at the abutment level, sinusitis, failure in osseointegration. Due to the palatal location of the implants in some surgical approaches, a more complex restorative design is needed.

Conclusion

The placement of zygomatic implants requires skilful and experienced clinicians as it includes vital anatomic structures. There is an impending need for conducting randomized controlled clinical trials to test the efficacy of zygomatic implants in comparison with the other traditional techniques to treat the atrophic edentulous maxilla, although they have high survival rates. Thus, the findings reported in the review must be interpreted with considerable caution. The use of zygomatic fixtures in patients with atrophic maxilla was predictable and reliable.[38] However, more studies with longer follow-up periods involving adequate number of zygomatic implants are needed. This will help to obtain a detailed information about survival of zygomatic implants in long term phases. It is suggested that multicenter, randomized controlled clinical trials and longer clinical studies should be implemented in this area, before recommending routine use of zygomatic implants for patients could be given.

References

1. Migliorança RM, Irschlinger AL, Peñarrocha-Diago M, Fabris RR, Vicente JA, et al. History of Zygomatic Implants: A Systematic Review and Meta-Analysis. Dent Oral Craniofac Res.2019;5-7
2. Parel SM, Branemark PI, Ohrnell LO, Svensson B. Remote implant anchorage for the rehabilitation of maxillary defects. J Prosthet Dent 2001: 86: 377–381.
3. Bedrossian E, Stumpel L III, Beckely ML, Indre Sano T. The zygomatic implant: preliminary data on treatment of severely resorbed maxillae. A clinical report. Int J Oral Maxillofac Implants 2002: 17: 861–865
4. Vrielinck L, Politis C, Schepers S, Pauwels M, Naert I. 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. Int J Oral Maxillofac Surg 2003: 32: 7–14.
5. Boyes-Varley JG, Howes DG, Lownie JF, Blackbeard GA. Surgical modifications to the Branemark zygomaticus protocol in the treatment of the severely resorbed maxilla: a clinical report. Int J Oral Maxillofac Implants 2003: 18: 232– 237.
6. Malevez C, Abarca M, Durdu F, Daelemans P. Clinical outcome of 103 consecutive zygomatic implants: a 6–48 months follow-up study. Clin Oral Implants Res 2004: 15: 18–22.
7. Darle C. Branemark system, Nobel BioCare, 2nd edn. Gothenburg, Sweden: Nobel Biocare AB, 2000
8. Hirsch JM, Ohrnell LO, Henry PJ, And reasson L, Branemark PI, Chiapasco M et al. A clinical evaluation of the Zygoma fixture: one year of follow-up at 16 clinics. J Oral Maxillofac Surg 2004: 62(Suppl. 2): 22–29
9. Branemark PI, Gröndahl K, OhrnellL O, Nilsson P, Petruson B, Svensson B et al. Zygoma fixture in the

management of advanced atrophy of the maxilla: technique and long-term results. Scand J Plast Reconstr Surg Hand Surg 2004: 38: 70–85

10. Becktor JP, Isaksson S, Abrahamsson P, Sennerby L. Evaluation of 31 zygomatic implants and 74 regular dental implants used in 16 patients for prosthetic reconstruction of the atrophic maxilla with cross-arch fixed bridges. Clin Implant Dent Relat Res 2005: 7: 159–165
11. Penarrocha M, Uribe R, Garcia B, Marti E. Zygomatic implants using the sinus slot technique: clinical report of a patient series. Int J Oral Maxillofac Implants 2005: 20: 788–792
12. Farzad P, Andersson L, Gunnarsson S, Johansson B. Rehabilitation of severely resorbed maxillae with zygomatic implants: an evaluation of implant stability, tissue conditions, and patients opinion before and after treatment. Int J Oral Maxillofac Implants 2006: 21: 399–404.
13. Ahlgren F, Storksen K, Tornes K. A study of 25 zygomatic dental implants with 11 to 49 months follow-up after loading. Int J Oral Maxillofac Implants 200
14. Aparicio C, Ouazzani W, Garcia R, Arevalo X, Muela R, Fortes V. A prospective clinical study on titanium implants in the zygomatic arch for prosthetic rehabilitation of the atrophic edentulous maxilla with a follow-up of 6 months to 5 years. Clin Implant Dent Relat Res 2006: 8: 114–122.
15. Bedrossian E, Rangert B, Stumpel L, Indresano T. Immediate function with the zygomatic implant: a graftless solution for the patient with mild to advanced atrophy of the maxilla. Int J Oral Maxillofac Implants 2006: 21: 937–942
16. Chow J, Hui E, Lee PK, Li W. Zygomatic implants protocol for immediate occlusal loading: a preliminary report. J Oral Maxillofac Surg 2006: 64: 804–811
17. Duarte LR, Filho HN, Francischone CE, Peredo LG, Branemark PI. The establishment of a protocol for the total rehabilitation of atrophic maxillae employing four zygomatic fixtures in an immediate loading system – a 30-month clinical and radiographic follow-up. Clin Implant Dent Relat Res 2007: 9: 186–196
18. Peñarrocha M, Garcıa B, Martı E, Boronat A. Rehabilitation of severely atrophic maxillae with fixed implant-supported prostheses using zygomatic implants placed using the sinus slot technique: clinical report on a series of 21 patients. Int J Oral Maxillofac Implants 2007: 22: 645– 650
19. Davo C, Malevez C, Rojas J. Immediate function in the atrophic maxilla using zygoma implants: a preliminary study. J Prosthet Dent 2007: 97: S44–S51. 20. Mozzati M, Monfrin SB, Pedretti G, Schierano G, Bassi F. Immediate loading of maxillary fixed prostheses retained by zygomatic and conventional implants: 24-month preliminary data for a series of clinical case reports. Int J Oral Maxillofac Implants 2008: 23: 308–314
20. Pi Urgell J, Revilla Gutierrez V, Gay Escoda CG. Rehabilitation of atrophic maxilla: a review of 101 zygomatic implants. Med Oral Patol Oral Cir Bucal 2008: 13: 363– 370
21. Davo R. Zygomatic implants placed with a two-stage procedure: a 5-year retrospective study. Eur J Oral Implantol 2009: 2: 115–124
22. Malo P, Nobre Mde A, Lopes I. A new approach to rehabili- tate the severely atrophic maxilla using extra maxillary anchored implants in immediate function: a pilot study. J Prosthet Dent 2008: 100: 354–366

23. Balshi SF, Wolf Inger GJ, Balshi TJ. A retrospective analysis of 110 zygomatic implants in a singlestage immediate loading protocol. Int J Oral Maxillofac Implants 2009: 24: 335–341.
24. Davo R. Zygomatic implants placed with a two-stage procedure: a 5-year retrospective study. Eur J Oral Implantol 2009: 2: 115–124
25. Aparicio C, Ouazzani W, Aparicio A, Fortes V, Muela R, Pascual A et al. Extra-sinus zygomatic implants: three-year experience from a new surgical approach for patients with pronounced buccal concavities for the edentulous maxilla. Clin Implant Dent Relat Res 2010: 12: 55–61
26. Aparicio C, Ouazzani W, Aparicio A, Fortes V, Muela R, Pascual A et al. Immediate/ early loading of zygomatic implants: clinical experiences after 2 to 5 years of follow-up. Clin Implant Dent Relat Res 2010: 12(Suppl. 1): 77–82.
27. Stievenart M, Malevez C. Rehabilitation of totally atrophied maxilla by means of four zygomatic implants and fixed prosthesis: a 6-40-month follow-up. Int J Oral Maxillofac Surg 2010: 39: 358– 363.
28. Davo R, Pons O, Rojas J, Carpio E. Immediate function of four zygomatic implants: a 1-year report of a prospective study. Eur J Oral Implantol 2010: 3: 323–334
29. Miglioranca RM, Coppede A, Dias Rezende RC, de Mayo T. Restoration of the edentulous maxilla using extrasinus zygomatic implants combined with anterior conventional implants: a retrospective study. Int J Oral Maxillofac Implants 2011: 26: 665–672
30. E.L. Agliardi, D. Romeo, S. Panigatti, M. de Araujo Nobre, P. Malo. Immediate fullarch rehabilitation of the severely atrophic maxilla supported by zygomatic implants: a prospective clinical study with minimum follow-up of 6 years. Int. J. Oral Maxillofac. Surg. 2017 32. Butura CC, Galindo DF. Combined immediate loading of zygomatic and mandibular implants: a preliminary 2-year report of 19 patients. Int J Oral Maxillofac Implants. 2014;29(1): e22-9.
31. Chana H, Smith G, Bansal H, Zahra D. A Retrospective Cohort Study of the Survival Rate of 88 Zygomatic Implants Placed Over an 18-year Period. Int J Oral Maxillofac Implants. 2019;34(2):461-470.
32. Coppedê A, de Mayo T, de Sá Zamperlini M, Amorin R, de Pádua APAT, Shibli JA. Three-year clinical prospective follow-up of extrasinus zygomatic implants for the rehabilitation of the atrophic maxilla. Clin Implant Dent Relat Res. 2017;19(5):926-934.
33. Tumedei, M, Piattelli A, Degidi M, Mangano C, Iezzi G. A Narrative review of the histological and histomorphometrical evaluation of the peri-implant bone in loaded and unloaded dental implants. a 30-year experience (1988–2018). Int. J. Environ. Res. Public Health 2020;17: 2088.
34. Neugarten J, Tuminelli, F, Walter L. Two bilateral zygomatic implants placed and immediately loaded: A retrospective chart review with up-to-54-month follow-up. Int. J. Oral Maxillofac. Implant. 2017; 32:1399–1403. 37. Sartori E.M, Padovan L.E.M, de Mattias Sartori I.A, Ribeiro P.D. Evaluation of satisfaction of patients rehabilitated with zygomatic fixtures. J. Oral Maxillofac. Surg. 2012; 70:314–319.
35. Zwahlen, R.A, Grätz K.W, Oechslin C.K, Studer S.P, Survival rate of zygomatic implants in atrophic or partially resected maxillae prior to functional loading: A retrospective clinical report. Int. J. Oral Maxillofac. Implant. 2006; 21:413–420.

36. Davó R. Zygomatic implants placed with a two-stage procedure: a 5-year retrospective study. Eur J Oral Implantol. 2009 Summer;2(2):115-24.
37. Bothur S, Jonsson G, Sandahl L. Modified technique using multiple zygomatic implants in reconstruction of the atrophic maxilla: a technical note. Int J Oral Maxillofac Implants. 2003 NovDec;18(6):902-4.
38. Bedrossian E. Rehabilitation of the edentulous maxilla with the zygoma concept: a 7-year prospective study. Int J Oral Maxillofac Implants 2010; 25:1213–1221
39. Stella JP, Warner MR. Sinus slot technique for simplification and improved orientation of zygomaticus dental implants: a technical note. Int J Oral Maxillofac Implants. 2000; 15:889–893
40. Testori T, Del Fabbro M, Capelli M, Zuffetti F, Francetti L, Weinstein RL. Immediate occlusal loading and tilted implants for the rehabilitation of the atrophic edentulous maxilla: 1-year interim results of a multicenter prospective study. Clin Oral Implants Res. 2008;19(3):227-32.