The incisal foramen as a means of insertion for one of three ultra-short implants to support a prosthesis for a severely atrophic maxilla — A short-term report

Rolf Ewers a,b,∗

a Hospital of Cranio-Maxillofacial and Oral Surgery, Medical University of Vienna, Waehringer Guertel 18-20, 1090, Vienna, Austria

b CMF Implant Institute Vienna, Schumanngasse 15, 1180, Vienna, Austria

∗ Corresponding author.
E-mail address: rolf@cmf-vienna.com (R. Ewers).

Abstract

As a continuation of our prospective cohort study for a total of 18 patients with 72 implants in severely atrophic maxillae corresponding to Cawood and Howell class V and VI (1988) [1] with four 4.0 × 5.0 mm ultrashort locking taper implants Ewers et al., 2018 [2], we now present a prospective cohort study with a total of 9 patients. The special feature of this newly modified study is the reduction of the number of implants to only three 4.0 × 5.0 mm or 4.5 × 6.0 mm or 5.0 × 6.0 mm calcium phosphate-coated Bicon Integra CP implants. Reducing the number of implants is possible by inserting the middle implant into the incisal foramen and the nasopalatine canal. All patients were restored with metal-free prostheses made of a glass fiber-reinforced hybrid resin material. Neither were any implants lost during the observation period, nor did any patient experience any sensory alteration due to the placement of an implant into the nasopalatine foramen.
canal. Three implants were sufficient in all patients to stabilize their 12-unit prosthesis.

Keywords: Dentistry, Surgery

1. Introduction

Rehabilitation of the atrophic maxilla is always a major surgical challenge. The premature loss of maxillary molars usually leads to the most pronounced atrophy of the maxillary alveolar ridge and pronounced pneumatization of the maxillary sinus [3]. Since Tatum’s description of the sinus lift [4] and innumerable augmentation procedures, many methods have been developed to solve this problem with excellent long-term success [5, 6, 7]. As more experience was gained, the methods described became more minimally invasive [8, 9, 10]. To avoid sinus lifts, we have been conducting a very successful prospective cohort study in our hospital since 2010 with four 4.0 × 5.0 mm ultrashort locking taper calcium phosphate-coated Integra CP™ implants from Bicon (Boston/USA) in the atrophic maxilla [2]. In few cases the frontal bone was so thin that we used two diameter-reduced 3.0 × 8.0 mm locking taper calcium phosphate-coated Integra CP™ Bicon implants [11]. Irrespective of this, however, in very complex cases we have observed that the options for augmentation reconstructions and implant application in the anterior maxilla are very limited due to the lack of alveolar ridge height and width. For this reason, we are currently conducting a prospective cohort study with three 4.0 × 5.0 mm ultrashort or 4.5 × 6.0 mm respectively 5.0 × 6.0 mm short locking taper calcium phosphate-coated Integra CP™ implants from Bicon (Boston/USA) in the atrophic maxilla parallel to the already existing mandibular study [12]. In order to decide whether it is possible to insert an implant in the area of the incisal foramen, a preoperative DVT is essential [13, 14]. The middle implant is inserted into the incisal foramen and the nasopalatine canal [15]. The incisal foramen provides the thickest and highest bone structure in the atrophic maxilla for implant placement. In the usually one-chambered incisal foramen, there are usually two incisal nerves [16, 17]. Nerve and vascular structures usually need to be severed in a Le Fort I osteotomy [18] and horseshoe Le Fort I osteotomy [19, 20]. Concerns have repeatedly been raised about sensitivity disorders with implant insertions. In a large-scale systematic review and meta-analysis, however, de Mello et al. [21] filtered 10 out of 238 articles and found a success rate of 84.6%—100% for a total of 91 implants placed in the incisal foramen. Regarding permanent nerve disorders, all 10 articles reported only one permanent nerve disorder following lateralization. The implant-supported screw-retained prosthetic constructions were provided with a 12-unit bridge made from metal-free fiberglass-reinforced hybrid resin material (TRINIA™/Bicon).
2. Material and method

After the approval of the institution’s ethical committee had been obtained (EK no. 018/2011) (ETHIK-KOMMISSION DER MEDIZINISCHEN UNIVERSITÄT WIEN

Borschkegasse 8b/6 - A-1090 Wien, Austria Tel. +43 1 40 400 2147, E-Mail: ethik-kom@meduniwien.ac.at/ethikkommission_meduniwien.ac.at) a prospective study was designed according to the Declaration of Helsinki as well as the Good Clinical Practice Guidelines (GCP). The results are reported according to the STROBE criteria. 9 patients aged between 58 and 86 years (average: 69.7 years) with pronounced maxillary atrophy corresponding to class V and class VI Cawood and Howell [1] were included in the study, with the consideration of the usual exclusion criteria and after they had given written consent. All patients were treated with one 4.0 \( \times \) 5.0 mm ultrashort calcium phosphate-coated locking taper Bicon Integra CP implant in the premolar region bilaterally and one 4.5 \( \times \) 6.0 mm or 5.0 \( \times \) 6.0 mm Bicon implant in the incisal foramen and nasopalatine canal [11, 22, 23, 24, 25]. In some cases, alveolar ridge expansion or splitting was required in very thin premolar regions following epi-periosteal (supra-periosteal) preparation [25].

The incisal foramen is located in the premaxilla, which is the intermaxillary bone in humans that was first described by Félix Vicq d’Azyr in 1780 and not by Goethe in 1784 as had been falsely assumed [26]. In the mostly one-chambered incisal foramen, we found very different diameters (Figs. 1 and 2) in which two incisal nerves were situated. In rare cases, a two-chambered incisal foramen was found (Fig. 3). In the case of a very thin incisal foramen, it is necessary to drill eccentrically, so that the dorsal palatal bone is not removed (Fig. 4).

2.1. Case studies

The 65-year-old patient had loose anterior teeth not worth preserving with pronounced periapical periodontitis and extensive periapical cysts (Fig. 5).

Eight weeks after the teeth were removed and a new DVT image was taken, we decided to place three Bicon implants (Fig. 6).

Since this patient met all the criteria of our Trio TRINIA study, a 4.5 \( \times \) 6.0 mm calcium phosphate-coated locking taper Bicon Integra CP implant was inserted into the area of the incisal foramen. Since it was a central foramen, it was not necessary to drill eccentrically as shown in Fig. 4 (Fig. 7). In the premolar region on both sides, a 4.0 \( \times \) 5.0 mm calcium phosphate-coated Morse taper Bicon Integra CP implant was inserted.
Fig. 1. DVT images of a broad incisal foramen. In transverse view (a), sagittal view (b) and frontal view (c).
Fig. 2. DVT images of a very narrow incisal foramen. In transverse view (a), sagittal view (b) and frontal view (c).
The postoperative DVT image 6 months after surgery and shortly before the uncovering of the implants shows a very nice central position of the middle implant with enough bone on the palatal side (Fig. 8).

When the middle implant was uncovered, it was found that the implant together with the polyethylene healing plug was partly covered with bone. The bone was removed.
with a round bur. Subsequently, a 3.0 mm green impression post with a corresponding green sleeve was placed. After the two implants in the premolar region were uncovered and the 2.5 mm impression posts and blue sleeves were inserted, a double impression was taken (Fig. 9).

After a few days, a bite registration was taken using the wax-up made by the Paolo Perpetuini Dental Laboratory in Cisterna di Latina/Italy. After a few more days, the twelve-unit metal-free fiber-glass-reinforced TRINIA bridge was incorporated and fixed with screws (Figs. 10 and 11). In the maxilla, we prefer the fixed-detachable Bicon abutments (Fig. 10b) Patients usually prefer a fixed restoration and willingly accept the somewhat more laborious daily bridge cleaning.

Fig. 5. 65-year-old patient with loose anterior teeth not worth preserving. (a) Clinical view. (b) DVT image in transverse view and (c) sagittal view.
Since the frontal area around the incisal foramen very often has the most residual bone, insertion of the 4.0 × 5.0 mm Bicon implants in the premolar region is usually more difficult. Either the alveolar ridge is too low (Fig. 12a) or too thin (Fig. 12b) to provide sufficient support for the implants.

If bone height is too low, we perform the well-established minimally invasive crestal sinus lift (Fig. 13a) [27, 28, 29]. Panoramic tomography and DVT allow the position of the implant to be checked and the small dome above the implant confirms the successful sinus lift (Fig. 13b and c).

Since the alveolar ridge was too narrow, (Fig. 12b) following epi-periosteal (supra-periosteal) mucosa preparation, we subsequently expanded and split the alveolar process and simultaneously inserted the implant (Figs. 14a and 15a) [30, 31] The DVT control confirmed the successful splitting of the alveolar ridge (Fig. 15b).

3. Results

In 9 patients with 27 implants, 5 women aged between 58.2 and 68.7 years and 4 men aged between 63.4 and 78.5 years were treated and routinely monitored. The average observation period was 8.3 months and the longest observation period was 22 months. Of the 27 implants, eighteen 4.0 × 5.0 mm calcium phosphate-
Fig. 7. Intraoperative clinical images of the implant insertion into the incisal foramen. (a) Epi-periosteal (supra-periosteal) exposure of the incisal foramen. (b) Expansion of the osteotomy to 4.5 mm with corresponding latch reamer. (c) Insertion of the 4.5 × 6.0 mm short Bicon implant.
coated Morse taper Bicon Integra CP implants were inserted in the premolar region. In the incisal foramen, four 4.5 × 6.0 mm, four 5.0 × 6.0 mm and one of the newly available 5.0 × 5.0 mm calcium phosphate-coated locking taper Bicon Integra CP implants were inserted. In the opposing jaw, three patients had partial dentures, three

Fig. 8. DVT images of the inserted 4.5 × 6.0 mm Bicon implant into the incisal foramen and nasopatalinal canal. In transverse view (a), sagittal view (b) and frontal view (c).
Fig. 9. Intraoperative clinical images at exposure after six months. (a) Removal of bone grown over the implant with round bur. (b) Exposed polyethylene healing plug. (c) Inserted impression posts with corresponding sleeves to take a double impression.
Fig. 10. (a) Palatal view of the CAD/CAM-fabricated TRINIA bridge from pink material and three titanium sleeves for the fixed-detachable abutments. (b) Completed 12-unit TRINIA bridge with three holes for the screws of the fixed-detachable abutments. (c) Inserted fixed-detachable abutments.
had their own teeth, one patient was wearing a full denture and two patients participated in our mandibular Trio-Trinia study. During the observation period to date, all Bicon implants were osseointegrated and no implant was lost.

4. Discussion

The aim of our study is to investigate whether it is possible to treat patients with extreme maxillary atrophy without complex augmentation surgery using TRINIA prostheses, a metal-free CAD/CAM-fabricated fiberglass-reinforced hybrid resin material, on 4.0 × 5.0, 4.5 × 5.0, 5.0 × 5.0 mm ultrashort or 4.5 × 6.0, 5 × 6.0 mm short implants. After achieving very good results with our maxilla and mandible studies with four ultrashort implants [11, 23, 24, 31], we decided to reduce the number of implants to three, first in the mandible [32, 33] and then in the maxilla [12]. To

Fig. 11. Clinical photo of the 12-unit TRINIA bridge fixed with three screws.

Fig. 12. DVT image in frontal view with (a) very low bone height in the molar region and (b) extremely narrow alveolar process in the premolar region.
reduce the number of implants, it is necessary to insert the middle implant into the incisal foramen and nasopalatine canal. Our good experience over the course of many years with the Le Fort I osteotomy [18] and the horseshoe Le Fort I osteotomy [19, 20] had not shown any sensitivity disorders of the incisal nerves although they were always severed during these procedures. The systematic review and meta-analysis published by de Mello et al. [21] confirms this observation. Survival rates are comparable to those of conventional long implants. This shows that it is possible to provide highly atrophic upper jaws with ultrashort implants using "all-on-three" implants. [33, 34, 35, 36] Our results are comparable to studies by other authors [37, 38]. Furthermore, this study has shown that restorations with a metal-free CAD/CAM-fabricated fiberglass-reinforced hybrid resin material have not led to any complications [34]. These results are very encouraging given that, due to the extreme maxillary atrophy, we additionally had to perform alveolar ridge expansions or splitting. By inserting the middle implant into the incisal foramen, we were able to forego the use of narrow implants.

Fig. 13. Schematic diagram of the lifting of the crushed cortical lamella of the sinus floor and the uninjured mucosa membrane of the maxillary sinus by applying augmentation material (a) [29]. Postoperative orthopantomogram with clearly visible “caps” over the two Bicon implants in the premolar region (b). DVT image in frontal view with clearly visible lift of the sinus floor (c).
Fig. 14. Clinical image of the epi-periosteal (supra-periosteal) exposed alveolar process in the premolar region (a). Splitting of the alveolar process with the double-edged “beaver knife” (b). Expanding or splitting the alveolar process using the “Hand Reamer” in a sequence of sizes with increasingly larger diameters. The non-cutting round side is directed buccally (c).
Whether the insertion of a single implant in the incisal foramen would be suitable for singular usage in the sense of the work of Kern et al. must be determined in future studies [39].

5. Conclusion

Considering the very difficult initial situation with highly atrophic maxillae in the vertical and transversal dimensions and avoiding extensive augmentations, we can see that the use of only three ultrashort locking taper Bicon implants in the short-term observation period shows good results comparable to those of standard implants.

Fig. 15. Clinical image of the insertion of the Bicon implant after successful expansion or splitting of the alveolar process in the premolar region (a). DVT image in frontal view after successful splitting in the premolar region and insertion of the 4.0 × 5.0 mm ultrashort Bicon implant (b).
with complex augmentations. The use of the incisal foramen did not lead to any complications, and it seems to be an ideal implant site for short and ultrashort implants. Long-term results with this issue are still very limited. Prospective long-term studies with a larger number of patients and implants over very long observation periods are necessary to be able to make more generally definitive recommendations.

Declarations

Author contribution statement

Rolf Ewers: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Funding statement

This work was partially supported by Bicon LLC, Boston/MA-USA.

Competing interest statement

This work was partially supported by Bicon LLC, Boston/MA-USA.

Additional information

No additional information is available for this paper.

References

[1] J.I. Cawood, R.A. Howell, A classification of the edentulous jaws, Int. J. Oral Maxillofac. Surg. 17 (4) (1988 Aug) 232–236.
[2] R. Ewers, M. Marincola, V. Morgan, P. Perpetuini, F. Wagner, R. und Seemann, Der atrophe Oberkiefer und seine Versorgungsmöglichkeiten mit vier ultrakurzen, Implantaten Implantologie 26 (1) (2018) 1–10.
[3] F. Wagner, G. Dvorak, S. Nemec, P. Pietschmann, M. Figl, R. Seemann, A principal components analysis: how pneumatization and edentulism contribute to maxillary atrophy, Oral Dis. 23 (2017) 55–61.
[4] O.H. Tatum, Lecture presented to the Alabama implant congress, in: Alabama Implant Congress, 1976.
[5] R. Ewers, Standard clinical situations - 4.7 edentulous maxilla, in: R. Ewers, J.T. Lambrecht (Eds.), Oral Implants — Bioactivating Concepts, Quintessenz Publ. Co, Chicago, 2012, pp. 329–356.
[6] R. Ewers, Implant surgery, in: J.T. Lambrecht (Ed.), Oral and Implant Surgery: Principles and Procedures - Implant Surgery, Quintessence, Chicago, 2009, pp. 350–360.

[7] M.I Esposito, M.G. Grusovin, P. Felice, G. Karatzopoulos, H.V. Worthington, P. Coulthard, The efficacy of horizontal and vertical bone augmentation procedures for dental implants - a Cochrane systematic review, Eur. J. Oral Implant. 2 (3) (2009 Autumn) 167–184. PMID: 20467628.

[8] R.B. Summers, A new concept in maxillary implant surgery: the osteotome technique, Compendium 15 (2) (1994), 152–154–6–158passim–quiz162.

[9] S.A. Ali, S. Karthigeyan, M. Deivanai, A. Kumar, Implant rehabilitation for atrophic maxilla: a review, J. Indian Prosthodont. Soc. 14 (3) (2014) 196–207.

[10] S. Pérez-Martínez, L. Martorell-Calatayud, D. Peñarrocha-Oltra, B. García-Mira, M. Peñarrocha-Diago, Indirect sinus lift without bone graft material: systematic review and meta-analysis, J. Clin. Exp. Dent. 7 (2) (2015 Apr 1) e316–e319.

[11] Wagner F, Seemann R, Marincola, Ewers R, Fixed, fiber-reinforced resin bridges on four short implants in severely atrophic maxillae: 1-year results of a prospective cohort study, J. Oral. Maxfac. Surg. 76 (6) (2018 Jun) 1194–1199. Epub 2018 Feb 19.

[12] R. Ewers, M. Marincola, V. Morgan, P. Perpetuini, R. Seemann, “all on three” – Kunststoffprothesen auf drei Implantaten, zm 108, Nr. 13, 1.7, 2018 (1).

[13] S. Al-Amery, P. Nambiar, M. Jamaludin, J. John, W. Ngeow, Cone Beam Computed Tomography Assessment of the Maxillary Incisive Canal and Foramen: considerations of Anatomical Variations When Placing Immediate Implants, PLoS One 10 (2) (2015) e0117251. Published online 2015 Feb 13.

[14] R.E. Friedrich, F. Laumann, T. Zrnc, A.T. Assaf, The nasopalatine canal in adults on cone beam computed tomograms-A clinical study and review of the literature, In Vivo 29 (4) (2015 Jul-Aug) 467–486. PMID: 26130792.

[15] R. Ewers, Reduzierte Implantatzahl - auch bei kurzen Implantaten? Vortrag auf dem 13, in: Experten Symposium des BDIZ EDI Köln am 11. Febr, 2018.

[16] H. Leboucq, Le canal nasopalatin chez l’homme, Arch. Biol. Paris 2 (1881). S. 386–397.

[17] R.H. Allard, K. de Vries, W.A. van der Kwast, Persisting bilateral nasopalatine ducts: a developmental anomaly, Oral Surg. Oral Med. Oral Pathol. 53 (1982). S. 24–26.
[18] W.H. Bell, Revascularization and bone healing after anterior maxillary osteotomy: a study using adult rhesus monkeys, J. Oral Surg. 27 (4) (1969 Apr) 249–255.

[19] F. Härle, R. Ewers, Die Hufeisenosteotomie mit Knocheninterposition zur Erhöhung des Oberkieferkammes - eine im Experiment steckengebliebene Operationsmethode, Dtsch Zahnärztl Z 35 (1980) 105–107.

[20] K.C. Yerit, M. Posch, U. Guserl, D. Turhani, Ch Schopper, F. Wanschitz, A. Wagner, F. Watzinger, R. Ewers, Rehabilitation of the severely atrophied maxilla by horseshoe Le Fort I osteotomy (HLFO) oral surg oral, Med. Oral Pathol. Oral Radiol. Endod. 97 (2004) 683–692.

[21] J.S. de Mello, F. Faot, G. Correa, O.L. Chagas Júnior, Success rate and complications associated with dental implants in the incisive canal region: a systematic review, Int. J. Oral Maxillofac. Surg. 46 (12) (2017 Dec) 1584–1591. Epub 2017 May 25.

[22] R. Ewers, P. Perpetuini, V. Morgan, M. Marincola, R. Wu, R. Seemann, TRINIA™— metal-free restorations, Implants 1 (2017) 2–7.

[23] R. Seemann, M. Marincola, D. Seay, C. Perisanidis, N. Barger, R. Ewers, Preliminary result of fixed, fiber-reinforced resin bridges on four 4- x 5- mm ultrashort implants in compromised bony sites: a pilot study, J. Oral Maxillofac. Surg. 73 (4) (Apr 2015) 630–640.

[24] R. Seemann, F. Wagner, M. Marincola, R. Ewers, Fixed, fiber-reinforced resin bridges on 5.0-mm implants in severely atrophic mandibles: up to 5 Years’ follow-up of a prospective cohort study, J. Oral Maxillofac. Surg. 76 (5) (2018 May) 956–962. Epub 2017 Dec 12.

[25] R. Ewers, Pedicled Sandwich Osteotomy- surgical technique for vertical and horizontal alveolar bone deficiency, in: Vortrag auf dem International Bone Symposium in Implant Dentistry in San Francisco/USA am 30.3, 2017.

[26] B. Peyer, Goethes Wirbeltheorie des Schädelns, in: Neujahrsblatt herausgegeben von der Naturforschenden Gesellschaft in Zürich auf das Jahr 1950, 152. Stück, S. 28, Kommissionsverlag Gebr. Fretz AG, Zürich, 1950.

[27] M. Marincola, R. Urdaneta, A. Bar, J. Gunther, Implantation mit gleichzeitigem Sinuslift bei geringer Knochenresthöhe, Implantologie J. 5 (2009) 44–50.

[28] M. Marincola, R. Ewers, G. Lombardo, M. Pallares, Sinus elevation with short implant, Implants 2 (2017). S. 20-24.
[29] M. Marincola, S. Daher, R. Ewers, J. Lehrberg, Sinus Lift Techniques in the Bicon Short Implant-A Thirty Year Perspective, Quintessence, Chicago, 2017, pp. 151–180.

[30] S. Daher, R. Ewers, A. Cicconetti, Ridge Splitting and the Split-thickness Flap in the Bicon Short Implant-A Thirty Year Perspective, Quintessence, Chicago, 2017, pp. 181–198.

[31] R. Ewers, P. Perpetuini, R. Seemann, T. De Witt, I. Sarvan, M. Coetzer, K. Pisarik, Atrophic Maxillary Ridges in the Bicon Short Implant-A Thirty Year Perspective, Quintessence, Chicago, 2017, pp. 199–213.

[32] R. Ewers, R. Seemann, TRINIA™ Trio – “all-on-three” – metallfreie Glasfaser- verstärkte Kunststoffprothese auf drei ultrakurzen Bicon Implantaten, Zahn Krone 3 (2017) 11–17.

[33] R. Ewers, Kurze Implantate - eine Lösung für alle Fälle? Vortrag auf dem 58, in: Bayerischen Zahnärztetag in München am 28. 10, 2017.

[34] R. Ewers, M. Marincola, P. Perpetuini, R. Seemann, V. Morgan, R. Wu, Leichtgewicht im Praxistest-Restorationen bei schwierigen Situationen und atrophen Kiefern, Z Oral Implant 13 (1) (2017) 28–36.

[35] R. Seemann, A. Jirku, F. Wagner, A. Wutzl, What do sales data tell us about implant survival? PLoS One 12 (2017) e0171128.

[36] J. Neugebauer, F. Vizethum, C. Berger, W. Bolz, A. Bowen, D. Deporter, R. Ewers, P. Fairbaim, A. Felino, T. Fortin, V. Gowd, M. Kern, P. Kobler, V. Konstantinovic, M. Marincola, H.J. Nickenig, H. Özyuvaci, N. Schmedtmann, J.E. Zöller, Update: Kurze, angulierte und durchmesserreduzierte Implantate - praxisleitfaden: 11. Europäische Konsensuskonferenz (EuCC), BDIZ/EDI Konkret 20 (2016) 88–90.

[37] P. Felice, L. Checchi, C. Barausse, R. Pistilli, G. Sammartino, I. Masi, D.R. Ippolito, M. Esposito, Posterior jaws rehabilitated with partial prostheses supported by 4.0 x 4.0 mm or by longer implants: one-year post-loading results from a multicenter randomised controlled trial, Eur. J. Oral Implant. 9 (1) (2016 Spring) 35–45.

[38] V. Pohl, D.S. Thoma, K. Sporniak-Tutak, A. Garcia-Garcia, T.D. Taylor, R. Haas, C.H. Hammerle, Short dental implants (6 mm) versus long dental implants (11-15 mm) in combination with sinus floor elevation procedures: 3-year results from a multicenter, randomized, controlled clinical trial, J. Clin. Periodontol. 44 (2017) 438–445.
[39] M. Kern, W. Att, E. Fritzer, S. Kappel, R.G. Luthardt, T. Mundt, D.R. Reissmann, M. Rädel, M. Stiesch, S. Wolfart, N. Passia, Survival and complications of single dental implants in the edentulous mandible following immediate or delayed loading: a randomized controlled clinical trial, J. Dent. Res. 97 (2) (2018 Feb) 163–170. Epub 2017 Oct 18. PMID: 2904580.