How to Cite:
Jamdade, V., Venugopal, K., Behera, S. S. P., Rani, A., Hiremath, A., & Das, A. (2022). Tubero pterygoid implants- a boom for atrophied maxillary ridges: Systematic review and meta analaysis. *International Journal of Health Sciences*, *6*(S5), 1669–1678.
https://doi.org/10.53730/ijhs.v6nS5.8958

Tubero pterygoid implants- a boom for atrophied maxillary ridges: Systematic review and meta analaysis

Dr. Vaishali Jamdade
Reader, Dept. of Oral and Maxillofacial Surgery, Mahatma Gandhi Dental College and Hospital, Jaipur
Email: drjvaishu@gmail.com

Dr. Kannan Venugopal
Department of Oral and Maxillofacial Surgery, PMS College of Dental Science and Research, Golden Hills, Vattapara, Trivandrum, Kerala
Email: kannan7072003@gmail.com

Dr. Sidhartha S P Behera
Reader, Dept of Prosthodontics, Sree Sai Dental College & Research Institute, Srikakulam, NTRUHS, Andhra Pradesh
Corresponding Author email: drsidentb@gmail.com

Dr Anusha Rani
Post Graduate, Dept of Conservative Dentistry and Endodontics, Jaipur Dental College, Jaipur
Email: dranushaendo@gmail.com

Dr. Ashwin Hiremath
MDS, OMFS, FAM, Consultant Maxillofacial Surgeon at Redymed Health Care, Belgaum, Karnataka, India
Email: ashwinhiremath77@gmail.com

Dr. Amrita Das
Senior lecturer, Department of Periodontology and Implantology, Dr. HSRSM dental college, Hingoli, Maharashtra, India
Email: das.amrita94@gmail.com

***Abstract*---**Introduction: Dental prosthetic rehabilitation based on Osseo integrated implants is a well-established and highly predictable treatment modality. Hence we aimed to systematic literature review to analyze clinical outcomes of tubero-pterygoid / Pterygoid implant for the treatment of patients with atrophic posterior maxillae and to provide clinical recommendations for this dental implant technique.

International Journal of Health Sciences ISSN 2550-6978 E-ISSN 2550-696X © 2022.
Manuscript submitted: 18 Feb 2022, Manuscript revised: 27 April 2022, Accepted for publication: 9 June 2022

Material and methods: Online data was collected from the search engines of EBSCO, Pubmed, Google Scholar, Scopus to identify literature presenting clinical outcomes of tubero-pterygoid implants in the treatment of patients with atrophic posterior maxillae. The study articles were collected that from Jan 1999 to Feb 2021. Based on the PRISMA guidelines the meta analysis was performed. Results: From 331 only 6 were finalized. All studies were retrospective in nature and were classified with a poor level of evidence. A total of 634 patients received 1.893 tubero- Pterygoid implants, with a mean implant survival rate of 94.87%. The mean prevalence of implant failure was 0.056 with a 95% CI of 0.04 to 0.077. Conclusion: It can be concluded that tubero-pterygoid implants can be successfully used in patients with atrophic posterior maxilla. However, the results should be interpreted with caution, given the presence of uncontrolled confounding factors in the included studies.

***Keywords*---**Tubero-Pterygoid, Atrophic Posterior Maxilla, Implants.

Introduction

Dental prosthetic rehabilitation based on osseointegrated implants is a well-established and highly predictable treatment modality[1-5]. However, the dental rehabilitation of patient with severe posterior maxillary atrophy using osseointegrated implants has been challenging. Bone graft procedures, such as maxillary sinus lifting and onlay/inlay grafts, have also been used to address insufficient bone volume in this region[6-10]. There are few studies in the literature evaluating pterygoid implant survival rates in short and long term follow-up studies[11-13]. Although a definition of pterygoid implants is provided in the glossary of Oral and Maxillofacial Implants (GOMI), as an “implant placed through the maxillary tuberosity and into the pterygoid plate”, several studies in the literature have incorrectly included implants inserted into the tuberosity or the pterygomaxillary region as pterygoid implants[18]. Short implants placed only in the maxillary tuber, tilted implants inserted into the tuberosity or in the pterygomaxillary region, and implants shorter than 13 mm that are not inserted into the dense cortical pterygoid plate should not be considered pterygoid but rather pterygomaxillary implants[14]. These considerations result in an even smaller number of studies correctly reporting pterygoid implants in the literature. This confusion in misclassifying pterygoid implants with pterygomaxillary or tuberosity implants should be deliberated and clarified. Since the last systematic review of the literature reported by Bidra[18], new clinical, anatomical studies have been published contributing to a better knowledge of implant installation in the pterygomaxillary region, which makes it necessary to systematically revise this topic[15-18]. Hence we aimed to systematic literature review to analyze clinical outcomes of tubero-pterygoid implant for the treatment of patients with atrophic posterior maxillae and to provide clinical recommendations for this dental implant technique.

Materials and Methods

We conducted the search for the data from the online sources like the “EMBASE”, “Pubmed”, “Scopus” and other sources. The study was conducted by two reviewers independently. The PRISMA guidelines were followed. The articles were collected from January 1999 to February 2021. The disputes between the reviewers were cleared by consent. The articles were screened for the abstract and the title for the initial screening. Later the entire text was studied by one reviewer and then was cross checked by the other reviewer. The present study was organized according to the PICOS. The inclusion criteria were: English and Spanish language; studies in humans; studies reporting implants in the pterygoid, pterygomaxillary, or maxillary tuberosity regions; studies with at least 1 year of follow-up; clinical cases with a minimum of 10 patients; randomized controlled trials (RCTs) and prospective studies; retrospective and prospective studies. The following definition of pterygoid implant was considered: an implant inserted through the maxillary tuberosity, engaging with the dense cortical bone formed by the pyramidal process of the palatine bone and the pterygoid laminae of the sphenoid bone[8,9,19]; implant length of minimum 13 mm and able to effectively reach the pterygoid plate[6,10,11,13]. The key words: “pterygoid implants,” “pterygomaxillary implants,” “pterygoid plate implants,” and “tuberosity implants”. The study design that were considered in the present review were organized according to the title, author, country, date of publishing, the number of the articles in the study, the number of the patients included, the search engine used, the registration of the study, the protocol followed.

Results

Out of the 331 studies only 6 were finalized. The figure 1 describes the selection. Author, level of evidence, number of patients, number of pterygoid implants, implant characteristics, survival rates, surgery complications, type of rehabilitation, peri-implant bone loss, and follow-up period of the 6 included studies are summarized in Table 1. All studies were retrospective case series[6,14,16,17,22,23], ranging from 1994 to 2015, and 5 of the 6 studies were published after 2005. A total of 634 patients received 1.893 pterygoid implants, with a mean implant survival rate of 94.87% (Figure 4). The follow-up period ranged from 12 to 132 months. Implant length varied from 13 to 20 mm. None of the studies reported significant clinical, surgical, or prosthetic complications. Five of the 6 studies[6,16,17,22,23] (except Balshi et al.[14]) had a mean healing time of 4-6 months prior to implant loading. Two studies reported low peri-implant bone loss of the pterygoid implants. Curi et al.[6] and Peñarrocha et al.[17] reported a mean bone loss of 1.21 mm and 0.71 mm, respectively. All studies mentioned the importance of adequate implant length and proper implant angulation to engage the dense cortical bone of the pterygoid plate (Table 2).

Implant failure

The lowest and highest implant failure rates were 2.9% and 10.9%. The mean prevalence of implant failure was 0.056 with a 95% CI of 0.040 to 0.077 (Figure 2). Of a total of 1893 pterygoid implants, 97 implants were lost. Most implant failures occurred 6 months after implant surgery and before loading.

Bias analysis

The risk of bias was evaluated through a funnel plot standard error rate. Results showed that there was a distribution of the studies within the funnel, with an index of heterogeneity of I^2 of 43,237 (p = 0,117; Q-value: 8,809), indicative of low heterogeneity (Figure 3). With regards to the total implant survival rate and moment of implant failure, 97 implants failed at the end of the follow-up period (132 months), with an overall survival rate of 94.87% (Figure 4). Related studies included those by Curi et al.[6], Rodrigues et al.[22], Peñarrocha et al[17], Valerón and Valerón[23], and Graves[16]. A study by Balshi et al.[14] was not clear; 10 failures occurred over a period of 1 to 9 years.

Table 1. Data summary of the six included studies analysed in this systematic review (NR, not reported)

Author Year	Number of Patients and Pterygoid Implants	Complications	Implant failure and period	Follow up period
Curi 2015	56 / 66	Two cases of intraoperative bleeding that stopped after implant placement. No complications such as infection, edema ou wound dehiscense, discompfort or pain in the postoperative reevaluations. Speech or hygiene problems where not observed.	4 failures before 2nd surgery	3 years
Balshi 2013	- / 925	NR	NR	NR
Rodriguez 2012	392 / 454	**Intraoperative:** 4 cases of hemorrhage that stopped when the implants were seated **Postoperative**: 1 case of transiente hypoesthsia of the palatine nerv lasting 4 weeks, and one case of pterygomaxillary pain thaht needed the implant removed. **Prosthetic**: 1 patient thaht exhibited bruxism fractured 2 bilateral pterygoid implants and the maxillary anterior implant of the premolar region. Three fractured hybrid proshtesis due to patients with bruxism.	16 failures - 13 before 2nd surgery	6 years
Penarrocha 2009	45 / 68	None of the patients exhibited sinus complications, local mucositis, paresthesias, or neurologic postoperative problems.	2 failures before 2nd surgery	Mean 35.5 months (12-69)
Valleron 2007	92 / 152	Slight venous intraoperative bleeding in cases where the drilling extended a few millimeters in the retropterygoid area that subsided with implant placement. Slight trismus and discomfort in those patients easely solved with phisioterapy and muscular relaxants.	8 failures - 6 before 2nd surgery	4 years (89.7+-30.7)
Graves 1994	49 / 64	NR	7 failures before 2nd surgery	4 years

Table 2. Life-table survival analysis showing the cumulative survival rate of pterygoid implants for the six selected studies

Study (Year)	NHMRC Level of Evidence	Number of Patients	Number of Pterygoid Implants	Pterygoid Implants Length (mm)	Implant Manufacturer	Survival Rate (%)	Surgical Complications	Antero-posterior Angulation	Osseointegration period	Periimplant Bone Loss (mean)	Follow up Period (mean)
Curi (2015)	III-3	56	66	18 - 20	Branemark MK III TiUnite	93.93	Slight venous intraoperative bleeding	15° - 60°	4 months	1.21mm	3 years
Balshi (2013)	III-3	NR	925	15 - 18	Branemark System – Nobel Biocare	94.16	NR	NR	NR	NR	NR
Rodriguez (2012)	III-3	392	454	13 - 18	Osseotite, 3i / Implant Innovations	96.5	Slight venous intraoperative bleeding	60° - 90°	4.2 months	NR	6 years
Penarrocha (2009)	III-3	45	68	16	Defcon Avantblast (Impladent, Senmenat) and ITI Straumann	97.05	None	NR	3 months	0.71mm	1 year
Valleron (2007)	III-3	92	152	NR	Branemark System – Nobel Biocare	94.6	Slight venous intraoperative bleeding	NR	6 months	NR	4 years
Graves (1994)	III-3	49	64	15 - 20	NR	89.1	NR	45°	6 months	NR	4 years

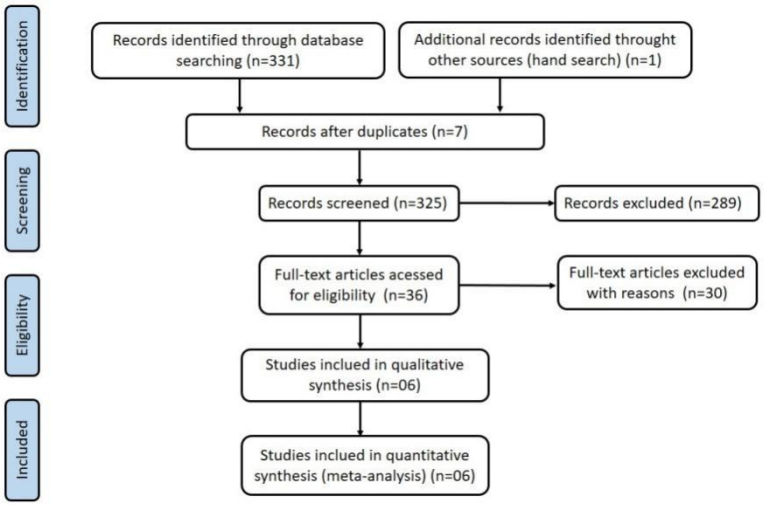

Figure 1. Flowchart of the search strategy for the systematic review

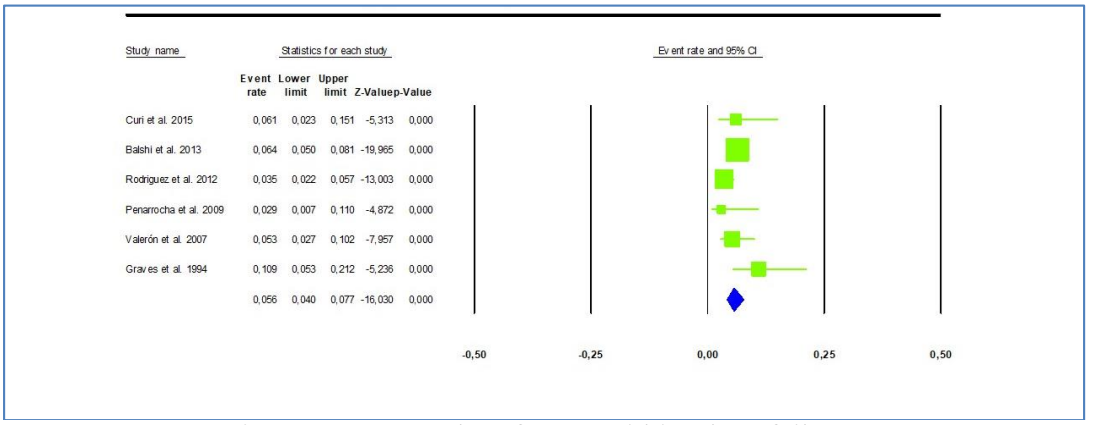

Figure 2. Forest plot of pterygoid implant failure

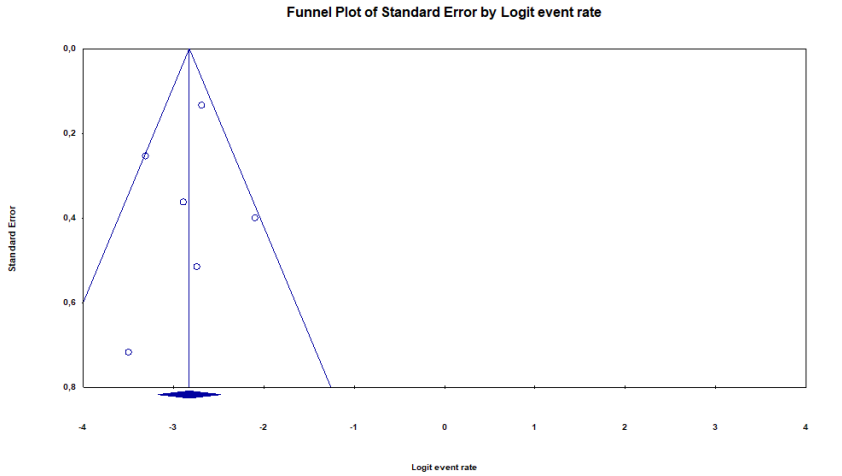

Figure 3. Funnel plot of the risk of failure of pterygoid implants

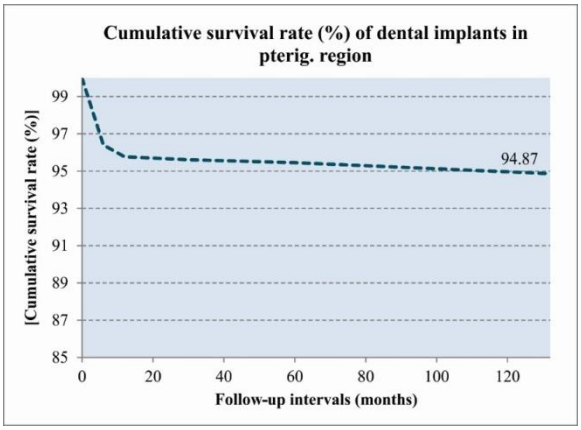

Figure 4. Pterygoid implants survival rate

Discussion

The main finding of this systematic review based on the retrospective studies analyzed is that the pterygoid implants have a high survival rate in the dental rehabilitation of posterior atrophic maxilla. Most of the implant failures occurred 6 months after implant installation surgery and before implant loading. Once osseointegrated, pterygoid implants remained stable and functional after the first year. In our revision, all included studies were retrospective and were classified with a low level of evidence (III-3 according to the NHMRC scale). Meta-analysis showed that the included studies were homogeneous, suggesting that the results are robust (Figure 3). This systematic review shows there is still misunderstanding regarding the definitions and differences among tubero-pterygoid, pterygomaxillary, and tuberosity implants, as reported in a previous systematic review of the literature. The outcomes of this systematic review are in agreement with those of a previous systematic review[18]; however, a smaller number of studies were included in the present systematic review, based on the current definition and inclusion criteria for pterygoid implants as described in the literature[6,9-19,22,23]. In the 6 included studies, there was lack of data, such as peri-implant bone loss, implant trademark, or number and type of anterior implants placed in the maxilla. No studies specified whether there were differences in their results related to patient age, gender, smoking status, or any other systemic condition associated with implant success or failure. All included studies had a minimum follow-up period of 1 year, and 3 of the 6 studies[6,16,23] had a minimum follow-up of 3 years. Measurements of bone loss were incomplete or not reported in most studies[14,16,22,23]. Tubero-Pterygoid implant surgical technique follows the same basic principles of conventional implant surgery. The pterygoid implant technique can be considered a simpler surgical approach, as it does not require a bone grafting procedure. This technique is associated with less overall morbidity, lower treatment costs, and shorter healing times. From a prosthetic point of view, dental rehabilitation with pterygoid implants has the advantage of eliminating long distal cantilevers, due to the emergence of pterygoid implants in the second molar region. Rodriguez et al.[10] analyzed 202 cone bean computed tomographic files of patients with atrophic maxilla, and found that bone density of the pterygoid plate area was three times higher compared to the tuberosity area. Bone density in the tuberosity area ranged from 285.8 to 329.1 DV units, and density in the pterygoid plate area varied from 602.9 to 661.2 DV units, with a 95% CI[10]. Some studies have established a minimum implant length of 13 mm for pterygoid implants[10-13]. Lee et al.[12] reported an anatomical study of the pyramidal process of palatine bone in relation to implant placement in the posterior maxilla; they measured the height and anteroposterior and mediolateral distances of the pyramidal process. They found a mean height of 13.1 mm, anteroposterior distance of 6.5 mm, and mediolateral distance of 9.5 mm. Rodriguez et al.[13] reported an anatomical study of the pterygomaxillary area with 100 cone-beam computed tomography; they found a mean bone corridor height of 22.5 mm. In this systematic review, implants were only considered pterygoid if they had minimum length of 13 mm. One study that did not mentioned the pterygoid implant length[19]. Although these authors did not mentioned implant length, they described the complete technique for pterygoid implants, with implant apex engaged at the pterygoid plate. It is important to highlight that in all the included studies, no major complications were reported. Although it might be expected that

the greater the bone reabsorption of the maxilla, the greater will be its complications or transoperative difficulties; however, none of the authors correlated or reported this association[6,14,16,17,22,23]. Some authors reported their major complications, which are summarized in Table 5[6,17,22,23]. The Curi[6], Graves[16] and Rodriguez[22] studies pointed out that one of the major "complications" associated with this technique might be the learning curve and the anatomical knowledge of the area so that the proper pterygoid implant technique may be accomplished. There were no associations in regard to the amount of bone atrophy and difficulties related to the insertion of the pterygoid implants. That could be explained to the fact that the bone corridor formed by the pyramidal process of the palatine bone and the lateral plate of the pterygoid process of the sphenoid bone does not undergo bone resorption like the maxillary alveolar bone, since it does not support teeth and does not have the influence of the masticatory forces or the periodontal ligament[12] There was no consensus as to pterygoid implant angulation insertion among the studies analyzed in this review. The anteroposterior angulation axis varied from 45° to 75° in relation to the Frankfurt plane[6,16,22] . However, the buccopalatal angulation axis had a mean of 80° degrees, in relation to the Frankfurt plane in all studies. There was no significant difference in pterygoid implant survival rates among the included studies, when comparing implant angulation. All included studies reported high pterygoid implant success rates, and varied from 97.1% to 89.1%. None of the included studies in this systematic review discussed the possible primary causes for pterygoid implant failure[6,14,16,17,22,23]. Pterygoid implant surgical technique has been associated with very few complications. The most common complication reported was intraoperative bleeding. Intraoperative bleeding is probably due to damage to pterygoid muscles during implantation or drilling through the pterygoid bone plate[9]. All surgery complications reported in the included studies are shown in Table 2[6,14,16,17,22,23]. All the other data analyzed (age, gender, implant manufacturer, type of prosthesis, implant surface) did not influence the survival rates of pterygoid implants. The quality of soft tissue commonly found in the tuberosity area (where pterygoid implants emerge) can be a positive factor when considering pterygoid implants for the rehabilitation of atrophic posterior maxillae. The soft tissue in this area is usually thick and keratinized. Curi[6] and Peñarrocha[17] found mean peri-implant bone losses of 1.21 mm and 0.71 mm, respectively, in 3-year follow- up periods. While these studies present good clinical results, they were all evaluated with panoramic radiographs, and even with good calibration and controlled clinical and radiographic evaluation, this can lead to imprecise interpretation of results. Further controlled studies with cone beam computed tomography evaluation are required to improve the level of knowledge on this topic. The lack of control over influencing factors limits our conclusions. In addition, no prospective studies were available for analysis and, therefore, the retrospective nature of the included studies should be considered when interpreting the outcomes of this review.

Conclusion

The tubero-pterygoid implant are predictable for the rehabilitation of posterior atrophic maxilla. The survival rates evaluated are as high as conventional dental implant survival rates in other regions of the maxilla.

References

1. Papaspyridakos P, Mokti M, Chen CJ, Benic GI, Gallucci GO, Chronopoulos V. Implant and prosthodontic survival rates with implant fixed complete dental prostheses in the edentulous mandible after at least 5 years: a systematic review. Clin Implant Dent Relat Res 2013; 16: 705-5
2. Brånemark P-I, Breine U, Adell R, Hansson BO, Lindstrom J, Ohlsson A. Intra-osseous anchorage of dental prostheses I: experimental studies. Scand J Plast Reconstr Surg 1969; 3: 81–100.
3. Peñarrocha M, Viña JA, Carrillo C, Peñarrocha M. Rehabilitation of reabsorbed maxillae with implants in buttresses in patients with combination syndrome. J Oral Maxillofac Surg 2012; 70: e322-e330.
4. Moraschini V, Poubel LAC, Ferreira VF, Barboza ESP. Evaluation of survival and success rates of dental implants reported in longitudinal studies with a follow-up period of at least 10 years: a systematic review. Int J Oral Maxillofac Surg 2015; 44: 377–388.
5. Al-Nsour MM, Chan HL, Wang HL. Effect of the platform-switching technique on preservation of peri-implant marginal bone: a systematic review. Int J Oral Maxillofac Implants 2012; 27: 138–45.
6. Curi MM, Cardoso CM, Ribeiro KCB. Retrospective study of pterygoid implants in the atrophic posterior maxilla: Implant and prosthesis survival rates up to 3 years. Int J Oral Maxillofac Implants 2015; 30: 378–383.
7. Balshi SF, Wolfinger GJ, Balshi TJ. Analysis of 164 titanium oxide-surface implants in completely edentulous arches for fixed prosthesis anchorage using the pterygomaxillary region. Int J Oral Maxillofac Implants 2005: 20: 946–952.
8. Tulasne JF. Implant treatment of missing posterior dentition. In: Al-brektson T, Zarb G, editors. The Branemark osseointegrated implant. Chicago, IL: Quintessence; 1989. p. 103–15.
9. Tulasne JF. Osseointegrated fixtures in the pterygoid region. In: Worthington P, Branemark PI, editors. Advanced osseointegration surgery, applications in the maxillofacial region. Chicago, IL: Quintessence;1992. p. 182–8.
10. Rodrıguez X, Lucas-Taulé E, Elnayef B, Altuna P, Gargallo-Albiol J, Peñarrocha MD, Hernandez- Alfaro F. Anatomical and radiological approach to pterygoid implants: a cross-sectional study of cone beam computed tomography examinations. Int J Oral Maxillofac Surg 2015; 45(5): 636-40.
11. Yamakura T, Abe S, Tamatsu Y, Rhee S, Hashimoto M, Ide Y. Anatomical study of the maxillary tuberosity in Japanese men. Bull Tokyo Dent Coll 1998; 39: 287-92.
12. Lee SP, Paik KS, Kim MK. Anatomical study of the pyramidal process of the palatine bone in relation to implant placement in the posterior maxilla. J Oral Rehabil 2001; 28: 125-32.
13. Rodriguez X, Rambla F, De Marcos Lopez L, Mendez V, Vela X, Jimenez Garcia J. Anatomical study of the pterygomaxillary area for implant placement: cone beam computed tomographic scanning in 100 patients. Int J Oral Maxillofac Implants 2014; 29: 1049-52.
14. Balshi TJ, Wolfinger GJ, Slauch RW, Balshi SF. Branemark System implant lengths in the pterygomaxillary region: a retrospective comparison. Implant Dent 2013; 22: 610-12.
15. Balshi FS, Wolfinger GJ, Slauch RW, Balshi TJ. A Retrospective comparison

of implants in the pterygomaxillary region: implant placement with 2 stage, 1 stage and guided: Int J Oral Maxillofac Implants 2013; 28: 184-189.
16. Graves S. The pterygoid plate implant: a solution for restoring the posterior maxilla. Int J Periodont Rest Dent 1994; 13: 513-523.
17. Penarrocha M, Carrillo C, Bonorat A, Penarrocha M. Retrospective study of 68 implants placed in the ptertygomaxillary region using drills and osteotomes. Int J Oral Maxillofac Implants 2009; 24: 720-726.
18. Bidra AS, Huynh-Ba G. Implants in the pterygoid region: a systematic review of the literature. Int J Oral Maxillofac Surg 2011; 40: 773–781.
19. Laney WR, ed: Glossary of oral and maxillofacial implants. Chicago, IL: Quintessence 2007: 182-188.
20. Moher D, Liberati A, Tetzlaff J, Altman DG, PRISMA Group. Preferred Reporting Items for Systematic Reviews and Meta-analyses: the PRISMA statement. Int J Surg 2010; 8: 336–41.
21. Cawood JL, Howell RA. A classification of the edentulous jaws. Int J Oral Maxillofac Surg 1988; 17:232-236.
22. Rodríguez X, Mendez V, Vela X, Segalá M. Modified surgical protocol for placing implants in the ptetygomaxillary region: clinical and radiologic study of 454 implants. Int J Oral Maxillofac Implants 2012; 27: 1547-1553.
23. Valerón JF, Valerón PF. Long-term results in placement of screw-type implants in the pterrygomaxillary-pyramidal region. Int J Oral Maxillofac Implants 2007; 22: 195-200.