



Full Arch Rehabilitation in Patients with Atrophic Upper Jaws with Zygomatic Implants using Sinus-Slot Technique as Compared to Conventional Implants: A Systematic Review

¹Dr. Devashish N Raut, ²Dr. Akshay Mishra, ³Dr. Manu Goel, ⁴Dr. Prafulla Gaikwad, ⁵Dr. Simona Joseph, ⁶Dr. Sanchi Kadbe

^{1,5}Post Graduate student, ²Associate Professor, ³Associate Professor, ⁴Professor and Head, Department of Oral and Maxillofacial Surgery, Swargiya Dadasaheb Kalmegh Smruti Dental College and Hospital, Nagpur, Maharashtra, India

Corresponding author: Dr. Devashish N Raut

devraut27@gmail.com

ABSTRACT

Background: The primary aim of this systematic review is to report on the results of using Zygomatic Implants (ZIs) with the sinus-slot technique in the treatment of upper jaw atrophy.

Findings: The search for relevant studies was conducted on PubMed, Google Scholar, and the Cochrane Library databases, as well as through manual searches, with consideration given to language and study period. The use of ZIs was included in any type of clinical trial or series. The search strategy employed Boolean operators "AND" and "OR" for PubMed searches, and "+" and "-" for Google Scholar searches. The search was limited to English language, full text, and human studies, while literature reviews and clinical case reports were excluded. After examining the full text of 61 potential reports, six studies with a total of 166 participants and 276 zygomatic implants were included, with a study period ranging from January 1998 to December 2021, and a follow-up period ranging from 12 to 144 months.

Conclusions: Based on the results of this review, the use of ZIs with the sinus-slot technique is a common approach for rehabilitating patients with upper jaw atrophy, with high survival rates reported. However, the success of the surgical technique is highly dependent on the professional experience of the surgeon and the local anatomy of the patient, and further clinical evidence is needed to assess bone resorption, aesthetic outcomes, and physiological characteristics.

Keywords: Full arch rehabilitation, Implant, Prosthetic rehabilitation, Surgery, Zygomatic implant, and sinus slot technique.

INTRODUCTION

In recent years, endosseous dental implants have become a popular solution for the replacement of lost or missing teeth. Continuous research in this field has led to improvements in the effectiveness, efficiency, and cost of dental implants, making them a viable option for a large population. However, limitations still exist, and successful implant placement requires sufficient bony height and width. This can be a challenging scenario for the oral surgeon and restorative dentist, particularly in patients with a severely atrophic maxilla, where successful implant placement is especially difficult.¹

In 1988, Professor P.I. Branemark introduced zygomatic implants for treating patients with severe bone loss in the upper jaw. Branemark is also credited with advancing osseointegration research, which greatly influenced the development of dental implant technology.² In 2000, Stella and Warner modified Branemark's original technique, calling it the sinus slot technique, which involved creating a slot in the zygomatic buttress. This

allowed the zygomatic implant to travel through the sinus cavity without interfering with the sinus membrane, resulting in simpler placement of the implant due to a more vertical angulation than the original technique.³

Various treatments have been proposed to solve the problem of low quality and quantity of maxillary bone for placing implants, including bone grafting procedures. However, for some patients, bone grafting may not be a viable or desirable option due to factors such as graft donor site morbidity, increased healing time, longer surgical time, and increased chance of infection. In addition, there is a lower implant survival rate for areas in the maxilla that have been grafted compared to native bone.⁴

For patients with compromised vasculature due to maxillary resection and/or radiation therapy for cancer treatment, certain metabolic disorders, congenital deformities, or those in an immunocompromised state, a non-grafting option to restore the atrophic maxilla could be of great value. The zygomatic implant may present a far simpler approach to restoring the atrophic maxilla, providing a viable alternative to bone grafting procedures.⁵

P-I Brånemark introduced the *original surgical technique* (OST) characterized by a palatal entrance and an intra-sinus path of the implant body until its zygomatic anchorage and two-stage surgery. However, it had drawbacks such as frequent bulky prostheses and oro-antral communication, which needed to be overcome. This protocol requires adequate alveolar bone to be present in the anterior maxilla to permit placement of two to four anterior maxillary implants combined with the zygomatic implants and involves rigid splinting of the fixtures.⁶

The sinus slot approach was first described by Stella and Warner in 2000 as an alternative to the classical approach for the placement of zygomatic implants. This technique involves making a slot in the lateral wall of the maxillary sinus, which allows for the placement of zygomatic implants without the need for sinus elevation. Since its introduction, this technique has been used by other authors in various clinical studies^{7,8,9}.

OBJECTIVE

The main goal of this systematic review is to provide an overview of the outcomes of using zygomatic implants (ZIs) with the sinus-slot technique for the treatment of severely resorbed upper jaws and to compare the results with those achieved with conventional implants.

MATERIALS AND METHODS

The systematic review was conducted in accordance with the PRISMA statement guidelines, which are widely accepted standards for reporting systematic reviews and meta-analyses. The review protocol was registered with PROSPERO, an international database for systematic review registration, which is hosted by the University of York's Centre for Reviews and Dissemination and funded by the UK's National Institute for Health Research (NHS). The registration of the review protocol provides transparency and credibility to the review process and helps avoid bias in the selection and reporting of the review outcomes.

RESEARCH QUESTION

The "PICO" question in our study is focused on the clinical problem, intervention, comparison, and outcomes. It is as follows: Among patients with atrophic upper jaw (P), does the use of zygomatic implants placed with sinus slot technique (I) compared to conventional implants (C) result in acceptable survival rates (O)

PICO OF THE STUDY

P: Patients with Atrophic Upper Jaws

I: Zygomatic Implants using Sinus-Slot Technique

C: conventional implant

O: full arch rehabilitation based

INCLUSION AND EXCLUSION CRITERIA

Inclusion criteria of this systematic review included the following:

Studies aimed at investigating patients with atrophic upper jaws rehabilitated with ZIs.

Clinical studies in humans, including prospective, retrospective, and case series studies.

1. At least one of the following reported results: clinical, radiographic, and patient-centred.
2. Full text available in pdf format.
3. Reported in the English language.

The exclusion criteria were as follows:

1. Articles published in another language other than English.
2. Experimental laboratory studies.
3. Animal studies.
4. Studies that the main theme was not the rehabilitation of atrophic upper jaws with ZIs.
5. Systematic reviews.
6. Full text articles were not available on the database search.
7. Case reports.
8. Duplicate articles.
9. Letters to editor.
10. Commentaries.

SEARCH STRATEGY AND STUDY IDENTIFICATION

DESCRIPTION OF SEARCH

To ensure the reliability and accuracy of the data synthesis, an inter-examiner reliability test was conducted between two examiners, resulting in a strong agreement of 0.89. The search for relevant articles was conducted using electronic databases, including PubMed, Google Scholar, and Cochrane Library. The search technique on PubMed made use of the boolean operators "AND" and "OR". Filters were applied to limit the search to randomized controlled trials published between 1998 and 2021.

Table: Search strategy

Data base	Search strategy
PubMed	PubMed search was done using Boolean terms "AND" "OR" Eg: Zygomatic and sinus slot technique zygomatic implant or conventional implants
Google scholar	For google scholar the Boolean used were "+" and "-"
Cochrane library	"Full Arch Rehabilitation in Patients with Atrophic Upper Jaws with Zygomatic Implants using Sinus-Slot Technique" in all text AND "Full Arch Rehabilitation with Zygomatic Implants" OR "sinus slot technique used for zygomatic implant"

In addition to the electronic search, a manual search of related journals was conducted to identify any relevant studies that may have been missed. The reference lists of the identified studies and relevant reviews on the subject were also scanned to identify additional studies.

The titles and abstracts of the search results were reviewed by two independent observers to identify studies that met the eligibility criteria. In cases where there was disagreement between the observers, a third observer was consulted to make a final decision. The full-text articles of the selected studies were then obtained and reviewed independently by the investigators.

Any conflicts in study selection were resolved through discussion and consensus between the investigators, with the assistance of a third party if needed. This rigorous approach to study

selection helped ensure that only high-quality studies meeting the eligibility criteria were included in the systematic review.

RESULT OF THE SEARCH

Initially, 531 articles were identified from the electronic search conducted from 1998 to 2021. To ensure the accuracy of the results, the articles were cross-checked by another examiner to remove any duplicates. As a result, 303 articles were removed. Subsequently, the remaining 228 articles were screened based on their titles and abstracts, which led to the exclusion of 53 articles that did not meet the inclusion criteria. The remaining 175 articles were further assessed based on the research question, leading to the exclusion of 148 additional articles. Finally, 27 articles were selected for full-text review, and after applying the eligibility criteria and matching with the PICO format, only six studies were included for qualitative analysis. The process of selecting the studies was done by two independent reviewers, and any disagreements were resolved through discussion or consultation with a third reviewer. Overall, the six studies included in the analysis were deemed to be of high quality and provided valuable insights into the use of zygomatic implants using the sinus slot technique compared to conventional implants in patients with atrophic upper jaws.

INCLUDED STUDIES

Upon examination of the full texts of 61 potentially relevant reports, a total of 6 studies were included in this systematic review, with a combined total of 166 participants. The included studies were all retrospective and spanned the period from 1998 to 2021. The selected studies were analyzed for their relevance to the research question and their methodological quality, ultimately resulting in their inclusion in this systematic review.

Table: studies included in the search

Author and year	Title
Ruben Davo 2008 ¹⁰	Clinical outcome of 42 patients treated with 81 immediately loaded zygomatic implants: a 12- to 42-month retrospective study
Ruben Davo et al ¹¹	Sinus reactions to immediately loaded zygoma implants: a clinical and radiological study
Miguel Peñarrocha et al 2012 ¹²	Rehabilitation of Reabsorbed Maxillae With Implants in Buttresses in Patients with Combination Syndrome
J. M Yates et al 2014 ¹³	Treatment of the edentulous atrophic maxilla using zygomatic implants: evaluation of survival rates over 5–10 years
Caesar C. Butura, and Daniel F. Galindo 2014 ¹⁴	Combining Zygomatic and Mandibular Implants for immediate Loading:: A Preliminary 2-Year Report of 19 Patients
Hilario Pellicer et al Chover 2015 ¹⁵	Influence of the prosthetic arm length (palatal position) of zygomatic implants upon patient satisfaction

STUDY DESIGN

All 6 studies included in the review were retrospective cohort.

LOCATION OF THE STUDIES

Study location include Spain and USA.

PARTICIPANTS

The participants of the study consisted of Patients with Atrophic Upper Jaws of both genders from 35 years to 77 years with a total number of 166 participants. Many of the studies did not provide more specific about context of intervention.

EXCLUSION OF THE STUDIES

During the final screening of the review, a total of 50 studies were excluded due to not meeting the eligibility criteria or not fulfilling the PICO question of the study. Additionally, any articles that were not in the English language were excluded from the study, and grey literature and conference proceedings were not included. While some of the formally excluded studies may have had useful contextual and intervention-related information, they did not have study designs that allowed for an unbiased assessment of the intervention effectiveness, which was a requirement for this systematic review.

OUTCOME MEASURE

The survival rate of Zygomatic Implants (ZIs) using the sinus slot technique for full arch rehabilitation was evaluated in terms of several parameters, including non-osseointegrated implants, paraesthesia, sinusitis, local infection, and fistula at the implant level. The calculation of the survival rate of ZIs using the sinus slot technique was based on the individual studies included in the systematic review. The survival rates of ZIs were compared with conventional implants for full arch rehabilitation. The studies analyzed the outcomes of the ZIs using different follow-up periods ranging from 12 to 144 months. The survival rate of ZIs using the sinus slot technique was found to be high, with an average of 97.28% after follow-up.

RISK OF BIAS AND QUALITY ASSESSMENT

Risk of Bias was calculated using (Risk of Bias In Non-randomized Studies - of Interventions)

ROBIN tool - Overall, the risk of Bias was low for all studies included in the report. Which is shown in the figure

Missing data

Missing data was observed in 2 studies by Miguel et al and JM Yates how those data were handled is not given in the study.

Confounding Bias

No mention regarding control of confounding factors is mentioned.

Selection bias

Calculation of sample size and mention of sampling is not given.

OUTCOME

Outcome bias was low for overall studies.

Study	Risk of bias domains							Overall
	D1	D2	D3	D4	D5	D6	D7	
Davo et al 2008	⊖	⊕	⊕	⊕	⊕	⊕	⊕	⊕
Ruben et al 2008	⊖	⊕	⊕	⚠	⊕	⊖	⊕	⊕
Miguel 2012	⊖	⊕	⊖	⚠	⚠	⊕	⊖	⊕
Batura et al 2014	⊖	⊕	⊖	⚠	⊕	⊕	⚠	⊕
JM Yates et al 2014	⊖	⊖	⊕	⊕	⊖	⊕	⊖	⊕
Hilario et al 2015	⊖	⊖	⊖	⚠	⊕	⊖	⊗	⊕

Domains:
D1: Bias due to confounding.
D2: Bias due to selection of participants.
D3: Bias in classification of interventions.
D4: Bias due to deviations from intended interventions.
D5: Bias due to missing data.
D6: Bias in measurement of outcomes.
D7: Bias in selection of the reported result.

Judgement
⚠ Critical
⊗ Serious
⊖ Moderate
⊕ Low

Fig: risk of bias for individual studies

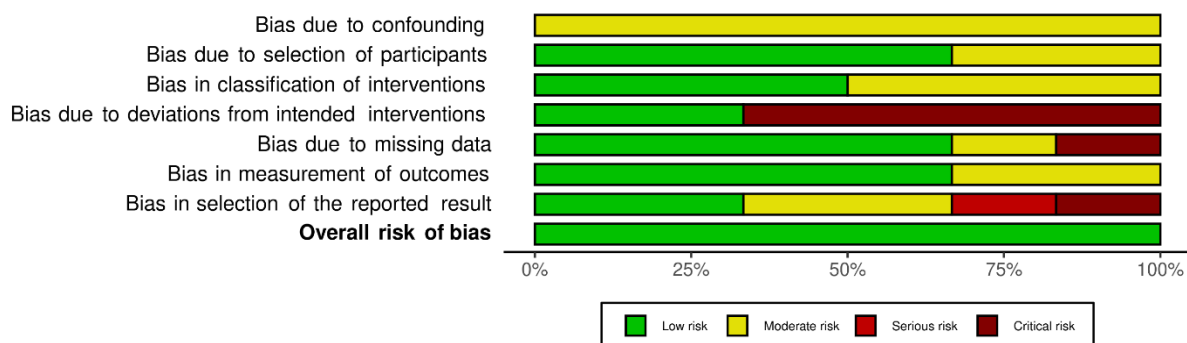


Figure: pooled risk of bias for all studies

RESULT

OVERVIEW OF INTERVENTION TYPE

In their study, Davo et al. (2008)¹⁰ aimed to assess the success rate of immediately loaded zygomatic implants in the rehabilitation of atrophic maxillae for the placement of fixed dental prostheses. The study was retrospective and involved 42 patients with a mean age of 57 years, 37 of whom were totally edentulous and five were partially edentulous. One hundred and forty conventional implants and 81 zygomatic implants were placed altogether. The success criteria for the zygomatic implants included confirmed individual implant anchorage to the zygomatic bone through radiographs, the implant serving as an anchor for the functional prostheses, the absence of suppuration, pain or pathological processes at the maxillary and zygomatic levels, and confirmed individual implant stability. All patients had a fixed prosthesis screwed onto the implants within 48 hours of implant placement, and descriptive statistics were used to analyze the data.

Davo et al.¹¹ conducted a retrospective study with the aim of evaluating the success rate of immediately loaded zygomatic implants in atrophic maxillae. They followed 42 patients, with a mean age of 57 years, for at least one year after the implant placement. Among these patients, 37 were totally edentulous and 5 were partially edentulous, and a total of 81 zygomatic and 140 conventional implants were inserted. The success criteria for zygomatic implants included individual implant anchorage to the zygomatic bone confirmed by anteroposterior cranial radiograph, the implant acting as an anchor for functional prostheses, no suppuration, pain, or ongoing pathological process at the maxillary and zygomatic level, and confirmed individual implant stability. Within 48 hours following implant insertion, a fixed prosthesis was put onto the implants for each patient.

In another study, Miguel¹² (2012) aimed to assess the success and marginal bone loss of implants placed in anatomic buttresses of atrophic maxillae in patients with combination syndrome. This was a retrospective case series study involving 22 patients who had Classes IV and V Cawood and Howell maxillary atrophy and were treated with implants in anatomic buttresses in the atrophic maxilla. The study included the presence of anterior remnant teeth in the mandible and a minimum follow-up of 12 months after implant loading. The criteria of Buser et al. were used to evaluate implant success, and marginal bone loss was measured on periapical radiographs. Statistical analysis was performed to investigate the relationship between implant success and marginal bone loss with gender, degree of maxillary atrophy, implant technique, and prosthesis type.

J.M. Yates¹³ and colleagues conducted a retrospective observational cohort study in 2014 to report the 5-10 year survival rates of zygomatic implants used to rehabilitate the atrophic maxilla. The study included 43 consecutive zygomatic implant placements in 25 patients over the 5-10 year period, and evaluated the success rate of the restored implants and the proportion of originally planned prostheses delivered to patients. The study showed an overall success rate of 86% for zygomatic implants, with six implants failing to integrate or requiring removal due to persistent infection. Nonetheless, every patient received their anticipated prosthesis, though in six cases the retention technique needed to be changed. The results suggest that zygomatic implants are a successful treatment option to restore the atrophic maxilla, with a high long-term success rate and potential to avoid additional augmentation/ grafting procedures.

In 2014, Caesar C. Batura¹⁴ and colleagues conducted a retrospective study to evaluate the feasibility of simultaneously using immediately loaded zygomatic and mandibular implants for full maxillomandibular restoration. The study included 19 edentulous and partially edentulous patients, in which 40 zygomatic and 112 conventional implants were placed and restored with full-arch acrylic resin prostheses within 3 hours of surgery. The implant insertion torque values were between 35 and 45 Ncm.

In 2015, Hilarion¹⁵ conducted a study to examine the impact of the prosthetic arm length (position on the palate) of zygomatic implants on patient satisfaction, stability, speech, functionality, and overall comfort. The study was a retrospective clinical study of patients who underwent complete maxillary implant-supported fixed prostheses for the rehabilitation of atrophic maxilla. The study involved a minimum of two zygomatic implants (one on each side) in conjunction with premaxillary implants, with 12 months of follow-up after implant loading. The patients used a visual analog scale (VAS) to score general satisfaction, comfort and stability, speech and functionality, and the results were analyzed in relation to the prosthetic arm; 12 months following the delivery of the prosthetic, the length of the zygomatic implants.

OVER VIEW OF OUTCOME

The use of zygomatic implants in conjunction with conventional implants has been found to be a reliable technique for immediate function in patients with severely resorbed maxillae. Loading zygomatic implants immediately after placement can substantially decrease the treatment time in a predictable way.

A study conducted by Davo et al¹⁰ found that after one year and no patient drop-out, none of the zygomatic implants were lost over the observation period, resulting in a 100% success rate. With four conventional implants lost, the success rate was 97%. The provisional prostheses were stable, and only one patient experienced oroantral fistula and sinusitis, which was solved with antibiotics and meatotomy, with no further complications. Another patient experienced soft tissue swelling and pain at the zygomatic area after 10 days of surgery, which was also solved with antibiotics, with no further complications.

Another study by Davo et al¹¹ found that no clinical signs or symptoms of sinusitis were found, and sinuses penetrated by zygomatic implants seem to maintain a normal physiology. However, early radiological findings without clinical symptoms were observed in approximately 15 to 20% of patients, with radiological opacity of the antrum found in two sinuses and minimal thickening of the Schneiderian membrane found in 12 patients, of which eight had this preoperatively.

In a study by Miguel et al¹², 117 implants were placed using various techniques, including conventional placement in the alveolar ridge, palatal placement, tilted placement in the frontomaxillary buttress, pterygomaxillary placement, nasopalatine canal placement, and zygomatic implant placement. The follow-up period ranged from 1 to 7 years after implant loading, and the implant success rate was 94%, with only 7 implants failing. The mean marginal bone loss was 0.63 mm, and a statistically significant relation was found between bone loss and implant placement technique and the level of maxillary atrophy. Specifically, bone loss was greater in tilted implants and in cases of severe maxillary atrophy.

Another study by Batura¹⁴ observed 19 patients over a 1-year follow-up period after simultaneous placement of zygomatic and conventional implants in the maxilla and mandible. None of the patients experienced implant or prosthesis failures, and there were no sinus infections or other complications related to the procedures. The study concluded that zygomatic and conventional implants can be successfully placed and loaded with an acrylic resin prosthesis using the All-on-Four concept.

Finally, J.M Yates et al¹³ reported an 86% overall success rate for zygomatic implants, with 6 implants failing to integrate or requiring removal due to persistent infection associated with the maxillary sinus. All patients received their planned prosthesis, but in 6 cases, modifications to the retention method were necessary. This study highlights the potential of zygomatic implants as a successful treatment option for restoring the atrophic maxilla, potentially avoiding additional augmentation or grafting procedures and resulting in a high long-term success rate.

The study conducted by Hilario et al¹⁵. involved 22 patients who received 22 prostheses supported by a total of 148 implants, out of which 44 were zygomatic implants and 94 were conventional implants. The researchers found that there was no significant correlation between the length of the prosthetic arm (i.e., its position on the palate) and patient satisfaction. In other words, patients reported similar levels of satisfaction regardless of where their prosthetic arm was placed.

Table: characteristic table for all studies

Study ID	Sample size	Age	Conventional implant	Zygomatic implant	Implant failed	Follow up	Loss of follow up	Survival rate	
								Zygomatic	Conv.
Davo 2008 ¹⁰	42	37-49 years	140	81	4	12-42month	0	100%	97%
Davo 2008 ¹¹	36	NA	125	71	0	13-42month	0	100%	100%
Miguel et al 2012 ¹²	22	35-69 years	85	41	0	1-7 years	4	100%	93.2%
Batura et al 2014 ¹⁴	19	NA	112	40	0	4 months	0	100%	100%
J.M Yates et al 2014 ¹³	25	NA	25	43	6	6 years	2	86% overall	
Hilario et al 2015 ¹⁵	22	31-77years	NA	NA	NA	12 months	0	97.7%	93.6%

According to the studies reviewed, a total of 276 zygomatic implants were placed in 166 patients, and the follow-up period ranged from 12 to 144 months. The survival rates of zygomatic implants using the sinus slot technique were found to be high, at 97.28%, after the follow-up period. In comparison, the survival rate for conventional implants was 96.76%. These results suggest that zygomatic implants placed using the sinus slot technique are a viable and reliable treatment option for patients with severe maxillary atrophy.

DISCUSSION

The objective of this systematic review was to assess the clinical outcomes of using Zygomatic implants with the sinus slot technique in patients with atrophic upper jaws. The 6¹⁰⁻¹⁵ articles analyzed in this review provided reliable evidence supporting the effectiveness of this treatment in improving patients' oral function. However, the literature reviewed exhibited some heterogeneity, with variation in study design, follow-up time, surgical technique, and outcome assessment methods across the included studies.

All of the studies included in this review were retrospective cohort studies, with follow-up periods ranging from 12 to 144 months for patients who underwent Zygomatic implant therapy. Treatment with conventional size and length implants in patients with severe atrophy is often challenging and may require bone grafting. In the past, it was recommended to use a combination of Zygomatic implants and conventional implants in a semicircular construction to rehabilitate edentulous or partially edentulous maxillary patients with insufficient bone volume for posterior conventional implant placement. However, with the advancement of techniques, Zygomatic implants can now be used alone for unilateral or bilateral rehabilitation in the upper jaw.

The classic intrasinus technique for placing Zygomatic implants involves using the Brånemark technique², which involves placing an endosseal-threaded implant with a 45°-angled platform into stable cortical maxillary buttress bone through an intrasinus path. The implant ranges in length from 30 to 52.5 mm, and two Zygomatic implants and four anterior maxillary implants can be placed in one surgical procedure without the need for bone grafting or hospitalization. This technique is highly successful and provides excellent support for a fixed prosthesis. However, several advancements have been made to improve implant positioning, the bone-implant interface, and prosthetic outcomes while minimizing soft tissue dissection, postoperative pain, and edema. The focus of this review is on the sinus slot technique for Zygomatic implant placement.

The sinus slot technique³ for placement of ZIs offers several advantages over traditional techniques, such as reduced surgical time, improved emergence prosthetic profile, and the ability to place the zygoma platform directly over the alveolar ridge. This technique involves making a guide window through the buttress wall of the maxilla and guiding the zygoma implant through the maxilla to the apex insertion at the junction of the zygomatic arch and the lateral orbital margin. In the studies reviewed, a total of 276 ZIs were placed in 166 patients using the sinus slot technique, with a follow-up ranging from 12 to 144 months. The survival rates for ZIs placed using this technique were high, at 97.28% after follow-up, compared to conventional implants which had a survival rate of 96.76%.

The use of Zygomatic implants with sinus slot technique has demonstrated higher survival rates than conventional implants. However, there is a possibility of complications during or after the surgery, and the most frequent one is sinusitis.

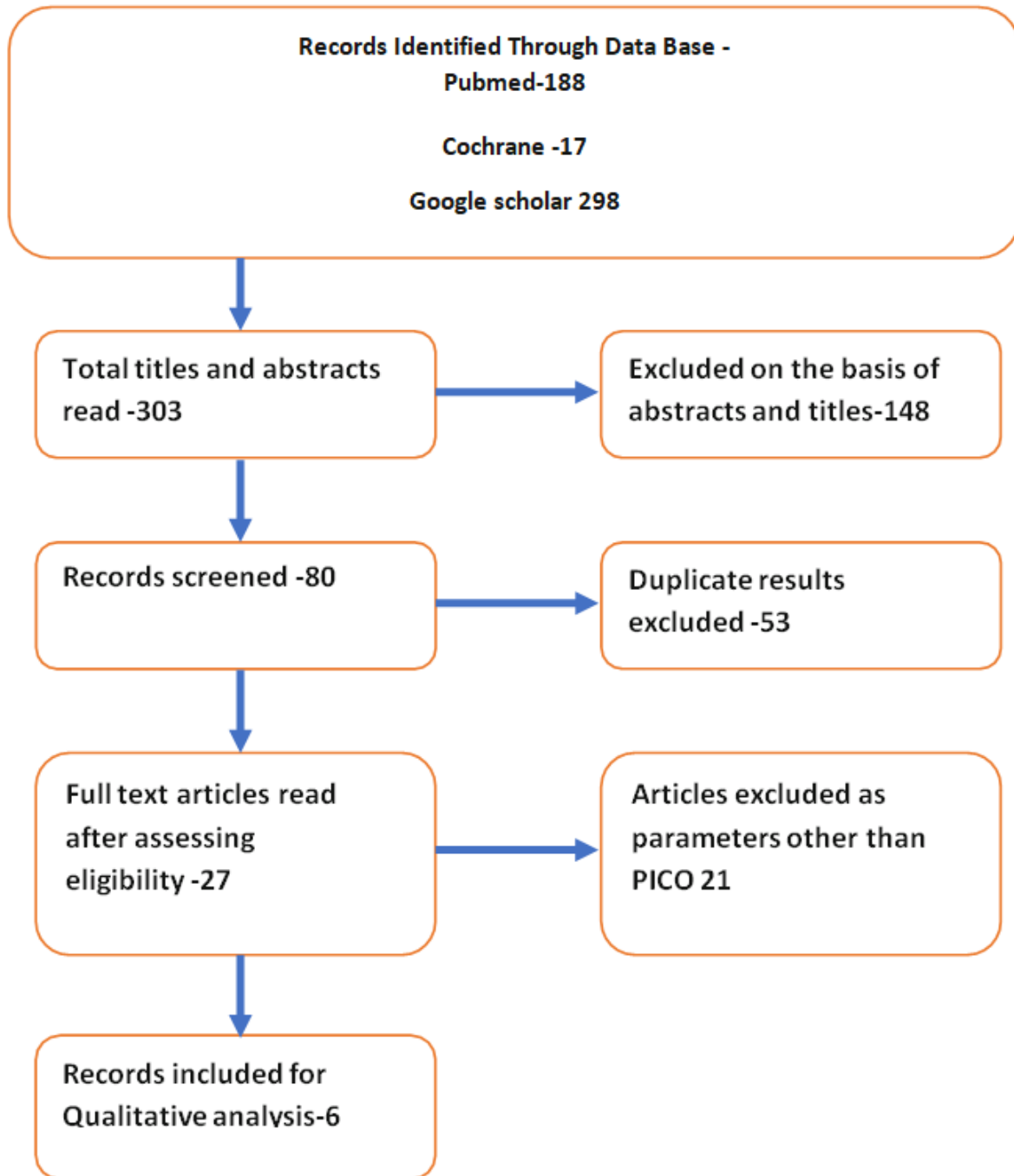
LIMITATIONS

One limitation of the current review is that the majority of the studies analysed were conducted in Spain, representing a single population, which could potentially act as a confounding factor. Another limitation of the study is the absence of randomized clinical trials on the topic, which reduces the level of evidence of the information obtained.

CONCLUSION

In summary, Zygomatic implants are a widely accepted treatment option for patients with severely atrophied upper jaws. A total of 276 ZIs were inserted into 166 patients, with follow-up periods ranging from 12 to 144 months. Studies have reported high survival rates for Zygomatic implants when using the sinus slot technique, with a rate of 97.28% compared to 96.76% for conventional implants. Therefore, suggesting better survival rates for Zygomatic implants using the sinus slot technique than for conventional implants. However, some complications may arise during or after the operation, with sinusitis being the most frequent. Although this review found high survival rates, additional clinical evidence is necessary to examine bone resorption, aesthetic outcomes, and physiological characteristics. It is also worth noting that the surgical technique depends on the surgeon's expertise and local anatomy.

Fig: PRISMA flow chart used for the study



REFERENCES

1. Zygomatic Implants A Solution for the Atrophic Maxilla Jonathan Rosenstein, DDS, Harry Dym, DDS.
2. Brånemark P-I (1998) Surgery and fixture installation: zygomaticus fixture clinical procedures, 1st edn. Nobel Biocare AB, Goteborg, p 1
3. 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 Nov-Dec;15(6):889-93.
4. Block MS, Haggerty CJ, Fisher GR. Nongrafting implant options for restoration of the edentulous maxilla. *J Oral Maxillofac Surg* 2009;67:872–81.

5. Devlin H, Horner K, Ledgerton D. A comparison of maxillary and mandibular bone mineral densities. *J Prosthet Dent* 1998;79:323–7.
6. Brånemark PI, Grondahl K, Öhrnell LO, Nilsson P, Petruson B, Svensson B, Engstrand P, Nannmark U (2004) Zygoma fixture in the management of advanced atrophy of the maxilla: technique and long-term results. *Scand J Plast Reconstr Surg Hand Surg* 38:70–85
7. Davó R, Malevez C, Rojas J, Rodríguez J, Regolf J (2008) Clinical outcome of 42 patients treated with 81 immediately loaded zygomatic implants: a 12- to 42-month retrospective study. *Eur J Oral Implantol* 1:141–150
8. Ferrara ED, Stella JP (2004) Restoration of the edentulous maxilla: the case for the zygomatic implants. *J Oral Maxillofac Surg* 62:1418–1422
9. Peñarrocha M, Uribe R, García B, Martí E (2005) Zygomatic implants using the sinus slot technique—clinical report of a patient series. *Int J Oral Maxillofac Implants* 20:788–792
10. Davó R, Malevez C, Rojas J, Rodríguez J, Regolf J. Clinical outcome of 42 patients treated with 81 immediately loaded zygomatic implants: a 12- to 42-month retrospective study. *Eur J Oral Implantol*. 2008 Summer;9 Suppl 1(2):141-50.
11. Davó R, Malevez C, López-Orellana C, Pastor-Beviá F, Rojas J. Sinus reactions to immediately loaded zygoma implants: a clinical and radiological study. *Eur J Oral Implantol*. 2008 Spring;1(1):53-60.
12. Peñarrocha M, Viña JA, Carrillo C, Peñarrocha D, Peñarrocha M. Rehabilitation of reabsorbed maxillae with implants in buttresses in patients with combination syndrome. *J Oral Maxillofac Surg*. 2012 May;70(5):e322-30.
13. Yates JM, Brook IM, Patel RR, Wragg PF, Atkins SA, El-Awa A, Bakri I, Bolt R. Treatment of the edentulous atrophic maxilla using zygomatic implants: evaluation of survival rates over 5-10 years. *Int J Oral Maxillofac Surg*. 2014 Feb;43(2):237-42.
14. 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 Jan-Feb;29(1):e22-9.
15. Pellicer-Chover H, Cervera-Ballester J, Peñarrocha-Oltra D, Bagán L, Peñarrocha-Diago MA, Peñarrocha-Diago M. Influence of the prosthetic arm length (palatal position) of zygomatic implants upon patient satisfaction. *Med Oral Patol Oral Cir Bucal*. 2016 May 1;21(3):e380-4.

