Dental Implant Placement in the Maxilla Following Ridge Augmentation with Free Iliac Bone Graft and Oral Rehabilitation with Fixed Prosthesis: a Three-Year Follow-Up Study

Kristian Kniha[1,2], Joud Alhares[3], Stephan Christian Möhlhenrich[4], Marie Sophie Katz[2], Philipp Winnand[1], Frank Hölzle[1], Ali Modabber[1], Marius Heitzer[1]

[1]Department of Oral and Cranio-Maxillofacial Surgery, University Hospital RWTH Aachen, Pauwelsstraße 30, Germany.
[2]Private Clinic for Oral Surgery Dres, Kniha, Rosental 6, 80331 Munich, Germany.
[3]Private dental clinic Zahnmedizin Velbert, Velbert, Germany.
[4]Department of Orthodontics, University of Witten/Herdecke, Alfred-Herrhausen Str. 45, 58455 Witten, Germany.

Corresponding Author:
Kristian Kniha
Department of Oral and Cranio-Maxillofacial Surgery
University Aachen
Pauwelsstraße 30, 52074 Aachen
Germany
Phone: +492418088258
E-mail: kkniha@ukaachen.de

ABSTRACT

Objectives: This prospective follow-up study aimed to evaluate the stability values of tapered titanium implants inserted into maxilla following ridge augmentation with free iliac bone graft and crestal bone changes up to three years of follow-up.
Material and Methods: A total of seven patients with 34 tapered titanium implants in the maxilla with fixed protheses were enrolled in this prospective follow-up study. Patients with previously augmented maxillae using free iliac bone grafts were included. Implant stability was measured (Osstell™) for up to three months of healing. Peri-implant bone resorption was measured using radiographic images taken immediately after implant surgery and after three years. Using a clinical and radiological examination survival and success rates were evaluated.
Results: After implant insertion, the stability was 60.93, whereas the stability increased significantly (P = 0.0192) to 64.97 at implant exposure (after 3 months). The mean bone loss around the implants was 1.13 mm after three years. Clinical parameters revealed a mean sulcus depth of 2.76 (1.18) mm and a bleeding on probing score of 0.29 (0.58). The survival rate was 100%, and the success rate was 67.65% at the end of the study.
Conclusions: Tapered implants can be used in free iliac bone grafts for fixed dentures. Implant stability values were high after insertion. In terms of a success rate of 67.65%, the patient's jaw reconstruction indicated a reduced implant success when comparing the data with healthy patients without any augmentation procedures.

Keywords: dental implant; titanium, bone transplantation; iliac crest.

Accepted for publication: 31 March 2024
To cite this article:
Kniha K, Alhares J, Möhlhenrich SC, Katz MS, Winnand P, Hölzle F, Modabber A, Heitzer M.
Dental Implant Placement in the Maxilla Following Ridge Augmentation with Free Iliac Bone Graft and Oral Rehabilitation with Fixed Prosthesis: a Three-Year Follow-Up Study
J Oral Maxillofac Res 2024;15(1):e3
URL: http://www.ejomr.org/JOMR/archives/2024/1/e3/v15n1e3.pdf
doi: 10.5037/jomr.2024.15103

INTRODUCTION

Peri-implant marginal bone stability is an important indicator of implant survival [1] and should be assessed by considering the entire implant-prosthetic complex [2]. Bone resorption prior to prosthetic loading may occur due to infection [3], poor oral hygiene [4], or surgical complications [5] Radiographic analysis in combination with clinical examination is the best noninvasive method for evaluating peri-implant bone levels [6-8] before implant loading. In addition, increasing probing depth around the implant over time may indicate bone loss [1]. Next to bone loss, the most reported dental implant failure criteria are mobility and pain [2].

Bone stability and sufficient bone volume to retain dental implants are important factors for implant treatment [9]. Implant treatments in atrophied jaws present a special challenge for surgeons. To promote implant stability, a mineralized, sufficient bone crest is important. This is not possible in cases of severe atrophy, and the jaw must usually be built up pre-implantologically.

Autologous bone is considered the "gold standard" compared to other materials, such as bone substitutes, due to its osteogenic potential [10]. Augmentation with iliac crest bone is one of the proven augmentation procedures, providing enough cortical bone and cancellous bone, as well as an osteoinductive and osteogenic potential [11-13]. The iliac crest is especially used in cases with high vertical bone loss. For optimal wound healing, implant placement should not occur until three months after augmentation [14-16]. Furthermore, modern tapered implants can improve implant stability, which is especially necessary in cases of softer cancellous bony structures [17].

The purpose of this prospective follow-up study was to assess the stability values of tapered titanium implants placed into the maxilla after crestal bone alterations and free iliac bone grafting for ridge augmentation throughout a three-year period of follow-up. In addition, survival and success rates were evaluated.

MATERIAL AND METHODS

Study design

In this long term observation study patients with partial or complete edentulism in the maxilla and indications for free iliac crest bone grafts were investigated from January 1, 2016 to March 31, 2023. Patients were treated in the University Hospital Aachen (Department of Oral and Maxillofacial Surgery, Faculty of Medicine, RWTH Aachen University, Aachen, Germany). Only patients treated with fixed dental prostheses were included. Patients who required sinus lift augmentation, were excluded. Patients who had one or more absolute contraindications for augmentation or implant placement could not participate in this study (Figure 1). The exclusion criteria were systemic disease (e.g., uncontrolled diabetes), smoking (> 10 cigarettes per day), untreated periodontitis, gingivitis (oral hygiene index [OHI-S scores 3.1 - 6]), and severe bruxism or clenching habits. The ethics committee of the Faculty of Medicine, RWTH Aachen University, approved the study protocol (No. 196/15), and documented informed consent was obtained from all patients. The study was conducted in accordance with the principles of the Declaration of Helsinki. As the study was a prospective observational one, it was conducted in accordance with the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) statement [18]. The study was registered at the German Clinical Trials Register - DRKS (No. DRKS00033960).

Surgical and prosthetic treatment

One experienced surgeon conducted the implant treatment (K.K.). At first, augmentation with a free bone graft from the iliac crest in the maxilla was performed (Figure 2A and B). Vertical and horizontal augmentation were included. In all cases, bone transfer was performed with cortical blocks, and cancellous bone was also used between and around the blocks. Bone blocs were fixed with two srews using a a predrilling with a pilot drill with a 1.5 mm diameter (Medartis AG; Basel, Switzerland) under strict cooling with sterile saline. Complications during or after treatment were recorded and treated with oral antiobiotcs if necessary.

No bone substitute materials were used. After a healing period of three months, the implant placement took place (Figure 2C). All implants used in this study were bone-level-tapered (BLT) (titanium, Roxolid® SLActive®) implants from Straumann® (Straumann AG; Basal, Switzerland). Implants were inserted according to manufacturer protocol using a pilot- and predrill with a under strict cooling with sterile saline. After an osseointegration period of five months, the implant exposure took place, and the healing abutment (titanium, 4 mm height, Straumann AG; Basal, Switzerland) was inserted (Figure 2D). After a further two weeks, a fixed implant - supported prosthesis was planned, fabricated, and inserted (conventional impression followed by a srew fixed crown with final occlusion assessment).

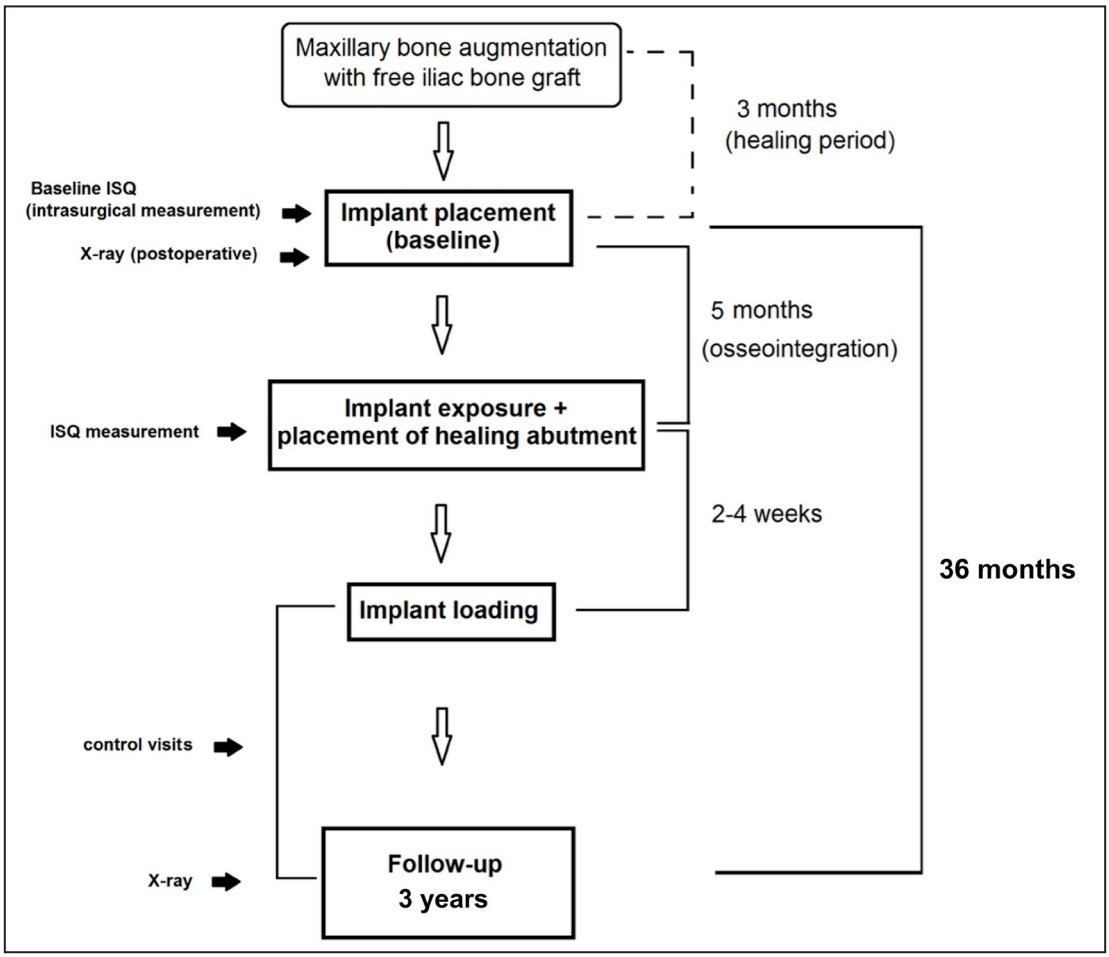

Figure 1. Flow diagram of studies selection according PRISMA guidelines.

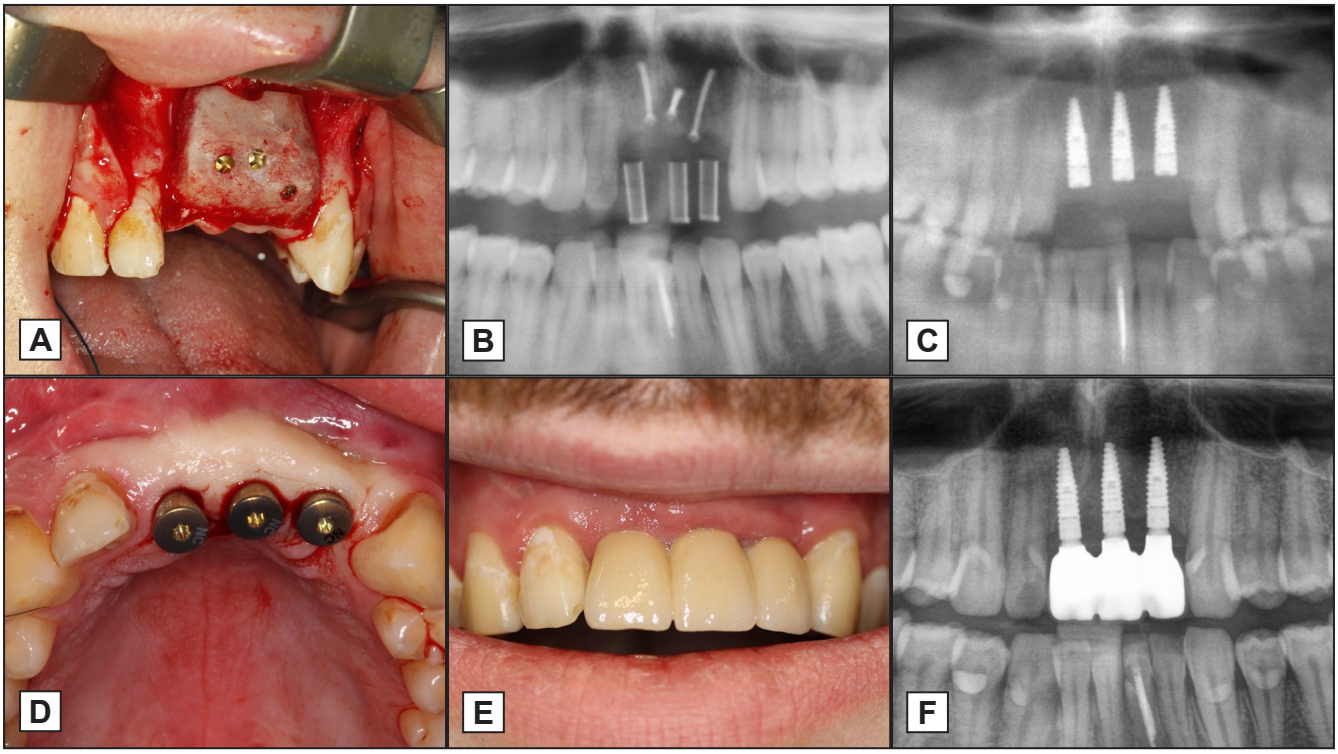

Figure 2. A = maxillary bone augmentation was performed in the anterior area. B = after a three-month healing period, implant placement was planned and a radiographic control was conducted. C = all three implants were inserted at areas 11, 21, and 22. D = after a five-month integration time, the implant exposure was performed, and healing caps were added. E and F = clinical and X-ray pictures after three years.

Follow-up appointments were scheduled at three years after occlusal loading (Figure 2E and F).

Resonance frequency analysis

Using resonance frequency analysis with hand-screwed individual smart pegs (Osstell™ SmartPegs® - Integration Diagnostics AB; Gothenburg, Sweden), primary stability was evaluated after implant insertion and at implant exposure. Stability was measured with the implant stability quotient (ISQ) value in four directions (i.e., from left and right and from front and back [19], resulting in a calculated mean ISQ value. One examiner (K.K.), performed the assessment.

X-ray examination

To evaluate bone resorption, digital panoramic radiographs (Orthophos SL - Sirona; Bensheim, Germany) were obtained using a previously published measuring method [20]. The distance between the bone contact at the implant to the implant shoulder was measured on both side of the implant body. All measurements carried out by one experienced examiner (K.K.). Images were viewed in a dimmed room on a Dell Precision display with a resolution of 1920 × 1200 pixels (Dell Inc.; Round Rock, TX, USA). The radiographs were taken at the following times: the first evaluation was performed after prosthodontic rehabilitation and the second after three years. To calibrate the radiographic images, the defined distance of the individual implant length was used.

Clinical examination

The modified sulcus bleeding index was measured after three years on four surfaces around the implants and contained the following scores: 0 = no bleeding, 1 = isolated bleeding, 2 = confluent linear bleeding, and 3 = severe bleeding. Another parameter, pocket depth, was measured at four points around each implant. One experienced clinician (K.K.) recorded all measurements using a probe with a standardized probing force of 0.2 N.

After three years of follow-up, the survival rate was calculated. In addition, the implant success rate in this study was assessed based on the following standard criteria used in the previous state-of-the-art approaches [1]: no mobility, no self-reported pain or paresthesia, no peri-implant radiolucency, peri-implant marginal bone loss after one year < 1.5 mm, and annual bone resorption thereafter < 0.2 mm. One examiner (K.K.), performed the assessment. Authors used a modified success criteria because bone changes were assessed after 3 year and not annually. Therefore a mean bone loss per year was calculated.

Statistical analysis

The power of the data was calculated using G*Power software version 3.1.9.2 (Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany) [21,22]. The matched-pair post hoc t-test was used as an indication. The authors hypothesized that implant stability was already high during implant insertion. With a significance level of 0.05, a mean of differences of 62.95, a standard deviation of 8.5, an effect size of 7.4, and a sample size of 34, the final power was 100%.

Statical analyses were performed using Prism 10.1.0 software for Mac OS X (GraphPad Software Inc.; La Jolla, CA, USA). The analysis values were tested for normal distribution using the Kolmogorov-Smirnov normality test. The matched-pair t-test was used as an indication. Any effect on the statistical model as significant was assessed if the corresponding P-value was below the 5% margin.

Parametric data were expressed as mean and standard deviation (M [SD]).

RESULTS

A total of seven patients with 34 implants (minimum 3 and maximum 8 per patient) who agreed to participate in this follow-up assessment were clinically and radiographically controlled from January 1, 2016 to March 31, 2023 according to a previously published evaluation [20]. Of these patients, four were men and three were women. The age ranged from 28 to 72 years (mean 50 years). All 34 implants were inserted into the maxilla (Table 1). No complications during or after treatment occoured.

A significant difference was evaluated regarding the implant stability ISQ value (P = 0.0192, Figure 3A). After implant insertion, the stability was 60.93, whereas the stability increased to 64.97 (8.09) at implant exposure. This showed a minimum value of 40, with a maximum value of 83.5. Regarding the distance between the bone contact at the implant and the implant shoulder, a significant increase in three years was measured (P < 0.0001, Figure 3B).

Table 1. Overview of all implant positions of the maxilla

Implant position	17	16	15	14	13	12	11	21	22	23	24	25	26	27	Total
Number	2	5	3	3	2	-	1	3	2	3	4	2	4	-	34

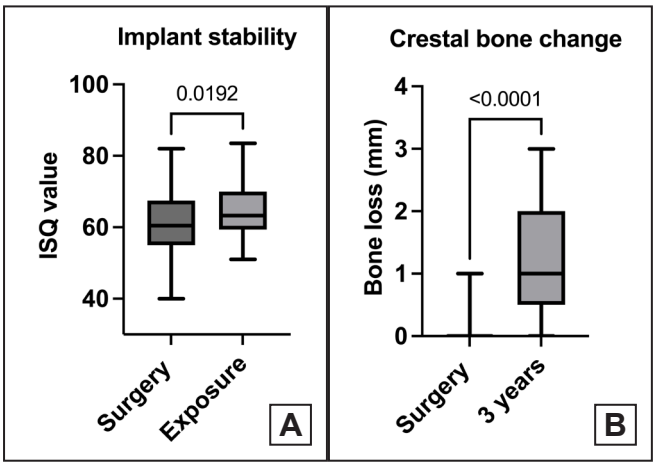

Figure 3. A = evaluation of the implant stability using implant stability quotient (ISQ) values (0 to 100) on the day of surgery and at implant exposure. B = assessment of the distance between the bone crest and the implant shoulder (mm) in three years of follow-up.

The mean bone loss around the implants was 1.13 (0.96) mm. The results ranged from a value of 0 mm to a value of 3 mm. The descriptive statistics of measured distances were presented in Table 2. Clinical parameters revealed a mean sulcus depth of 2.76 (1.18) mm and a bleeding on probing score of 0.29 (0.58) after the three-year follow-up. The results of the sulcus depth ranged from 0 to 6 mm. The maxiumum value score regarding bleeding on probing was 2. The survival rate was 100%, and the success rate was 67.65% at the end of the study.

DISCUSSION

Peri-implant bone loss is one of the most important factors in determining implant survival, so regular monitoring of bone resorption is an important part of this study. Severe and rapid bone loss indicates an abnormal response of the bone and the soft tissue and usually leads to irreversible bacterial inflammation of the peri-implant tissue (peri-implantitis) [23]. When dental X-rays are taken annually, changes in the peri-implant bone can be observed and bone loss can be measured. This regular measurement enables the early detection of pathological changes in the bone and provides the opportunity to take therapeutic measures in time and prevent the occurrence of peri-implantitis [24].

All implant types displayed decreased implant stability values, as determined by the ISQ values, with an increased defect size. The most apparent loss of stability occurred around circular defects [17]. In our study with free iliac bone grafts for fixed dentures, the implant stability values were high during surgery.

A retrospective study [25] evaluated the survival of Straumann® implants placed between 1999 and 2012. This study summarized 2060 patients with a total of 4591 Straumann® implants and a follow-up period of up to 10 years. The evaluation showed survival rates of 99%, 99%, and 98% at three, five, and seven years, respectively. This result showed that the survival rate drops only minimally after three years and that Straumann® implants still perform with a high survival rate of 98% after seven years. In our study, a new type of implant was used, which was not considered in the reference study by French et al. [25]. A three-year follow-up period is a realistic time frame and a good starting point for long-term implant monitoring. Our results revealed a survival rate of 100% and a success rate of 67.65% after three years. The results of one study showed that dental implants implanted in a free iliac graft during the rehabilitation of atrophic jaws were related to tolerable marginal bone loss, a high survival rate, patient satisfaction, and positive esthetic outcomes and had a total average of 2.44 mm of crestal bone resorption [26].

Possible causes for increased bone resorption, on the one hand, can be found in the large augmentation procedure of this investigation. The larger the argumentation, the more complex the diffusion appears for augmentation. This, in turn, can cause

Table 2. Descriptive statistics of measured distances

		Mean (SD)	Min; max	P-value[a]
ISQ value	Surgery	60.93 (9.2)	40; 82	-
	Exposure	64.97 (8.09)	51; 83.5	0.0192
Crestal bone change (mm)	Surgery	0.06 (0.19)	0.00; 1.00	-
	3 years	1.13 (0.96)	0.00; 3	< 0.0001
Sulcus depth (mm)	3 years	2.76 (1.18)	1.00; 6	-
Bleeding on probing (BOP score)	3 years	0.29 (0.58)	0.00; 2	-

[a]Statistically significanct at level P-value < 0.05 (matched-pair t-test). A significant difference was evaluated between surgery and 3 years for ISQ values and cresral bone changes.
ISQ = implant stability quotient; SD = standard deviation.

bone resorption. One comprehensive research and meta-analysis showed that intraoral bone grafts routinely outperform iliac crest transplants in terms of implant longevity. Complications at the donor site appeared to be a common observation in iliac crest and mental transplants [27]. In addition, soft tissue plays an important role. This, too, is often characterized in the atrophic jaw by a reduced attached gingiva and must be surgically readapted.

Although large bone augmentation was performed, the primary stability of the investigated implants was shown to be in the high range. More specifically, this was significantly different, but in absolute values, only slightly different from those after three months.

Future studies should focus on a larger study group, as well as on difficult implant cases such as immediate implant placement. Nevertheless, it is appropriate to interpret these results with some caution because of the limited sample size.

CONCLUSIONS

Tapered implants can be used in free iliac bone grafts for fixed dentures as implant stability values were high during surgery. In terms of a success rate of 67.65%, the patient's jaw reconstruction indicated a reduced implant success when comparing the data with healthy patients without any augmentation procedures.

ACKNOWLEDGMENTS AND DISCLOSURE STATEMENTS

Funding

With the financial support of the FGD, and according to the Finanzplan of the study, all materials were ordered via the Material Center of the University Hospital Aachen for the Department of Oral and Maxillofacial Surgery.

Support of institut Straumann AG

All implants used in this study were provided freely for research purposes by Institut Straumann AG - Basel.

Conflict of interest

The authors report no conflicts of interest in connection with the submitted manuscript.

REFERENCES

1. Misch CE, Perel ML, Wang HL, Sammartino G, Galindo-Moreno P, Trisi P, Steigmann M, Rebaudi A, Palti A, Pikos MA, Schwartz-Arad D, Choukroun J, Gutierrez-Perez JL, Marenzi G, Valavanis DK. Implant success, survival, and failure: the International Congress of Oral Implantologists (ICOI) Pisa Consensus Conference. Implant Dent. 2008 Mar;17(1):5-15. [Medline: 18332753] [doi: 10.1097/ID.0b013e3181676059]
2. Papaspyridakos P, Chen CJ, Singh M, Weber HP, Gallucci GO. Success criteria in implant dentistry: a systematic review. J Dent Res. 2012 Mar;91(3):242-8. [Medline: 22157097] [doi: 10.1177/0022034511431252]
3. Esposito M, Hirsch JM, Lekholm U, Thomsen P. Biological factors contributing to failures of osseointegrated oral implants. (I). Success criteria and epidemiology. Eur J Oral Sci. 1998 Feb;106(1):527-51. [Medline: 9527353] [doi: 10.1046/j.0909-8836..t01-2-.x]
4. Tonetti MS, Schmid J. Pathogenesis of implant failures. Periodontol 2000. 1994 Feb;4:127-38. [Medline: 9673201] [doi: 10.1111/j.1600-0757.1994.tb00013.x]
5. Toljanic JA, Banakis ML, Willes LA, Graham L. Soft tissue exposure of endosseous implants between stage I and stage II surgery as a potential indicator of early crestal bone loss. Int J Oral Maxillofac Implants. 1999 May-Jun;14(3):436-41. [Medline: 10379119]
6. Hänggi MP, Hänggi DC, Schoolfield JD, Meyer J, Cochran DL, Hermann JS. Crestal bone changes around titanium implants. Part I: A retrospective radiographic evaluation in humans comparing two non-submerged implant designs with different machined collar lengths. J Periodontol. 2005 May;76(5):791-802. [Medline: 15898941] [doi: 10.1902/jop.2005.76.5.791]
7. Hermann JS, Schoolfield JD, Nummikoski PV, Buser D, Schenk RK, Cochran DL. Crestal bone changes around titanium implants: a methodologic study comparing linear radiographic with histometric measurements. Int J Oral Maxillofac Implants. 2001 Jul-Aug;16(4):475-85. [Medline: 11515994]
8. Isidor F. Clinical probing and radiographic assessment in relation to the histologic bone level at oral implants in monkeys. Clin Oral Implants Res. 1997 Aug;8(4):255-64. [Medline: 9586471] [doi: 10.1034/j.1600-0501.1997.080402.x]
9. Rana M, Warraich R, Kokemüller H, Lemound J, Essig H, Tavassol F, Eckardt A, Gellrich NC. Reconstruction of mandibular defects - clinical retrospective research over a 10-year period -. Head Neck Oncol. 2011 Apr 28;3:23. [Medline: 21527038] [PMC free article: 3098818] [doi: 10.1186/1758-3284-3-23]

10. Schmitt CM, Doering H, Schmidt T, Lutz R, Neukam FW, Schlegel KA. Histological results after maxillary sinus augmentation with Straumann® BoneCeramic, Bio-Oss®, Puros®, and autologous bone. A randomized controlled clinical trial. Clin Oral Implants Res. 2013 May;24(5):576-85. [Medline: 22324456] [doi: 10.1111/j.1600-0501.2012.02431.x]
11. Lundgren S, Rasmusson L, Sjöström M, Sennerby L. Simultaneous or delayed placement of titanium implants in free autogenous iliac bone grafts. Histological analysis of the bone graft-titanium interface in 10 consecutive patients. Int J Oral Maxillofac Surg. 1999 Feb;28(1):31-7. [Medline: 10065646] [doi: 10.1016/S0901-5027(99)80673-0]
12. Moses O, Nemcovsky CE, Langer Y, Tal H. Severely resorbed mandible treated with iliac crest autogenous bone graft and dental implants: 17-year follow-up. Int J Oral Maxillofac Implants. 2007 Nov-Dec;22(6):1017-21. [Medline: 18271386]
13. van der Meij EH, Blankestijn J, Berns RM, Bun RJ, Jovanovic A, Onland JM, Schoen J. The combined use of two endosteal implants and iliac crest onlay grafts in the severely atrophic mandible by a modified surgical approach. Int J Oral Maxillofac Surg. 2005 Mar;34(2):152-7. [Medline: 15695044] [doi: 10.1016/j.ijom.2004.05.007]
14. Nelson K, Ozyuvaci H, Bilgic B, Klein M, Hildebrand D. Histomorphometric evaluation and clinical assessment of endosseous implants in iliac bone grafts with shortened healing periods. Int J Oral Maxillofac Implants. 2006 May-Jun;21(3):392-8. [Medline: 16796281]
15. Heberer S, Rühe B, Krekeler L, Schink T, Nelson JJ, Nelson K. A prospective randomized split-mouth study comparing iliac onlay grafts in atrophied edentulous patients: covered with periosteum or a bioresorbable membrane. Clin Oral Implants Res. 2009 Mar;20(3):319-26. [Medline: 19397644] [doi: 10.1111/j.1600-0501.2008.01638.x]
16. Semper W, Heberer S, Nelson K. Retrospective analysis of bar-retained dentures with cantilever extension: marginal bone level changes around dental implants over time. Int J Oral Maxillofac Implants. 2010 Mar-Apr;25(2):385-93. [Medline: 20369100]
17. Ibrahim A, Heitzer M, Bock A, Peters F, Möhlhenrich SC, Hölzle F, Modabber A, Kniha K. Relationship between Implant Geometry and Primary Stability in Different Bony Defects and Variant Bone Densities: An In Vitro Study. Materials (Basel). 2020 Sep 30;13(19):4349. [Medline: 33007841] [PMC free article: 7579538] [doi: 10.3390/ma13194349]
18. Vandenbroucke JP, von Elm E, Altman DG, Gøtzsche PC, Mulrow CD, Pocock SJ, Poole C, Schlesselman JJ, Egger M; STROBE Initiative. Strengthening the Reporting of Observational Studies in Epidemiology (STROBE): explanation and elaboration. Epidemiology. 2007 Nov;18(6):805-35. [Medline: 18049195] [doi: 10.1097/EDE.0b013e3181577511]
19. Shin SY, Shin SI, Kye SB, Hong J, Paeng JY, Chang SW, Yang SM. The Effects of Defect Type and Depth, and Measurement Direction on the Implant Stability Quotient Value. J Oral Implantol. 2015 Dec;41(6):652-6. [Medline: 26653132] [doi: 10.1563/AAID-JOI-D-13-0031]
20. Kniha K, Möhlhenrich SC, Foldenauer AC, Peters F, Ayoub N, Goloborodko E, Hölzle F, Modabber A. Evaluation of bone resorption in fibula and deep circumflex iliac artery flaps following dental implantation: A three-year follow-up study. J Craniomaxillofac Surg. 2017 Apr;45(4):474-478. [Medline: 28258918] [doi: 10.1016/j.jcms.2017.01.014]
21. Faul F, Erdfelder E, Buchner A, Lang AG. Statistical power analyses using G*Power 3.1: tests for correlation and regression analyses. Behav Res Methods. 2009 Nov;41(4):1149-60. [Medline: 19897823] [doi: 10.3758/BRM.41.4.1149]
22. Faul F, Erdfelder E, Lang AG, Buchner A. G*Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences. Behav Res Methods. 2007 May;39(2):175-91. [Medline: 17695343] [doi: 10.3758/BF03193146]
23. Lang NP, Wilson TG, Corbet EF. Biological complications with dental implants: their prevention, diagnosis and treatment. Clin Oral Implants Res. 2000;11 Suppl 1:146-55. [Medline: 11168263] [doi: 10.1034/j.1600-0501.2000.011S1146.x]
24. Albrektsson T, Zarb G, Worthington P, Eriksson AR. The long-term efficacy of currently used dental implants: a review and proposed criteria of success. Int J Oral Maxillofac Implants. 1986 Summer;1(1):11-25. [Medline: 3527955]
25. French D, Larjava H, Ofec R. Retrospective cohort study of 4591 Straumann implants in private practice setting, with up to 10-year follow-up. Part 1: multivariate survival analysis. Clin Oral Implants Res. 2015 Nov;26(11):1345-54. [Medline: 25134415] [doi: 10.1111/clr.12463]
26. Shirani G, Hashemi Nasab M, Bashiri S, Kordi S. Survival Rate and Cervical Bone Loss of Dental Implants Placed in Regenerated Areas with Free Iliac Graft. J Dent (Shiraz). 2023 Mar;24(1):53-59. [Medline: 36864991] [PMC free article: 9971605] [doi: 10.30476/DENTJODS.2022.90184.1474]
27. McKenna GJ, Gjengedal H, Harkin J, Holland N, Moore C, Srinivasan M. Effect of autogenous bone graft site on dental implant survival and donor site complications: a systematic review and meta-analysis. J Evid Based Dent Pract. 2022 Sep;22(3):101731. [Medline: 36162883] [doi: 10.1016/j.jebdp.2022.101731]

To cite this article:
Kniha K, Alhares J, Möhlhenrich SC, Katz MS, Winnand P, Hölzle F, Modabber A, Heitzer M.
Dental Implant Placement in the Maxilla Following Ridge Augmentation with Free Iliac Bone Graft and Oral Rehabilitation with Fixed Prosthesis: a Three-Year Follow-Up Study
J Oral Maxillofac Res 2024;15(1):e3
URL: http://www.ejomr.org/JOMR/archives/2024/1/e3/v15n1e3.pdf
doi: 10.5037/jomr.2024.15103