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EVALUATION OF SHORT DENTAL IMPLANT IN POSTERIOR ATROPHIC PARTIALLY EDENTULOUS MAXILLA AND MANDIBLE

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ABSTRACT

Objective: This study was carried out to evaluate short dental implant in posterior atrophic partially edentulous mandible and maxilla. **Subjects and methods:** This study was conducted on patients with missed posterior teeth with sever bone resorption where there is no enough bone for placement of standard length implant, where 4mm ultra-short implant was placed .patients were divided into two groups; first group have short implant in maxilla, and second group have short implant in the mandible. Alveolar ridge were measured bucco-lingually, implant stability quotient (ISQ), vertical and horizontal bone loss were assessed during 6 months postoperatively. **Results:** The results of this study revealed that; after implant placement, there was a statistically significant difference in mean stability between both groups, where the mandibular group showed a statistically significant increase in mean stability. After 6 months, there was a statistically a significant difference in stability between both groups. Mandibular group showed a statistically significant increase in mean stability. After 3 and 6months, there was a statistically non-significant difference in mean bone loss between two groups. **Conclusion:** Short implants considered as a viable treatment alternative in both maxilla and mandible in cases with severs alveolar bone resorption because short implants reduce the need for complex surgeries.

KEYWORDS: Short dental implants, reduced alveolar bone, maxillary sinus augmentation, alveolar bone augmentation technique.

INTRODUCTION

Dental implants are prosthetic devices made of inert material as titanium and ceramic, and surgically implanted into the mandible or maxilla to provide retention and support for fixed or removable dental prosthesis. Dental implants are used to replace missing teeth and are retained in the jaw bone by a process of osseointegration [(1)].

The posterior jaw may lack the bone height needed for insertion of dental implants of adequate length, presenting anatomical issues such as injury of inferior alveolar nerve or pneumatized maxillary sinus. Several strategies have been suggested over the years to overcome the dimensional limitations of the bone available for implant placement, these techniques include bone augmentation surgery, bone grafts, guided bone regeneration, sinus floor elevation, distraction osteogenesis and mandibular nerve transposition .Such techniques reportedly have high success rates in implantology, but the outcomes have varied and unpredictable , many patients are also unable or unwilling to do this type of surgical approach because it is costly and demands

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multiple surgical procedures. Inferior alveolar nerve transposition procedures also increase the risk of parasthesia [2,3].

Using short implants has been suggested as an alternative to such surgical options for prosthetic rehabitation in resorbed jawbones, and it can be a solution in many such cases. Short implants offer the advantages of minimizing the surgical trauma involved, limiting the number of surgical procedures required and patients benefit from less morbidity and less postsurgical discomfort[4].

Modification of the design and length of the implants are another approach to overcome jaw bone atrophy. Some authors showed that improvements on those surfaces technologies can increase implant stability quotient (ISQ) values, decrease the marginal bone loss, and produce a better contact interface between the bone and the implant [5-7].

The biomechanical basics for the use of short implants is that the crestal portion of the implant body is the most involved in supporting the load, while less stress is transmitted through the apical portion, moreover, the maximum bone stress is practically independent of the length of the implant, as arguably the width of the implant is more important than the length[8,9].

The predictability of short implants is controversial at present, some studies report lower survival rates than longer implants ; However, there are many publications where the survival an success of short implants appears to be comparable to longer implants[10-13].

Study of Slotte et al. shows that 4-mm-long titanium implants with an SLA active surface can be safely and successfully used to support a fixed dental prostheses in severely resorbed posterior mandibles for at least 2 years with healthy periodontal conditions. Short implant survival success rate with fixed, fiber-reinforced resin bridges on 4 mm ultrashort implants in highly atrophic jaws was 97.25%. The average mesial and distal bone level was 0.2 - 0.3 mm in the atrophic mandibles and 0.4 - 1.2 mm in the fibula transplants at the last follow-up visits [14-15]. Accordingly the main aims of this work was to evaluate stability and bone loss of ultra-short 4-mm length straumann standard plus short dental implants in posterior maxilla and mandible during first 6 months and compared between maxillary and mandibular results.

SUBJECTS AND METHODS

This study was conducted on 38 patients indicated for short implant placement in posterior maxilla and mandible. Patients were selected from that attending outpatient clinic of Al-Azhar University, Cairo (boys) and Sayed Jalal University Hospital.

All patients were divided randomly into two equal groups as the follow:

Group “I”: 19 Patients were received implant in posterior maxilla.

Group “II”: 19 Patients were received implant in posterior mandible.

Patient Selection

Selections of patients were based on specific inclusion and exclusion criteria as the follow:

Inclusion criteria :

1- Partially edentulous patients in the premolar and molar regions of the maxilla and mandible, for whom the residual bone will be sufficient for the insertion of 4mm length short implant, but insufficient for insertion of standard length implants.

2- Patients over 18 years old.

Exclusion criteria:

- General systemic contraindications against implant surgery (psychiatric disorders, pregnancy, metabolic bone diseases, etc.).

1. The presence of systemic diseases which may jeopardize the success of implant integration (uncontrolled diabetes, osteoporosis, etc.).
2. The use of drugs which may negatively affect the osseointegration process (bisphosphonates, antiresorptive agents, corticosteroids, etc.).
3. Active inflammation or neighboring pathologies in the areas intended for implant placement.
4. Radiation therapy to the head and/or neck region in the preceding 12 months.
5. Requirement of bone augmentation during implant placement.
6. Clinically significant parafunction.
7. Tobacco and alcohol abuse.

Ethical Consideration:

This study was carried out after approval of ethical committee, Faculty of Dental Medicine, Al-Azhar University, Cairo, Boys. Number (482/2153)

Patient Consent:

Each patient was signed an informed consent having details about the whole procedures before starting the study. After getting informed consent from the patient, the treatment was done.

Preoperative assessment:

Each patient was inspected to make sure that this patient is indicated to be candidate of this study regarding to:

- Medical history: full medical history was obtained from the patients to exclude any systemic disease that affect the study.
- Dental history: complete dental history was obtained to evaluate the attitude of the patients towards the dental therapy.
- Clinical examination: was done by:

A- Inspection to assess the general oral hygiene, occlusion, condition of the existing teeth and oral mucosa, and available inter arch space.

B- Inspection to assess presence of infection, and gingival biotype.

- Radiographic examination:

A- Periapical radiograph: to exclude any pathosis.

B- Cone beam computed tomography (CBCT) to evaluate the following:

- Vital structure related to the implant position.
- Vertical and horizontal dimensions of the alveolar bone.

Surgical procedures:

The same Surgical protocol has been followed in two groups .After extra oral disinfection with betadine, patients were instructed to rinse their mouths with Chlorhexidine HCL 1.25% mouthwash immediately preoperatively, then local anesthesia Articaine 4% with 1:100,000 epinephrine was injected.

- ***Preparation of the implant position:***

A midline incision was done at the alveolar crest from the distal surface of the most distally placed tooth and extended posteriorly. Full thickness mucoperiosteal flaps were raised. Careful ridge contouring to achieve a flat bone surface of sufficient width (≥6.1 mm) was done if needed. Preparation of the implant sites was performed according to the Straumann information manual. After proper osteotomy preparation, straumann Standard Plus Short (SPS) Implant (4mm length.4.1mm or 4.8mm diameter, Switzerland) was removed from its pack and inserted completely within the confine of the prepared osteotomy in vertical plane and screwed manually to reach the maximum manual torque then continue with ratchet wrench to seat the implant into its final position.

Primary implant stability was evaluated by resonance frequency analysis (RFA) technique through using Ostell device, smart pegs were attached to implant to record the stability, ISQ value were recorded into chart to compare between groups of study, ISQ scale ranging from 1 to 100.

Cover screws were placed over the implants and the flaps were replaced and sutured. Post-surgical periapical radiographs were done to ensure proper position of implant.

Postsurgical medication:

- Antibiotic flumox 500mg (t.d.s) was prescribed for 3 days.
- Ibuprofen 400 mg tabs. (t.d.s) was prescribed for 3 days and then when necessary.

Patients were instructed to refrain from mechanical plaque removal around the implant sites for two weeks and to rinse their mouths twice daily with a solution of Chlorhexidine HCL 1.25% mouthwash for 7 days.

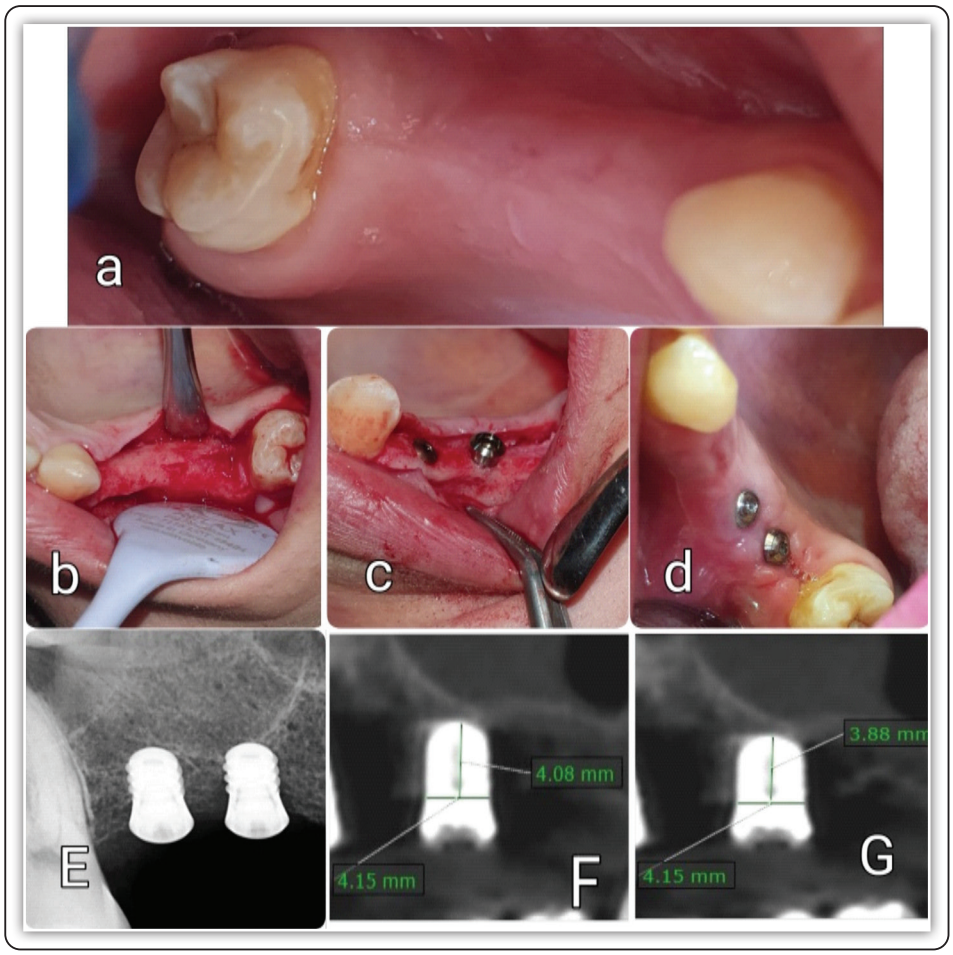

FIG (1) (a): Preoperative photo. (b): After incision and full mucoperiosteal flap elevation. (C):after complete implant insertion. (d): After soft tissue healing (E): Periapical x ray. (F): Cbct immediately after insertion.(G): Cbct after six months.

Post-operative evaluation:

A) Biomechanical evaluation:

Implant stability:

Implant Stability Quotient (ISQ) assessments of all implants were performed immediately after implant installation according to the manufacturer's instructions. The device used was Ostell® ISQ (Ostell® ISQ, Gothenburg, Sweden). All implants were assessed in terms of stability at the time of implant placement and six months post operatively. The results are expressed in ISQ values.

B) Radiographic parameters:

Vertical and horizontal bone loss:

CBCT scan immediately, after 3mounths and after 6 months postoperatively, aided in the assessment of the horizontal and vertical bone level which represents the primary outcome of this study. Cross sectional views were interpreted to measure the bone dimensional changes as follows: for the horizontal bone level, a line was drawn intersecting the implant apex and perpendicular to the implant shoulder. From that line, another line was drawn to the outer margin of the buccal and lingual plate of bone to record the horizontal bone level for each implant in both groups.

For the vertical bone level, starting from the implant shoulder, perpendicular lines were drawn to the bone crest buccally and lingually and the average was recorded for each implant in both groups. The difference between horizontal bone levels immediately postoperatively and after three and six months calibrates the horizontal bone loss. The same modality was repeated to calculate the vertical bone loss.

RESULTS

Stability

TABLE (1A) Descriptive statistics of stability in each studied groups

Groups	Time	Stability					
		Min.	Max.	Mean ± SD	Median	95% CI	
						LL	UL
Maxilla (n = 19)	After implant placement	44.0	65.0	59.84 ± 5.05	61.0	57.41	62.27
	6 months	64.0	76.0	69.53 ± 2.91	69.0	68.12	70.93
Mandible (n = 19)	After implant placement	57.0	65.0	61.71 ± 2.51	62.0	60.53	62.95
	6 months	70.0	77.0	73.21 ± 2.27	73.0	72.11	74.31

Table (1b) shows the comparison between the different times in each group according to stability. Both maxilla and mandible showed a statistically a significant increase in mean stability after 6months (<0.001*)

TABLE (1B) Comparison between the different time periods in each group according to stability

	Stability		t	P
	After implant placement	6months		
Maxilla (n = 19)	59.84 ± 5.05	69.53 ± 2.91	9.979*	<0.001*
Mandible (n = 19)	61.71 ± 2.51	73.21 ± 2.27	24.879*	<0.001*

Data was expressed using Mean ± SD.

t: Paired t-test

p: p value for comparing between the two studied periods

**: Statistically significant at p ≤ 0.05*

Table (1c): Comparison between the two studied groups according to stability. After implant placement, there was a statistically a non-significant difference in mean stability between both groups. After 6 months, there was a statistically a significant difference in mean stability between both groups. Mandible group showed a statistically a significant increase in mean stability (p<0.001*).

TABLE (1C) Comparison between the two studied groups according to stability

	Short implant		t	P
	Maxilla (n = 19)	**Mandible (n = 19)**		
Stability				
After implant placement	59.84 ± 5.05	61.71 ± 2.51	1.465	0.152
6 months	69.53 ± 2.91	73.21 ± 2.27	4.345*	<0.001*
Change	**↑9.68 ± 4.23**	**↑11.47 ± 2.01**	1.665	0.108

Data was expressed using Mean ± SD.

t: Student t-test

p: p value for comparing between the studied groups

**: Statistically significant at p ≤ 0.05*

II) Bone loss:

TABLE (2A): Descriptive statistics of bone loss in each studied groups

Groups	Time	Bone loss					
		Min.	Max.	Mean ± SD	Median	95% CI	
						LL	UL
Maxilla (n = 19)	**3 months**	0.30	0.42	0.37 ± 0.03	0.37	0.35	0.38
	6 months	0.43	0.54	0.49 ± 0.03	0.48	0.47	0.50
Mandible (n = 19)	**3 months**	0.30	0.42	0.36 ± 0.04	0.35	0.34	0.38
	6 months	0.42	0.52	0.48 ± 0.03	0.48	0.46	0.49

Table (2b) shows the comparison between the different times in each group according to bone loss. Both maxilla and mandible showed a statistically a significant increase in mean bone loss after 6 months.

TABLE (2B) Comparison between the different time periods in each group according to bone loss

	Bone loss		t	P
	3 months	6 months		
Maxilla (n = 19)	0.37 ± 0.03	0.49 ± 0.03	11.287	<0.001*
Mandible (n = 19)	0.36 ± 0.04	0.48 ± 0.03	26.331*	<0.001*

Data was expressed using Mean ± SD.

t: Paired t-test

p: p value for comparing between the two studied periods

**: Statistically significant at p ≤ 0.05*

Table (2c) shows the comparison between the two studied groups according to Bone loss. After 3 months, there was a statistically a non-significant difference in mean Bone loss between both groups. After 6 months, here was a statistically a non-significant difference in mean Bone loss between both groups.

TABLE (2C) Comparison between the two studied groups according to bone loss

	Short implant		t	P
	Maxilla (n = 19)	Mandible (n = 19)		
Bone loss				
3 months	0.37 ± 0.03	0.36 ± 0.04	0.823	0.416
6 months	0.49 ± 0.03	0.48 ± 0.03	0.832	0.411
Change	**↑0.118 ± 0.05**	**↑0.119 ± 0.02**	0.092	0.927

Data was expressed using Mean ± SD.

t: Student t-test

p: p value for comparing between the studied groups

DISCUSSION

Prosthetic rehabilitation using dental implants in edentulous and partially edentulous patients with adequate bone condition is usually a safe treatment with predictable results, showing long term survival rates around 98%. Anatomical limitations, such as reduced bone width and height, generate significant surgical difficulties in the installation of dental implants. In situations involving limited remaining bone, advanced surgical techniques were developed to make possibility of installation of the implant, in a simultaneous or staged fashion [16] .

With the development of bone augmentation techniques, it became possible to rehabilitate many of these cases with implant supported prosthesis. However, clinical results show that vertical bone augmentation techniques, such as guided bone regeneration, distraction osteogenesis, interpositional bone grafts, onlay bone grafts, and the use of growth factors, are sensitive techniques, requiring significant surgical experience, and producing unpredictable results. Moreover, they also increase treatment time, morbidity, complications, and cost [17].

For the posterior maxilla, the sinus floor elevation is a predictable and well-documented technique, but also requires more time and a staged approach in severe atrophies. The vertically deficient posterior mandible remains a challenging anatomic area to restore with implant-supported fixed prosthesis [18, 19].

In the last decade, the use of short implants (<8 mm) became of great interest among professionals. Rehabilitation using short implants in areas with limited bone height offers a less complex, less costly, and less traumatic treatment for patients. It has been demonstrated by several systematic reviews, RCTs, prospective, and retrospective clinical series publications that the use of short implants is a safer option for edentulous areas with limited bone height, when compared to the advanced and complex vertical augmentation techniques [20-24].

Some aspects such as; achieving good primary stability, adequate bone to implant contact, potentially a high crown-to-implant ratio, and the effect on the marginal bone loss after loading should be considered as it influence in the short- and long-term survival rates of short implants,. Those factors are directly influenced by the implant design, surface, and implant/abutment connection [25].

Due to the scarcity of long-term randomized control trial reports, the aim of this study was to evaluate Short dental implant in posterior atrophic partially edentulous maxilla and mandible with focus on bone loss and stability during first first six months after implant insertion.

Straumann Standard Plus SLActive surface short implant that used in this study characterized by unique implant design where implant body itself has a solid screw parallel-wall configuration, with the thread pitch of 0.8 mm and made of Roxolid (Titanium-Zirconium alloy) with rounded apex, the body has 4.1 mm, and the neck has 4.8mm (for the RN design), the "tulip-shaped" design helps to improve the primary stability at the neck of the implant, especially in the posterior maxilla sites .The polished collar neck provides a crown-to-implant connection at a supra-gingival (Soft Tissue) level, allowing for less crestal bone loss and an excellent peri-implant tissue stability. The Tissue Level design also has an internal morse taper conical connection providing a biological seal and excellent mechanical stability. This characteristic may also be beneficial when dealing with short implants, giving more stability and helping to decrease the crown-to-implant ratio [26].

In the present study, after implant placement, there was statistically a significant difference in mean stability between both groups. Mandible group showed a statistically significant increase in mean stability ($p<0.001$*). After 6 months, there was a statistically a significant difference in mean stability between both groups. Mandible group showed a statistically significant increase in mean stability ($p<0.001$*).

Some studies showed that short implants placed in the maxilla showed a lower survival rate than those placed in the mandible. This result could be due to the difference in bone density, which can reduce stress concentration around implants and improve mechanical properties of the implant-bone interface, consequently facilitating primary stability and early osseointegration, which compensate the implant lengths reduction [27].

In the present study, After 3 months, there was a statistically non-significant difference in mean bone loss between both groups. After 6 months, there was a statistically a non-significant difference in mean bone loss between both groups. Rossi et al. wanted to compare the clinical and radiographic findings obtained between short and standard implants over five years of follow-up. This study showed similar marginal bone loss in both groups [28].

Anitua et al. in a retrospective study evaluated the influence of crown to implant(C/I) ratio on marginal bone loss and on the survival rates of implant-supported prostheses in 128 short implants placed in the posterior maxilla and mandible of 63 patients over a period of 10 years. Based on the C/I ratio (C/I <2 and C/I ≥ 2), two groups were designed. According to this study, marginal bone loss in the posterior area is not significantly influenced by C/I ratio [29].

Anitua et al., evaluated survival and marginal bone loss around short dental implants and assess the influence of the anatomical location (mandible or maxilla) on these outcomes, the marginal bone loss has been significantly higher in the maxilla than the mandible [30].

In the present study, Maxilla success rate was 18 (94.74%) and Mandible success rate was 19 (100.0%) There was a statistically non-significant difference between both groups regarding success rate. Maló et al. found a short implant success rate of 99% in mandible and 92% in maxilla. According to these authors, the maxilla's spongy bone, probably, influenced on the losses, and consequently on the success rate [31].

On one hand, other study also reported higher success rates of mandible compared to maxilla: 94.5% and 78.3%, respectively. On the other hand, in the study of Arlin 630 implants were installed and 17 were lost. From these, 16 were placed into mandible, and only one into maxilla, with 11 located into type III or IV bone. For several researches, bone quality is a significant risk factor for failures due to lack of blood irrigation, overheating during implant drilling in dense bones, and lack of bone density in trabeculated bone. Goodacre et al. considered that implants performed in poor bone quality areas showed unsuccessful rates of 16% higher than those placed into grater bone density areas [32-35].

These study revealed that with increasing the trend of minimally invasive surgical treatment with dental implants, especially with the elderly patients' population, ultra-short dental implants should be considered when treating posterior vertically atrophic areas of the maxilla and the mandible. Current undergoing and future studies should bring long-term outcomes and stronger evidence for its use. The characteristics that contribute to the success of straumann Standard Plus Short (SPS) implant that used in this study are the excellent surface treatment (SLActive), applied at the novel Titanium-Zirconium alloy (Roxolid), and the well documented tissue level polished collar neck design, that carries a strong and stable internal conical connection in addition to popper selection of implant position regarded to bone density and occlusion. Detailed restorative care and recommendations (should be used splinted, reduced occlusal surface, premolarization, and low cusp occlusal tables) should be followed to optimize long-term results.

CONCLUSION

- Short implants should be considered as a viable treatment alternative in both maxilla and mandible.
- The use of short implants reduces the need for complex surgeries.
- The absence of surgical and postsurgical complications has to be considered in choosing a treatment and should be taken into account.

REFERENCES

1. Barikani H, Rashtak S, Akbari S, Fard MK, Rokn A. The effect of shape, length and diameter of implants on primary stability based on resonance frequency analysis. Dent Res J. 2014;11:87-91.
2. Hermann I, Lekholm I, Holm S, Kult je G. Evaluation of patient and implant characteristics as a potential prognostic factor for oral implant failure. Int J Oral Maxillofac Implants. 2005; 20: 220-30.
3. Renouard F, Nissand D. Short implants in the severely resorbed maxilla: A 2-year retrospective clinical study. Clin Implant Dent . 2005; 7 (supplement 1): s104-10. 1. Felice P, ChecchiV, Pistilli R, Scarano A, Pellegrino G, EspositoM Bone augmentation versus 5-mm dental implants in posterior atrophic jaws. Four-month post-loading results from a randomised controlled clinical trial. Eur J Oral Implantol.2009; 2:267– 281
4. Annibali S, CristalliMP, Dell'Aquila D, Bignozzi I, La Monaca G, Pilloni A Short dental implants: a systematic review. J Dent Res .2012;91:25–32
5. Sul, Y.T., Jönsson, J., Yoon, G.S. & Johansson, C. (2009) Resonance frequency measurements in vivo and related surface properties of magnesium-incorporated, micropatterned and magnesium-incorporated TiUnite, Osseotite, SLA and TiOblast implants. Clinical Oral Implants Research 20: 1146– 1155.
6. Karabuda, Z.C., Abdel-Haq, J. & Arisan, V. Stability, marginal bone loss and survival of standard and modified sand-blasted, acid-etched implants in bilateral edentulous spaces: a prospective 15-month evaluation. Clinical Oral Implants Research 22:2011; 840– 849..
7. Botzenhart, U., Kunert-Keil, C., Heinemann, F., Gredes, T., Seiler, J., Berniczei-Roykó, A. & Gedrange, T. Osseointegration of short titan implants: a pilot study in pigs. Annals of Anatomy .2015;199: 16– 22.
8. Kim, S., Kim, S., Choi, H., Woo, D., Park, Y.B., Shim, J.S., Kim, H.S. & Lee, K.W. A three-dimensional finite element analysis of short dental implants in the posterior maxilla. The International Journal of Oral & Maxillofacial Implants .2014;2: 155– 164.
9. Anitua, E., Tapia, R., Luzuriaga, F. & Orive, G. Influence of implant length, diameter, and geometry on stress

distribution: a finite element analysis. The International Journal of Periodontics & Restorative Dentistry.2010; 1: 89– 95.

10. Romeo, E., Bivio, A., Mosca, D., Scanferla, M., Ghisolfi, M. & Storelli, S. The use of short dental implants in clinical practice: literature review. Minerva Stomatologica .2010;1–2: 23– 31.
11. Telleman, G., Raghoebar, G.M., Vissink, A., den Hartog, L., Huddleston Slater, J.J. & Meijer, H.J. A systematic review of the prognosis of short (<10 mm) dental implants placed in the partially edentulous patient. Journal of Clinical Periodontology.2011; 7: 667– 676.
12. Annibali, S, Cristalli, MP, Dell'Aquila, D, Bignozzi, I, La Monaca, G & Pilloni. A Short dental implants: a systematic review. Journal of Dental Research .2012;1: 25– 32.
13. Atieh, M.A., Zadeh, H., Stanford, C.M. & Cooper, L.F. Survival of short dental implants for treatment of posterior partial edentulism: a systematic review. The International Journal of Oral & Maxillofacial Implants .2012;6: 1323–1331.
14. Slotte, C., Grønningsaeter, A., Halmøy, A.M., Öhrnell, L.O., Stroh, G., Isaksson, S., Johansson, L.Å., Mordenfeld, A., Eklund, J. & Embring, J. Four-millimeter implants supporting fixed partial dental prostheses in the severely resorbed posterior mandible: two-year results. Clinical Implant Dentistry & Related Research .2012;1: e46– e58.
15. Seemann, R., Marincola, N., Seay, D., Perisanidis, C., Barger, N. & Ewers, R. Preliminary results of fixed, fiber-reinforced resin bridges on four 4–5-mm ultrashort implants in compromised bony sites: a pilot study. Journal of Oral and Maxillofacial Surgery,2015; 73: 630– 640.
16. Buser D, Janner SFM, Wittneben J-G, Brägger U, Ramseier CA, Salvi GE. 10-Year sur-vival and success rates of 511 titanium implants with a sandblasted and acid-etched sur-face: a retrospective study in 303 partially edentulous patients. Clin Implant Dent Relat Res. 2012;14(6):839–51.
17. Esposito M, Grusovin MG, Felice P, Karatzopoulos G, Worthington HV, Coulthard P. The efficacy of horizontal and vertical bone augmentation procedures for dental implants: a Cochrane systematic review. In: Evidence-based practice: toward optimizing clinical outcomes. Berlin: Springer; 2010. p. 195–218.
18. Buser D, Monje A, Polido W. Treatment options for the posterior edentulous jaw: surgical options for implant therapy in the posterior maxilla of partially edentulous patients. ITI Forum Implantologicum. 2017;13(1):4–17.
19. Plonka AB, Urban IA, Wang H-L. Decision tree for vertical ridge augmentation. Int J Periodontics Restorative Dent. 2018;38(2):269–75.
20. Srinivasan M, Vazquez L, Rieder P, Moraguez O, Bernard J-P, Belser UC. Survival rates of short (6 mm) micro-rough surface implants: a review of literature and meta-analysis. Clin Oral Implants Res. 2014;25(5):539–45.
21. Thoma DS, Cha J-K, Jung U-W. Treatment concepts for the posterior maxilla and man-dible: short implants versus long implants in augmented bone. J Periodontal Implant Sci. 2017;47(1):2–11.
22. Thoma DS, Zeltner M, Hüsler J, Hämmerle CHF, Jung RE. EAO Supplement Working Group 4—EAO CC 2015 short implants versus sinus lifting with longer implants to restore the posterior maxilla: a systematic review. Clin Oral Implants Res. 2015;26:154–69.
23. Tong Q, Zhang X, Yu L. Meta-analysis of randomized controlled trials comparing clinical outcomes between short implants and long implants with bone augmentation procedure. Int J Oral Maxillofac Implants. 2017;32(1):e25–34.
24. Uehara PN, Matsubara VH, Igai F, Sesma N, Mukai MK, Araújo MG. Short dental implants (≤7mm) versus longer implants in augmented bone area: a meta-analysis of randomized controlled trials. Open Dent J. 2018;12(1):354–65.
25. Gonçalves TMSV, Bortolini S, Martinolli M, Alfenas BFM, Peruzzo DC, Natali A, et al. Long-term short implants performance: systematic review and meta-analysis of the essential assessment parameters. Braz Dent J. 2015;26(4):325–36.
26. Fan, T.; Li, Y.; Deng, W.W.; Wu, T.; Zhang, W. Short Implants (5 to 8 mm) Versus Longer Implants (>8 mm) with Sinus Lifting in Atrophic Posterior Maxilla: A Meta-Analysis of RCTs. Clin. Implant. Dent. Relat. Res. 2017, 19, 207–215.
27. Lombardo, G.; Pighi, J.; Marincola, M.; Corrocher, G.; Simancas-Pallares, M.; Nocini, P.F. Cumulative Success Rate of Short and Ultrashort Implants Supporting Single Crowns in the Posterior Maxilla: A 3-Year Retrospective Study. Int. J. Dent. 2017, 2017, 8434281.
28. Anitua E, Alkhraisat MH. 15-year follow-up of short dental implants placed in the partially edentulous patient: Mandible Vs maxilla. Ann Anat. 2019 Mar;222:88-93.
29. Anitua E, Piñas L, Orive G. Retrospective study of short and extra-short implants placed in posterior regions: influence of crown-to-implant ratio on marginal bone loss. Clin Implant Dent Relat Res. 2015;17:102–110.

30. Anitua E, Alkhraisat MH. 15-year follow-up of short dental implants placed in the partially edentulous patient: Mandible Vs maxilla. Ann Anat. 2019 Mar;222:88-93.

31. Maló P, Araujo Nobre M, Rangert B. Short implants placed one-stage in maxillae and mandibles: a retrospective clinical study with 1 to 9 years of follow-up. Clin Implant Dent Relat Res. Clin Implant Dent Relat Res. 2007 Mar;9(1):15-21.

32. Arlin ML. Short dental implants as a treatment option: results from an observational study in a single private practice. Int J Oral Maxillofac Int J Oral Maxillofac Implants. 2006 Sep-Oct;21(5):769-76.

33. Griffin TJ, Cheung WS. The use of short, wide implants in posterior areas with reduced bone height: a retrospective investigation. J Prosthet Dent. 2004 Aug;92(2):139-44.

34. Morand M, Irinakis T. The challenge of implant therapy in the posterior maxilla: providing a rationale for the use of short implants. J Oral Implantol. 2007;33(5):257-66.

35. Goodacre CJ, Bernal G, Rungcharassaeng K, Kan JY. Clinical complications with implants and implant prostheses. J Prosthet Dent. 2003 Aug;90(2):121-32.