



STUDY RESULTS

Results, planned / ongoing studies
and user reports – up to 04/ 2025



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Clinical studies with the ICX-templant[®]-, ICX[®]-Premium-, ICX[®]-Active Master- and ICX[®]-Liquid-implant systems

medentis medical GmbH is an internationally active company specializing in implantology, aesthetic dentistry and CAD/CAM fabricated prosthetics based in Bad Neuenahr/Ahrweiler, Germany. As the manufacturer of the well-known ICX[®]-Premium dental Implant System and with the ICX[®]-denta5-CAD/CAM-System for patient-specific abutments, medentis medical GmbH is successful in more than 40 countries around the world. Since the beginning of 2010, the ICX[®]-System has been one of the ten most successful implant systems in Germany. In recent years, medentis medical GmbH has established itself as one of the fastest-growing implant manufacturers.

Our investment in research and development

Research work is carried out both in our own laboratory (medentis medical evidence center) and in specialist clinics, medical practices and universities around the world. The evaluation of research & development projects ranges from basic research *in-vitro*- to preclinical studies *in-vivo*, pilot and advanced clinical studies as well as comprehensive observational studies.

The medentis medical GmbH actively supports studies initiated by and with external cooperation partners (investigator-initiated studies) that wish to investigate our products and technologies. In addition, we work closely with renowned, scientifically independent research institutes.

The development of the ICX[®] implant system is based on the best features of market-leading systems. The primary aim was to develop a reliable implant system based on known design parameters that is surgically and prosthetically versatile enough to cover as many indications as possible - one- or two-stage procedures, immediate or delayed implant placement, with or without immediate restoration.

In cooperation with leading clinics, research institutes and universities, medentis medical GmbH actively supports research in the fields of oral implantology and tissue regeneration. Scientific data from studies confirm the reliability of our products and support the development of new quality standards.

Tables 1a-d, 2a+c, 3a+c, 5c show a systematic overview of studies demonstrating the clinical use of the ICX-templant[®]-, ICX[®]-Premium, ICX[®]-Active Master and ICX[®]-Liquid implant systems from medentis medical GmbH.

These include data showing the long-term success of the templant[®] implant system. Other studies document the stable peri-implant hard and soft tissue situation when using the ICX[®] implant system. These are followed by scientific articles on the prosthetic restoration of the ICX[®] implant system. Preclinical studies are also presented.

The aim of this overview is to provide scientific evidence of the successful use of the ICX[®] implant system. Excerpts from relevant articles have been summarized on the following pages. The original studies can be found at the source indicated.

Ongoing studies are carefully analyzed by the medentis medical GmbH on an ongoing basis. The medentis medical GmbH will periodically publish interim results as well as the final results of the studies after completion.

In addition, case reports show medentis products in use - from the ICX[®] locator system to immediate implant placement, Cerec abutments manufactured using the pioneering CAD/CAM system and the successful ICX[®]-Magellan software for digital implant planning.

In addition to clinical studies, the medentis medical GmbH also supports basic research and scientifically interested dentists and young researchers. For example, material is made available to scientists. The results of these research projects are then published as dissertations.

If you are interested in further information, please do not hesitate to contact our customer service on the service number: +49 2641 9110-0

1. ICX-templant® implant system
2. ICX®-Standard implants (ICX®-Premium)
3. ICX®-Standard implants (ICX®-Active Master)
4. ICX®-Liquid implants (ICX®-Active Liquid)
5. ICX®-Zygoma implants

- a) Experimental *in-vitro*-Studies
- b) Experimental *in-vivo*-Studies
- c) Retrospective Studies
- d) Prospective Studies
- e) Ongoing Studies

Table 1a: Experimental in-vitro-Studies ICX-templant® implant system

Study-No.	Page	Study Location / Year	Timepoint Follow-Up in Months	Number of Subjects	Number of Implants	Endpoint (Survival rate [%])
1.a.1	10	Regensburg University Medical Center, 2014 M. Rosentritt; A. Rembs; M. Behr; S. Hahnel; V. Preis; C. Kolbeck	–	In vitro	8	Breaking Force in Newton (N)
		Study Observative / Study Title	In-vitro-performance of titanium implants / adhesive bases with zirconia sleeves			
		Research Results / Evaluation	The fracture force for ICX-templant® implants was 540 N. No failure could be determined during the simulated ageing.			
1.a.2	12	University of Cologne, 2014/2015 Dr. D. Duddeck; Dr. H. Maghaireh; Dr. F. J. Faber; PD Dr. J. Neugebauer	–	In vitro	120	Quantitative and Qualitative analysis of Organic and Inorganic Impurities
		Study Observative / Study Title	Surface analysis of 120 implants with the scanning electron microscope			
		Research Results / Evaluation	The vast majority of the implants examined showed no significant impurities. The ICX® implants showed a very precise geometry under the SEM and showed no significant traces of inorganic and organic substances.			
1.a.3	16	University of Cologne, 2021 Dr. D. Weißweiler; Prof. em. W. Niedermeier	–	In vitro	6	Fatigue and crash test / (load test) Breaking Force in Newton (N)
		Study Observative / Study Title	Testing the stability of implant-abutment connections in the rotational vibration test			
		Research Results / Evaluation	In the rotational vibration test, damage to the implant-abutment connection occurs within a very short time, similar to that which occurs after years of implant use, and the results are consistent with stability tests in the chewing simulator (DIN 14801) and long-term clinical experience. Overall, the use of the rotational oscillator method as an accelerated "lifetime" test has clear advantages over other methods.			
1.a.4	18	University of Szeged, Hungary, 2021 Á.L. Nagy; Z. Tóth; T. Tarjányi; N. T. Práger; Z. L. Baráth	–	In vitro	68	Static and dynamic load test (3-point bending test)
		Study Observative / Study Title	Biomechanical properties of the bone during implant placement			
		Research Results / Evaluation	The pre-drilled bone was much weaker in both static and dynamic tests than the natural or implanted specimens. According to the results of the dynamic tests and after a certain loading cycle the implanted samples behaved the same as the control samples, which suggests that the implantation have stabilized the skeletal bone structure.			
1.a.5	20	University of Freiburg, 2024 J. Angermair; G. Iglhaut; K. Meyenberg; W. Wiest; A. Rack; S. Zabler; T. Fretwurst; K. Nelson; F. Kernen	–	In vitro	Not specified	Static Load Tests; analysis of the microgap and the abutment displacement by means of synchrotron-microtomography and phase-contrast radioscopy
		Study Observative / Study Title	In-vitro-assessment of internal implant-abutment connections with different cone angles under static loading using synchrotron-based radiation			
		Research Results / Evaluation	In contrast to the implant-abutment connection with a large cone angle (45°), the conical connections based on a friction fit (small cone angles with <12°) demonstrated an abutment displacement, which resulted in a deformation of the outer implant wall. The design of the implant-abutment connection seems to be crucial for the force distribution at the implant wall, which might influence the peri-implant bone stability.			

1.a.1 *In-vitro* performance of titanium implants / adhesive bases with zirconia sleeves

M. Rosentritt; A. Rembs; M. Behr; S. Hahnel; V. Preis; C. Kolbeck; Department of Prosthetic Dentistry, Regensburg University Medical Center, 2014

Introduction:

Custom-made implant abutments offer an alternative to prefabricated abutments because they can be manufactured individually for a single patient case.

Objective:

This study deals with a method of producing the abutments in two parts, i.e. manufacturing the abutment from zirconium oxide ceramic and bonding it to a titanium base, in order to obtain an assessment of the behavior of such individual implant abutments and in particular of the bond between base and abutment in the *in-vitro*-chewing simulation test.

Material and Methods:

For this purpose, eight adhesive base combinations from different manufacturers were screwed onto the respective implants, which were fixed at an angle of 135° to the tooth axis to simulate clinically relevant loads in the anterior region (tooth 11). The diameters of the abutments and implants were on average between $D = 4.0$ to 4.3 mm). The ICX® implants had a diameter $D = 4.1$ mm and a length $L = 12.5$ mm. The abutments and implants are used and processed according to the manufacturer's instructions. All implant/abutment units are restored with identical anterior crowns made of zirconium oxide ceramic and then subjected to a chewing simulation. The parameters of the simulation are selected so that a wearing time of 5 years is simulated ($6000 \times 5^\circ\text{C}/55^\circ\text{C}$, 2min per cycle, 1.2×10^6 chewing force cycles of 50 N each). During the simulation, all fittings are monitored and any failures are further examined for their failure behavior. Constructions that survive the simulation without damage are to be subjected to the maximum breaking load in a fracture test with a testing machine (Zwick, $v = 1\text{mm/min}$) after the chewing simulation.

The causes of damage to the restorations are to be examined further photographically, e.g. in the SEM.

Results:

The fracture force for ICX-templant® implants was around 540 N. During the simulated ageing, no failure can be determined.

Conclusion:

The *in-vitro* data for the ICX® implant system demonstrates good fracture resistance.

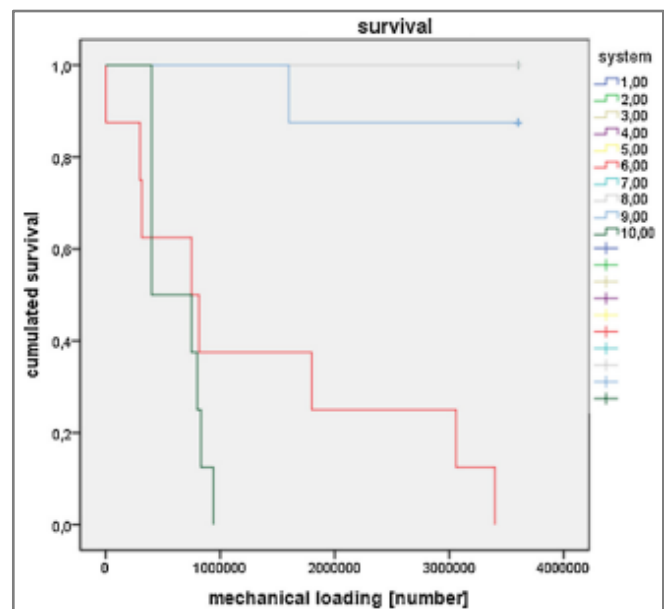


Fig. 1: Cumulated survival curve of the tested systems.

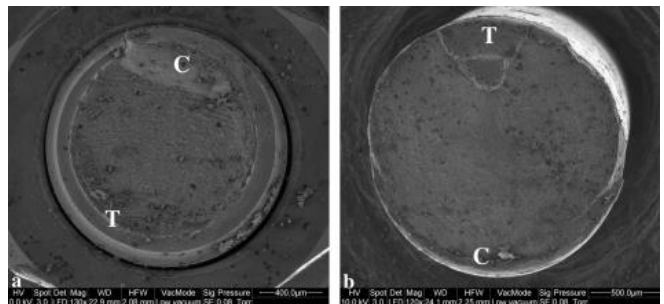


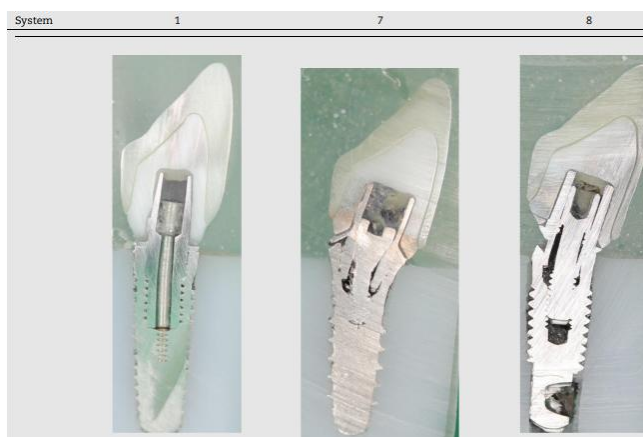
Fig. 2: Exemplary SEM images of typical bending fractures of the screws of system 9 (a) and system 10 (b) during TCML, showing the tension zone (T; fracture origin) and the compression zone (C) at the fracture surface.

System	Implant	Manufacturer	Diameter × length	Base (material)
1	Camlog screw line	Camlog, Wimsheim, Germany	Ø4.3 × 13 mm	SIC base (Ti6Al4V)
2	Semados	BEGO Implant Systems, Bremen, Germany	Ø4.1 × 15 mm	Sub-Tec CAD/CAM (Ti)
3	Neoss implant system	Neoss, Köln, Germany	Ø4.0 × 11 mm	Neolink Titanium Mono (Ti grade 4)
4	ICX-templant hex	Medentis Medical, Dernau, Germany	Ø4.1 × 12.5 mm	ICX templant hex base (Ti grade 5)
5	Schilli implant circle	SIC invent AG, Basel, Switzerland	Ø4.0 × 9.5 mm	(Ti grade 5)
6	Experimental 1	–	Ø4.0 × 14.5 mm	n.i.
7	Standard implant SLA	Institut Straumann, Basel, Switzerland	Ø4.1 × 10 mm	Variobase abutment
8	Zimmer tapered screw-vent implant	Zimmer Dental, Carlsbad, USA	Ø4.1 × 11.5 mm	Zimmer/Zfx Titanium (Ti grade 5)
9	Experimental 2	–	Ø4.0 × 14.5 mm	n.i.
10	Experimental 3	–	Ø4.0 × 10 mm	(Ti, PEEK)

Tab. 1: Materials and manufacturers (n.i.: not specified)

System	TCML	Fracture test	
		Static load [N] (mean ± std)	(n number of failures, failure type)
1	–	763 ± 161 ^a	n = 6; B screw/ n = 2; F abutment
2	–	608 ± 43 ^a	n = 3; B screw/ n = 5; F screw
3	–	404 ± 30 ^{bc}	n = 7; B screw/ n = 1; F abutment
4	–	540 ± 60 ^{ac}	n = 2; B screw/ n = 6; F screw
5	–	430 ± 36 ^{bc}	n = 6; B screw/ n = 2; F screw
6	2, 300, 315, 750, 815, 1800, 3060, 3400 (n = 8; debonding base-abutment)	0 ^d	–
7	–	641 ± 126 ^{aa}	n = 8; B screw
8	–	428 ± 142 ^{bc}	n = 8; B screw
9	1600 (n = 1; screw fracture)	371 ± 28 ^b	n = 7; F screw
10	4 × 400, 750, 800, 833, 940 (n = 8; screw loosening/fracture)	0 ^d	–

Tab. 2: Results after TCML and fracture testing (identical letters indicate no significant ($p > 0.05$) differences (Bonferroni $\alpha = 0.05$); failure types: B: bending, F: fracture).



Tab. 3: Exemplary systems 1, 7 and 8 after fracture testing (cut view).

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Reference:

Rosentritt M, Rembs A, Behr M, Hahnel S, Preis V. *In vitro* performance of implant-supported monolithic zirconia crowns: Influence of patient-specific tooth-coloured abutments with titanium adhesive bases. J Dent. 2015 Jul;43(7):839-45. doi: 10.1016/j.jdent.2015.04.011. Epub 2015 May 4. PMID: 25953721.

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1.a.2 Surface analysis of 120 Implants with the scanning electron microscope

Dr. D. Duddeck^{1,2}, Dr. H. Maghaireh³, Dr. F.J. Faber⁴ and PD Dr. J. Neugebauer^{1,5}; ¹University of Cologne / ²Medical Materials Research Institute Berlin / ³University of Manchester / ⁴University of Cologne / ⁵Dental Group Practice Dr. G. Bayer, Dr. F. Kistler, Dr. S. Kistler, Dr. A. Elbertzhagen, PD Dr. J. Neugebauer

Introduction:

Surface treatments of implants to increase the biologically active surface have been established and clinically proven by all manufacturers as the basis for successful osseointegration of the implants. Different methods are used by manufacturers to create a suitable surface morphology for endosseous implants. A combination of blasting and etching, for example, results in a bimodal surface structure that enables biological and mechanical anchoring of the bone with the material in the micro range. The microstructure of an implant has a significant influence on the osteoblast proliferation and osteoblast differentiation.

In the past, numerous working groups and implant manufacturers have developed surface structuring techniques that lead to faster and optimized osseointegration and thus a higher success rate or earlier loading of the inserted implants. Surface structuring can be achieved using additive or abrasive procedures. Additive procedures such as for example titanium plasma coating are only used to a limited extent. Sintered implant surfaces, such as the OT-F3 implant (OT medical), in which spherical particles are applied to the surface, offer the advantage of a relatively large surface and have no thread structures due to their design. In ablative or subtractive procedures, implants are sometimes only blasted with hydroxyapatite (Zimmer) or titanium oxide (Astra, Dentsply Implants). Or they are only etched, such as the Interna Implant (BTI).

Various blasting media are used for blasted-etched implants, which produce micro-roughnesses of 2 to 10 µm. The subsequent etching process not only removes the blasting material from the implant, but also creates surface roughness in areas below 2 µm. The abrasive used is titanium dioxide, such as in the ZirTi surface from Sweden Martina, or corundum (Al₂O₃), as in the ICX-templant® implant. The typical structure is clearly visible, which in this case shows no residues of the blasting material aluminum oxide. The T3 implant from Biomet 3i is first blasted with calcium phosphate, then double etched and finally coated with calcium phosphate nanoparticles.

Objective:

In a study at the beginning of 2014/2015, which was completed at the end of March 2015, 120 different systems from 83 suppliers from 16 countries were subjected to an extensive qualitative and quantitative element analysis. Implants are essentially distinguished by different macro designs, such as the different thread pitch or a more or less progressive thread design depending on the indication, and by different surface finishes that determine the microstructure.

In his Dissertation "Surface examination of implants with the scanning electron microscope" at the Medical Faculty of the University of Cologne, Dr. Duddeck had already examined the surface of 23 endosseous implants from different manufacturers for organic and inorganic residues, such as those that can result from surface conditioning during the manufacturing process or downstream cleaning, sterilization and packaging processes, as part of an electron microscopic examination.

Material and Methods:

A total of 120 different implant systems from 83 manufacturers from 16 countries were analyzed by scanning electron microscopy in this study. The SEM device used to visualize the surface topography (Phenom proX, Netherlands) has a highly sensitive detector for backscattered electrons (BSE), which allows conclusions to be drawn about the composition of the material under investigation as soon as the so-called material contrast image is created. Elements with a low atomic number, i.e. with fewer electrons, such as carbon or aluminum, are displayed comparatively dark, while elements with a higher atomic number, such as titanium or zirconium oxide, appear comparatively light. For this study, the implants were removed with a sterile forceps and fixed to the sample holder before being placed in the vacuum chamber. As implants made of zirconium oxide are more electrically charged than those made of titanium, a so-called Charge Reduction Sample Holder was used to largely contain this charging phenomenon, which leads to the formation of artifacts.

A qualitative and quantitative elemental analysis of the implant surfaces was carried out using energy dispersive X-ray spectroscopy (EDX).

The electron beam generates an interaction between the primary emitted electrons and the atoms of the sample surface, and an electron of the inner shell is released as a "secondary electron". The resulting gap is immediately filled by an electron from a higher orbital. The resulting energy difference is released as an X-ray quantum and recorded by a thermoelectrically cooled detector, allowing both the composition of the elements and their concentration to be measured. Surface analyses were carried out on each implant and, in the event of anomalies, corresponding spot analyses.

To visualize the surface roughness of each of the implant systems examined, a so-called "3D Roughness Reconstruction", which allows an optical comparison of the respective surface structure, was performed. In this imaging process, the three-dimensional shape of the object is calculated from the brightness distribution in the grid field of the four quadrants of the backscattered electron detector.

Results:

The vast majority of the implants examined showed no significant impurities. The ICX® implants showed a very precise geometry under the SEM and had no significant traces of inorganic and organic substances.

Conclusion:

The Dissertation published by Dr. Duddeck in 2009 already confirmed that the ICX-templant® implants have a high surface cleanliness. None of the other manufacturers' implant systems examined in the test showed a significantly higher surface purity than the ICX-templant® implant, which, together with 6 other Implant Systems, led the test results. There were no significant differences within this top group in the multiple comparison ($p \geq 0.05$). Test results from the University of Cologne confirm the high surface cleanliness of the ICX-templant® implants (Dissertation Dr. Duddeck 2009, University of Cologne). The ICX® implant system has a relatively high degree of surface cleanliness.

Author / Correspondence:

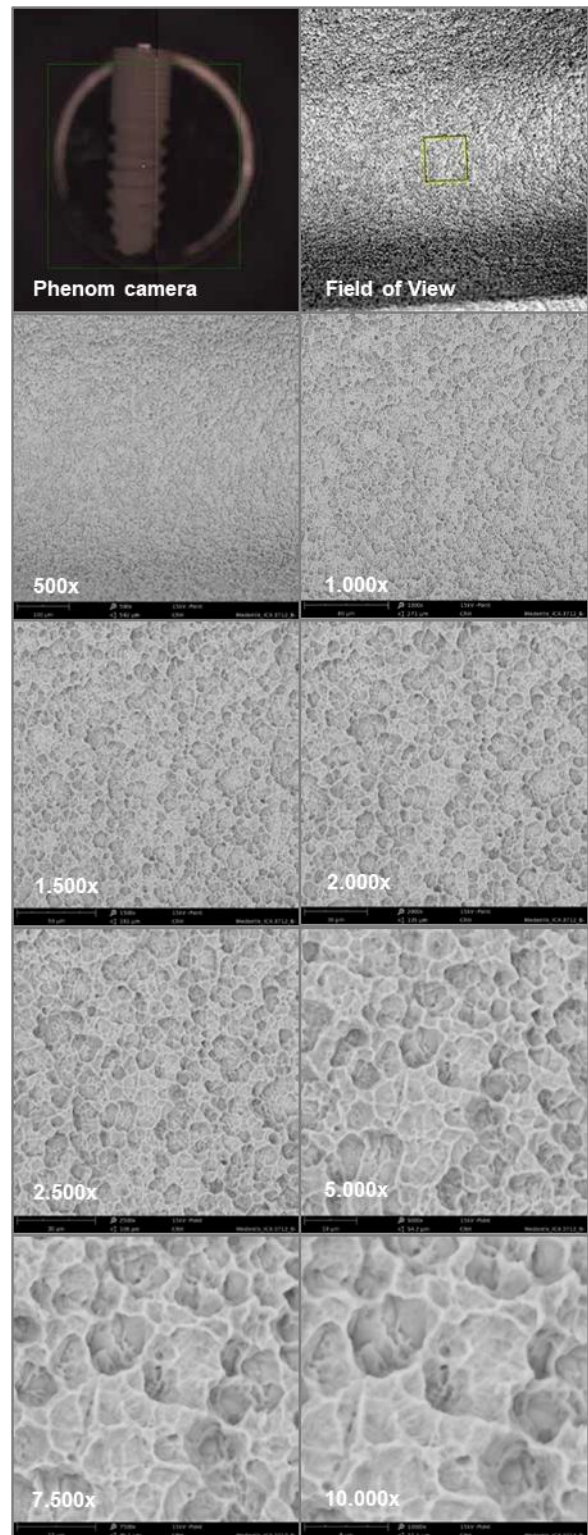
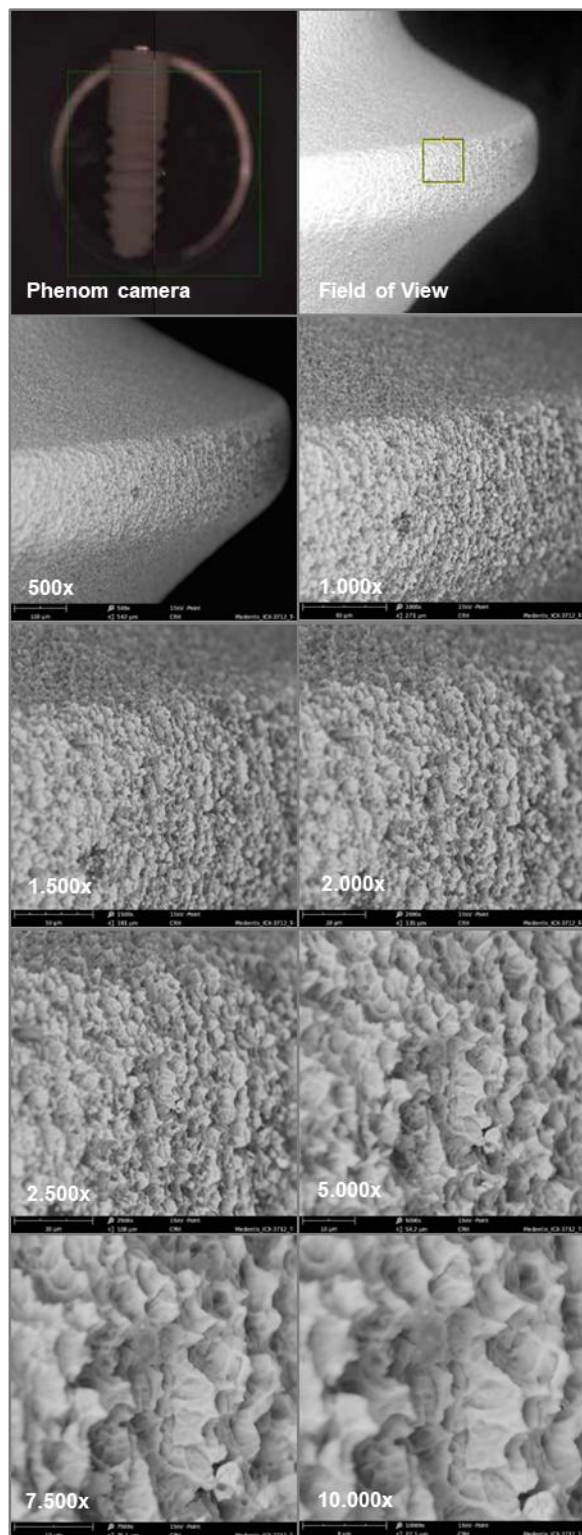
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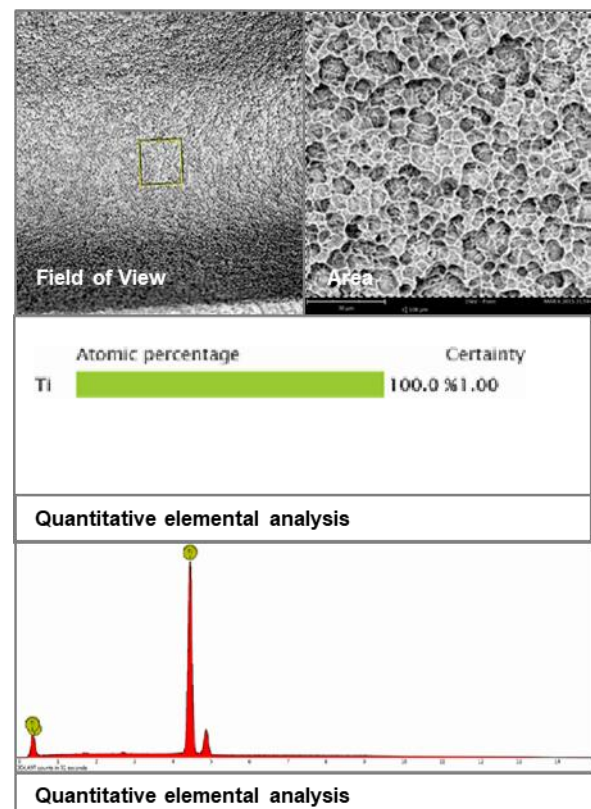
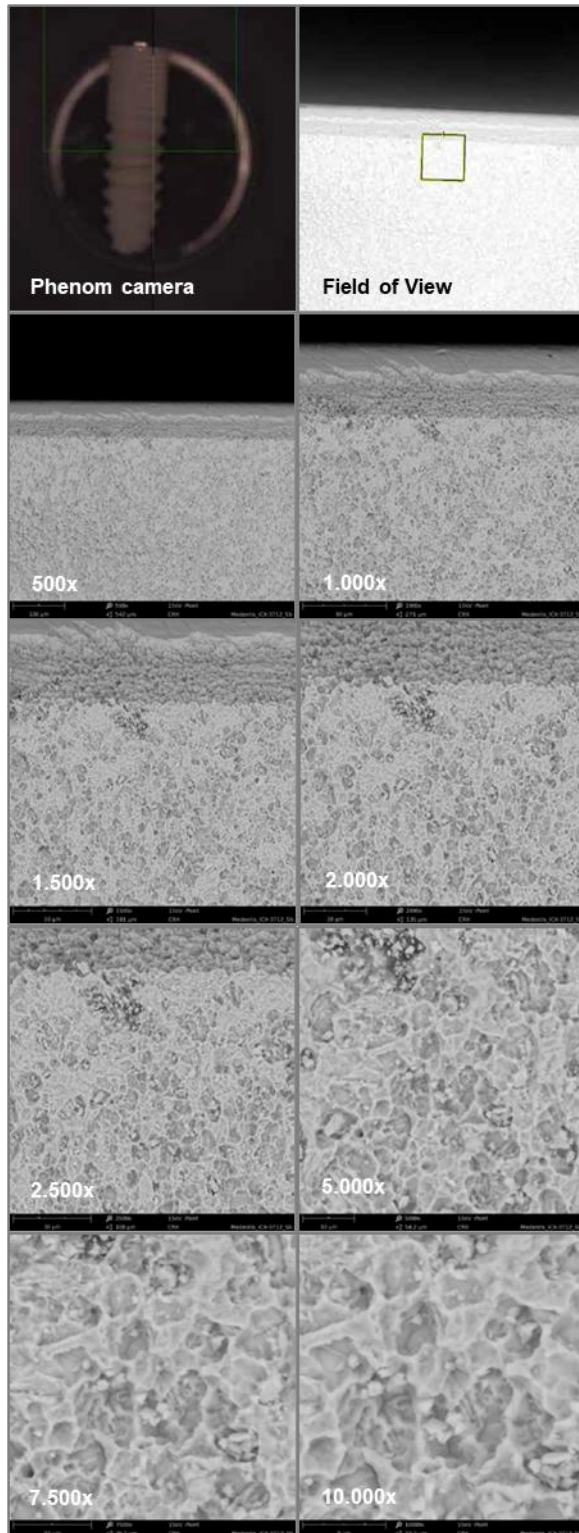
Oberflächenanalysen steril verpackter Implantate. Dr. D. Duddeck und PD Dr. J. Neugebauer. BDIZ EDI konkret **1-2015**, S. 58 ff., *Oberflächenanalysen von 120 Implantaten mit dem Rasterelektronenmikroskop.* Dr. Dirk Duddeck, Dr. Hassan Maghaireh, Dr. Franz-Josef Faber, PD Dr. Jörg Neugebauer. BDIZ EDI konkret **2-2015**, S. 68 ff.

Dirk U. Duddeck, *Oberflächenuntersuchung von Implantaten mit dem Rasterelektronenmikroskop* (Dissertation), **2009**, 169 Seiten

Surface-Topography- Material Contrast Image (Left: Thread; Right: Body)



Left: Surface-Topography- Material Contrast Image (Shoulder) / Right: EDX Area Analysis



1.a.3 Examination of the stability of Implant-abutment connections in the rotational vibration test

A new test method for quality assurance of dental implants

Dr. D. Weißweiler, Prof. em. W. Niedermeier, Department of Prosthetic Dentistry, University of Cologne, 2021

Introduction:

To date, investigations into the stability of the implant-abutment connection have only been based on the standardized test method in accordance with DIN 14801. However, there is an additional need for test methods which, for quality assurance reasons alone, allow stability tests of dental implants to be carried out at comparatively short intervals.

Objective:

An alternative test method based on the established rotational vibration test according to DIN 1311-2 was examined for its practical value as a "life-time test" for implant systems. (testing the mechanical strength of dental implant-abutment connections).

Material and Methods:

Through 2 test protocols with 30 and 60 Ncm deflection torque, sub- and supra-threshold loading situations were simulated on 8 different implant abutment systems (implant systems: Frialit®-2 Synchro; Bredent blueSKY; Bego Semados® S; Medentis ICX-templant®) investigating morphological changes and ultimately the fracture strength of the 6 test specimens.

Results:

The freedom of rotation of the abutment changed significantly from the original 1-2° to up to 6°. The loosening torque of the abutment screw decreased significantly by 10-45% depending on the tightening torque, with several implant-abutment systems already showing a highly significant ($p < 0.01$) loss of loosening torque in the first loading interval (Table 1).

Screw loosening continued in the subsequent fatigue periods. Only the Bego Semados® /BeCe® Sub-TecPlus and Medentis ICX-templant®/titanium abutment the screw loosening did not reach the significance threshold.

Widening of up to 0.2 mm of the implant neck region was only seen with Frialit®-2 implants. Abutment fractures occurred in 35% of cases.

Conclusion:

In the rotational oscillator test, damage to the implant-abutment connection occurs within a very short time, similar to that which occurs after years of implant use, and the results are consistent with stability tests in the chewing simulator (DIN 14801) and long-term clinical experience. Overall, the use of the rotational oscillator method as an accelerated "lifetime" test has clear advantages over other methods.

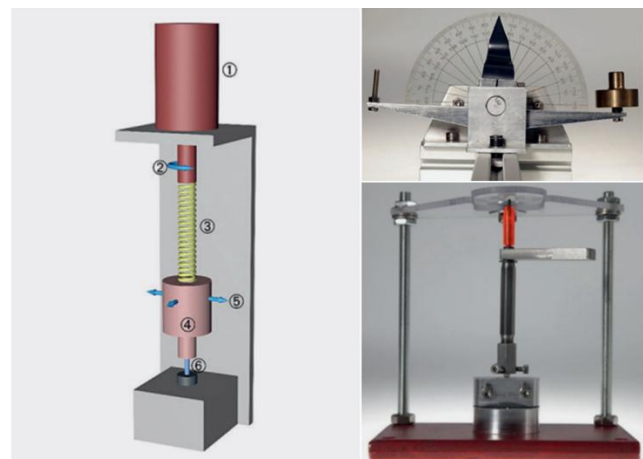


Fig. 1 (left): Schematic representation of the rotary oscillator system according to DIN 1311-2. **Fig. 2 (top right):** Device for determining the rotational backlash between abutment and fixture with weight for constant loading and elimination of sliding friction. **Fig. 3 (bottom right):** Device for determining the tilting clearance between abutment and fixture with weight for generating a constant tilting load.

Implant-Type	Bego Semados® S	Medentis ICX-templant®
Abutment	BeCe®-Sub-TecPlus Ceramic Abutment	ICX®-Titanium-Abutment
Tightening torque	30	30
20 min M (Q1/Q3)	22,9 (21,7 / 24,02)	20,38 (17,82 / 22,85)
40 min M (Q1/Q3)	19,58 (16,4 / 22,17)	18,43 (15,47 / 21,97)
60 min M (Q1/Q3)	20,72 (17,02 / 26,07)	20,65 (19,42 / 22,47)
CR 10 min M (Q1/Q3)	19,88 (16,65 / 23,12)	20,15 (17,47 / 22,9)

Tab. 1: Recommended tightening torque and mean loosening torques (M = median values, Q1 = lower and Q3 = upper quartile) of the implant test specimens before and during the fatigue test in Ncm, statistical differences (Friedman test) to the initial condition (* $p < 0.05$, ** $p < 0.01$). (Excerpt modified according to Table 3 of the original article)

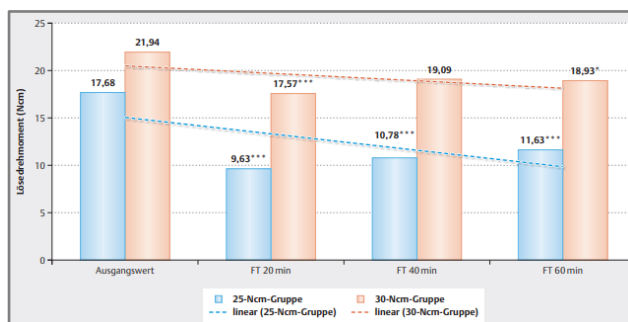


Fig. 4: Loosening torque median values within the different tightening torque groups with linear trend in the fatigue test; statistical differences (Friedman test) in each case compared to the initial state (* $p < 0.05$, *** $p < 0.001$).

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Reference:

Weißweiler D, Niedermeier W (2021). Prüfung der Stabilität von Implantat-Abutment-Verbindungen im Rotationsschwinger-Test. ZWR-Das Deutsche Zahnärzteblatt 130:536-45.

1.a.4 Biomechanical properties of the bone during implant placement

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Introduction:

In this study, the biomechanical properties of a porcine bone model were investigated. Porcine ribs were used as the experimental model, as their cortical bone is similar to that of a human mandible due to its excellent homogeneity and thickness.

Objective:

The aim of this study was to investigate the biomechanical properties of the bone model before and after implantation.

Material and Methods:

Animals were not sacrificed for the experiment. The dimensions of the pig ribs were measured with an analog dial caliper (0.01 mm, Hofmann Group AK600203). The average length, width and height of the bones were 117.1 mm, 13.4 mm and 9.8 mm, respectively. The average value and standard error of cortical thickness was 2.13 mm $\pm$ 0.08 mm.

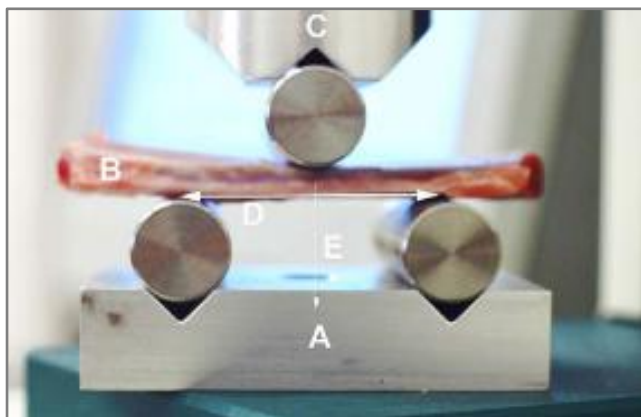


Fig. 1: Experimental layout. (a) Supporting platform with point support rollers; (b) pork rib segment; (c) pressure head of the mechanical tear/break device with the roller used for point loading. (d) distance between support points (standard 40 mm). (e) Vector of the force acting on the bone segment.

The porcine ribs were randomly divided into three groups: Group 1, in which the ALL-ON-FOUR™ protocol was applied during pre-drilling and placement of implants, Group 2, in which the ALL-ON-FOUR™ protocol was applied during pre-drilling and no implants were placed, and Group 3, which consisted of intact bone, served as the control group.

In the first group (Group 1, n=17), the implants were placed according to the ALL-ON-FOUR™ protocol: two implants were placed medially in parallel (ICX-templant® 4.1 mm $\times$ 10 mm, WS-75L surgical contra-angle handpiece, Implantmed Classic SI-923 Physiodispenser, W&H, Bürmoos, Austria), and two tilted implants were placed laterally (ICX-templant® 4.1 mm $\times$ 15 mm). In the second group (Group 2, n=16), the implant nests were pre-drilled for the same implant type and size (WS-75L surgical contra-angle handpiece, Implantmed Classic SI- 923 Physiodispenser, W&H, Bürmoos, Austria), but left empty without placing an implant. During predrilling and insertion of the implants the manufacturer's recommendations and the professional code of conduct were followed. No intervention was performed on the ribs of the control group (Group 3, n=18).

For mechanical testing, each group was randomly divided into two parts. Half of the samples were tested using a static tensile and compression testing machine (Tinius Olsen H5KT Atec, USA), while the other half were subjected to a fatigue test using an All-Electric Dynamic Testing Device (Instron ElectroPuls™E3000, USA).

For the mechanical test, 3-point bending tests were carried out, which are the most widely accepted for fracture testing.

Mechanical components were manufactured individually that could be applied for both the static and dynamic equipment. The devices became suitable for performing 3-point bending tests (Fig. 1).

During the static load measurements, the bending deformation was increased steadily on the bones. The according force was measured, digitized. The equipment recorded the position of the crosshead and the measured force. The maximum deformation was 10 mm, which was reached in 5s. During the measurement, an automatic halt was actuated, when the device observed a sudden decrease in the force.

The other part of the samples was examined using a dynamic fatigue test. The dynamic test followed the arrangement of three-point bending fatigue measurements. Prior to the dynamic tests, the stiffness of each rib was determined by measuring the force-deflection curve between 0.2 and 0.8 mm deflection. After this process the fatigue test was performed on the samples, where the initial deflection was set at 2 mm, which was reached in 5 s. The fatigue test was performed in deflection control mode. The fatigue signal was a sinus function with 20 Hz frequency at a 0.5 mm deflection amplitude over 10,000 cycles. At the end of the fatigue process, the load was decreased to 0 N in 5s.

Results:

According to the static loading, there was no significant difference between the implanted and the original ribs, however, the toughness values of the bones decreased largely on account of pre-drilling of the bones. The analysis of the dynamic fatigue measurements by Kruskal-Wallis test showed significant differences between the intact and pre-drilled bones.

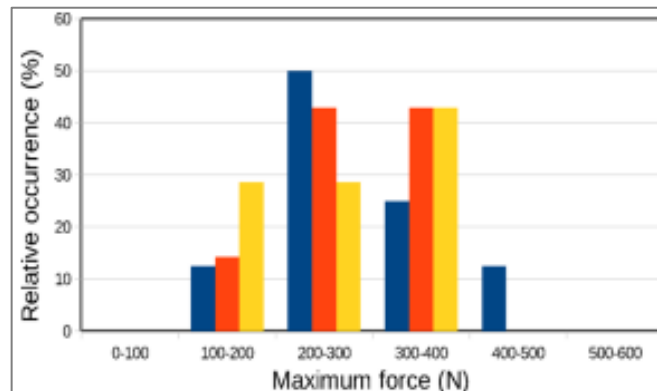


Fig. 2: The occurrence of the maximum static load force values: blue: control, orange: predrilled, yellow: implanted

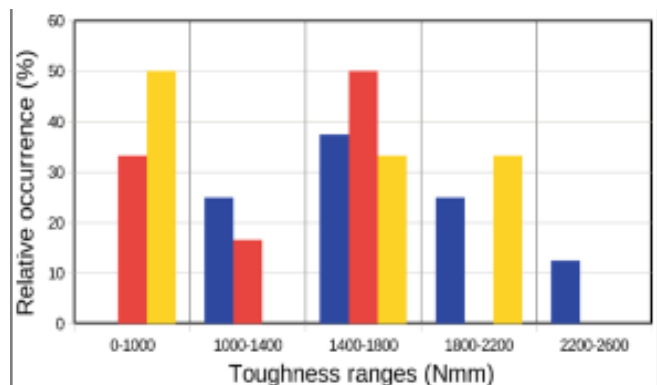


Fig. 3: Occurrence of various toughness ranges in the study groups.

Conclusion:

The pre-drilled bone was much weaker in both static and dynamic tests than the natural or implanted specimens. According to the results of the dynamic tests and after a certain loading cycle the implanted samples behaved the same way as the control samples, which suggests that the implantation has stabilized the skeletal bone structure.

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Reference:

Nagy ÁL, Tóth Z, Tarjányi T, Práger NT, Baráth ZL. *Biomechanical properties of the bone during implant placement*. BMC Oral Health. 2021 Feb 25;21(1):86. doi: 10.1186/s12903-021-01442-1. PMID: 33632191; PMCID: PMC7908763.

1.a.5 *In-vitro*-assessment of internal implant-abutment-connections with different cone angles under static loading using synchrotron-based radiation

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Objective:

The stability of the implant-abutment connection is crucial to minimize mechanical and biological complications. Therefore, an assessment of the microgap behavior and abutment displacement in different implant-abutment designs was performed.

Material and Methods:

Four implant systems were tested, three with a conical implant-abutment connection based on friction fit and a cone angle $<12^\circ$ (Medentika®, Medentis, NobelActive®) and a system with an angulated connection ($<40^\circ$) (Semados®). In different static loading conditions (30 N- 90° , 100 N- 90° , 200 N- 30°), the microgap and abutment displacement was evaluated using synchrotron-based microtomography and phase-contrast radioscopy with numerical forward simulation of the optical Fresnel propagation yielding an accuracy down to $0.1\ \mu\text{m}$.

Results:

Microgaps were present in all implant systems prior to loading ($0.15 - 9\ \mu\text{m}$). Values increased with mounting force and angle up to $40.5\ \mu\text{m}$ at an off axis loading of 100 N in a 90° angle.

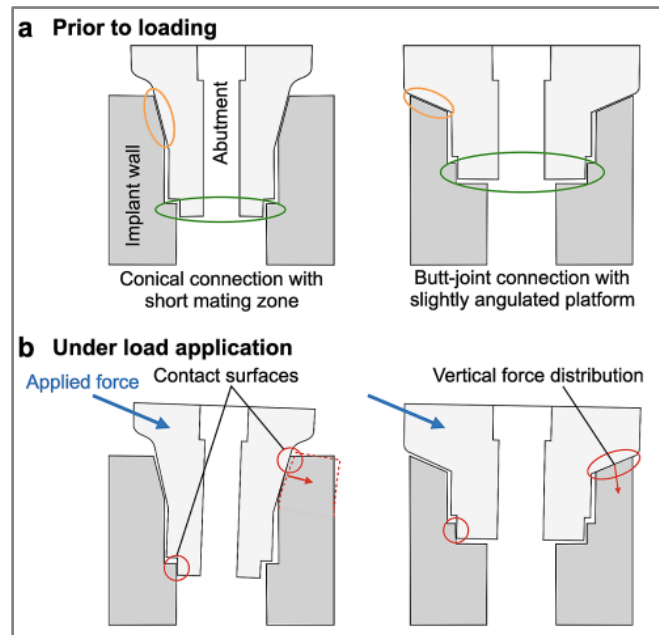


Fig. 1: Schematic figure of a conical connection with a short mating zone (mating zone: orange circle) and a butt-joint connection with a slightly angulated platform before (a) and after load application (b). The anti-rotational indices are encircled in green color. Red lines demonstrate lateral force transmission on the implant wall in conical connections and the vertical distribution in butt-joint connections. Butt-joint connections with adequate preload of the abutment screw distribute the force more vertically into the implant shoulder.

Conclusion:

In contrast to the implant-abutment connection with a large cone angle (45°), the conical connections based on a friction fit (small cone angles with $<12^\circ$) demonstrated an abutment displacement, which resulted in a deformation of the outer implant wall. The design of the implant-abutment connection seems to be crucial for the force distribution at the implant wall, which might influence the peri-implant bone stability.

Abbrevia- tion	Implant manufacturer	Implant diameter [mm]	Abutment diameter [mm]	Type of connection	Cone angle ^a [°]	Cone length ^b [mm]
MA	Medentika	3.5	2.8 ^c – 2.2 ^d	Conical connection	10.5	0.78
MS	Medentis	4.1	3.0 ^c – 2.8 ^d	Conical connection	11.3	0.92
NO	Nobel Biocare	4.3	3.3 ^c – 3 ^d	Conical connection	12.2	0.74
BE	BEGO	4.1	2.8 ^c – 2.4 ^d	Butt-joint connection	45	0.61

Tab. 1: Geometric design parameters of tested IACs. The abutment diameter was measured at most apical and coronal part of connection to depict different cone shapes. **a** - estimated from x-ray radiographs; **b** - height of the IAC measured in radiography; **c** - largest diameter of the abutment in the area of the mating zone; **d** - smallest diameter of the abutment in the area of the mating zone

		MS		BE		NO		MA	
Position at IAC		1	2	1	2	1	2	1	2
Prior to loading	UL	0.3	1.3	4.5	4.5	0.7	0.5	6	1.5
	LL	3.0	1.2	5.5	5.3	1.4	0.2	6	0.8
	LR	2.2	4	5.4	4	2	0.8	8	6
	UR	0.3	0.7	0.2	1.9	0.2	0.3	0.7	9
30 N at 90°	UL	2.3	2.4	8	7	1	0.6	5	15
	LL	3.8	2.6	9	11	4	0.3	9	0.6
	LR	3.2	4.5	6	5	1.6	0.2	9	11
	UR	0.3	1.3	0.2	2.2	0.5	0.2	1.4	2
100 N at 90°	UL	11	9.5	38	40.5	13	6	29	32
	LL	8	7	36	39	11	2.5	12	7
	LR	3.3	5	0.8	1.5	2.4	0.4	14	13
	UR	0.2	0.3	0.3	0.5	0.2	0.2	0.3	0.2
200 N at 30°	UL	3	4.2	23	26	6.5	4	20	20
	LL	3.3	1.3	25	26	3.4	0.3	8	1.5
	LR	2.1	6	1.8	0.8	1.7	0.4	10	13
	UR	0.2	0.4	0.4	0.5	0.2	0.2	0.2	0.3

Tab. 2: Microgaps of all implant systems under different loading conditions measured using synchrotron-based radiographies and phase-contrast radiography. (According to Zabler et al., an uncertainty of 50% can be assumed for microgaps up to 2 µm, whereas larger microgaps are determined with 2 µm uncertainty [31])

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Reference:

Angermair, J., Iglhaut, G., Meyenberg, K. et al. *In vitro* assessment of internal implant-abutment connections with different cone angles under static loading using synchrotron-based radiation. *BMC Oral Health* **24**, 396 (2024). <https://doi.org/10.1186/s12903-024-04156-2>

Table 1b: Experimental in-vivo-Studies ICX-templant® implant system

Study-No.	Page	Study Location / Year	Timepoint Follow-Up in Months	Number of Subjects	Number of Implants	Endpoint (Survival rate [%])
1.b.1	23	University of São Paulo, 2014 P. Vigano; D. Botticelli; LA. Salata; MT. Schweikert; J. Urbizo Velez; NP. Lang	3	6 (Beagles)	24	Histological Evaluation BIC (Bone to Implant Contact)
		Study Observative / Study Title	Healing at implant sites prepared conventionally or by means of Sonosurgery®. An experimental study in dogs.			
		Research Results / Evaluation	No statistically significant differences were found in the evaluation of the histological sections in the hard and soft tissue (bone to implant contact) test side (65.4%) vs. control side (58.1%). Both the use of a conventional drilling method and the use of the Sonosurgery® method showed comparable osseointegration behavior and remodeling of the hard tissue. The ICX-templant® surface showed very good bone contact rates during the healing phase.			

1.b.1 Healing at implant sites prepared conventionally or by means of Sonosurgery®. An experimental study in dogs.

P. Vigano, D. Botticelli, LA. Salata, MT. Schweikert, J. Urbizo Velez, NP. Lang; University of São Paulo, 2014

Introduction:

The term Sonosurgery is based on the well-known ultrasound-driven Piezosurgery® instruments. The operating frequency of Sonosurgery® instruments is in the sonic range and is therefore clearly audible. Due to the selective processing of bone, the risk of soft tissue and nerve injuries is low compared to surgical milling. Bone can therefore be harvested safely and atraumatically.

Objective:

Comparison of wound healing of the peri-implant tissue with conventional implant placement or minimally invasive Sonosurgery®.

Material and Methods:

Six dogs (beagles) underwent bilateral extraction of the mandibular molars and premolars. After 3 months, the mucoperiosteal flap was removed and the recipient region was prepared.

On the right side, the osteotomy was performed with conventional drills (control side) and on the left side with an ultrasonic drill (test side). Two ICX-templant® implants (medentis medical GmbH, Dernau, Germany) were then inserted on each side. After 8 weeks of open healing, biopsies were taken and the samples were processed histologically.

Results:

The time consumed for the osteotomies at the test was more than double compared to the conventional control sites. No statistically significant differences were found in the evaluation of the histological sections in the hard and soft tissue. Only a small but not statistically significant difference in BIC (bone to implant contact) was found between the test side (65.4%) and the control side (58.1%).

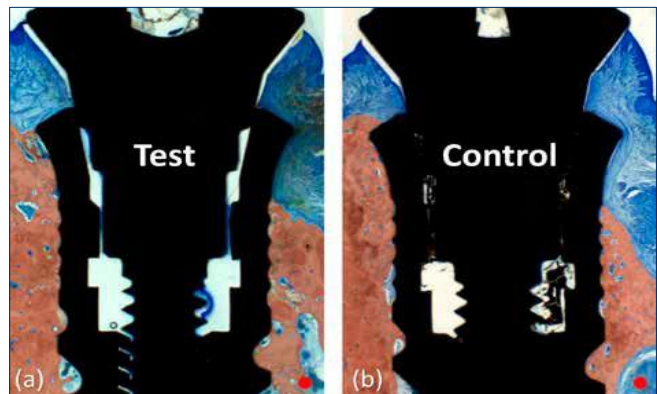


Fig. 1: Histological section after an 8-week healing phase following implant placement. All implants were placed in mature bone. The soft tissue, free of inflammatory markers, was well developed around the implant neck. Original magnification 16x, Stevenel's blue and Alizarin red staining (a) test side; (b) control side

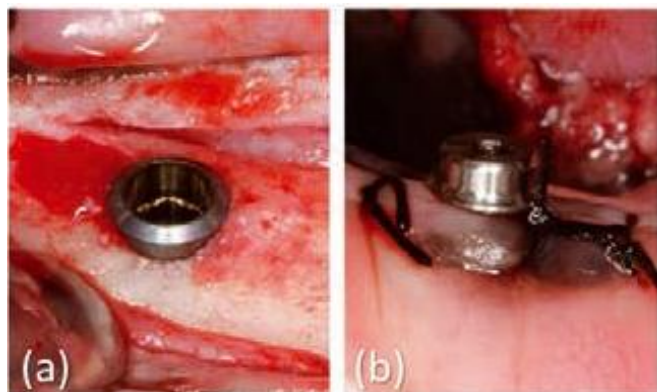


Fig. 2: Clinical view (a) The implants were placed with the rough/smooth coronal margin flush to the buccal bony wall. (b) Healing abutments were applied to the top of the implants, and the flaps were sutured to allow a non-submerged healing.

Conclusion:

Both the use of a conventional drilling method and the use of the Sonosurgery® method showed comparable osseointegration behavior and remodeling of the hard tissue.

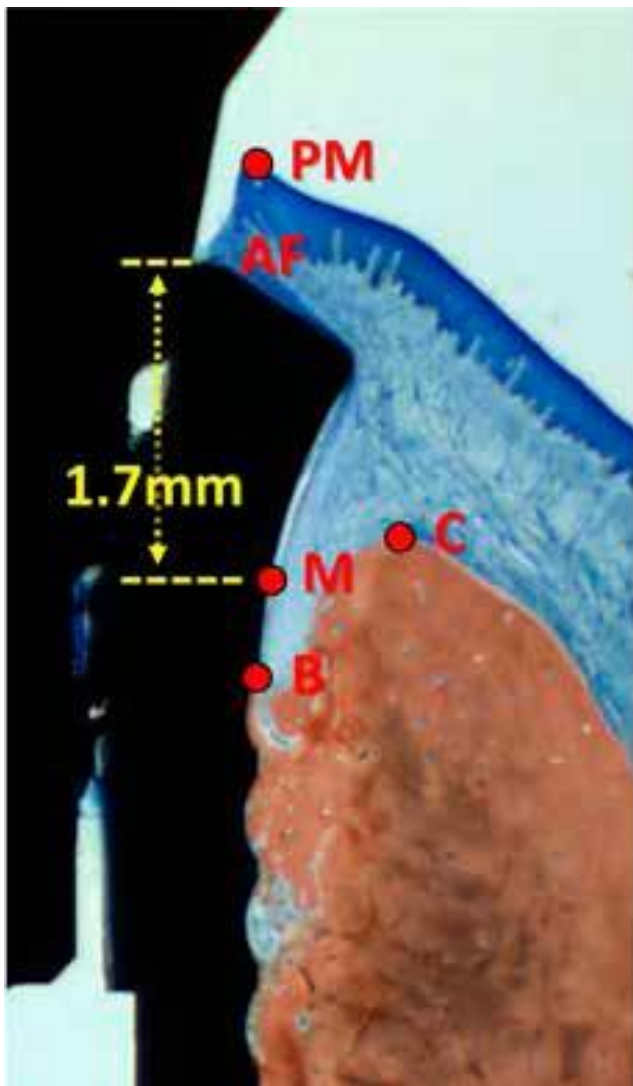


Fig. 3: Schematic representation of the analysis points of the histological evaluation. **PM**, top of the peri-implant mucosa; **AF**, abutment/fixture connection; **C**, top of the adjacent bony crest; **M**, coronal margin of the rough/smooth limit; **B**, most coronal bone-to-implant contact area (**BIC**); The neck of the implant (between **AF** and **M**) was 1.7 mm high. Original magnification 16x

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Reference:

Viganò P, Botticelli D, Salata LA, Schweikert MT, Urbizo Velez J, Lang NP. Healing at implant sites prepared conventionally or by means of Sonosurgery®. An experimental study in dogs. Clin Oral Implants Res. **2015** Apr;26(4):377-382. doi: 10.1111/clr.12348. Epub 2014 Feb 13. PMID: 24524198.

Table 1c: Retrospective Studies ICX-templant® implant system

Study- No.	Page	Study Location / Year	Timepoint Follow-Up in Months		Number of Subjects	Number of Implants		Endpoint (Survival rate [%])	
1.c.1	27	University of Cologne, 2010 V.E. Karapetian; M. Roels; J. Neugebauer; J. Zöller	14	31	37	114		98,2	96
		Study Observative / Study Title	A retrospective study on the probability of success of two different diameter-reduced implant systems (ICX-templant® vs. XIVE®)						
		Research Results / Evaluation	The ICX® showed a good probability of success, which also correlates with values from the literature						
1.c.2	30	Health Center St. Willehad, 2010 R. Fangmann; C. Picht	10		27	108		99,1	
		Study Observative / Study Title	MKG-Abutments for immediate interim restoration						
		Research Results / Evaluation	With the ICX® System, a prosthetic interim restoration can be realized easily, cost-consciously and without restrictions according to previous experience due to the newly developed MKG-Abutment.						
1.c.3	33	RWTH Aachen, 2011 Prof. Dr. Murat Yildirim	36		94	413		99,27	
		Study Observative / Study Title	Results of a 2-years study of the ICX-templant® in clinical practice						
		Research Results / Evaluation	The ICX-templant® implant system is characterized by its ease of use, technical precision and high cost-effectiveness						
1.c.4	34	Luisenhospital Aachen, 2011 / 2012 Dr. Bastian Wessing; Dr. Martin Emmerich	18.3		1	4		100	
		Study Observative / Study Title	Investigation of the ICX-templant® implant system in combination with the Rемаix collagen membrane (Matricel) / Safe bone regeneration using a new collagen membrane						
		Research Results / Evaluation	The ICX-templant® system platform is suitable for a wide range of medical applications, e.g. in combination with a Rемаix membrane (Matricel). No increased wound healing disorders, pain or failures were recorded. The surgical handling of the new membranes with the ICX- templant® system is advantageous. The clinical use of the Rемаix membrane in combination with the ICX-templant® implant system for augmentation in implantology shows promising initial results.						
1.c.5	37	University of Cologne, 2014 Dissertation Umut Baysal	Not specified		Total: 98, Analysis: 53	Total: 216, Analysis: 185, medentis medical: 10		Not specified	
		Study Observative / Study Title	Analysis of the metric deviation of three-dimensionally planned implant positions						
		Research Results / Evaluation	The ICX-templant® implant system is ideally suited for template-supported implantation. Even when using third-party software such as the Simplant software (Sicat), the system enables template-supported implant placement in this study, which offers sufficient accuracy for everyday clinical practice with regard to the implementation of preoperative planning.						
1.c.6	39	Danube Private University, Krems, 2016 Masterthesis Oliver Stupar	60		19	43		100	
		Study Observative / Study Title	ICX-templant® implants - A clinical comparison with the question "Is an inexpensive implant less successful?"						
		Research Results / Evaluation	The intention "An affordable implant system for a broad population" can be summarized in this study as meeting the requirements of the practice and patients and is comparable to other implants in terms of results						
1.c.7	40	Danube Private University, Krems, 2016 Masterthesis Andreas van Orten	Until prosthetic restoration		22	28		100	
		Study Observative / Study Title	Outcome quality of the placement of ICX® implants with tooth-supported ICX®-Magellan surgical guides						
		Research Results / Evaluation	It has been shown that with the aid of a Magellan drilling template, transfer accuracies can be achieved that are comparable to those of comparable systems and which can be placed in the context of the currently available study data						
1.c.8	42	Karol-Marcinkowski-Medical University Poznan, 2016 Dr. med. Przemysław Kopczyński; Dr. med. Rafał Flieger	12		20	15	15	100	100
		Study Observative / Study Title	Minimally-invasive implantation of the short implants ICX-templant® as an alternative to bone augmentation procedures - a retrospective assessment of marginal bone levels						
		Research Results / Evaluation	The application of modern implantology systems using minimally invasive protocols for augmentation procedures is limited for the use of longer implants. Short implants such as the ICX®-Shorty, on the other hand, appear to be a good alternative, as a minimally invasive protocol and a prosthetic restoration tailored to it can minimize bone loss at the implant-bone contact surface and even promote bone remodeling.						

Study- No.	Page	Study Location / Year	Timepoint Follow-Up in Months	Number Subjects	of	Number Implants	of	Endpoint (Survival rate [%])
1.c.9	44	Kabardino-Balkarian State University named after H.M. Berbekov, Nalchik, Kabardino-Balkarian Republic, Russian Federation, 2017 M. Sh. Mustafaev; Z. F. Kharaeva; V. A. Vissarionov; F. M. Mustafaeva; A. K. Zhigunov; M. M. Atmurzaev	18	103		489		Not specified
		Study Observative / Study Title	Complex prophylaxis and prognosis of inflammatory complications after dental implantation					
		Research Results / Evaluation	Local investigation of the correlation of pro- and anti-inflammatory immunocytokines reliably reflects the dynamics of osseointegration processes and can be used to predict the development of complications after dental implantation. The administration of a complex of antioxidant vitamins and amino acids to patients with extensive implantation helps to eliminate the identified imbalance between prooxidant and antioxidant systems, thereby reducing the risk of complications in the long term.					
1.c.10	46	Karol-Marcinkowski-Medical University Poznan, 2019 Dr. med. Rafał Flieger	24	1		2		100 %
		Study Observative / Study Title	Bilateral Bone Ridge Splitting in Maxilla with Immediate Implant Placement in a Patient with Osteoporosis: A Clinical Report with 2-Year Follow-up					
		Research Results / Evaluation	The piezosurgery device has great potential to advance surgical techniques where precise bone preparation is expected. Piezosurgery® is useful and has safe instruments for ridge splitting with a very thin ridge (4.5 and 3.0 mm). Ridge splitting and guided bone regeneration with immediate implant placement can be performed safely in patients taking bisphosphonates to treat osteoporosis.					
1.c.11	49	Charité Universitätsmedizin Berlin, 2020 Verena Huber	Mean Wearing Time of evaluated Bridges: 45,0 ± 15,6 Months Mean Follow-Up Time: ICX-templant®: 43,4 ± 13,80 Months Mean Follow-Up Time: ICX-templant® plus: 46,8 ± 15,88 Months	32		88		Bone Loss 0.34-1.07mm
		Study Observative / Study Title	Comparative clinical studies of tooth-borne and implant-borne bridges of veneered base metal and zirconium dioxide					
		Research Results / Evaluation	Monolithic ZrO ₂ restorations have the potential to become the new standard restorative material in dentistry. The examination of the peri-implant bone level, which showed constant or improved bone conditions on 28.4 % of all implants examined, provided very promising results.					

1.c.1 A retrospective study on the probability of success of two diameter-reduced implant systems

V. E. Karapetian; M. Roels; J. Neugebauer; J. E. Zöller; University of Cologne, 2010

Objective:

The aim of this study was to retrospectively determine the probability of success of two implant systems (templant® and XiVE®) with a reduced diameter (2.8-3.8 mm diameter) compared to standard implants (> 3.8 mm diameter). A reduced diameter means a smaller contact surface of the implant to the bone. The question arises as to whether osseointegration is sufficient to withstand the loading forces despite the smaller contact surface. The question also arises as to the extent to which any implant losses are directly or indirectly related to the implant diameter. Do other parameters correlate with the loss of the implants? What other causes are responsible for the possible failure? Are reduced-diameter implants an adequate alternative to standard implants, even if there is no compelling indication for a reduced diameter?

Is the success rate of the reduced-diameter implant systems from XiVE® and templant® comparable with the success rate of reduced-diameter implants from other manufacturers?

Material and Methods:

A total of 108 patients, 56% female (n=60) and 44% male (n=48), were treated with 469 implants, of which 24.3% were templant® (n=114) and 75.7% XiVE® (n=355). The implantations were mostly late implantations and only in individual cases immediate implantations or delayed immediate implantations. For the purpose of the retrospective study, the data of the patients treated with XiVE® and templant® reduced-diameter implants over a period from 2000 to 2008 were collected according to the information from the OP-books and index cards of the Department of Oral and Maxillofacial and Plastic Facial Surgery, University of Cologne. The following information on both patient groups was documented on the basis of the index cards:

- Number of patients treated
- Age of patients at the time of implantation
- Gender distribution of patients
- Number of implants inserted
- Rate of the implants
- Length and diameter of the inserted implants
- Manufacturer of the inserted implants (XiVE® or templant®)
- Topographic distribution of implantations
- Post-operative complications

In order to determine the possible cause of implant loss, X-ray images (digital orthopantomograms [OPGs] or digital volume tomography [DVT]) were taken in these cases. The peri-implant bone resorption was determined using a "virtual" ruler in the SIDEXIS next Generation program (Sirona Dental Systems GmbH) when evaluating the X-ray images taken. The bone resorption rate of the implants corresponded to the mean value of the mesial and distal measurements on the radiograph (angular bone defect). An immediately postoperative X-ray (usually a digital OPG) served as a reference.



Fig. 1a-d-Insertion of an ICX-templant®-Implant: (a) ICX-templant® Implant; (b) Opening of the Implant des Implant regio 21; (c) Abutment on the Implant regio 21; (d) Final situation with Cerec® Crown

The bony situation in the area of the implants was assessed for signs of bone resorption or its dynamics, as well as for the presence of a narrow translucent zone around the implant. The data obtained were statistically analyzed according to the following criteria:

- Age distribution
- Topographic distribution per gender
- Topographic distribution per unit length or diameter of the implant
- Topographic distribution per manufacturer
- Gender distribution pr manufacturer
- Rate of the implants
- Survival rate and losses

All data collected in the study were analyzed using descriptive statistics (frequency distribution, mean, standard deviation) and exploratory statistics (Kaplan-Meier survival function) with the Microsoft Excel 2007 for Windows program (Microsoft Corp.) and the SPSS 17 for Windows statistics program (SPSS Inc.).

Results:

In the period from September 2000 to February 2008, n=469 reduced-diameter implants were inserted, of which n=355 (75.7% XiVE®) were from the manufacturer Friadent/Dentsply GmbH and n=114 (24.3% templant®, medentis medical GmbH). from Almost twice as many XiVE® implants (n=225; 63.4%) were placed in the maxilla than in the mandible (n=130; 36.4%). For templant® implants, more than twice as many were placed in the maxilla (n=78; 68.4%) than in the mandible (n=36; 31.6%). Most XiVE® implants were implanted in region 024 (n=23; 6.5%), the fewest in region 041 (n=2; 0.6%). templant® implants were most commonly used in region 026 (n=14; 12.3%). No templant® implants were placed in the region of the second molars, both in the maxilla and mandible. The duration of implant placement was evaluated according to the criterion "implant in situ or implant loss". The most common cause of implant loss was failed osseointegration during the healing phase (1.1%; n=5), followed by peri-implantitis (0.4%; n=2). The frequency distribution and causes of implant loss are shown in *Table 1*.

The result of the Kaplan-Meier survival function for the XiVE® implants shows a probability of success of 98.6% for 56 months and 87% for the maximum observation period of 7.75 years (data not shown). The probability of success for the templant® implants was 98.2% after 14 months and 96% after 31 months. 60.5% (n=69) of all templant® implants were implanted in the posterior region.

The average duration of the study was 29 months, 31 months for the XiVE® implant system and 14 months for the templant® implant system.

Three quarters of the implants placed were XiVE® implants. templant® implants only came onto the market in the middle of the observation period mentioned here. This explains why XiVE® implants were used more frequently in the Department of Oral and Maxillofacial and Plastic Facial Surgery, University of Cologne. Friadent/Dentsply GmbH has many years of experience in implant production.

XiVE® implants have so far been shown to be effective in a study by Degidi *et al.* [6]. The templant® implants had just received marketing authorization and were therefore tested in this study for their clinical performance. 60.5% (n=69) of all templant® implants were implanted in the posterior region; n=2 (2.9%) were failures. Of all XiVE® implants, 60% (n=213) were also placed in the posterior region; n=3 (1.4%) were explanted. The average duration of placement in our study was 29 months, 31 months for the XiVE® implant system and 14 months for the templant® implant system.

Many studies, both for standard and reduced-diameter implants, have similar observation periods [1], [8], [11], [15]. In some studies, e.g. Vigolo *et al.* (84 months) [16], the duration of implant placement is longer. The probability of success for XiVE® implants after implant loss drops sharply after 57 months. This is due to the fact that only a few implants with a longer duration were included in the data collection.

We therefore assume an average success rate of 98.6% for XiVE® implants and 98.2% for templant® implants.

	templant® (n = 114)	%	XiVE® (n = 355)	%
<i>in situ</i>	112	98,2	350	98,6
Explanted	2	1,8	5	1,4
Reason for Implant Loss				
Insufficient Osseointegration	2	1,8	3	0,8
Periimplantitis	-	-	2	0,6

Tab. 1: Frequency distribution of implant failures and causes of failure for templant® and XiVE® implants

In the specialist literature, the probability of success for both standard implants and reduced-diameter implants in analog follow-up examinations is between 93% [3] and 99.4% [8] with a mean observation period of 48 months. The probability of success of 98.6% (XiVE® implants) and 98.2% (templant® implants) for the maximum observation period of 93 months determined in our study is comparable with other studies.

Conclusion:

The difference in the probability of success for templant® and XiVE® is not statistically significant with an error probability of $p > 0.05$.

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1.c.2 MKG-Abutments for immediate interims restauration

R. Fangmann; C. Picht; Health Center St. Willehad, 2010

Introduction:

The edentulous, atrophied jaw, in particular the mandible, is considered a classic indication for implant-retained dentures, whereby the anchoring of implants in the case of insufficient mandibular denture support is to be classified as an absolute indication. The edentulous mandible is the oldest indication for an immediate restoration.

In implantology, there are concepts for immediate restoration and loading that have been specially developed for the edentulous mandible, expressly for restorations from a single practitioner. "Single practitioner concepts" provide a final prosthetic restoration with limited options for the patient. These treatment concepts only find limited acceptance in the teamwork-concept between surgical and prosthetic implantologists, as is the case between an oral and maxillofacial surgeon/oral surgeon and the general dentist.

The principle is as follows: at least four implants must be inserted and locked together. This interlocking stabilizes the implants and prevents rotational loading, which is particularly unfavourable during healing. The advantage for the patient is that they can enjoy the benefits of the implants immediately without having to wait for the traditional healing period of three months.

Objective:

The aim was to implement a method for immediate prosthetic restoration by applying the teamwork concept and additionally meeting the prosthetic and surgical requirements e.g. primary splinting and the avoidance of micro- and macromovements in the osseointegration phase.

Material and Methods:

A treatment concept of transgingival healing and immediate loading with a soft lined full denture was applied. The implantation was performed according to current standard protocols.

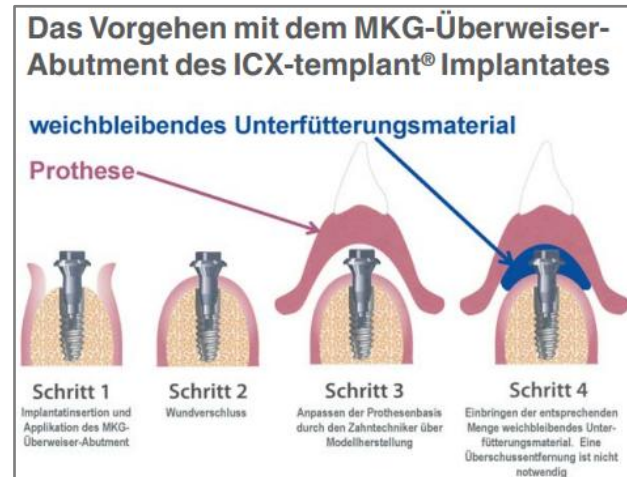


Fig. 1: Illustration of the technical procedure with the MKG-Abutment

Denture was prepared after wound closure and alginate printing. An interims denture with appropriate basal space was prepared for the MKG (maxillofacial)-abutments. The denture was equipped with soft remaining relining material at the basal side. Wounds were checked and the relining material was renewed after one week.

After two further weeks, the stitches were removed and the soft remaining relining material was replaced. This procedure was repeated in the 6th post operative week. Telescope restorations on the ICX®-Meso-Telescope-titanium abutment and Locator® restorations on implants were used in the final operation phase.

The ICX®-Meso-Telescope-Titanium abutment is suitable for the ICX®-MKG (maxillofacial) abutment (medentis medical GmbH). After the 10th post operative week, a final prosthetic restoration by the implantologist was executable.

This section describes the case of a patient treated with ICX-templant® implants on conventional Locators® after 12 weeks of implant insertion. To the author's knowledge, there is no other appropriate system on the market available with a specially designed abutment, the ICX®-MKG (maxillofacial)-abutment, which uses a healing abutment with a circular undercut to accommodate the soft relining material.



Fig. 2a-d: (a) Pre-drilling of the implant bed using guide pins, (b) Inserted ICX-templant® Implants, (c) Hand-fixed MKG-Abutments, (d) Situation seven days postoperatively

Results:

A total of 13 patients received 52 ICX-templant® implants and the corresponding MKG-abutments (4 implants and abutments per patient), which were treated immediately in the intraforaminal region. Patients were between $66,98 \pm 7,62$ years old. The diameter of ICX-templant® implants was at 4.1 mm (58%) and 12.5 mm length (75%).

Depending on the mucosa type, the MKG-abutment was used in two heights, 5 mm and 7mm, respectively. 6 months after implant insertion i.e. 3 months after Locator® restoration as a definitive prosthetic rehabilitation, post radiographic images were taken. No bone resorption was detected immediately after implantation procedure. Since the MKG-abutment was presented, the described method was applied by 13 dentists offering prosthetic support. $3,25 \pm 1,71$ patients were treated with implants per dental practice. A total of 27 patients were treated according to this procedure. Based on the teamwork concept 4 implants were used intraforaminally – by 108 implants in total. One implant was lost during the prosthetic procedure. Telescope restorations were placed in 20 patients and Locator® restoration in 7 patients. Radiographic follow-up images did not reveal any bone resorption at the implant shoulder.



Fig. 3: Orthopantomogram (OPG) ten months postoperatively.

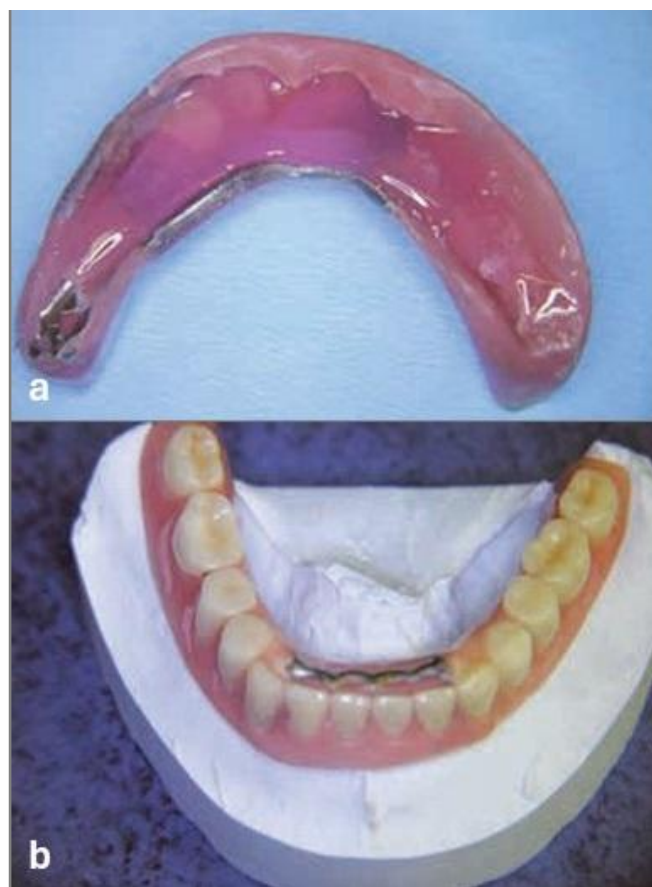


Fig. 4a+b: (a) Prosthesis with the soft remaining relining material in the corresponding application quantity; (b) Basally milled prosthesis auf the model.

Conclusion:

This new MKG-abutment enables the surgical implantologist to perform an immediate restoration on an edentulous patient without interfering with the teamwork-concept of the implanting prosthodontist. The patient benefit lies in the immediately fixed dentures.

The prosthetic implantologist has the advantage of the planned, definitive concept of the final prosthetic restoration (e.g. Locator®, bar connection, etc.) for the patient. The implantation can be carried out according to the standard protocols. The immediately loaded restoration of the edentulous mandible in the teamwork-concept using special abutments (ICX®-Fangmann abutments) for interim prosthetic restorations with relining materials that remain soft enables immediate prosthetic rehabilitation for the patient.

In addition, this concept gives both the patient and the prosthetic implantologist complete freedom with regard to the final prosthetic restoration options. For the first time, the patient is given the opportunity to assess their final prosthetics in relation to the pull-off forces prior to restoration.

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Reference:

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1.c.3 Results of a 2-years study of the ICX-templant® in clinical practice“

Prof. Dr. Murat Yildirim, University of Aachen, 2011

Introduction:

During the last 37 years, insertion of enossal implants for the replacement of lost teeth and anchoring of dental prostheses has proven a safe and reliable procedure. As with most treatment procedures in dentistry today, dental implants not only involve scientific discovery, research and understanding, but also application in clinical practice. The practice of implant dentistry requires expertise in planning, surgery and tooth restoration.

Objective:

The aim of the study is the clinical investigation of the templant® implant system (medentis medical GmbH, Dernau, Germany), including both the surgical and the prosthetic requirements of the product.

Material and Methods:

This user study includes the placement of 413 implants as well as the adjacent prosthetic procedure. 173 (42%) implants were placed in the maxilla and 240 (58%) implants in the mandible. The study population includes 94 patients.

The target populations were patients with completed growth and therefore with an indication for implant prosthetic rehabilitation. The selection was based on the regular admission to the Clinic for Dental Prosthetics. Exclusion criteria are absolute contra-indications for implant surgery treatments. Based on medical indication, the patients were subjected to immediate or conventional loading (up to 6 months healing period). The study was conducted over an observation period of 2 years. A radiographic follow-up was performed 6, 12, 18 and 24 months after insertion.

Results:

Of the 413 implants placed, 3 were not osseointegrated, corresponding to a success rate of 99.27%.

Conclusion:

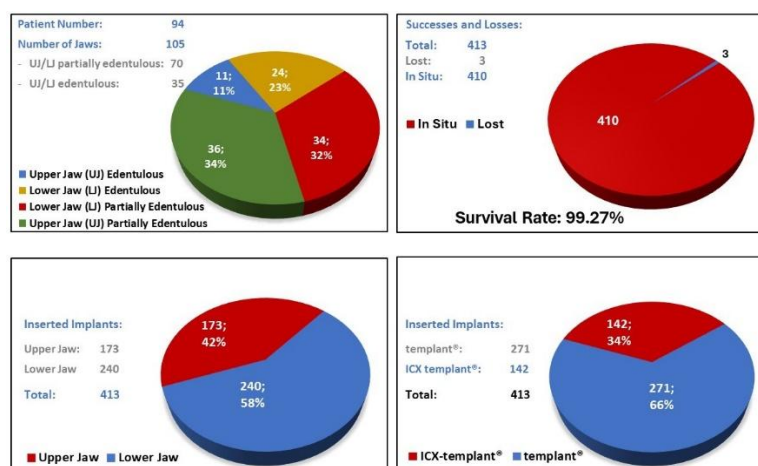
The ICX-templant® represents an established standard restauration method in dentistry with an outstanding price/performance ratio.

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Yildirim M. *Klinische Bewährung des ICX templant®-Systems im Praxisalltag medentis medical GmbH: „2-Jahresstudie“*, Dental Tribune, No. 12 Vol. 6, 11. Dezember 2009, Seite 15



Figures: Graphical Summary and Evaluation of the User Study.

1.c.4 Safe bone regeneration using a new collagen membrane

Dr. med. dent. Bastian Wessing; Dr. med. dent. Martin Emmerich, M.Sc. / Luisenhospital Aachen, 2011/2012

The ICX-templant® implant system has been used successfully for years in a variety of applications in everyday clinical practice. The following article describes, for example, an application in combination with other medical device systems such as e.g. bone replacement material or biomembranes.

Safe bone regeneration using a new collagen membrane

Guided bone regeneration (GBR), one of the standard procedures in implant surgery, is a well-described and well-researched method for restoring an adequate implant site and esthetically pleasing implant surfaces. The basic prerequisite for sufficient regeneration of bony defects or ridge augmentation using "Guided Bone Regeneration" (GBR) is the use of a barrier membrane to shield rapidly proliferating epithelial and connective tissue cells.

In the USA, the FDA recommends that suitable membranes should be used for bone augmentation in order to prevent the migration of bone replacement materials into the soft tissue. Resorbable membranes are superior to non-resorbable membranes due to better tissue compatibility, lower dehiscence rates and easier handling. They exhibit high cell compatibility in relation to periodontal ligament (PDL) fibroblasts and osteoblasts and are significantly more biocompatible than polytetrafluoroethylene (PTFE) membranes. This means better tissue integration, lower foreign body reactions and, as a result, lower dehiscence rates. Furthermore, rapid transmembrane angiogenesis can be recognized, which has shown faster new bone formation in animal experiments. Finally, good dimensional stability of the augmented area is required to prevent collapse of the created space during GBR.

This is normally achieved with the use of collagen membranes and application of autologous bone or bone substitute material under the membrane.

However, the membrane itself should have sufficient mechanical strength to hold the augmentation material securely in position until remodeling has progressed to the point where a positionally stable new bone precursor tissue is present. For this reason, membranes made from resorbable collagen of animal origin are most commonly used in Germany today. The use of such membranes is well documented with results showing a high probability of success. Non-chemically cross-linked collagen membranes have a dehiscence rate of 22 to 32 percent with a stable barrier function of around four to six months. Although additional chemical cross-linking allows the membrane to remain in place for longer before it is resorbed, it also results in significantly higher dehiscence rates of 39 to 64 percent.

Bioresorbable barrier membrane

The innovative Rемаix membrane (Matricel) presented here is a bioresorbable barrier membrane made of porcine collagen and elastin. It was launched on the German market in 2009 as a CE-certified class 3 medical device. It is highly pure, natural and not chemically cross-linked. The Rемаix membrane is based on a Matricel development for the orthopaedic field, where it has been used since 2002 under the name ACI-Maix for matrix-coupled autologous chondrocyte implantation (MACI) in over 10,000 patients. This membrane has been further optimized for use as a dental barrier membrane.

Rемаix has a homogeneous structure on both sides, which eliminates the risk of confusion between the sides during surgery. *In vitro studies* show a significantly higher collagenase stability of Rемаix compared to, among others, the Bio-Gide® membrane (Geistlich Biomaterials) as an example of another non-crosslinked reference product (as yet unpublished study by Matricel).

Comparing various studies in rats, a significantly longer absorption rate can also be seen *in vivo*.

Rothamel *et al.*, for example, state a resorption time of two to six weeks for Bio-Gide®, while Jäger *et al.* have stated a resorption time of six to twelve weeks for ACI-Maix.

Unpublished data from animal implantation studies by the manufacturer Matricel GmbH have shown a resorption time of 12 to 16 weeks for Rемаix. There is a need for a resorbable collagen membrane without clinical side effects and risk of infection with a low dehiscence rate and a higher stability rate due to longer resorption times in order to ensure the necessary mechanical stability and a longer healing time even for larger bone augmentations. We have been using the Rемаix membrane as standard in our clinic since October 2010 for augmentation procedures on the alveolar ridge or in the maxillary sinus. Previously, these or similar procedures were performed in our clinic using the Bio-Gide® collagen membrane. Otherwise, the surgical procedure has not been changed.

The success of augmentations using the GBR technique essentially depends on primary, tension-free wound closure and stable positioning of the augmentation material. The success of GBR "Guided Bone Regeneration" can be used for both horizontal and vertical augmentations. It is significantly more successful when combined with bone or bone substitute material. The GBR method is a convenient method for everyday practice with a high probability of success and low invasiveness for the patient. We therefore use this technique very frequently.

However, it reaches its limits very quickly, especially in the vertical augmentation of atrophied alveolar ridges. Other bone augmentation measures are therefore often required, especially in severely atrophied mandibles. If vertical bone augmentation is performed using the GBR technique, success depends heavily on whether a stable space above the augmentation material can be guaranteed. The resorption processes described above can already be prevented during tooth extraction if there is no acute apical inflammation.

In such cases, especially in the maxillary anterior region, we often perform socket preservation by filling the socket with a bone substitute. The probability of success when filling defects larger than 2 mm or even entire sockets is higher when a barrier membrane is used.

Patient Case 1

A 71-year-old female patient with a maxillary full denture presented to the clinic with the request for a palate-reduced prosthetic restoration. Due to the patient's financial situation, the minimal option of a palate-reduced prosthesis in the maxilla was chosen. The implantation was to take place in regions O13, O15, O23, O25. The orthopantomogram (Fig. 1) showed sufficient residual bone height for the insertion of implants with a length of 11.5 mm. The insertion of four 11.5 mm/4.1 mm ICX-templant® implants (medentis medical GmbH) was planned. During the surgical visualization of the alveolar ridge, it turned out that the alveolar ridge was only 4mm wide on both sides in the planned area, i.e. not wide enough even for thinner implants of this type.

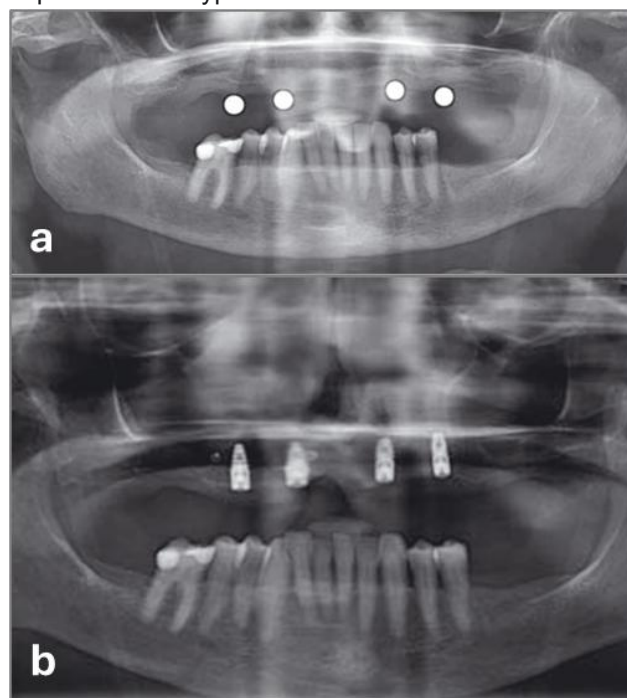


Fig. 1: Patient Case 1 – (a) Pre-operative Orthopantomogram (OPG); (b) Postoperative OPG

For this reason, it was decided to perform a bone splitting with simultaneous implant placement and augmentation. The planned area was split with a piezoelectronic bone saw in the middle up to approx. two thirds of the implant length and expanded with a chisel. After pilot drilling, the implant site was formed with osteotomes to the desired length and width. The four planned implants were inserted at 30 cm. The remaining bone gap and the buccal bone lamella were augmented with Bio-Oss® (Geistlich Biomaterials) and blood previously collected from the bone drilling.

The augmentation was covered with a Rемаix 25 x 30 mm membrane (Matricel, Germany) (Fig. 2). The region O13, O15 had to be augmented significantly, here the membrane was fixed with three titanium pins. Region O23, O25 could be securely augmented and closed without tension without the use of titanium pins.

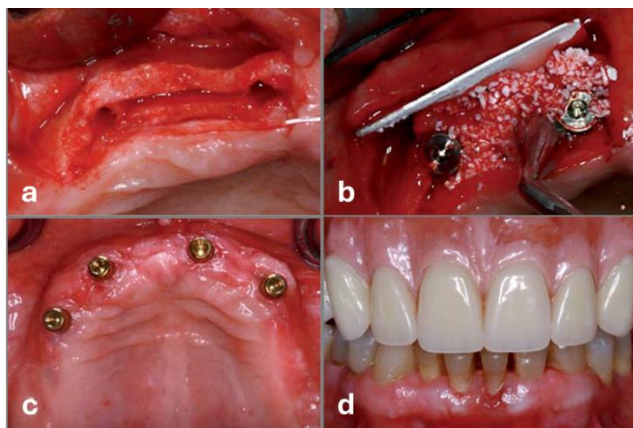


Fig. 2: (a) Image of the alveolar ridge in regions 11-15 after bone spreading and formation of the implant site; (b) The situation after insertion of the ICX-templant® implants in regions 12 and 14 (medentis medical GmbH), augmentation with Bio-Oss® (Geistlich Biomaterials) and membrane fixation (Rемаix collagen membrane, Matricel) using titanium pins; (c) Overall situation after healing and opening of the implants and insertion of the Locator® abutment components; (d) En face situation of the completed palate-reduced overdenture prosthesis and individualized gingival situation.

Conclusion:

The ICX-templant® system platform is suitable for a wide range of medical applications, e.g. in combination with a Rемаix membrane (Matricel). No increased wound healing disorders, pain or failures were recorded. The surgical handling of the new membranes with the ICX-templant® system is advantageous. The clinical use of the Rемаix membrane in combination with the ICX-templant® implant system for augmentation in implantology shows promising initial results.

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Dr. med. dent. Bastian Wessing, Dr. med. dent. Martin Emmerich, Implantologie Journal SPECIAL PRINT Edition 5/11 • Volume 16 *Neue Materialien in der GBR*

Dr. med. dent. Bastian Wessing, Implantologie Journal SPECIAL PRINT Edition 5/12 • Volume 16 *„Sichere Knochenregeneration durch neue Kollagenmembran“*

1.c.5 Analysis of the metric deviation of three-dimensionally planned implant positions

Dr. med. dent. Umut Baysal, University of Cologne, 2014

Introduction:

Dental implantology, which deals with the functional, aesthetic and phonetic rehabilitation of the masticatory organ as a sub-aspect of dental, oral and maxillofacial medicine, has become a standard procedure in modern dentistry. Numerous studies confirm high success and survival rates in edentulous and partially edentulous patients. The prerequisite is the precise implementation of implant planning in the clinic, which depends on the implantological experience of the surgeon, his surgical expertise and the quality of the preoperative planning. The possibility of three-dimensional diagnostics has led to a significant improvement in preoperative planning. Based on the wax-up or set-up (backward planning) prepared by the dental technician and checked in the patient's mouth and the three-dimensional data records, it is possible to combine the two central aspects of the precisely planned ideal prosthetic solution and the anatomical conditions pre-operatively. For this purpose, the three-dimensional data of a digital volume tomography (DVT) in DICOM (Digital Imaging and Communications in Medicine) format are used in special software programs for visualization, analysis and template production. In addition, the bone bed is visualized with high precision in all three dimensions and evaluated reliably. This forms the basis for a minimally invasive procedure. Precise knowledge of the anatomical situation makes it possible to make better use of the available bone, anticipate necessary augmentations and safely preserve anatomical structures. A diagnosis based on models and two-dimensional X-ray images is not sufficient and should be supplemented by further imaging procedures. Three-dimensional radiological diagnostics have therefore been recommended for several years to assess the exact anatomical conditions.

Objective:

The aim of this retrospective follow-up study is to determine the accuracy of the positioning of implants inserted with the aid of a surgical guide. First, all surgical guides ordered from SiCAT (Bonn, Germany) were collected from the Department for Cranio Maxillofacial and Plastic Surgery, University of Cologne. Preoperative and postoperative CBCT scans were superimposed using special software (registration). Deviations between the preoperative planning and possible influencing factors on the postoperative result were determined.

Material and Methods:

Material:

The ICX-templant® implant system, which was introduced to the market in 2004, is one of the implants used in this study. A total of five diameters (2.9 - 4.8 mm) in five different lengths (6.5 - 15.0 mm) are available. The titanium blanks are made of pure titanium (grade 4KV) and undergo a precision-controlled blasting and etching process. The implant-abutment connection is an internal hexagonal connection, which is located deep inside the implant and secures the fit of the prosthetic component. The external geometry is characterized by the apically tapered implant thread. A total of 216 implants from various implant manufacturers were used, which were inserted using a drilling template:

Implant Manufacturer	Number of Implants
Friadent®	171
Camlog®	14
Medentis	10
AstraTech	4
Bredent	10
Neoss	5
Not Specified	2
Total	216

Tab. 1: Implants divided by Manufacturer.

Methods:

In 98 patients, 117 surgical guides (n = 117 cases) from SiCAT (Bonn, Germany) were used for the implantation of dental implants at the Department for Cranio Maxillofacial and Plastic Surgery, University of Cologne between 2007 and 2011. The ratio between men and women was 1:1.3. In 44 cases there was no indication for a postoperative control image in the form of a CBCT scan, which was taken either as an OPG or dental film. In 14 cases, due to metal and movement artifacts no registration could be carried out. A total of 59 cases were successfully registered.

All implantations were performed according to the surgical protocols of the respective manufacturers. After analgesia in the surgical area, a comb incision was made with buccal and oral mucoperiosteal flaps. In comparison to freehand implantation, the use of the 3D drilling template made it possible to dispense with a clear representation of the alveolar ridge with anatomically relevant structures, such as the mental foramina, in favor of a minimally invasive procedure. After the alveolar process had been freed of soft tissue and all bone edges had been smoothed, the first pilot drilling was carried out with a 2 mm thin drill to finalize the implant length and implant axis. Depending on the bone quality, the cortical bone was prepared with continuous internal cooling in ascending order. Depending on the manufacturer, special crestal drills were used. Implants were inserted using both mechanical and conventional insertion instruments. The soft tissue cover was then closed tension-free with single button or backstitch seams (brand name).

The GALILEOS system (Sirona, Bensheim, Germany), which works with the cone-beam technique and has an image volume of 15x15x15 cm³, was used in 73 cases for postoperative control imaging to assess the insertion; in the remaining 49 cases, two-dimensional imaging procedures (OPG and dental film) were generated for postoperative diagnostics.

Results:

The deviations of 185 inserted implants in 53 patients were statistically analyzed. The mean deviation (x, y) was 0.92 ± 0.56 mm at the implant shoulder and 1.50 ± 0.90 mm at the implant tip. The axial deviation in the longitudinal axis was 7.16 ± 4.69°. The type of support (periodontal, gingival) differed significantly in the area of the deviations at the implant shoulder and in the longitudinal axis. However, there were no significant differences at the implant apex. (Excerpt from the dissertation by Umut Baysal, 2012, Medical Faculty of the University of Cologne)

Conclusion:

The ICX-templant® implant system is ideally suited for template-supported implantation. Even when using third-party software such as the Simplant software (SiCAT), the system enables template-supported implant placement in this study, which offers sufficient accuracy for everyday clinical practice with regard to the implementation of preoperative planning.

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Reference:

Umut Baysal. *Analyse der metrischen Abweichung von dreidimensional geplanten Implantatpositionen (Inaugural-Dissertation)*, Universität zu Köln, 2012.

1.c.6 ICX-templant® Implants – A clinical comparison with the question „Is an inexpensive implant less successful? “

Dr. med. dent. Oliver Stupar, Danube Private University Krems (Austria), Masterthesis 2016

Introduction:

The implantology market in Germany is essentially dominated by three large companies. In contrast, there are more than 150 companies offering implantology products and equipment. Medentis Medical GmbH, a company from Dernau has undermined the implant market with its strategy "An affordable implant system for the populace". The sales figures for the ICX-templant® implant led the company to fourth place in terms of market shares in Germany.

Objective:

In this retrospective study, the question should be clarified whether this implant system can meet all the requirements of medical practice and the patient.

Material and Methods:

Over a period of about five years, clinical and radiological conditions were documented and evaluated after implant insertion in the routine operations of a general dentist's practice.

Results:

Within the scope of the retrospective evaluation of a dataset in an ambulant practice the following conclusions are derived from the results.

- 98% of the examined ICX templant® implants show no, minor or moderate peri-implant bone loss within a period of 63 months

- In the examined patient's group of 19 by chance well-chosen patients with a total of 43 ICX-templant® implants no implant losses are recorded in the routine check.
- Implant risk factors such as diabetes, smoking, osteoporosis and rheumatism show no appreciable influencing on the implant success.
- Implant diameter and implant length also show no significant impact concerning the implant success.
- In the present 5-year study the significantly slightest osseous loss at the ICX-templant® implants was ascertained retrospectively within an enduring healing period of five to six months

Conclusion:

In summary, the intention "An affordable implant system for the populace" can fulfill the requirements of medical practice and patients in the present study and the results are comparable with other implants.

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Reference:

Oliver Stupar. ICX-templant®-Implantate – Ein klinischer Vergleich mit der Fragestellung „Ist ein preiswertes Implantat weniger erfolgreich?“ (Masterthesis Orale Chirurgie und Implantologie an der Donauuniversität Krems (Österreich), 2016

1.c.7 Outcome quality of the placement of ICX®-Implants with tooth-supported ICX®-Magellan surgical guides

Andreas van Orten, MSc., MSc., Danube Private University Krems (Austria), Masterthesis 2016

Introduction:

The transfer accuracy is one of the key criteria in ensuring that the implant is correctly positioned, thus preventing patient injury and suboptimal implant positions.

Objective:

The aim of the present study was to determine the transfer accuracy of Magellan-template-guided ICX®-Implants in relation to the virtual planning data set. Furthermore, it should be investigated whether the recently released Magellan-template is as accurate as established systems and other image-guided surgery techniques.

Material and Methods:

A total of 28 ICX®-Implants were placed in 22 partially edentulous patients with tooth gaps.22 (Maxilla: 11 Implants, Mandible: 17 Implants). The implant widths used were 3.75 mm; 4.1 mm and 4.8 mm. The implant lengths used were 8mm, 10 mm and 12.5 mm. The implant positions were transferred to the study plaster models with screw-fixed implant impression posts attached with flowable composites. Patient-matched implants were screwed to the posts. The insertions were carried out with insertion torques of 12-45 Ncm. A cone beam computed tomography scan of the study model with set back surgical template and the original 3D implant planning data set have been matched and compared.

The absolute linear difference between the planned and the real implant apex level was determined and the data were analyzed using analysis of variance.

Results:

The transfer accuracy of the apex level achieved with the Magellan-surgical guide template was similar to comparable systems. The results of this study are in accordance with comparable studies in the literature. Hence this new system provides an alternative with a similar accuracy to existing systems. The distribution of the data is shown s box plot in Fig. 1.

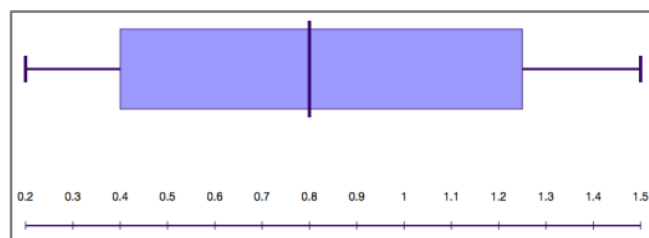


Fig. 1: Distribution of the data as a box plot.

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Reference:

Andreas van Orten, *Ergebnisqualität der Insertionen von ICX-Implantaten mit zahngetragenen Magellan-Bohrschablonen*; Masterthesis zur Erlangung des akademischen Grades „Master of Science Orale Chirurgie/Implantologie“ (MSc), Danube Private University Krems, Österreich, 2016

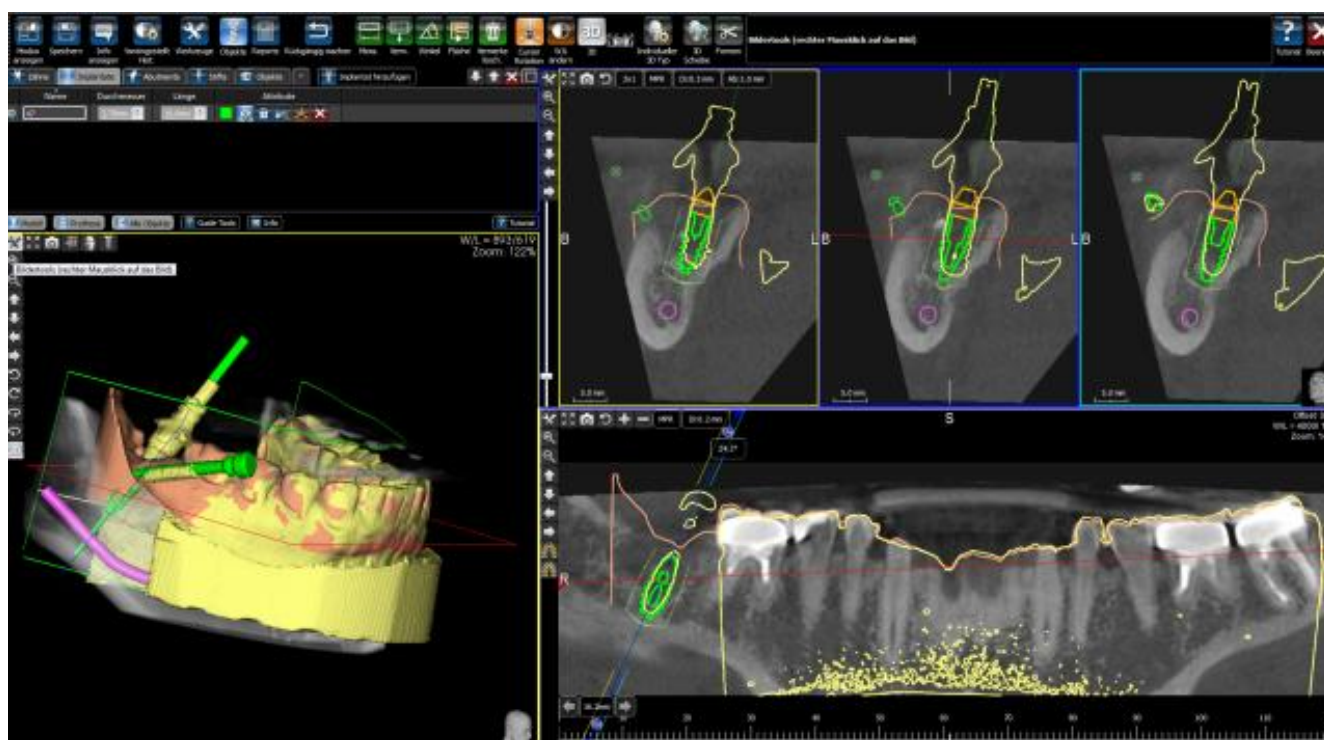


Fig. 2: Screenshot of the Magellan software showing the preoperative planning data set and the superimposed postoperative CBCT data set of the surgical template and study model with impression post and implant (shown in yellow)

1.c.8 Minimally invasive implantation of the short ICX-templant® as an alternative to bone augmentation procedures – a retrospective assessment of marginal bone levels

Dr. med. Przemysław Kopczyński, Dr. med. Rafał Flieger, Karol-Marcinkowski-Medical-University Poznan, 2016

Introduction:

The insertion of implants, used for various types of dental deficiencies, is usually the best solution when it comes to achieving esthetically and functionally high-quality dentures. In order to achieve long-term success, prosthetic solutions or restorations should be sought that increase patient satisfaction, such as the preservation of the patient's own teeth with a parallel prosthetic restoration.

The simplest way to replace a missing tooth is a fixed prosthetic filling, which is supported on adjacent teeth by means of cement composite crowns. Bony defects or poor bone quality often result in impairments in the jaw area that make dental implantation only possible with complex surgical measures. However, an invasive solution can have a destructive effect on the hard tissue and dental pulp of neighboring teeth.

In addition, there is a risk of reduction of the alveolar process. An alternative is a prosthetic restoration based on intrabony implants. The prerequisite for successful and esthetic implantation is the presence of an appropriate amount of tissue. Very often, due to considerable bone atrophy of the alveolar process the implementation of tissue augmentation is necessary, which results in an increase in its width and height. However, this procedure means an additional surgical intervention, which can cause even more unforeseen complications and prolong the entire treatment time. An alternative for this process can be the implantation of a short and narrow implant into the atrophic bone of the alveolar process.

However, this procedure still needs to be investigated in clinical studies in connection with prosthetic treatment.

Objective:

The aim of the study is to evaluate the usability of ICX®-Shorty implants in severely atrophied maxillae and mandibles and in soft bone. In addition, the bone preservation and prosthetic restoration of patients with congenital tooth root defects (e.g. missing tooth buds) after insertion of short ICX-templant® implants will be evaluated retrospectively.

Material and Methods:

The study is being conducted with 20 patients and is planned for 4 years. The first orthopantomogram control images were taken after 12 months. The ICX®-Shorty implant system was used, namely 15 ICX-templant® implants with a diameter of 3.75 mm and a length of 8 mm and 15 ICX-templant® plus implants with a diameter of 3.45 mm and a length of 6.5 mm with a 1.7 mm flange. The standardized protocol for the preparation of the bone bed is based on drills with stop sleeves for corresponding implants. After using the last stop drill, a revision of the tapping holes was performed using a periodontal probe, which confirmed the exclusive occurrence of bone bed limitations of the implants. The implants were inserted according to the manufacturer's protocol for the ICX® system with a torque of 40 Ncm and covered with cover screws. Wound healing and osseointegration proceeded without complications and lasted 4 to 6 months. After this time, the implants were prosthetically restored and loaded. After a further period of 12 months (+/- 1 month), OPG control images were taken for in situ assessment of the maintenance of the marginal bone level around the ICX® implants. The landmark was the primary thread of the implant according to the instructions of Quirynen, Jansen, Behneke and Richter [1-6].

Conclusion:

The results (Table 1) show that the use of modern implantology systems using minimally invasive surgical protocols reduces the indications for tissue augmentation procedures and the use of long or standard length implants. Short implants, such as the ICX®-Shorty, appear to be a good alternative. With short implants, a suitable minimally invasive surgical protocol and a prosthetic restoration designed according to biomechanical principles can minimize bone loss at the implant-bone contact surface and even promote bone remodelling.



Abb. 1: Orthopantomogram (OPG) after 12 Months

	Number of Implants [n]	Group I No Bone Loss	Group II Bone Loss bis 1 mm	Group III Bone Loss 1-2 mm
ICX-templant® D= 3.75mm / L=8mm	15	14	1	0
ICX-templant® plus D= 3.45mm / L=6.5mm	15	13	2	0

Tab. 1: Study results after the 1-year time point: The level of marginal bone around the integrated implants

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Reference:

Kopczyński P. Minimally-invasive implantation of the short implants ICX-templant® as an alternative to bone augmentation procedures – a retrospective assessment of marginal bone levels. TPS- Twój Prz. Stom. 2016, No. 10, SS. 64-66.

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1.c.9 Complex Prophylaxis and Prognosis of Inflammatory Complications after Dental Implantation

Dr. M.Sh. Mustafaev; Z.F. Kharaeva; V.A. Vissarionov; F.M. Mustafaeva; A.K. Zhigunov; M.M. Atmurzaev; "Kabardino-Balkarian State University named after H.M. Berbekov", Nalchik, Kabardino-Balkarian Republic, Russian Federation, 2017

Introduction:

The main task of dental implantation at the modern stage of its development remains the struggle against complications. At present, there is no generally accepted set of biomarkers and an algorithm for their use for early diagnosis of the risk of complications and monitoring of osseointegration.

Objective:

The objective of the study is to increase the effectiveness of dental implantation by developing a method of complex prophylaxis and prediction of development of complications in the long-term perspective after the operation.

Material and Methods:

A method of preventing the development of complications of dental implantation by applying a complex of antioxidant vitamins and amino acids was approved and introduced.

For a follow-up implant treatment, 103 patients (57 men and 46 women, 55.3% and 44.7%, respectively) underwent a comprehensive examination at the KBSU KBGU and the department of the CFC RCH for partial secondary adentia. The average age of patients was 47 years and ranged from 28 to 66 years. The patients were divided into three groups depending on the number of inserted implants:

First Group: 24 patients with 1-2 implants (13 men, 11 women; 28 to 62 years (23,3 %))

Second Group: 28 patients with 3-4 implants, 16 men, 12 women; 38 to 66 years (27,2%)

Third Group: 51 patients with ≥ 5 implants, 28 men, 23 women; 39 to 61 years (49,5%).

Total number of implants installed was 489 (268 for men and 221 for women, i.e., 54.8% and 45.2%, respectively). All patients were fitted with screw endosseous implants, ICX-templant® system, Volksimplantat, Germany. Determination of concentrations of IL-1 β , IL-10, and IL-17A (pg/ml) in the blood serum and content of gingival sulcus of the teeth adjacent to implants of patients with different dental implants was performed in early postoperative period (1–3 days) and in more distant terms (2–3 months after surgery). To study the effect of the number of implants onto local mediator response of patients of this group, the level of nitrate nitrites ($\mu\text{M/ml}$) was studied in 1–3 days after implantation and 2–3 months later.

Results:

The significance of serum and local indices of the cytokine profile as diagnostic and prognostic parameters in patients with peri-implantitis developed after the operative intervention, was determined. It was found that patients with simultaneous installation of 5 or more implants, in spite of competent surgical work, are at higher risk of complications development in the long-term due to the presence of peculiarities of the mediator reaction with the prevalence of local inflammation processes.

Conclusion:

Patients with peri-implantitis which developed in the remote period after the installation, significantly increased serum concentrations of IL-1 β , IL-6, and IL-17A ($P < 0.01$). Anti-inflammatory IL-10 in serum has not significantly changed.

Index	First group n=17	Second group n=15	"Control" n=25
IL-1 β	46.0 $\pm$ 4.0 ¹	85.0 $\pm$ 7.0 ^{1,2}	14.0 $\pm$ 3.0
IL-6	4.5 $\pm$ 0.5 ¹	15.0 $\pm$ 0.8 ^{1,2}	2.5 $\pm$ 0.5
IL-10	14.0 $\pm$ 1.0	11.0 $\pm$ 1.0	12.0 $\pm$ 2.0
IL-17A	16.0 $\pm$ 1.0 ¹	28.5 $\pm$ 5.0 ^{1,2}	9.0 $\pm$ 2.0

Tab.1: Concentrations of IL-1 β , IL-6, IL-10, IL-17A in blood serum of patients with peri-implantitis of different severity, pg/ml. 1p< 0.01 in comparison with the rate of the 'control' group; 2p<0.01 in comparison with the rate of the first group. IL: Interleukin.

In contrast to serum levels, the detected burst of pro-inflammatory cytokines in the content of gingival sulcus occurs against the background of a low level of IL-10, which aggravates the severity of the inflammatory response.

Index	Group one n=17	Second group n=15	"Control" n=25
IL-1 β	45.0 $\pm$ 4.0 ¹	65.0 $\pm$ 7.0 ^{1,2}	15.0 $\pm$ 3.0
IL-6	3.5 $\pm$ 0.5 ¹	5.0 $\pm$ 0.8 ¹	1.5 $\pm$ 0.5
IL-10	4.5 $\pm$ 1.0 ¹	1.5 $\pm$ 0.5 ^{1,2}	10.0 $\pm$ 2.0
IL-17A	83.0 $\pm$ 18.0 ¹	152.5 $\pm$ 20.0 ^{1,2}	23.0 $\pm$ 2.0

Tab.2: Concentrations of IL-1 β , IL-6, IL-10, IL-17A in contents of gingival sulcus of teeth adjacent to implants of patients with peri-implantitis of different severity degrees, pg/ml. 1p< 0.01 in comparison with the rate of the 'control' group; 2p<0.01 in comparison with the rate of the first group. IL: Interleukin.

The serum (by 163.0 $\pm$ 17.0%) and local (by 231.0 $\pm$ 24.0%) CD401 levels were significantly increased in the group of patients with severe fever, indicating the active involvement of macrophages and T-killers into the systemic response of organism onto local inflammation. In tissue samples taken from the peri-implant area during the inflammatory process, an increase in activity of tissue myeloperoxidase (P < 0.01) was revealed against a background of a decreased tissue antioxidant potential.

In patients with extensive implantation, a pro-inflammatory mediator reaction with significantly increased concentrations of pro-inflammatory ILs and nitrate nitrites (P < 0.01) was detected in 3–6 months after implantation.

Local study of the correlation of pro-inflammatory (IL-1 β , IL-6, and IL-17A) and anti-inflammatory (IL-10) immunocytokines reliably reflects the dynamics of osseointegration processes and can be used to predict the development of complications of dental implantation.

Admission of a complex of antioxidant vitamins and amino acids to patients with extensive implantation (5 or more implants) helps to eliminate the identified imbalance of pro-oxidant and antioxidant systems, thereby reducing the risk of complications in the long term.

Perhaps a promising direction of prevention in the future will be the development of methods for targeted delivery of antioxidant substances to tissues to fill the deficit of protective components and establish an equilibrium.

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Reference:

Mustafaev, M. S. (2018). Complex Prophylaxis and Prognosis of Inflammatory Complications after Dental Implantation. Asian Journal of Pharmaceutics (AJP), 11(04). <https://doi.org/10.22377/ajp.v11i04.1747>

1.c.10 Bilateral Bone Ridge Splitting in Maxilla with Immediate Implant Placement in a Patient with Osteoporosis: A Clinical Report with 2-Year-Follow-up

Dr. med. Rafał Flieger, Karol-Marcinkowski-Medical-University Poznan, 2019

Introduction:

Every year, a higher percentage of bisphosphonates is prescribed for osteoporosis treatment which can lead to bone osteonecrosis after several surgical procedures in the oral cavity. This report describes an approach to restore two missing teeth, employing bilateral bone ridge splitting in the maxilla with immediate placement of implants in a patient using bisphosphonates in the management of osteoporosis.

Material and Methods - Preoperative Phase:

A 56-year old white woman was referred to our clinic for prosthetic crown reconstruction of two missing molars in the maxilla. The patient lost her teeth (15, 24 FDI) 15 months ago because of a deep carious lesion. The patient was not using any dental prostheses post the extractions. Medical history revealed that she suffered from hypertension and osteoporosis, which were all under medical control. For her osteoporosis, the patient used oral bisphosphonate of alendronate (Fosamax) at a dose of 70 mg/week for 24 months. During the time of osteoporosis treatment with alendronate, there were no accidents of bone osteonecrosis following the teeth's extraction. After a consultation with the medical doctor of the patient and reviewing the literature concerning surgical therapy in patients with osteoporosis, we decided to perform the placement of the implants without stopping the bisphosphonate therapy.

However, before the operation the patient was given antibiotic treatment with amoxicillin+clavulanic acid (Amoxiclav, Sandoz, Poland) at a dose of 1000 mg/day for 1 week, and laser photobiomodulation using a diode laser with a wavelength of 635 nm (dose of 4 J per point, 2 points at each site) was performed one day before the procedure.

Intraoral examination using CBCT (Kodak 9000 3D, Carestream/Trophy, Marne-la-Vallée, France) revealed that the volume of the ridge at the right side of the maxilla was 4.5 mm in width and 16.5 mm in height. At the opposite left side of the maxilla, the ridge amounted to 3.0 mm in diameter and 13.5 mm in height (*Fig. 1*). A written informed consent form was signed by the patient before the treatment.



Fig. 1: A CBCT scan of the patient with a very thin maxillary alveolar ridge.

Surgical Phase and Prosthetic Rehabilitation:

The surgical procedure was conducted under local infiltrative anesthesia with articaine hydrochloride 4% plus epinephrine (Ubistesin®, 3M, USA). The access to the buccal and lingual part of the maxillary crests on both sides was prepared with a cold blade and a soft tissue elevator.

Three cuts were conducted during the proceedings of the ridge splitting: one horizontal cut on the alveolar ridge and two vertical cuts on the buccal bone plate using the piezosurgery unit (Piezotome Solo, Acteon, New Jersey, USA) with a BS1 tip. In the first phase of the implant bed preparation, the Lindemann guide drill with a diameter of 2.2 mm was utilized; then, the ridge was split employing a bone spreader (Meisinger, Colorado, USA).

In the last stage, the final drill with a diameter of 2.9 mm was used to prepare the implant bed, and two titanium implants (ICX-templant® plus, medentis medical GmbH, Germany, USA) with a width of 3.45 mm and a length of 10 mm were placed. On both surgical sides, the guided bone regeneration was done using an alloplastic material (SinossGraft, Novadento, Italy) and a collagen membrane (SinossMem, Novadento, Italy) with a long disintegration time (5-6 months). The wound was protected using a nonabsorbable monofilament and an uncoated suture made of polyamide (Dafilon, B. Braun, Germany) with a size of 4.0 (Fig. 2).

After the surgery, an antiseptic mouth rinse (chlorhexidine gluconate 0.12%, twice a day for 7 days) was directed and the patient was provided with the usual postsurgical indications (cold compresses in the first two days, antibiotic treatment with amoxicillin+clavulanic acid (Amoxiclav, Sandoz, Poland) at a dose of 1000 mg/day for 1 week, and non-steroidal anti-inflammatory drugs, i.e., ibuprofen 200 mg, 3 times per day for 3 days). Five months later, the implants were uncovered with use of a scalpel and healing screws were placed for two weeks.

Next, the open tray method with prosthetic transfers was used to take the impression of the upper jaw. After ten days, the final porcelain crowns were made by a dental laboratory and cemented onto the implants (Fig. 3)

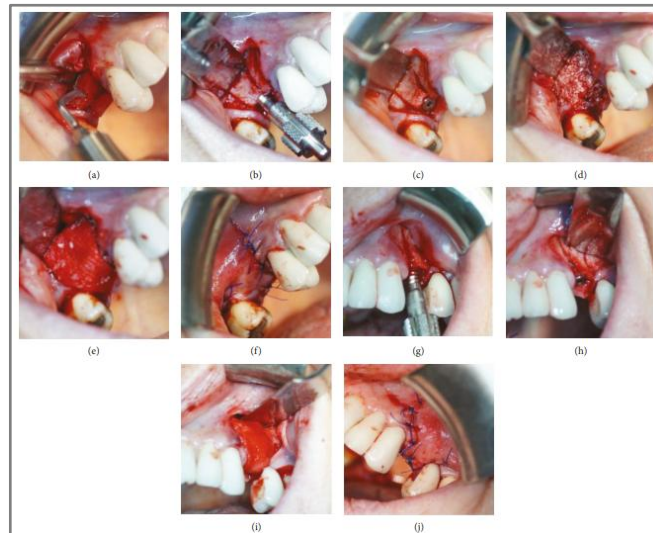


Fig. 2: Ridge splitting with immediate placement of implants. (a) Bone osteotomy using piezosurgery. (b) Bone spreading with hand instruments. (c) The implant placement on the right side of the maxilla. (d) Alloplastic material grafting. (e) Collagen membrane placement. (f) Sutures. (g) Bone spreading with hand instruments on the left side of the maxilla. (h) The implant placement on the left side of the maxilla. (i) Placement of alloplastic material and collagen membrane. (j) Sutures



Fig. 3: Prosthetic crowns immediately after cementation on the abutments. (a) Right side of the maxilla. (b) Left side of the maxilla.

Case Presentation - Follow-Up-Phase:

Every six months, the patient was referred for a check-up visit and the last control 24 months after the prosthetic crown placement showed a lack of bone loss in the collar part of both implants and the normal status of the peri-implant soft tissue without any signs of inflammation

Conclusion:

The piezosurgery device has great potential to advance surgical techniques where accuracy in bone preparation is expected. Piezosurgery is useful and has safe tools for ridge splitting surgery on a very thin ridge (4.5 and 3.0 mm). Ridge splitting and guided bone regeneration with immediate implant placement can be safely performed on a patient taking bisphosphonates in the management of osteoporosis.

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Reference:

Flieger R. *Bilateral Bone Ridge Splitting in Maxilla with Immediate Implant Placement in a Patient with Osteoporosis: A Clinical Report with 2-Year Follow-up.* Case Rep Dent. **2019** Jun 16; 2019:1458571. doi: 10.1155/2019/1458571. PMID: 31316838; PMCID: PMC6604491.

1.c.11 Comparative clinical studies of tooth-borne and implant-borne bridges of veneered base metal and zirconium dioxide

Verena Huber, Charité Universitätsmedizin Berlin, 2020

Introduction:

In the present study, three- to five-unit bridges made of a veneered precious metal-free alloy (remanium® segura) and monolithic Prettau® zirconia were compared regarding dental and periodontal parameters. In addition, the tribological effect of the monolithic material was tested on natural tooth structure. Furthermore, attention was paid to the peri-implant bone conditions.

Material and Methods:

For this purpose, in a private dental practice 41 veneered EMF and 74 Prettau® zirconia bridges as well as 88 ICX® implants that were placed between 2009 and 2013 were clinically examined in 82 patients. The plaque and gingival index according to Silness and Löe, marginal integrity, marginal discoloration, chipping, pocket depth and probing bleeding on the bridges were assessed. To determine the abrasion behavior of Prettau® Zirkon against natural tooth structure, the current opposing jaw models were superimposed with those at the time of insertion. The abrasion could then be determined selectively on the 1st molars and 2nd premolars. The peri-implant bone level was also determined directly post-op and at the time of follow-up using orthopantomograms, in order to determine possible changes in bone level.

The 88 ICX-templant® and ICX-templant® plus implants, which were distributed among 32 patients, were divided as follows:

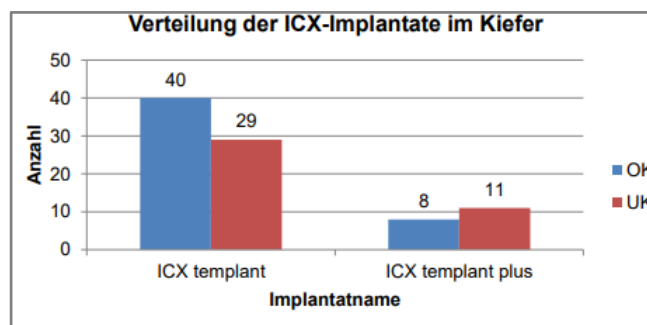


Fig. 1: Distribution of the post-examined ICX® implants in the jaw

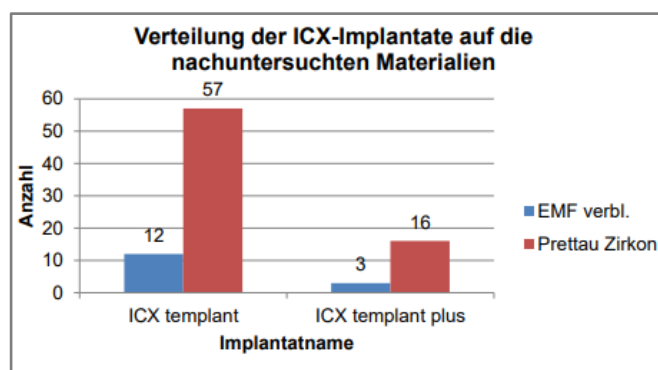


Fig. 2: Distribution of the ICX® Implants between the two materials under investigation

	Implantatbreiten:		Implantatlängen:	
	• 3,75 mm		• 8,0 mm	
	• 4,10 mm		• 10,0 mm	
	• 4,80 mm		• 12,5 mm	
			• 15,0 mm	

(Bild: <https://pp.vk.me/c407022/v407022885/418b/Mh2brp5zT0o.jpg>; 25.10.201)

Tab. 1: Available implant widths and lengths of the ICX-templant® system

	Implantatbreiten:		Implantatlängen:	
	• 3,45 mm		• 6,5 mm	
			• 8,0 mm	
			• 10,0 mm	
			• 12,5 mm	

(Bild: http://osseosource.com/dental-implants/images/products/medentis/medentis_icxplus_3.jpg; 25.10.2016)

Tab. 2: Available implant widths and lengths of the ICX-templant® plus system

Results:

The examination of the dental and periodontal parameters revealed no significant differences between the two materials. The loss of natural tooth structure averaged 71.64 µm, on EMF crowns 66.17 µm. The abrasion on 1st molars (85.71 µm) was significantly higher than on 2nd premolars (42.44 µm). The assessment of the peri-implant bone level revealed a significantly higher bone loss on ICX-templant® plus (-1.07 mm) compared to ICX-templant® (-0.34 mm). At 17.4 % of the ICX® implants, bone apposition was observed. In addition, significantly greater bone resorption was observed on maxillary implants (-0.63 mm) than on mandibular implants (-0.33 mm). When looking at the distribution in relation to the material of the superstructure (see Fig. 2), it became clear that over three-quarters of the implants were restored with Prettau® zirconia bridges.

Radiographic evaluation of the bone level on ICX-templant®- and ICX-templant® plus-Implants:

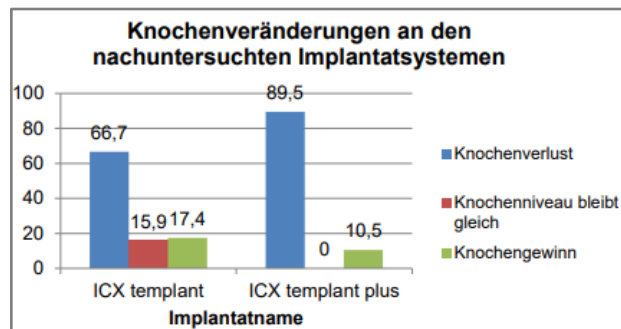


Fig. 3: Bone level change of the ICX-templant® and ICX-templant® plus implants from the time of insertion to the follow-up appointment

Bone loss was observed in 89.5 % (n = 17) of the ICX-templant® plus implants, while this was only the case in 66.7 % (n = 46) of the ICX-templant® implants, which were inserted for an average of 43.4 ± 13.80 months. Bone gain was recorded in 17.4 % (n = 12) of the ICX-templant® implants.

However, a significant correlation between implant type and bone level could not be determined (Chi-square(2) = 4.553; p = 0.103). Thus, the strength of the correlation is also rather weak (Cramer's V = 0.227; p = 0.103). Overall, the ICX-templant® implants showed a mean bone loss of -0.34 mm, the ICX-templant® plus, whose mean wearing time was 46.8 ± 15.88 months was -1.07 mm on average. The bone resorption mesial to the implants amounted to -0.38 mm on average (ICX-templant®) or -1.07 mm (ICX-templant® plus). Greater bone resorption was also measured distally on the ICX-templant® plus implants (MW: -1.06 mm) than on the ICX-templant® implants (MW: -0.29 mm) (see Fig. 4 and Tab. 3).

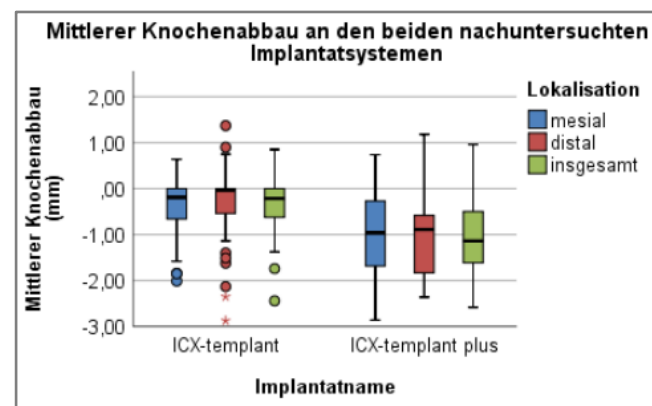


Fig. 4: Comparison of the mesial, distal and overall mean bone level change on ICX-templant® and ICX-templant® plus implants

It is clear that the bone resorption on the 19 ICX-templant® plus implants is significantly higher compared to the 69 ICX-templant® implants that were subsequently examined. This applies to both the mesial (z = -3.399; p = 0.001) and distal (z = -3.459; p = 0.001) bone levels as well as to the total vertical bone loss (z = -3.954; p = 0.000) per implant.

Knochenabbau		MW	Median	SD	Minimum	Maximum
ICX-templant	insgesamt	-0.34	-0.22	0.53	0.85	-2.44
	mesial	-0.38	-0.19	0.55	0.64	-2.01
	distal	-0.29	-0.03	0.70	1.37	-2.87
ICX-templant plus	insgesamt	-1.07	-1.14	0.83	0.96	-2.58
	mesial	-1.07	-0.96	0.95	0.74	-2.86
	distal	-1.06	-0.89	0.93	1.18	-2.36

Tab. 3: Comparative illustration of the bone level change on ICX-templant® and ICX-templant® plus implants

When examining the influence of the restorative material on bone resorption on implants, no significant effect could be determined ($z = -1.538$; $p = 0,124$). The bone loss on implants restored with veneered EMF was -0.71 mm (median: -0.76 ; SD: 0.77 ; min.: 0.72 ; Max.: -2.58). Implants with Prettau® zirconia restoration showed a reduction of -0.45 mm (median: -0.28 ; SD: 0.65 ; min.: 0.96 ; max.: -2.44). Table 4 and Fig. 5 show the mean bone level changes on the two post-examined implant systems as a function of the restorative material.

Material	Implantatname	Anzahl	Mittelwert	Standardabweichung
EMF verbl.	ICX-templant	12	-0,45	0,54
	ICX-templant plus	3	-1,72	0,79
Prettau Zirkon	ICX-templant	57	-0,31	0,53
	ICX-templant plus	16	-0,94	0,80

Tab. 4: Interrelated representation of the mean bone resorption on both implant systems with the restorative material

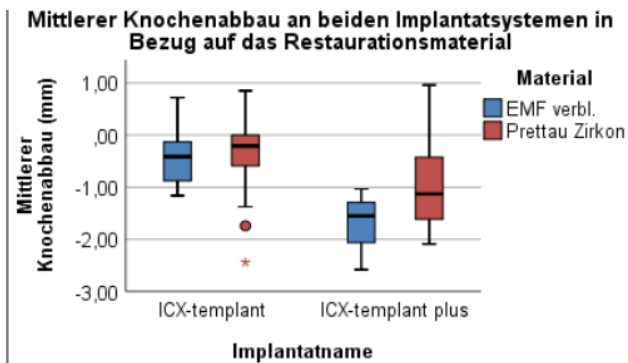


Fig. 5: Boxplot showing the mean bone level change at the of the two post-examined implant systems regarding the restorative material

With the veneered precious metal-free alloy, bone resorption was significantly lower on ICX-templant® implants than on ICX-templant® plus implants ($U = 2.000$; $p = 0.018$). With Prettau® zirconia, the ICX-templant® implants also showed a significantly less bone loss than the ICX-templant® plus implants ($z = -3.338$; $p = 0.001$).

In addition, the bone level change on implants in the maxilla and mandible were compared. The mean bone loss on maxillary implants was -0.63 mm (median: -0.46 ; SD: 0.698). In the mandible, this was -0.33 mm on average (median: -0.21 ; SD: 0.62). Bone loss was significantly higher in the 48 maxillary implants than in the 40 mandibular implants ($z = -1.992$; $p = 0.046$). Table 5 compares the average bone loss values in the maxilla and mandible on ICX-templant® and ICX-templant® plus implants.

Implantatname	Kiefer	Anzahl	Mittelwert	Standardabweichung
ICX templant	OK	40	-0,47	0,59
	UK	29	-0,15	0,39
ICX templant plus	OK	8	-1,40	0,74
	UK	11	-0,82	0,84

Tab. 5: Distribution and mean bone loss of the two post-examined implant systems in the jaws

The ICX-templant® implants showed a significantly higher vertical bone loss in the maxilla compared to the mandible ($z = -2.455$; $p = 0.014$). With the ICX-templant® plus, no significant difference in bone loss could be determined regarding the position in the jaw ($U = 30.000$; $p = 0.272$). This is also illustrated once again in Fig. 6.

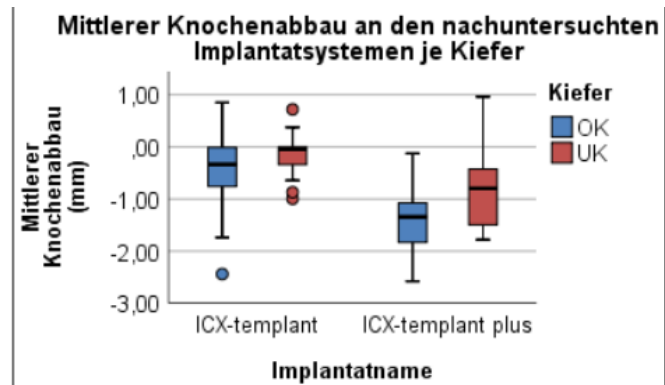


Fig. 6: Comparison of mean bone resorption on ICX-templant® and ICX-templant® plus implants in the maxilla and mandible

As the ICX-templant® implants are available in three different widths (3.75 mm, 4.10 mm, 4.80 mm), the influence of the implant width on the bone level was also investigated. *Table 6* illustrates the change in bone level of the ICX-templant® implants of different widths.

Implantatbreite	Anzahl	Mittelwert	Median	SD	Minimum	Maximum
3,75	51	-0,41	-0,28	0,544	-2,44	0,72
4,10	12	-0,07	0,00	0,512	-1,18	0,85
4,80	6	-0,21	-0,15	0,299	-0,64	0,13

Tab. 6: Bone level change of the ICX-templant® - implants of different widths

This clearly shows that the 4.10 mm wide implants exhibit the least bone loss on average. Nevertheless, the Kruskal-Wallis test did not reveal any difference between the three different implant widths in terms of vertical bone loss on the ICX-templant® implants (Chi-square(2) = 5.448; $p = 0.066$).

Fig. 7 illustrates the above-mentioned Bone level changes on the ICX-templant® implants with different widths in comparison.

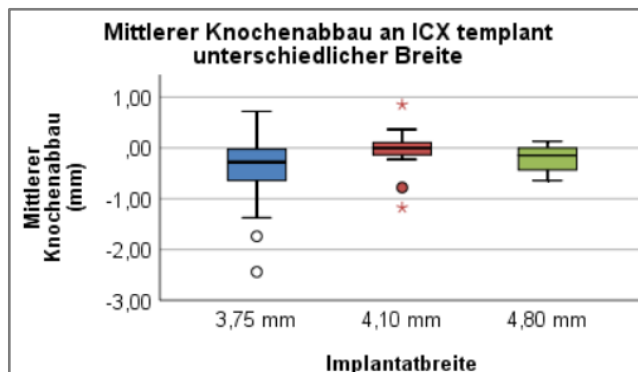


Fig. 7: Boxplot representation of the mean bone loss on ICX-templant® implants of different widths

The effect of the implant length on the vertical bone level of the two implant systems was also tested. As shown in *Tab. 1* and *2*, the ICX-templant® and ICX-templant® plus implants are available in different lengths.

As only three cases were followed up for both the 6.5 mm and 8.00 mm implant lengths, these were defined as a new group < 10.0 mm implant length. The mean bone loss on the < 10.0 mm implants was -0.33 mm (median: -0.17; SD: 1.01; Min.: -1.73; Max.: 0.96), on the 10 mm long implants -0.65 mm (median: -0.50; SD: 0.72; Min.: -2.58; Max.: 0.85), while the 12.5 mm Implant length -0.30 mm (median: -0.18; SD: 0.49; Min.: -1.38; Max.: 0.72) showed vertical bone resorption. However, the distribution of the different implant lengths between the two reexamined systems is as follows (*Fig. 8*):

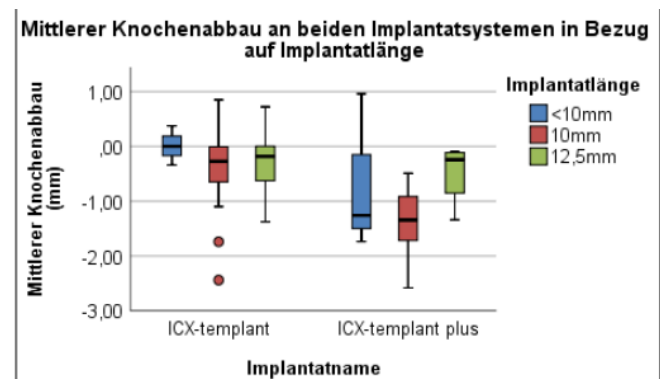


Fig. 8: Comparison of the mean vertical bone loss on the two implant systems examined in relation to the implant length

There was no significant difference in mean vertical bone loss between the ICX-templant® implants (Chi-square(2) = 2.501; $p = 0.286$) and the ICX-templant® plus implants (Chi-square(2) = 4.053; $p = 0.132$) between the three different implant lengths. *Fig. 9* and *Fig. 10* illustrate once again the determination of the reference lines for the two implant systems examined and possible difficulties in assessing the reference points, which can cause measurement inaccuracies.



Fig. 9: Comparative representation of clearly visible and unclearly defined reference lines in the ICX-templant® (excerpts from screenshot with own representation from SIDEXIS XG X-ray software). Left: Clear representation of the reference lines, right: Unclear representation of the reference lines due to a blurred X-ray image

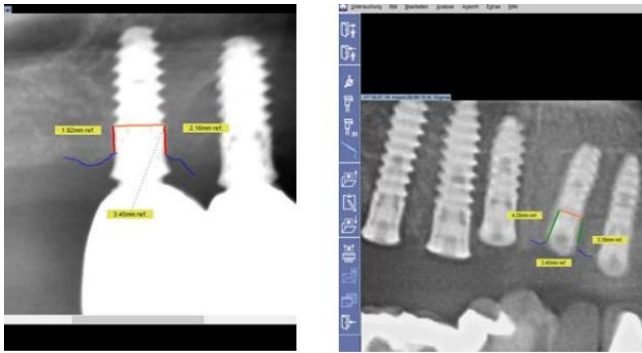


Fig. 10: Comparative representation of clearly visible and unclearly defined reference lines in the ICX templant® plus (excerpts from screenshot with own representation from SIDEXIS XG X-ray software). Left: Clear representation of the reference lines, Right: Unclear representation of the reference lines due to a blurred X-ray image

Conclusion:

Based on the data obtained, monolithic ZrO₂ restorations have the potential to become the new standard restorative material in dentistry. Likewise, the examination of the peri-implant bone level on ICX® implants after a median observation period of 45 months studies provides a bone level change comparable to other studies. For 28.4 % of all implants examined same or even improved bone conditions were observed.

Taking into account the limitations caused by the study design, both the investigated Prettau® Zirkon and the ICX-templant® and ICX-templant® plus implants can generally be recommended for everyday practice due to the promising results. However, further long-term studies are desirable for unrestricted use and recommendation.

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Study Director: Prof. Dr. Peter Pospiech; Practice Team Dental Family Dr. Dr. Andreas Pohl & Carmen Pohl (Jahnsdorf/Erzgebirge), examining dentists: Anke Bosler, Verena Huber, Benedikt Merkle

Reference:

Huber, Verena [Verfasser]. "Vergleichende klinische Nachuntersuchungen von zahn- und implantatgetragenen Brücken aus einer verblendeten edelmetallfreien Legierung (EMF) und Zirkoniumdioxid / Comparative clinical studies of tooth-borne and implant-borne bridges of veneered base metal and zirkonium dioxide Verena Huber." Berlin: Medizinische Fakultät Charité - Universitätsmedizin Berlin, 2020. <http://d-nb.info/1218076526/34>.

Table 1d: Prospective Studies ICX-templant® implant system

Study-No.	Page	Study Location / Year	Timepoint Follow-Up in Months	Number of Subjects	Number of Implants	Endpoint (Survival rate [%])
1.d.1	55	University of Cologne, 2005 V.E. Karapetian; J. Neugebauer; J.E. Zöller	3	20	In the group of immediately loaded patients, at least 6 implants were set in the maxilla and/or 4 in the mandible	77.25 ISQ (Implant Stability Quotient)
		Study Observative / Study Title	Immediate loading of implants in the augmented maxilla and mandible			
		Research Results / Evaluation	A comparison of the data shows no significant differences in primary stability between the regularly loaded and the immediately loaded implants			
1.d.2	56	Karol-Marcinkowski-Medical University Poznan, 2013 P. Kopczynski; R. Flieger	–	20	48	–
		Study Observative / Study Title	Orthodontic implant treatment of congenital absence of the lateral incisors germ in the maxilla with the use of short implants			
		Research Results / Evaluation	The ICX® system meets all the requirements of a modern prosthetic restoration while at the same time being economical			
1.d.3	57	Marmara University, 2014 P. Karasu; F. Ugurlu; A. Sertgöz	12	13	52	–
		Study Observative / Study Title	Complete edentulous rehabilitation with immediate function and "ALL-ON-FOUR™" concept			
		Research Results / Evaluation	OCC system enables immediate restoration of edentulous patients without augmentation procedures			
1.d.4	60	Johannes Gutenberg-University Mainz, 2014 J. Karbach; S. Hartmann; J. Eimermacher; W. Wagner	6	30	120	98
		Study Observative / Study Title	Oral Health-Related Quality of Life in Edentulous Patients with Two- vs. Four-Locator®-Retained mandibular Overdentures: A Prospective, Randomized, Crossover Study			
		Research Results / Evaluation	The evaluation of the one-year results shows a statistically significant improvement in quality of life for patients in whom all four implants were inserted into the mandibular prosthesis with Locators®. This was also confirmed in the survey using the visual analog scale.			

1.d.1 Immediate loading of implants in the augmented maxilla and mandible

V.E. Karapetian, J. Neugebauer J, J.E. Zöller; University of Cologne, 2005

Introduction:

Immediate implant placement in the mandible is a widely used treatment method, but immediate loading of implants after iliac crest transplantation or even immediate loading of implants in the maxilla with and without iliac crest transplantation has not yet been investigated. The quality of the implant bed after bone grafting varies depending on the choice of abutment material. The mechanical stability can be determined using resonance frequency analysis (Osstell®, Integration Diagnostics Inc.).

Objective:

The aim of this study is to demonstrate the success of immediately loaded implants in the maxilla and mandible. The success rates of implants with and without iliac crest transplants are to be compared. Primary stability and mechanical anchorage will be determined as success factors for osseointegration. It should also be shown that immediately loaded implants in the mandible with and without iliac crest transplantation exhibit comparable stability.

Material and Methods:

To determine the stability of immediately loaded implants compared to late loaded implants, a group of ten patients was examined immediately after implant placement and three months after prosthetic treatment. In the group of patients with immediately loaded implants, at least six implants were placed in the maxilla and/or four implants in the mandible. If the mean insertion torque within a bar construction was higher than 35 Ncm, the implants were immediately loaded and the bar prosthesis was inserted a few hours after the surgical procedure.

Results:

A comparison of the data for the regularly loaded and immediately loaded implants did not reveal any significant differences in terms of implant stability at the time of insertion or at the follow-up examination. In the group with the immediately loaded implants, a mean value of 77.25 ISQ (Implant Stability Quotient) was determined in the lower jaw, while in the upper jaw it was 70.53 ISQ for these implants.

After three months of loading, the values were 75.67 ISQ in the maxilla and 83.50 ISQ in the mandible. No clinical or radiographic differences were recognizable.

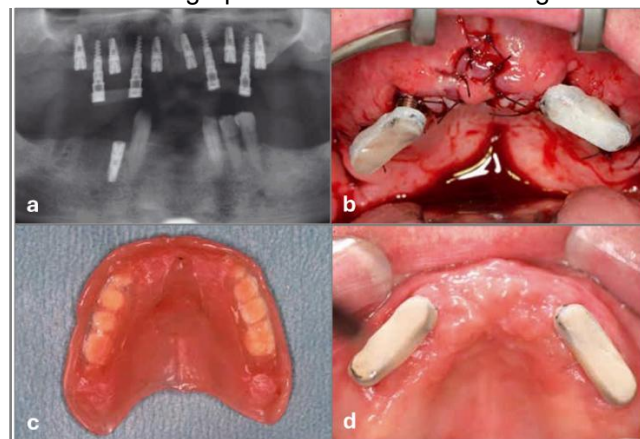


Fig. 1a-d: (a) Orthopantomogram postoperative ICX-templant® implant, (b) plaster cast, (c) fitting of the maxillary prosthesis, (d) 4 weeks postoperative

Conclusion:

The treatment results show that immediate loading after augmentation in the maxilla and mandible is an unproblematic treatment method, provided that the surgical and prosthetic treatment procedures are followed correctly. The primary stability of the inserted implants should not fall below an insertion torque of 35 Ncm. It should also be noted that the implant length is not related to the primary stability, the latter is determined by the bone density. The clinical and radiographic success also showed that osseointegration of the immediately loaded implants in the maxilla and mandible was successful.

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Reference:

Karapetian VE, Neugebauer J, Zöller JE: Die Sofortbelastung von Implantaten im augmentierten Ober- und Unterkiefer. Wissenschaftliches Poster, 20. Meeting der Academy of Osseointegration, 10. – 12. März 2005

1.d.2 Orthodontic implant treatment of congenital absence of the lateral incisors germ in the maxilla with the use of short implants

Dr. med. R. Flieger, MD, PhD, Dr. P. Kopczyński; Karol-Marcinkowski-Medical University Poznan, 2013

Introduction:

Anatomical conditions such as the maxillary sinus in the upper jaw or the mandibular nerve often limit the possibility of simple implant placement. In such cases, optimal conditions can be restored by vertical or transverse bone augmentation if there is a lack of bone. For the patient, this means that these traditional procedures also lead to long treatment times (often up to 12 months until the denture is completed, with months of laborious healing phases). Considering these additional surgical measures, it seems sensible to consider a less disruptive treatment for the patient. For example, treatment using shorter implants (shorties) is an interesting alternative to complex surgical therapy.

Objective:

This abstract describes the case of a 15-year-old female patient with a hereditary root defect and resulting tooth loss. The absence of a canine tooth led to a displacement of the anterior teeth and thus to gaps in the maxillary region.

Material and Methods:

Analyses revealed a very narrow interradicular area between regions 21 and 23. For this reason, the team of implantology specialists opted for a short implant from the ICX-templant® system (diameter: 3.45 mm, length: 6.45 mm), which was inserted minimally invasively according to the surgical ICX® system protocol in accordance with the manufacturer's instructions and closed with an ICX® cover screw.

Results:

The healing and osseointegration phase lasted 3 months and showed no complications. In the near future, the patient will receive a prosthetic reconstruction with a ceramic crown on a standard connection type.

Conclusion:

Numerous studies show that the use of modern implant systems, such as the ICX-templant® implant system and adherence to a minimally invasive surgi-

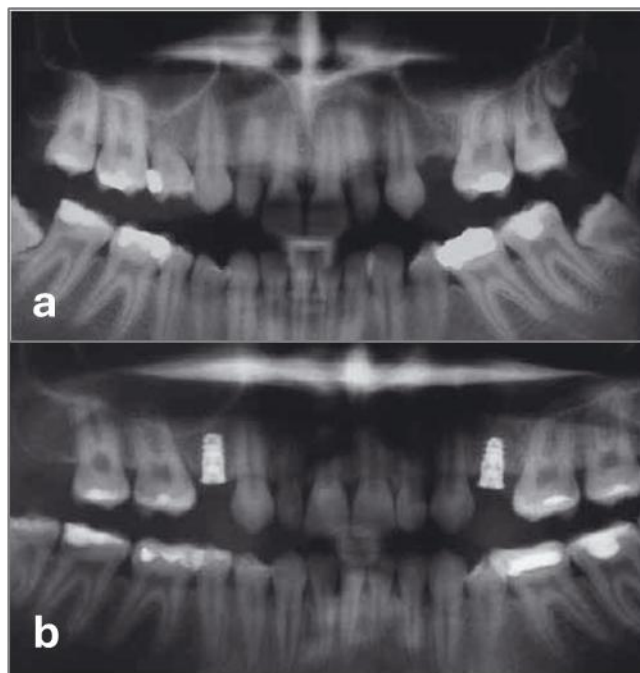


Fig. 1a+b: Orthopantomogram Initial situation (Baseline) (a) without treatment) und (b) after implant placement

cal protocol reduces the indications for tissue expansion procedures and the use of long implants or standard implants. Due to the unique features of ICX-templant® implants, such as the special osteotomic thread, microporosity, hydrophilic surface, platform switching or internal conical connection, it can be concluded that implant-based rehabilitation of congenital root defects with short implants is a predictable, effective and modern treatment option.

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Reference:

Rafał Flieger, Przemysław Kopczyński. Orthodontic-implant treatment of congenital absence of the lateral incisors germ in the maxilla with the use of short implants. Sztuka Implantologii 2013

1.d.3 Complete edentulous rehabilitation with immediate function and „ALL-ON-FOUR®“ concept

P. Karasu, F. Ugurlu, A. Sertgöz; Marmara University, 2014

Introduction:

Implant-supported dentures are now regarded as an established treatment option. The increasing number of dental implants placed each year also demonstrates the growing acceptance of this treatment alternative among the population [1,2]. In addition, the demographic change in the population requires dentists to have a better understanding of patients' wishes and evidence-based therapies in order to permanently replace lost teeth, even in old age [3].

Caries, periapical inflammation or periodontal disease are among the most common diseases in humans and often lead to tooth loss, particularly in the posterior region [4-6]. Bone atrophy is always associated with tooth loss [7], which often necessitates bone augmentation if a fixed restoration on implants is subsequently desired.

Both bone augmentation in the maxilla (sinus lift or lateral augmentation) [8, 9] and bone augmentation in the mandible (block augmentation or lateral augmentation) [10] require healing times between 4 and 8 months. Extensive augmentations are also associated with comorbidities that are stressful for the patient [11].

With angulated implants posteriorly, vertical bone augmentation measures in the maxilla and mandible can be avoided, if there is sufficient bone width.

The OCC system for occlusal screw-retained implant prosthetics enables immediate prosthetic restorations for edentulous patients. The implant therapy concept for conditionally removable dentures on four to six implants, which has been further developed on the basis of the Malo concept, is very suitable for patients with atrophied jawbones, as they can be provided with the wearing comfort of a fixed denture using OCC without the need for complex augmentation procedures.

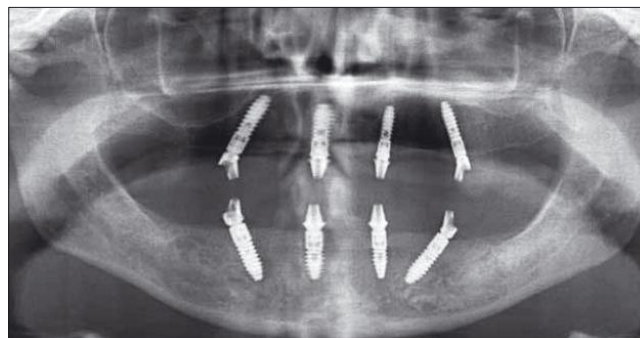


Fig. 1: Orthopantomogram of a patient from the OCC-study with ICX®-Implants [12]

The OCC system for ICX-templant® consists of various occlusal screw-retained abutments angled up to 40 degrees in different gingival heights, prosthetic caps made of titanium, plastic and gold, various auxiliary parts and instruments, such as bite registration, angle ruler, impression posts and model analogs, as well as a scan base for CAD/CAM-supported fabrication of customized prosthetics.

Thanks to the "ICX® implant-abutment interface" specially designed by medentis the terminal implants can also be prosthetically restored with OCC abutments that can be rotated through 360 degrees in 0°, 20°, 30° and 40° angles and thus optimally adapted to the individual anatomical patient situation.

Objective:

In a study conducted under the direction of Professor Dr. Atilla Sertgöz [12], the primary stability was examined using the All-on-4® concept developed by Nobel BiocareTM using the medentis OCC (occlusal screw-retained implant prosthetics) system. This system makes it possible to use the often still favorable bone supply in the anterior region of the edentulous jaw in such a way that a fixed prosthesis can be placed on only 4 implants.

Material and Methods:

With OCC, only four implants are placed for an edentulous jaw. High stability is ensured by inserting the implants into the jaw at an angle of 20-40°. The implants placed at an angle can be made longer than with conventional techniques and therefore have greater contact with the surface of the bone.

A total of 88 implants were inserted in this study, whereby the rear 2 implants were inserted at a 30-40° angle (previously considered impossible) with the implant tip pointing forwards. For this purpose, 30-40° abutments were used. An immediate provisional prosthetic restoration was realized by modifying the existing complete denture and using screw-retained abutments. After the third month, a final prosthetic restoration with a fixed prosthesis was carried out.

The stability of the implants was determined for 8 weeks using the Osstell Mentor Device, weekly, and after 6 and 12 months. The results were expressed as ISQ values (Implant Stability Quotient), the unit of measurement for resonance frequency analysis (RFA, results in kHz) on a clinically useful scale of 1-100 ISQ.

Numerous studies have been conducted based on RFA measurements and the ISQ scale, which provide valid evidence that the acceptable stability range is above 55 ISQ [13-15]. An initially high ISQ value usually decreases as mechanical stability is replaced by osseointegration. An initially low value usually increases once osseointegration begins. According to Osstell, the risky scenario is an ISQ of around 55 and below. Here, osseointegration has not started as planned and loading the implant could lead to failure.

Results:

In this study, 13 patients with an average age of 55.3 years (33 to 68 years) were treated with an immediate prosthetic restoration using the All-on-4® concept.

In the examination of implant stability, the ISQ values recorded for the mandible were in the following ranges: 1st week approx. 70-75 (n = 11), after 4 weeks 70-80 (n = 11), after 6 months 75 to 85 (n = 11) and after 12 months 75 to 85 (n = 9).

The following ISQ ranges were determined for the maxilla: 1st week 70 to 75 (n = 10), after 4 weeks 65 to 70 (n = 10), after 6 months 70 to 75 (n = 10) and after 12 months 65 to 70 (n = 8). The ISQ data of most patients showed good values, indicating very good stability.

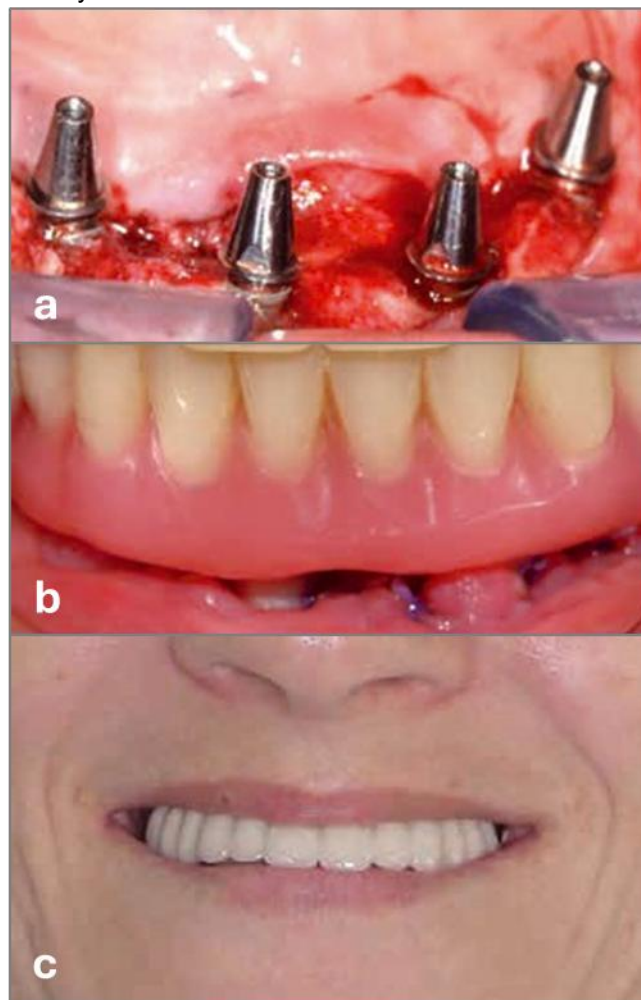


Fig. 2a-c: (a) ICX® implants with a diameter of 3.45 mm and a length of 12.5 mm were placed in the mandible and implants with diameters of 3.45 - 3.75 mm and a length of 12.5 mm were placed in the maxilla. The two anterior implants were placed straight and the two posterior implants were placed 30-40° angled using 30-40° abutments. Inserting the implants into the jaw rotated by 30-40° ensures high stability and enables immediate prosthetic restoration [12]. (b)+(c) The OCC system from medentis allows a fixed temporary bridge construction to be inserted directly after insertion of the implants, which enables immediate loading. 6-8 weeks later, the original is then inserted [12].

Conclusion:

Lost teeth significantly impair the oral health-related quality of life and have a negative psychological effect on the person concerned [13,14]. The time span for conventional implant restorations with permanent dentures ranges from 3 months to sometimes 1.5 years in cases with extensive augmentation and/or long implant healing times.

This often leads to increased stress levels in patients [15], who are no longer patient enough for the final prosthetic restoration after the strenuous surgical pre-treatment phase. The method of providing edentulous patients or patients with a dentition that is not worth preserving with "fixed teeth" within one day offers the possibility of achieving an enormous oral improvement in their quality of life without long stress intervals [13].

The medentis OCC system enables immediate prosthetic restorations for edentulous patients. The implants placed at an angle can be made longer than with conventional techniques and therefore have greater contact with the surface of the bone. The larger contact surface therefore allows the implants to be inserted without prior time-consuming bone augmentation. Another advantage of the method is that it protects the nerves in the posterior jaw area. Toothless patients can have a fixed restoration without augmentation using angled implant abutments at a reasonable cost. Immediate loading is possible with appropriate bone quality and quantity.

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Reference:

Pelin Karasu, Faysal Ugurlu, Atilla Sertgöz. *Complete edentulous rehabilitation with immediate function and All-on-Four Concept* Wissenschaftliches Poster, European Prosthodontic Association EPA, İstanbul 25. – 27. September 2014

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1.d.4 Oral Health-Related Quality of Life in Edentulous Patients with Two- vs. Four-Locator®-Retained mandibular Overdentures: A Prospective, Randomized Crossover Study

Karbach J. DMD, MD, DDS; Hartmann S. DMD; Jahn-Eimermacher A.; Wagner W. MD, DMD; Johannes-Gutenberg-University Mainz, 2014

Introduction:

Instruments such as the Oral Health Impact Profile (OHIP) are used to assess oral health-related quality of life (MLQ). In addition to the original English version (OHIP-49) with 49 questions and the German versions with 49 and 53 questions (OHIP-G49; OHIP-G53), there is also a short version with 14 items (OHIP-G14). Short instruments require less time and effort and are easier to integrate into the practice routine. An epidemiological randomized prospective study comparing the quality of life of patients with four implants in the edentulous mandible was conducted at the University Medical Center Mainz. The first preliminary study results on the quality of life of patients who were randomized to receive two of the four implants and all four implants with Locators® inserted into the prosthesis for three months each were presented by Prof. Dr. Dr. Winfried Wagner, Dr. Dr. Julia Karbach and Dr. Sinsa Hartmann at the Implantology Quality Forum in February 2013 at Mainz University Hospital.

Objective:

The aim was to conduct a prospective epidemiological randomized prospective study to compare the quality of life with two different forms of treatment for edentulous mandibles (using ICX® implants).

Material and Methods:

In 30 patients with an edentulous mandible, 4 ICX®-plus implants were inserted intraforaminally. The ICX® implant system was used. The prosthetic restoration was based on the principle of two versus four Locators® on ICX® implants in the mandible. After eight weeks of transgingival healing, either 2 or 4 implants were used for prosthetic restoration in the patients. After 3 months a change was made. After a further 3 months, four Locators® on ICX® implants were used for prosthetic restoration in all patients.

The MLQ (oral health-related quality of life) was assessed using the Oral Health Impact Profile (OHIP-G 14) score.

Results:

At the end of the study, all four implants with Locators® were incorporated into the mandibular prosthesis in the patients. In the early healing phase, two implants of the 120 ICX® implants were lost in patients with severely atrophied mandibles (survival rate after 1 year 98%). These one-year results, which are currently being published, demonstrate a statistically significant improvement in the quality of life of patients (n=30) in whom all four implants with Locators® were inserted into the prosthesis.

Conclusion:

The statistical evaluation showed an advantage for patients in whom all four implants were loaded. This was also confirmed in the survey using the visual analog scale. An annual check-up with documentation and evaluation of the clinical and radiological parameters is planned up to the fifth postoperative year.

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Reference:

Karbach J, Hartmann S, Jahn-Eimermacher A, Wagner W. Oral Health-Related Quality of Life in Edentulous Patients with Two- vs Four-Locator-Retained Mandibular Overdentures: A Prospective, Randomized, Crossover Study. Int J Oral Maxillofac Implants. 2015 Sep-Oct;30(5):1143-8. doi: 10.11607/jomi.3987. PMID: 26394352 (Study conducted at the University Hospital Mainz, Germany by Dr. med. dent Julia Heider (born Karbach, Mainz) Start of the study: 2012, planned duration: 5 Years.

Table 2a in vitro-Studies – ICX®-Premium

Study- No.	Page	Study Location / Year	Timepoint Follow-Up in Months	Number of Subjects	Number of Implants	Endpoint (Survival rate [%])
2.a.1	63	Saarland University, Homburg, 2020 T. Grobecker-Karl; A. Dickinson; S. Heckmann; M. Karl; C. Steiner	-	In vitro	20	Primary Implant Stability
		Study Observative / Study Title	Evaluation of Insertion Energy as Novel Parameter for Dental Implant Stability			
		Research Results / Evaluation	The implant stability and insertion energy differed significantly between the groups, but the maximum insertion torque did not. Short implants led to a significant decrease in implant stability, while a reduction in implant diameter had no significant effect. Using the dense bone drilling protocol resulted in a significantly higher insertion energy but a significant decrease in implant stability. The insertion energy did not prove to be a more reliable parameter for evaluating primary implant stability than the maximum insertion torque and resonance frequency analysis			
2.a.2	65	Saarland University, Homburg, 2022 C. Steiner; M. Karl; T. Grobecker-Karl	-	In vitro	5	Bone Elongation
		Study Observative / Study Title	Wedge-Shaped vs. Round Implants: Bone Strain During the Insertion Process			
		Research Results / Evaluation	Wedge implants differ from round implants with regard to the insertion process, which is characterized by a gradual increase in bone deformation. A high load development in the buccal bone can be a risk factor for bone resorption and should be avoided by reducing the underpreparation of the implant site.			
2.a.3	67	Steinbeis University, Stuttgart, 2023 L. Weissbach Masterthesis	-	In vitro	100	Transfer Accuracy and Sterilizability of Surgical Guides
		Study Observative / Study Title	The Accuracy and Sterilizability of Surgical Guides Depending on Their Material and the Drill Guide Used			
		Research Results / Evaluation	The statistical analysis revealed no significant differences between the methods and materials investigated. These results are in line with comparable studies on the accuracy of surgical guides and confirm the literature that surgical guides are an adequate instrument to ensure the accuracy of implant positions. The omission of the metallic drill sleeve and the sterilization of surgical guides do not appear to have any negative effects on the accuracy of the implant positions.			
2.a.4	69	Rheinische Friedrich-Wilhelms-University Bonn, 2024 A. Sium-Abel	-	In vitro	30	Transfer Accuracy of Surgical Guides
		Study Observative / Study Title	Accuracy of template-based guided dental implant placement - An in -vitro-comparison of different manufacturing methods			
		Research Results / Evaluation	The study showed that the method used to create the implant guide had no influence on the accuracy of implant placement within the limits of an in vitro environment. All methods resulted in implant placement that did not exceed the accepted range of safety deviation (1.5-2.0 mm).			

Table 2b in vivo-Studies – ICX®-Premium

Study- No.	Page	Study Location / Year	Timepoint Follow-Up in Months	Number of Subjects	Number of Implants	Endpoint (Survival rate [%])
2.b.1	72	University of Medical Sciences, Mashhad, Iran / University Hospital of Bonn, 2023 M. Gholami; F. Ahrari; H.S. Sedigh; C. Bourauel	-	In vivo, 13 Iranian Dogs	3-5 per animal, according to the surgical conditions	Bone Implant Area (BIA), Bone Implant Volume (BIV)
		Study Observative / Study Title	Micro-computed tomography analysis of mineral attachment to the implants augmented by three types of bone grafts: An experimental study in dogs			
		Research Results / Evaluation	All graft materials showed comparable performance in mineral support of the implants up to 4 months after surgery. In the long-term interval (6 months), autogenous bone showed significant superiority over xenogenic and synthetic replacement material in terms of bone surface and volume around the implant.			

Table 2c Retrospective Studies – ICX®-Premium

Study- No.	Page	Study Location / Year	Timepoint Follow-Up in Months	Number of Subjects	Number of Implants	Endpoint (Survival rate [%])
2.c.1	74	Semmelweis University Budapest, Hungary, 2021 Z. Radoczy-Drajko; P. Windisch; E. Svidro; P. Tajti; B. Molnar; G. Gerber	12	5	9	Not Specified
		Study Observative / Study Title	Clinical, radiographical and histological evaluation of alveolar ridge preservation with an autogenous tooth derived particulate graft in EDS class 3-4 defects			
		Research Results / Evaluation	The preliminary results of the Bonmaker® therapy with autogenous tooth grafts show that ATB can be safely and successfully used as a graft material for ARP. Optimal graft incorporation and histologically proven effective remodelling as well as complication-free wound healing support the clinical use of ATB to minimize hard tissue loss after extraction.			
2.c.2	76	Guangdong Province Stomatological Hospital, 2021 Dr. Wuwei Yin; Dr. Yong Yang	3-4	Total: 90, medentis medical: Not Specified	Total: 91, medentis medical: 21	Marginal Bone Loss (MBL) 0.22 ± 0.20 - 0.82 ± 0.56 mm
		Study Observative / Study Title	Influence of implant cover screw loosening on early peri-implant marginal bone loss: a retrospective evaluation of risk factors			
		Research Results / Evaluation	During the healing process, CSL is associated with early peri-implant MBL. The position of the maxilla is considered a significant risk factor for CSL.			
2.c.3	78	Dazhong Stomatological Hospital, Wuhan, China, 2022 B. Men; H. Yang; J. Zhang	6	78	95	97,40%
		Study Observative / Study Title	Preoperative CBCT Guided Bone Regeneration Combined with Concentrated Growth Factor Applied in the Implantation of Maxillary Teeth with Insufficient Bone Mass			
		Research Results / Evaluation	Preoperative CBCT-guided bone regeneration (GBR) in combination with concentrated growth factor (CGF) can promote the bone formation content in the controlled regeneration of labial bone defects in the maxillary teeth.			
2.c.4	80	Medical University, Bulgaria, 2022 K.A. Fakih; M. Stiliyanova Edreva; B.B. Stoichkov	Not Specified	1	2	Not Specified
		Study Observative / Study Title	Removal of a Horizontally Displaced Dental Implant below the Mandibular Canal			
		Research Results / Evaluation	Several reasons can influence implant displacement. To avoid similar incidents, in addition to a detailed pre-implant radiographic assessment (CBCT), it is also necessary to follow surgical protocols for implant placement in soft bone and to ensure controlled surgical conditions (good visibility, adequate bleeding control) during the procedure.			
2.c.5	83	Weissenfels, 2023 Dr. med. dent. Sandro Strößner	Not Specified	1	1	Not Specified
		Study Observative / Study Title	Complication management of membrane perforation during external sinus lift			
		Research Results / Evaluation	In a case of membrane perforation during external sinus lift, complication management is demonstrated by intraoperative perforation coverage in a single-stage sinus lift and subsequent prosthetic restoration.			
2.c.6	85	Charité Universitätsmedizin Berlin, 2024 N. Neckel; N. Pohl; S. Preissner; O. Wagendorf; C. Sachae; K. Vach; M. Heiland; S. Nahles	Not Specified	52	244	Bone Loss, Periimplantitis
		Study Observative / Study Title	Cross-sectional analysis comparing prefabricated titanium to individualized hybrid zirconia abutments for cemented zirconia based fixed dental prostheses - a critical concept assessment			
		Research Results / Evaluation	ihZiA showed comparable results to pTiA. To optimize the long-term result, not only the material alone, but also the creation of sufficient soft tissue thickness, minimization of EA and the application of a concave EP seem to be the most important factors. To improve the OH-QoL, special attention must be paid to the esthetic zone.			

2.a.1 Evaluation of Insertion Energy as Novel Parameter for Dental Implant Stability

T. Grobecker-Karl¹; A. Dickinson²; S. Heckmann¹; M. Karl^{1,*}; C. Steiner¹, Saarland University, Homburg, 2023

Introduction:

Insertion energy has been advocated as a novel measure of primary implant stability, but the effect of implant length, diameter, or surgical protocol remains unclear.

Material and Methods:

Twenty implants from one specific bone-level implant system (ICX®, Medentis Medical GmbH) were divided into four groups (n = 5). The implants differed in diameter and length (Fig. 1; Table 1), with one group of implants (4.8 mm diameter and 12.5 mm length) serving as a control group. The implants were placed in layered polyurethane foam (Fig. 2), and the maximum insertion torque, torque-time curves and primary stability were measured using resonance frequency analysis (RFA). The insertion energy was calculated as area under the torque-time curve applying the trapezoidal formula. Statistical analysis was based on analysis of variance, Tukey honest differences test and Pearson's product moment correlation tests ($\alpha = 0.05$).



Fig. 1 (left): Implant dimensions used in this study: (left) Implant dimension 4.8 × 10 mm; (center) implant dimension 4.8 × 12.5 mm; (right) Implant dimensions 4.1 × 12.5 mm; **Fig. 2 (right):** The implants were inserted into laminated polyurethane foam using a surgical motor capable of recording the actual torque applied over time.

Group	Implant	Surgical Protocol
Control	ICX 4.8 × 12.5 mm	Medium Bone
Short	ICX 4.8 × 10.0 mm	Medium Bone
Slim	ICX 4.1 × 12.5 mm	Medium Bone
Dense	ICX 4.8 × 12.5 mm	Dense Bone

Tab. 1: Description of the four test groups studied

Results:

Implant stability ($p = 0.01$) and insertion energy ($p < 0.01$) differed significantly among groups, but the maximum insertion torque did not ($p = 0.17$). Short implants showed a significant decrease in implant stability ($p = 0.01$), while reducing implant diameter did not cause any significant effect. Applying the drilling protocol for dense bone resulted in significantly increased insertion energy ($p = 0.02$), but a significant decrease in implant stability ($p = 0.04$). Insertion energy was not found to be a more reliable parameter for evaluating primary implant stability when compared to maximum insertion torque and resonance frequency analysis.

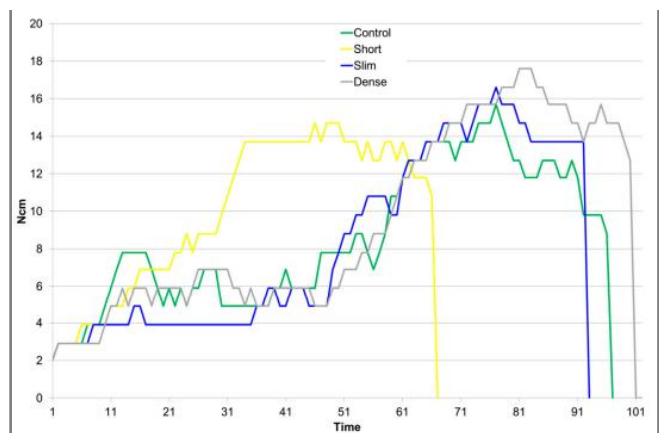


Fig. 3: Overview of characteristic torque-time curves determined for the different implants and surgical protocols. Each curve represents one randomly chosen sample per group.

Group	Control		Short		Slim		Dense	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Maximum insertion torque [Ncm]	15.9	2.24	15.1	0.85	15.7	1.53	17.2	0.55
Implant Stability [ISQ] *	64.0	1.32	61.0	0.79	62.8	1.40	61.6	1.47
Insertion Energy [Ncm-s] *	819.08	77.78	703.46	46.41	800.36	77.86	973.24	82.56

Tab. 2: Mean values and standard deviations (SD) for all evaluated parameters

	Maximum Insertion Torque	Implant Stability	Insertion Energy
ANOVA	0.17	0.01	0.00
Control vs. Short	0.82	0.01	0.09
Control vs. Slim	0.99	0.47	0.98
Control vs. Dense	0.49	0.04	0.02
Short vs. Slim	0.92	0.16	0.19
Short vs. Dense	0.14	0.88	<0.01
Slim vs. Dense	0.36	0.47	<0.01

Tab. 3: Results (*p*-values) of ANOVA and pairwise comparisons between the different implant systems used for all three parameters tested (Tukey's test for honest differences; $\alpha = 0.05$; significant differences are in bold).

	ISQ vs. Maximum Insertion Torque		ISQ vs. Insertion Energy		Maximum Insertion Torque vs. Insertion Energy	
	r-Value	<i>p</i> -Value	r-Value	<i>p</i> -Value	r-Value	<i>p</i> -Value
Control	-0.38	0.53	0.09	0.89	0.77	0.13
Short	-0.35	0.56	-0.69	0.20	0.86	0.06
Slim	0.15	0.81	-0.01	0.99	0.68	0.20
Dense	-0.25	0.69	-0.06	0.92	0.78	0.12
Overall	-0.10	0.67	0.02	0.95	0.75	<0.01

Tab. 4: Pearson's product-moment correlation for the parameters implant stability quotient (ISQ), maximum insertion torque and insertion energy ($\alpha = 0.05$; significant correlations are printed in bold)

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Reference:

Grobecker-Karl T, Dickinson A, Heckmann S, Karl M, Steiner C. Evaluation of Insertion Energy as Novel Parameter for Dental Implant Stability. J Clin Med. 2020 Sep 15;9(9):2977. doi: 10.3390/jcm9092977. PMID: 32942697; PMCID: PMC7565125.

2.a.2 Wedge-Shaped vs. Round Implants: Bone Strain During the Insertion Process

T. Grobecker-Karl¹; A. Dickinson²; S. Heckmann¹; M. Karl^{1,*}; C. Steiner¹, Saarland University, Homburg, 2023

Introduction:

A novel implant system resembling the shape of a wedge and employing piezosurgery for implant bed preparation has been introduced with the aim of solving the problem of horizontal bone deficiency. This *in-vitro*-study compared emerging bone strain during insertion of a conventionally round implant vs. the wedge implant.

Material and Methods:

Placement of the wedge implants (Fig. 2a; REX TL 1.8 H11; REF T1-11; LOT T1110819, REX Implants Inc., Columbus, OH, USA) was performed with a system-specific implant placement device (REX Implant Placement Device, mectron s.p.a.), which acts like an electromagnetic surgical hammer. In the control group, conventional round bone-level implants (ICX®-PREMIUM 4.8 x 10.0mm; REF C-001-480100; LOT 20110729-01, medentis medical GmbH, Bad Neuenahr/Ahrweiler, Germany) according to the recommended surgical protocol for medium bone. The implants (Fig. 2b) were placed at a speed of 25 rpm using a surgical motor (iChiropro, BienAir, Biel, Switzerland). According to the manufacturers' protocols, the implants were placed in polyurethane foam blocks with strain gauges on the buccal and occlusal surfaces.

Five implants were placed per group and the development of the strains during insertion was recorded. Primary implant stability was determined using resonance frequency analysis (RFA). Statistical analysis was based on Welch two-sample t-tests ($\alpha=0.05$).

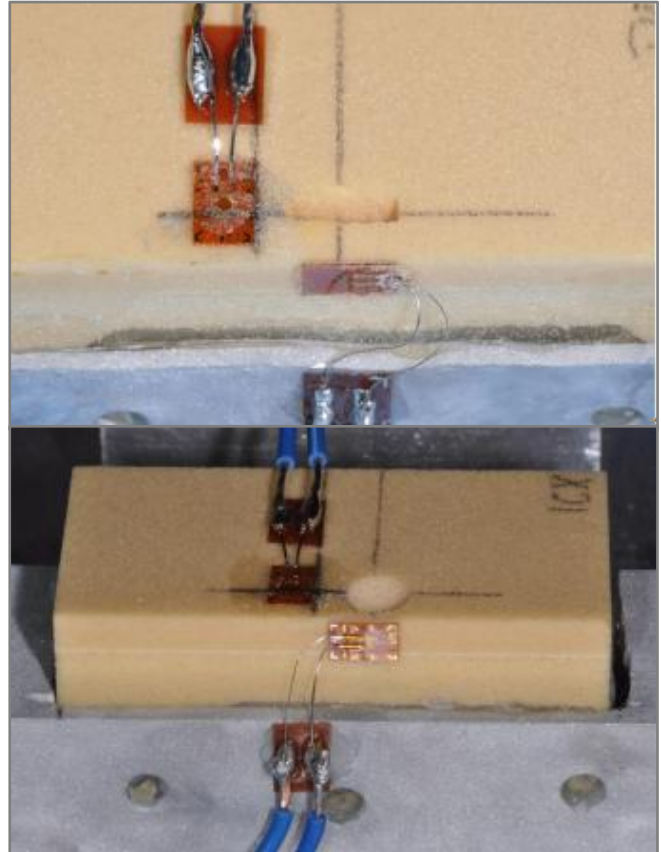


Fig. 1: Bone surrogate materials used for this study, consisting of a cortical layer and underlying trabecular bone. Strain gauges positioned on the occlusal (bucco-lingual alignment) and buccal surface (mesio-distal alignment) allow the recording of strains during implant placement. The strain gauges were positioned at a distance of 2 mm from the wedge implant (a-top) and the round implant (b-bottom).

Results:

In general, a greater strain development was observed on the buccal aspect of bone as compared to the occlusal aspect with an overall range between - 724 μ m/m and 9,132 μ m/m. For the wedge implants, a gradual increase in strain development was observed, while for the round implants a continuous increase in strain development was observed for the round implants.



Fig. 2: Implant types used in this study were (a) wedge implants with maximum thickness of 1.8mm and length of 11mm and traditional round implants 4.8mm in diameter and 10mm in length (b)

Absolute strain development on the buccal aspect of bone was significantly greater in wedge implants ($p=0.0137$) while on the occlusal aspect significantly lower strain development was seen for wedge implants ($p=0.0012$). Primary stability of wedge implants was significantly lower as compared to round implants ($p=0.0005$).

	Strain gauge occlusal [µm/m]		Strain gauge buccal [µm/m]		ISQ	
	Mean of absolute values	SD	Mean of absolute values	SD	Mean of absolute values	SD
ICX	1026.56	108.70	4444.79	461.55	62.5	1.9
REX	475.03	193.38	6946.18	1407.10	43.6	5.0
Welch two sample test	$p=0.0012$		$p=0.0137$		$p=0.0005$	

Tab. 1: Means and standard deviations (SD) of absolute strain values and ISQ recordings determined in both groups of implants. Comparisons between groups were based on Welch two sample tests and resulted in significant differences for all three parameters ($p<0.05$)

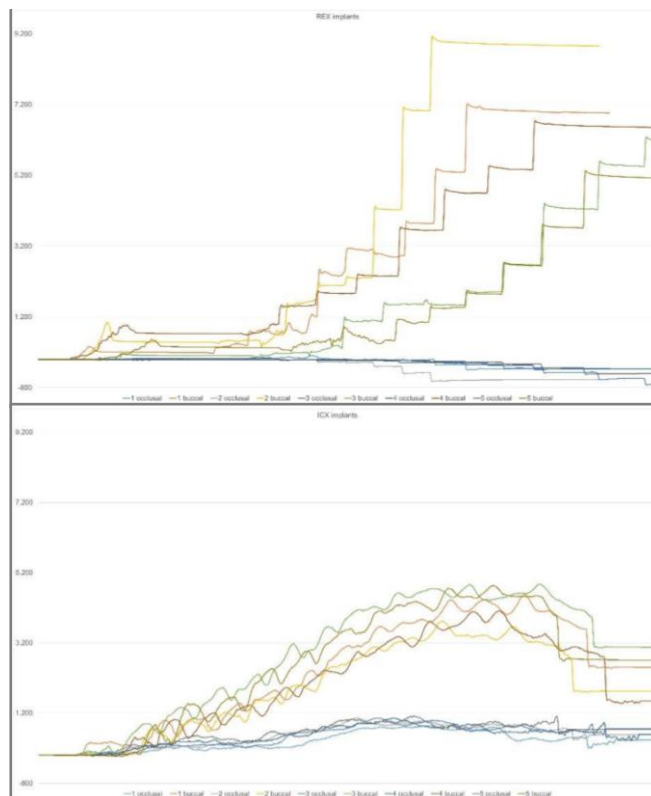


Fig. 3: Strain development recorded on the buccal and occlusal aspects of bone during the insertion of wedge implants (REX implants; a) and conventionally round implants (ICX® implants; b)

Conclusion:

Wedge implants differ from round implants with respect to the insertion process characterized by a stepwise increase in bone deformation. High strain development in buccal bone may constitute a risk factor for bone resorption and should be avoided by reducing the degree of underpreparation of the implant site.

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Reference:

Steiner C, Karl M, Grobecker-Karl T. Wedge Shaped vs Round Implants: Bone Strain During the Insertion Process. J Oral Implantol. 2022 Dec 1;48(6):557-561. doi: 10.1563/aaaid-joi-D-21-00135. PMID: 35446948

2.a.3 The Accuracy and Sterilizability of Surgical Guides Depending on Their Material and the Drill Guide Used

L. Weissbach, Masterthesis, Steinbeis University, Stuttgart, 2023

Introduction:

The success of implant therapy depends directly on the correct positioning of the implants in the patient. Incorrectly positioned implants can lead to esthetic and biological complications. Depending on the extent of the deviation from the ideal position, the prosthetic restoration may not be feasible or the implant may be completely lost.

Objective:

Transferring the desired implant position to the patient as accurately as possible is therefore key to a successful treatment outcome. To solve this challenge, drill guides have become established in dental implantology. They provide orientation and guidance to the practitioner during surgery and thus make the planned implant position in the mouth reproducible. The decisive factor is how accurately the drill guide reproduces the implant position. The aim of this in vitro study is to investigate the effects of the type of drill sleeve, differences in material and sterilization of drill guides.

Material and Methods:

Drill guides made of 5 different materials were compared, 4 of them created with the 3D printer and one milled. Templates were created from each material for 5 standardized patient cases, for a total of 25 drill guides. All five corresponded to the criteria of an interdental gap situation in the posterior region and approximately symmetrically distributed implant positions in both quadrants.

At least two implants must be placed per quadrant. This meant that all four variants of the variables under investigation could be implanted in a plastic jaw. One implant each through a metal drill sleeve, before and after sterilization. And one each purely plastic-guided, before and after sterilization. The five different situations are referred to below as A, B, C, D and E and are illustrated in *Table 2*. The surgical guides were designed to match the implant situations. An overview of the materials and their manufacture can be found in *Table 1*.

The 100 implants placed in this trial (ICX®-Premium, 3.75mm x 10mm) were subsequently analyzed with regard to their deviation from the planned position. The measurements were made in postoperatively acquired DVT data sets. Statistical analysis revealed no significant differences between the procedures and materials studied.

Results:

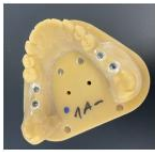
Statistical analysis revealed no significant differences between the procedures and materials studied. These results are in line with comparable studies on the accuracy of surgical guides and confirm the literature that surgical guides are an adequate tool to ensure the accuracy of implant positions. The omission of the metallic drill sleeve and the sterilization of drill guides does not seem to have a negative impact on the accuracy of the implant position.

Conclusion:

These findings may simplify clinical practice and reduce the cost of surgical guides. It allows for easier production and sterilization, which would also be possible in an outpatient practice. This simplifies workflow and improves patient availability. Nevertheless, further thorough testing of these results in *in vivo* studies is needed to ensure safe use of drill guides after sterilization and without a metallic drill sleeve.

Hersteller	3D-Drucker	Material	Technologie	Nr.
3D Systems	MJP 2500	VisiJet M2S-HT90	MultiJet MJP	1
DWS	XFAB2500 PB	DS 3000	Laser Stereolithography	2
3D Systems	MJP 3600	VisiJet M3 StonePlast	MultiJet MJP	3
Asiga	Max TM	Scheu Imprim LC Splint	DLP	4
Imes Icore	CNC – Fräse	Zirlux Spint transparent	Fräsen	5

Tab. 1: Overview of the materials used and their manufacture, including assignment of a number for simplified reference.

Benennung des Modells	Modell nach Implantation	Schablone passend zum Modell
A		
B		
C		
D		
E		

Tab. 2: Assignment of the individual plastic models to the corresponding templates using the example of the test series for material 1.

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Reference:

Lucas Victor Markus **Weissbach**. *Die Genauigkeit und Sterilisierbarkeit von Bohrschablonen in Abhängigkeit von deren Material und der verwendeten Bohrerführung (Masterthesis)* 2022/2023, Stuttgart Steinbeis Hochschule)

Zeller AN, Neuhaus MT, Weissbach LVM, Rana M, Dhawan A, Eckstein FM, Gellrich NC, Zimmerer RM. *Patient-Specific Mandibular Reconstruction Plates Increase Accuracy and Long-Term Stability in Immediate Alloplastic Reconstruction of Segmental Mandibular Defects*. J. Maxillofac. Oral Surg. 19, 609–615 (2020). <https://doi.org/10.1007/s12663-019-01323-9>

2.a.4 Accuracy of template-based guided dental implant placement – An *in-vitro*-comparison of different manufacturing methods

A. Sium-Abel; L. Keilig; I. Dörsam; C. Bourauel; Rheinische Friedrich-Wilhelms-University Bonn, 2024

Objective:

This study investigates effects of surgical guide manufacturing process on 3D transfer accuracy of planned dental implant position, using three production methods: additive 3D-printed (3DF), subtractive milled (MF), and analog laboratory fabricated templates (LF).

Material and Methods:

Implant position for a single-tooth gap (#26) planned digitally. 3DF and MF templates were designed digitally, while LF templates were analogously created. For each manufacturing type, 10 surgical guides were fabricated. Each guide was used for template-guided implant placement in model replicas. For evaluation of implant placement, cone beam computed tomography scans of all implanted models were superimposed, and implant positions were determined. Deviations at implant shoulder/apex were measured, and median and inter-quartile range (IQR) were determined for mesio-distal, oro-facial, coronal apico, 3D spaces, and angles.

Results:

At implant shoulder, vertical components dominated position deviations (up to 1.04 mm, IQR 0.28 mm for 3DF). Horizontal deviations were much lower (mesio-distally up to 0.38 mm, IQR 0.36 mm (LF)). Implant apex shows similar vertical deviations, while horizontal deviations clearly increased compared to shoulder, especially in mesio-distal direction. Median angular deviations were between 2.1° (IQR 2.0 mm, max. 4.2°) for 3DF and 3.3° (IQR 1.9 mm, max. 5.3°) for MF. No statistical differences were found between manufacturing types (Kruskal–Wallis test, $p=0.05$)

Conclusion:

The study showed the method of implant guide fabrication did not affect the accuracy of implant placement within the limits of an *in vitro* environment. All methods resulted in implant placement which did not exceed the accepted safety deviation envelope (1.5–2.0 mm).

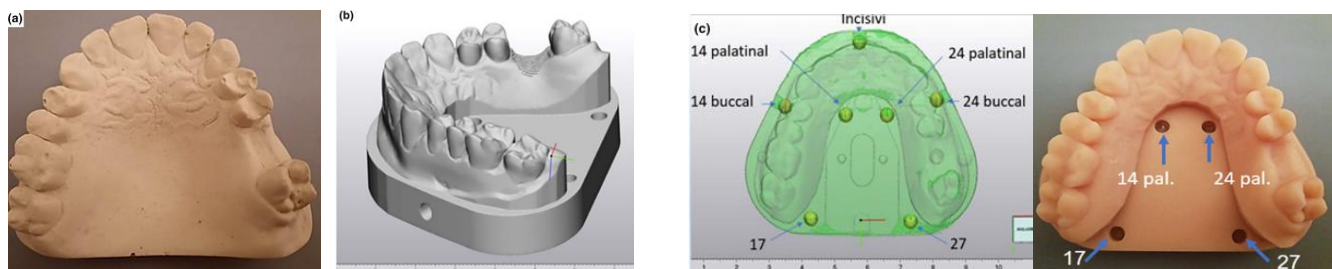


Fig. 1: (a) Occlusal view of the master cast made of super hard plaster with single tooth gap in the maxilla (region #26). (b) Lateral view of the model, with diametrical alignment to the perforated implant region #26. (c) Occlusal View: Model (green), spheres shown with anatomical designation (yellow). (d) Occlusal view: 3D-printed model with radiopaque glass spheres inserted (indicated by arrows).

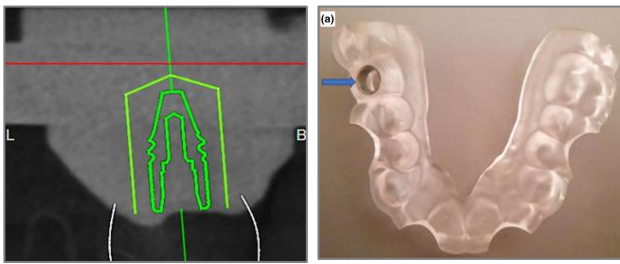


Fig. 3: Frontal view of the planned implant with slightly subcrestally planned implant in Region #26 (green, marked thickly).

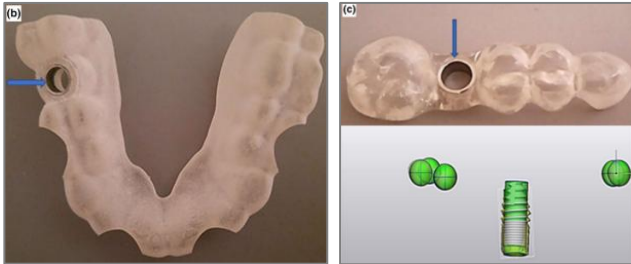


Fig. 4: Three types of surgical guides. (a) 3D-printed surgical template, extending from Tooth 17 to Tooth 27, dento-gingival support, with bonded titanium sleeve in Region #26 (blue arrow). (b) Surgical template milled fabrication, expansion from 17 to 27, dento-gingival support, with bonded titanium sleeve in Region #26 (arrow). (c) Orientation guide, laboratory fabricated, extending from Tooth 23 to Tooth 27, dentally supported, with glued titanium sleeve in Region #26 (arrow) - **Fig. 5:** Left buccal view of the superimposition of implant planning (grey) and inserted implant in Region #26 (yellow) and cylindrical auxiliary body (green). Radiopaque glass spheres with associated analytical spheres (green)

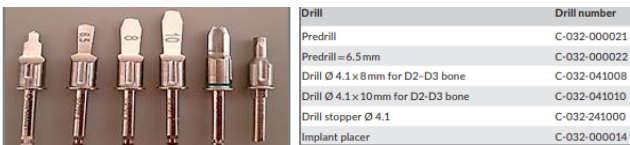


Fig. 6: Drills used, order from left to right- **Tab.1:** Drilling protocol

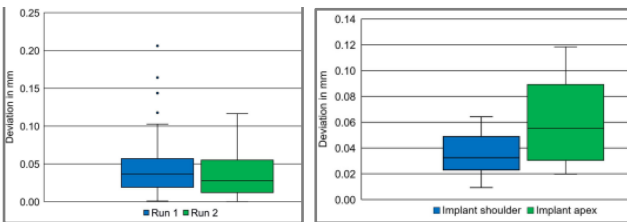


Fig. 7: Box plots of the two measurement runs of the 3D deviations between the manually inserted glass spheres among each other (seven spheres per sample model, n=5) compared to the distances of the seven spheres in the planning model. - **Abb. 8:** Box plots of the 3D deviations of the cylindrical auxiliary bodies to the implant at the implant shoulder (blue) and at the implant apex (green).

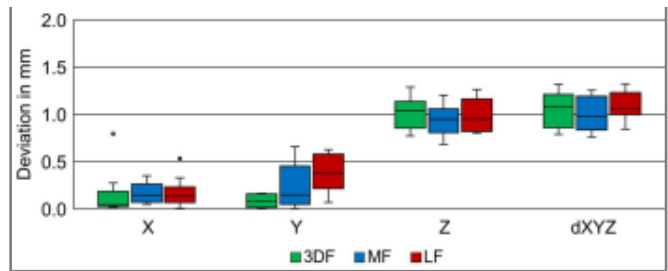


Fig. 9: Box plot of the linear (X, Y, Z) and spatial deviations (dXYZ) at the implant shoulder in relation to the different manufacturing processes (3D-printed fabrication (3DF) in green, milled fabrication (MF) in blue, and analog laboratory fabrication (LF) in red) of the different surgical guides. The Kruskal-Wallis test resulted in $p = 0.44$.

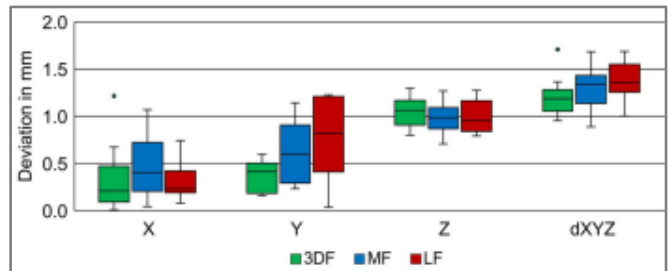


Fig. 10: Box plot of the linear (X, Y, Z) and spatial deviations (dXYZ) at the implant apex in relation to the different manufacturing processes (3D-printed fabrication (3DF) in green, milled fabrication (MF) in blue, and analog laboratory fabrication (LF) in red) of the different surgical guides. The Kruskal-Wallis test resulted in $p = 0.22$.

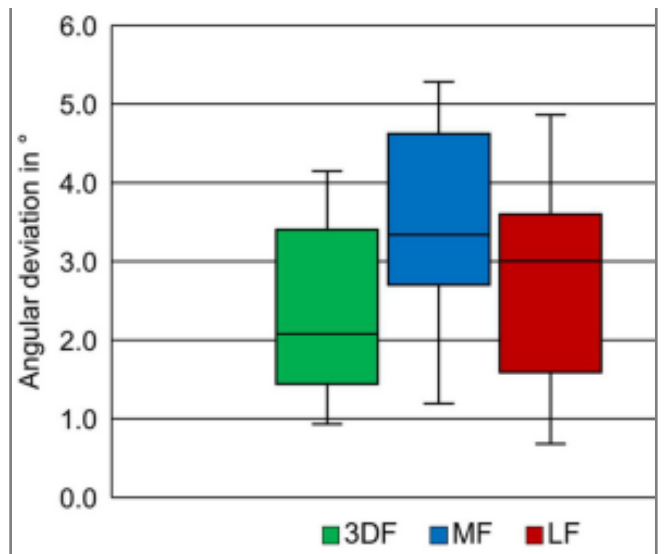


Fig. 11: Angular deviations of the implants depending on the manufacturing process of the surgical guide (3D-printing fabrication (3DF) in green, milled fabrication (MF) in blue, and analog laboratory fabrication (LF) in red). The Kruskal-Wallis test resulted in $p = 0.17$.

	Median			Q1			Q3			IQR			Minima			Maxima		
	3DF	MF	LF	3DF	MF	LF	3DF	MF	LF	3DF	MF	LF	3DF	MF	LF	3DF	MF	LF
X-axis shoulder (mm)	0.05	0.15	0.13	0.02	0.07	0.07	0.19	0.26	0.23	0.17	0.19	0.16	0.02	0.05	0.01	0.80	0.35	0.53
X-axis apex (mm)	0.21	0.40	0.23	0.09	0.20	0.19	0.47	0.72	0.42	0.38	0.52	0.23	0.01	0.04	0.08	1.22	1.07	0.74
Y-axis shoulder (mm)	0.08	0.15	0.38	0.01	0.00	0.22	0.15	0.45	0.58	0.14	0.45	0.36	0.01	0.00	0.07	0.17	0.66	0.63
Y-axis apex (mm)	0.41	0.59	0.82	0.18	0.30	0.41	0.50	0.91	1.21	0.32	0.61	0.80	0.16	0.23	0.04	0.60	1.14	1.23
Z-axis shoulder (mm)	1.04	0.95	0.95	0.86	0.80	0.82	1.14	1.06	1.17	0.28	0.26	0.35	0.77	0.68	0.80	1.29	1.20	1.26
Z-axis apex (mm)	1.06	0.98	0.95	0.91	0.87	0.84	1.17	1.09	1.16	0.26	0.22	0.32	0.80	0.71	0.79	1.29	1.27	1.27
dXYZ-shoulder (mm)	1.08	0.98	1.07	0.95	1.06	1.11	1.25	1.36	1.51	0.30	0.30	0.40	0.79	0.76	0.84	1.32	1.26	1.32
dXYZ-apex (mm)	1.19	1.34	1.35	1.05	1.14	1.26	1.28	1.43	1.55	0.23	0.29	0.29	0.95	0.89	1.00	1.71	1.68	1.69
Angle° (degrees)	2.1	3.3	3.0	1.4	2.7	1.6	3.4	4.6	3.6	2.0	1.9	2.0	0.9	1.2	0.7	4.2	5.3	4.9

Tab. 1: Results of transfer accuracy of templates for guided oral Implants based on different manufacturing types. Note: The significance level was set to a p-value of 0.05. p-Value (X, Y, Z) at implant shoulder was p=0.44 at implant apex (p=0.22) and for the angles (p=0.17). Abbreviations: 3DF, 3D-printed fabrication; LF, laboratory fabrication; MF, milled fabrication; SD, standard deviation

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Reference:

Sium-Abel A, Keilig L, Dörsam I, Bourauel C. Accuracy of template-based guided dental implant placement-An in vitro comparison of different manufacturing methods. Clin Oral Implants Res. 2024 Apr 17. doi: 10.1111/clr.14272. Epub ahead of print. PMID: 38629760.

Aura Sium-Abel. Übertragungsgenauigkeit von Bohrschablonen unterschiedlicher Herstellungsart auf die Implantatposition – Eine in vitro-Studie (Inaugural-Dissertation), 2024, Rheinische Friedrich-Wilhelms-University Bonn

2.b.1 Micro-computed tomography analysis of mineral attachment to the implants augmented by three types of bone grafts: An experimental study in dogs

M. Gholami^{1,2}; F. Ahrari³; H.S. Sedigh⁴; C. Bourauel²; Mashhad University of Medical Sciences, Mashhad, Iran / University Hospital of Bonn, 2023

Objective:

This study compared the effect of various grafting materials on the area and volume of minerals attached to dental implants.

Material and Methods:

In this animal study, 13 dogs were divided into three groups according to the time of sacrificing (2 months, 4 months, or 6 months). The implants were placed in oversized osteotomies, and the residual defects were filled with autograft, bovine bone graft (Cerabone®), or a synthetic substitute (Osteon™ II). At the designated intervals, the dogs were sacrificed and the segmented implants underwent micro-computed tomography analysis. The bone-implant area (BIA) and bone-implant volume (BIV) of bone and graft material were calculated in the region of interest around the implant. The data were analyzed by two-way analysis of variance (ANOVA) at $P < 0.05$.

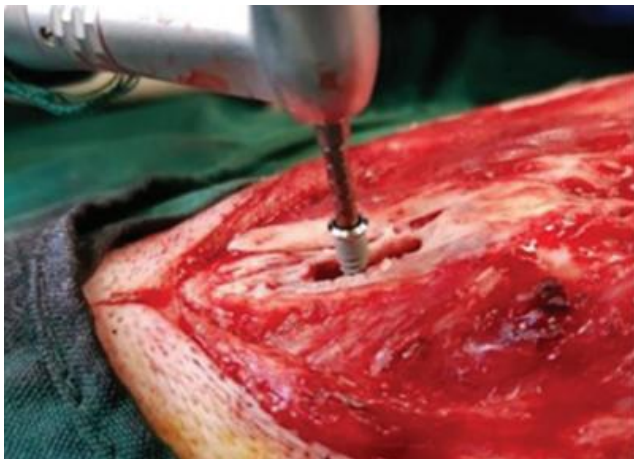


Fig. 1: Placement of an implant at the center of the osteotomy defect.

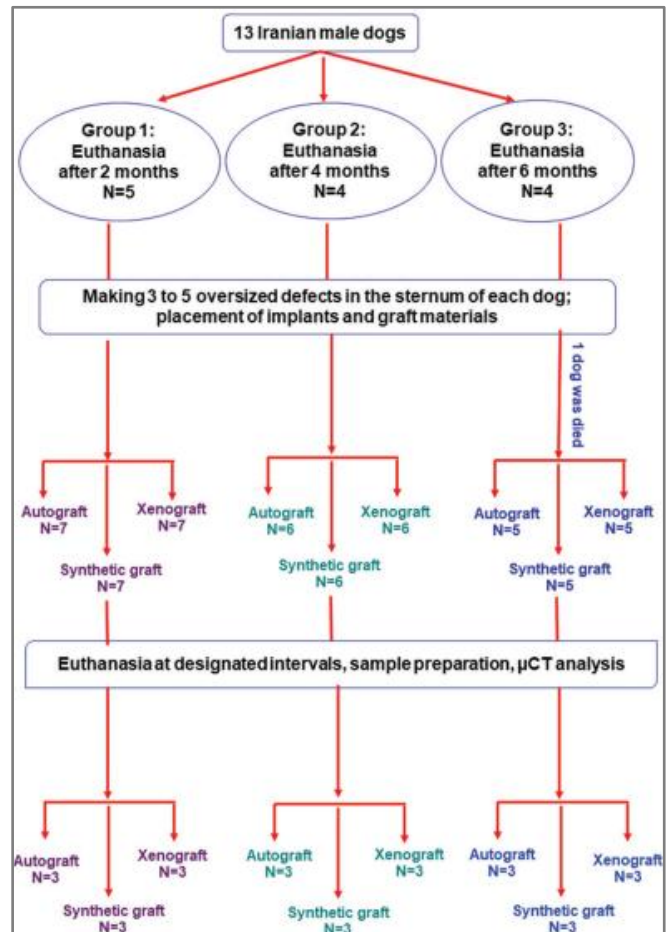


Fig. 2: A flowchart of the methodology. Three representative samples were selected for micro-computed tomography (μCT).

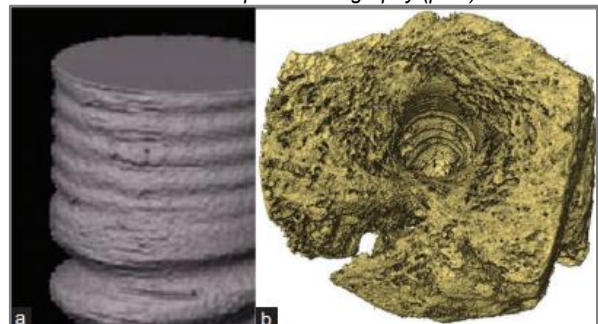


Fig. 3: The three-dimensional reconstruction by micro-computed tomography for a sample retrieved after concurrent implantation and grafting procedure by deproteinized bovine bone mineral (cerabone®). (a) Inside section (fixture view). (b) Outside section (bone and graft view).

Results:

There was no significant difference in BIA and BIV between the healing intervals for any of the grafting materials ($P > 0.05$). ANOVA exhibited comparable BIA and BIV between the grafting materials at 2 and 4 months after surgery ($P > 0.05$), although a significant difference was observed after 6 months ($P < 0.05$). Pairwise comparisons revealed that BIA was significantly greater in the autograft-stabilized than the synthetic-grafted sites ($P = 0.035$). The samples augmented with autograft also showed significantly higher BIV than those treated by the xenogenic ($P = 0.017$) or synthetic ($P = 0.002$) particles.

Conclusion:

All graft materials showed comparable performance in providing mineral support for implants up to 4 months after surgery. At the long-term (6-month) interval, autogenous bone demonstrated significant superiority over xenogenic and synthetic substitutes concerning the bone area and volume around the implant.

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Reference:

Gholami M, Ahrari F, Sedigh HS, Bourauel C. *Micro-computed tomography analysis of mineral attachment to the implants augmented by three types of bone grafts: An experimental study in dogs.* Dent Res J 2023; 20:100

Group	Mean±SD (%)			Statistical significance (P)
	2 months	4 months	6 months	
Graft material				
Autograft	29±8	58±15	56±4 ^a	0.123
Xenograft	39±1	28±14	46±4 ^{a,b}	0.167
Synthetic graft	37±4	41±2	37±1 ^b	0.488
Statistical significance (P)	0.329	0.147	0.039*	

Tab. 1: The mean (%) and standard deviation of the bone implant area variable (BIA = the percentage of bone and graft area per total implant area) according to the grafting materials and healing intervals. *A statistically significant difference at $P < 0.05$. Different superscript letters indicate statistical significance among the grafting materials. SD: Standard Deviation

Group	Mean±SD (%)			Statistical significance (P)
	2 months	4 months	6 months	
Graft material				
Autograft	38±14	60±5	63±2 ^a	0.127
Xenograft	43±1	31±14	52±2 ^b	0.125
Synthetic graft	42±4	51±4	40±1 ^c	0.121
Statistical significance (P)	0.819	0.078	0.002*	

Tab. 2: The mean (%) and standard deviation of the bone implant volume variable (BIV = the percentage of bone and graft volume per total volume) according to the grafting materials and healing intervals. *A statistically significant difference at $P < 0.05$. Different superscript letters indicate statistical significance among the grafting materials. SD: Standard Deviation

2.c.1 Clinical, radiographical and histological evaluation of alveolar ridge preservation with an autogenous tooth derived particulate graft in EDS class 3-4 defects

Z. Radoczy-Drajko; P. Windisch; E. Svidro; P. Tajti; B. Molnar; G. Gerber; Semmelweis University, Budapest, Hungary, 2021

Introduction:

The shrinkage of alveolar bone dimensions after tooth extraction is a well-known issue. This clinical phenomenon poses a challenge for clinicians aiming at implant-prosthetic treatment. BonMaker® ATB is a novel autogenous bone grafting material, produced by the mechanical and chemical processing of natural teeth.

Objective:

This pilot case report aims at providing a clinical, radiographical, and histological evaluation of the safety and efficacy of BonMaker® ATB powder in the treatment of EDS class 3–4 postextraction sockets with alveolar ridge preservation.

Material and Methods:

5 patients aged 18–70 with good general health and proper individual oral hygiene (confirmed by full mouth plaque and bleeding scores below 20%) underwent initial periodontal treatment prior to tooth extraction [Suvan *et al.* 2000], followed by ARP utilizing ATB and a free gingival graft (FGG).

A total of 9 teeth were extracted from 5 patients. The exclusion criteria were: major relevant clinical diseases, untreated periodontal disease, systemic use of steroids, current or previous intravenous bisphosphonate treatment, chronic or acute periapical infection at the operation site, and previous GBR/GTR treatment at the extraction site.

Each patient presented at least one single rooted tooth scheduled for extraction. All enrolled patients were examined by two independent periodontists to assure that the teeth scheduled for extraction were hopeless. Standardized intraoral X-rays and CBCT scans (Fig. 1a, b) were taken preoperatively at the sites of interest. Hard tissue dimensions and alveolar socket dimensions were measured in the CBCT images preoperatively.

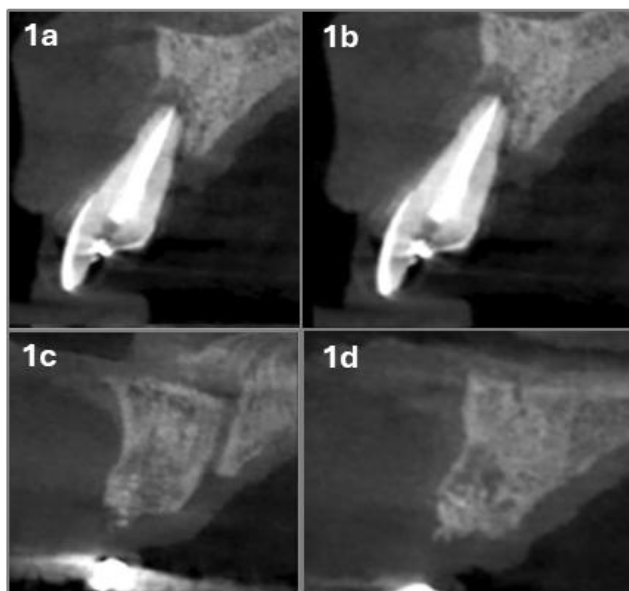


Fig. 1: Baseline CBCT-Scan (Baseline [BL], a+b) / postoperative after 6 Months [p.o. 6M], before re-entry, c+d) of upper middle incisors, (a) upper right first incisor, BL (b) upper left first incisor, BL (c) upper right first incisor, p.o. 6M (d) upper left first incisor, p.o. 6M

ARP = Alveolar ridge preservation; ATB = Autogenous Tooth Bone Graft, FGG = Free Gingival Graft,

The extracted teeth were prepared immediately with the BonMaker® device. The extraction sockets were filled up with ATB powder. Six months after extraction, standardized intraoral x-rays and CBCT scans were performed (Abb. 1c, d). Re-entry was performed under local anaesthesia.



Fig. 2: (a) Alveolar ridge preservation was carried out with the disinfected auto-tooth bone graft (BonMaker®, Korea Dental Solutions Co. Ltd., South Korea), (b) Post extraction sockets covered with FGG transplants, (c) 6-month postoperative view, before re-entry

Core biopsies were harvested for histological analysis and implants were placed.

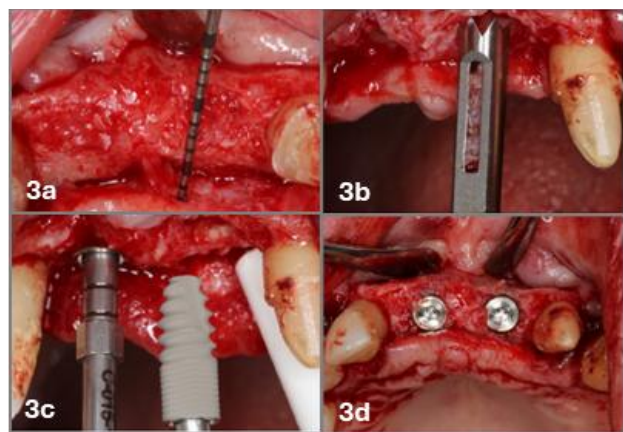


Fig. 3: (a) Intraoperative picture before histological sample harvesting, (b) Histological sample harvesting with trephine burs, (c) Implant placement (ICX®, medentis medical GmbH, Deutschland) after the histological harvesting, (d) Implants in final position.

Results:

Horizontal alveolar dimension loss occurred, even though ARP was performed, but the horizontal shrinkage was moderate. Vertical dimensions did not show loss of volume, but increased defect fill. Core biopsies showed ATB particles surrounded by newly formed bone and connective tissue.

According to histomorphometric analysis, the harvested samples contained 56% of newly formed bone on average, and only a mean of 7% of non-remodelled ATB material was observed.

Conclusion:

The preliminary clinical, radiographical, and histological results of Bonmaker® autogenous tooth graft therapy indicate that ATB may be safely and successfully used as a grafting material for ARP. Optimal graft incorporation and histologically proven effective remodelling, as well as uneventful wound healing support the clinical application of ATB to minimize post-extraction hard tissue loss. Further research is needed to exploit the full potential of ATB and to evaluate the long-term peri-implant hard and soft tissue stability of ATB-treated post-extraction sites.

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Reference:

Radoczy-Drajko Z, Windisch P, Svidro E et al. Clinical, radiographical and histological evaluation of alveolar ridge preservation with an autogenous tooth derived particulate graft in EDS class 3–4 defects. *BMC Oral Health* 21, 63 (2021). <https://doi.org/10.1186/s12903-021-01429-y>

2.c.2 Influence of implant cover screw loosening on early peri-implant marginal bone loss: a retrospective evaluation of risk factors

Dr. Wuwei Yin and Dr. Yong Yang; Guangdong Province Stomatological Hospital, 2021

Objective:

This study aimed to evaluate the risk factors of cover screw loosening (CSL) and its influence on peri-implant marginal bone during early bone healing process.

Material and Methods:

A total of 91 implants in 90 patients (75 normal patients and 15 patients with CSL) were included in this study. Panoramic radiographs were taken for the measurement of peri-implant marginal bone loss (MBL). A piece of soft tissue above the cover screw during the second-stage surgery was taken for pathological examination. The differences between the two groups were evaluated and the possible risk factors associated with CSL were analyzed.

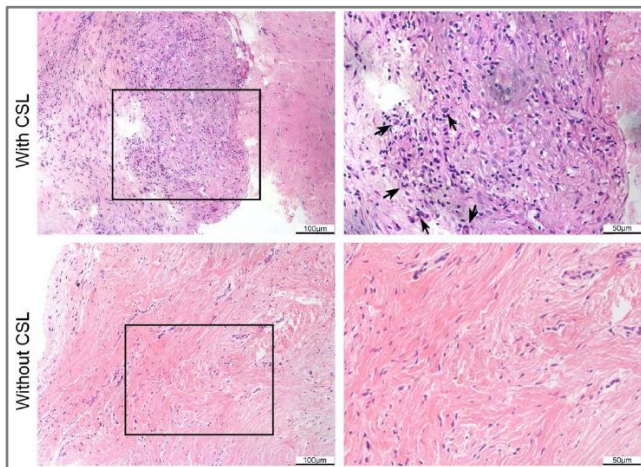


Fig. 1: Histological analysis of peri-implant soft tissue. Inflammatory granulation around loose cover screws was infiltrated with inflammatory cells (arrows).

Results:

Increased frequency of CSL showed significant association with maxillary region ($p=0.038$). The mean MBL at implants with CSL was 0.82 ± 0.56 mm, and it was 0.22 ± 0.20 mm at normal implants ($p < 0.001$). The inflammatory granulation tissue around the loose cover screws showed infiltration of a large number of inflammatory cells.

Parameters	Without CSL	Revealing CSL	<i>p</i>
Age (years)			
Mean (SD)	40.2 (14.0)	43.0 (12.4)	
Range	20–73	23–64	
Median	37.0	44.0	
Agegroups			
18–25	13 (17.3%)	1 (6.7%)	
26–35	20 (26.7%)	5 (33.3%)	
36–49	24 (32.0%)	3 (20.0%)	
50–59	10 (13.3%)	5 (33.3%)	
60–69	6 (8.0%)	1 (6.67%)	
≥ 70	2 (2.7%)	0 (0.0%)	
Total	75	15	0.399
Gender			
Female	50 (66.7%)	11 (60.0%)	
Male	25 (33.3%)	4 (40.0 %)	0.614

Tab.1: Demographic parameters of included patients.

Conclusion:

CSL during healing process is associated with early peri-implant MBL. The location of the maxilla is considered as a significant risk factor for CSL.

Parameters	p	Remarks		
Maxilla/mandible	0.038		Without CSL	Revealing CSL
		Maxillary sites	20 (26.3%)	8 (50.0%)
		Mandibular sites	56 (73.7%)	7 (50.0%)
Implant system	0.482			
		SiCace*	36 (47.4%)	5 (33.3%)
		Astra Tech†	19 (25.0%)	6 (40.0%)
		ICX‡	17 (28.3%)	4 (26.7%)
		Zimmer T3§	4 (5.3%)	0 (0.0%)
Cover screw designs				
Connection type	0.318			
		Conical connection	40 (52.6%)	10 (66.7%)
		Without conical connection	36 (47.4%)	5 (33.3%)
Diameter of screw stem	0.355			
		1.5mm	40 (52.6%)	5 (33.3%)
		1.75mm	17 (22.4%)	4 (26.7%)
		2.0mm	19 (25.0%)	6 (40.0%)
Height of cover screw	0.939			
		Higher than the implant platform	55 (72.4%)	11 (73.3%)
		Flush with the implant platform	21 (27.6%)	4 (26.7%)
Vertical mucosal thickness	0.369			
* SiCace implants (SiC invent, Switzerland)				
† Astra Tech implants (Dentsply, Sweden)				
‡ ICX implants (medentis medical GmbH, Germany)				
§ Zimmer T3 implants (Zimmer Biomet, USA).				

Tab. 2: Assessment of factors associated with cover screw loosening at implant level.

Parameters	p	Remarks		
		> 2mm	27 (35.5%)	3 (20.0%)
		≤ 2 mm	49 (64.5%)	12 (80.0%)
* SiCace implants (SiC invent, Switzerland)				
† Astra Tech implants (Dentsply, Sweden)				
‡ ICX implants (medentis medical GmbH, Germany)				
§ Zimmer T3 implants (Zimmer Biomet, USA).				

Tab. 3: Peri-implant marginal bone loss

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Reference:

Yin Wuwei, Yang Yong, Wu Zhenzhen et al. *Influence of implant cover screw loosening on early peri-implant marginal bone loss: a retrospective evaluation of risk factors*, 24 February 2021, PREPRINT (Version 1) available at Research Square [https://doi.org/10.21203/rs.3.rs-223040/v1]

2.c.3 Preoperative CBCT-guided Bone Regeneration Combined with Concentrated Growth Factor Applied in the Implantation of Maxillary Teeth with Insufficient Bone Mass

B. Men; H. Yang, Jie Zhang, Dazhong Stomatological Hospital, Wuhan, China, 2022

Objective:

Aim of this retrospective study was to explore the application effect of cone beam computed tomography (CBCT) guided bone regeneration (GBR) combined with concentrated growth factor (CGF) in the implantation of maxillary teeth with insufficient bone mass.

Material and Methods:

Overall clinical data of 78 patients (53 men and 25 women, age: 21-68 years, $\bar{X}$ 35.4 $\pm$ 8.3 years; $\bar{X}$ BMI 22.42 $\pm$ 2.41 kg/ m²; 95 Implants, 8 ICX® implants; Survival rate: 97,4 %) with single maxillary anterior tooth loss and labial alveolar defects from Dazhong Stomatological Hospital were retrospectively analyzed and randomly divided into groups A and B.

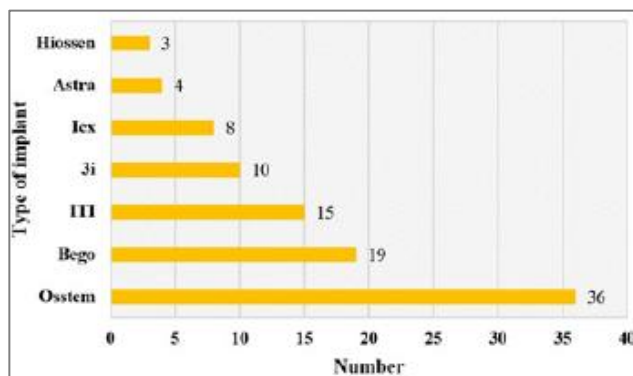


Fig. 1: Patient's implants statistics

Both groups were treated with surgical methods of GBR at the same time of implantation.

Group A: CGF fibrin fluid and Bio-Oss® bone powder, covered with CGF membrane on the surface to guide bone regeneration. **Group B:** Bio-Oss® bone powder was implanted and covered with Heal All collagen biofilm.

The horizontal bone width, keratinized gingival width, bone plate thickness, implant margin results, and alveolar ridge width were analyzed at 3 and 6 months before and after the operation in both groups.

Results:

6 months after the operation, the difference in the indexes between the two groups was evident; and in group A, the indexes had an obvious difference in contrast with those before operation; the healing rate of soft tissue was 100% in group A and 80% in group B, which was significantly different ($P < 0.05$).

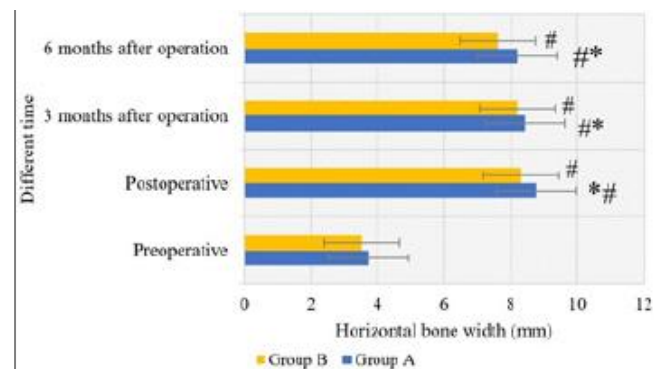


Fig. 2: CBCT measurement results of horizontal bone width at different time points in the two groups. (Note: * means the evident difference between two groups, $P < 0.05$; # means obvious difference between two groups at 3 and 6 months after the operation and before the operation, $P < 0.05$).

Conclusion:

Preoperative CBCT GBR combined with CGF can promote the bone formation content of guided regeneration of bone defects in the maxillary teeth region.

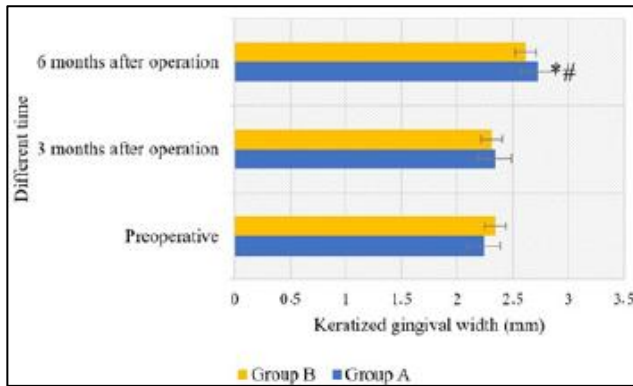


Fig. 3: Comparison of keratinized gingival width between the two groups.

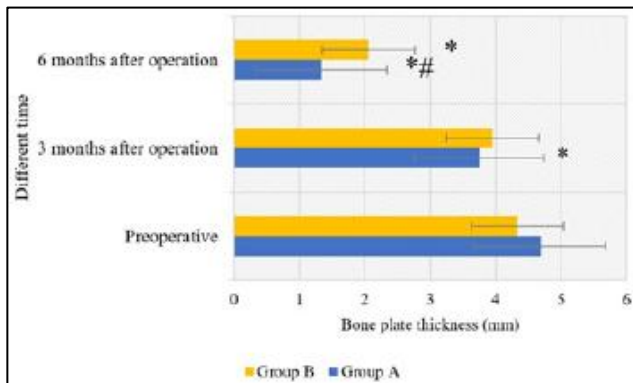


Fig. 4: Comparison of bone plate thickness between the two groups.

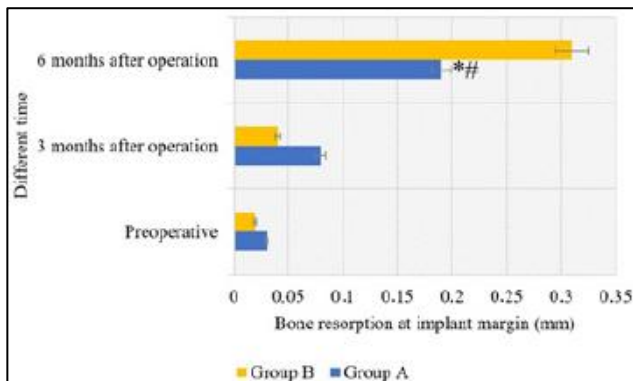


Fig. 5: Analysis of implant margin results in the two groups.

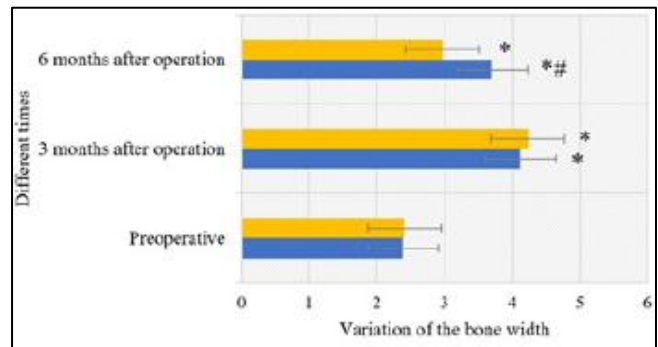


Fig. 6: Comparison of alveolar ridge width between the two groups.

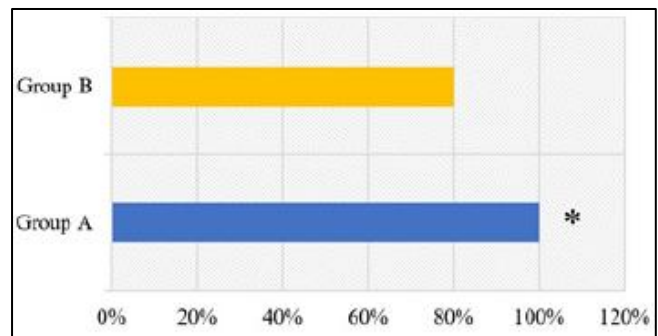


Fig. 7: Comparison of healing rate between the two groups



Fig. 8: Different surgical procedures and CBCT images. (A: CBCT guide plate positioning; B: plane diameter measurement, red indicates the measurement range; C: postoperative CBCT image).

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Reference:

Men B, Yang H, Zhang J. Preoperative CBCT Guided Bone Regeneration Combined with Concentrated Growth Factor Applied in the Implantation of Maxillary Teeth with Insufficient Bone Mass. Cell Mol Biol (Noisy-le-grand). 2022 Dec 31;68(12):68-73. doi: 10.14715/cmb/2022.68.12.13. PMID: 37130178.

2.c.4 Removal of Horizontally Displaced Dental Implant below the Mandibular Canal

K.A. Fakih; M. Stiliyanova Edreva; B.B. Stoichkov; Medical University Sofia, Bulgaria, 2022

Case Presentation:

A 36-year-old patient accompanied with his dentist visited the Denta Puls Clinic (Sofia, Bulgaria) on January 17, 2020 for an emergency. According to their anamnestic data, an attempt was made to place two implants (ICX®-Premium, Medentis Medical GmbH, Bad Neuenahr-Ahrweiler, Germany, 4.1 mm x 8.0 mm) in the distal area of the right mandible (teeth #46 and 47). A two-stage surgical protocol for implantation was performed using a mucoperiosteal flap elevation. The bleeding had been extensive. Two osteotomies were performed in the lower right molars. After the machine-driven insertion of the first implant in the first lower right molar (tooth #46), the bleeding continued. During the placement of the second implant, using machine-driven insertion, the implant "sunk and disappeared in the bone" in the area of the second lower right molar (tooth #47), causing an increase of bleeding. Therefore, the surgical procedure was terminated, and the patient was brought to the clinic.

During the clinical examination (1) it was found that there was a freely un-adapted mucoperiosteal flap; (2) profuse bleeding in the area of placement of the second implant and in adjacent soft and bone tissues; and (3) an uncovered bone at the site of surgery. The CBCT examination revealed the presence of one vertically positioned implant in the area of tooth #46 and one horizontally displaced implant below the level of the mandibular canal (Fig. 1). The bleeding was stopped urgently without removing the displaced implant under local anesthesia [inferior alveolar nerve (IAN) block]. Lavage and debridement of the wound were made and at and around the site of the displaced implant, an absorbable oxidized cellulose gauze (Gelita-Cel® Standard, Gelita Medical GmbH, Eberbach, Germany) moisturized with Etamsylate, 250 mg/2 mL (Dicynone®, Sanofi Winthrop Industrie, Paris, France) was used as local hemostatic.

The flap was adapted and sutured tightly. Additionally, two ampules of Etamsylate, 250 mg/2 mL were administered intramuscularly to control and prevent possible postoperative bleeding. The hemorrhage was stopped completely. Amoxicillin (875 mg) and clavulanic acid (125 mg) were administered twice daily, along with (calcium carbonate, vitamin K2, and vitamin D3) 2x1 tablets of Kalcikine for 10 days, as antibacterial and hemostatic therapy.

A blood test was conducted immediately after surgery. The indicators related to the hematological status of the patient were examined. Based on their reference values, no abnormalities were found. This was also confirmed following consultation with a hematologist. The case was monitored under outpatient conditions till the 10th day when the sutures were removed. There were no complications during the postoperative period. The patient had no sensory disorders. The surgical procedure for removal of displaced implant was planned at the end of February 2020.

The patient lived abroad and there were strict epidemic restrictions (including travel and elective surgery) related to COVID-19 pandemic; thus, the surgery was postponed until the epidemic measures were relieved. These restrictions were partially removed in July 2020. After 7 months, the surgery was scheduled to remove the implant, and the patient provided the relevant consent. The operations goals were as follows:

1. To determine the condition and stability of the implant in the first lower right molar (tooth #46).
2. Removal of the displaced dental implant in the second lower right molar (tooth #47).
3. To prevent damage to the neurovascular bundle of the mandible during surgery

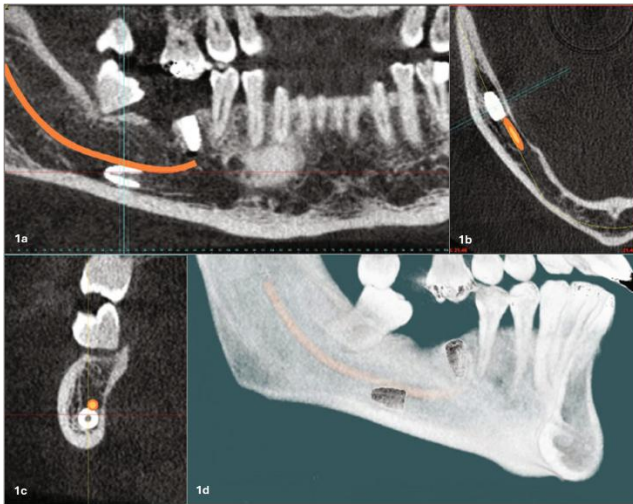


Fig. 1a-d: CBCT after implant dislocation. (a) Reformatted panoramic image. (b) Axial reconstruction. (c) Sagittal reconstruction. (d) 3D reconstruction of the mandible (lingual view). All images show that the implant is located below the level of the mandibular canal.

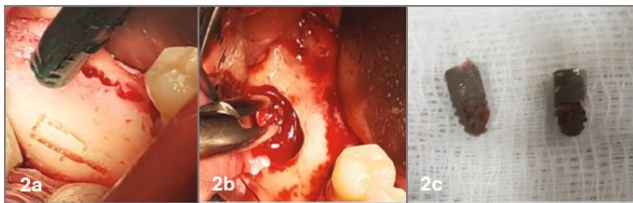


Fig. 2a-c: (a und b) Stages of operation to remove the dislocated implant. (c) The removed implants

Conclusion:

The displacement of the dental implant below the level of the mandibular canal during implantation can be a severe complication. Its removal requires the safest surgical approach to avoid damaging the inferior alveolar nerve. The description of one clinical case does not provide grounds for drawing definite conclusions.

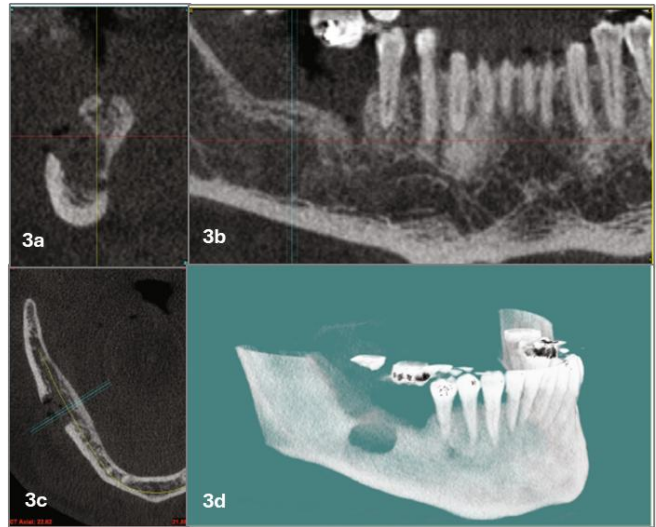


Fig. 3a-d: CBCT after implant removal. (a) Sagittal reconstruction. (b) Reformatted panoramic image. (c) Axial image. (d) 3D reconstruction

Multiple reasons can influence the implant displacement. Besides, the proven unfavorable bone morphology, low bone density at the site of the osteotomy (265.32 ± 86.41 , Hounsfield Units), overpreparation of the implant site, and high pressure during implant insertion, and the impaired visibility due to inadequate bleeding control during the surgery also contributed.

To avoid similar incidents, detailed radiographic assessment before implantation is necessary; it is also important to follow the surgical protocols of implant placement into soft bone and to create conditions for a good visibility and sufficient control of bleeding during surgery.

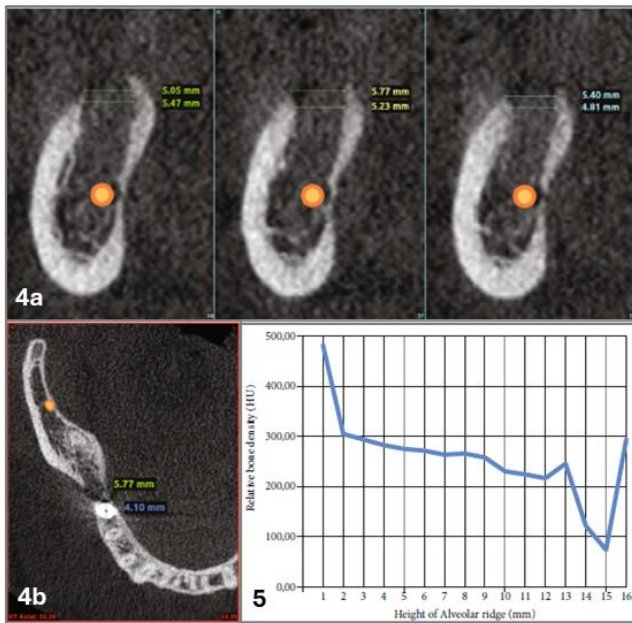


Fig. 4: CBCT data after implant displacement. **(a)** (left) Vertical cuts. **(b)** (right) Axial reslice. Measurements of the implant bed at the site of displaced implant. The data show that the osteotomy dimensions are significantly larger than the diameter of the implant used. The lower border could not be determined. **Fig. 5:** Distribution of relative bone density considering height of the alveolar ridge, next to the osteotomy area. The sharp decrease in bone density from the 13th to 15th mm corresponds to the position of the mandibular canal.

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Reference:

Fakih KA, Edreva MS, Stoichkov BB. Removal of a Horizontally Displaced Dental Implant below the Mandibular Canal. Case Rep Dent. 2023 Mar 24; 2023:6663874. doi: 10.1155/2023/6663874. PMID: 37006703; PMCID: PMC10065860

Supporting Materials:

A PDF file (Additional_Information-from-the-bone_densityexamination.pdf) contains 22 CBCT axial images with measurements of the bone density in the distal adjacent area of the osteotomy and a table describing the exact positions and values of the traced indicators. (Supplementary Materials: <https://downloads.hindawi.com/journals/crid/2023/6663874.f1.pdf>)

2.c.5 Complication management of membrane perforation during external sinus lift

Dr. med. dent. Sandro Strößner; Weissenfels, 2023

Introduction:

External sinus lift is a predictable surgical procedure for bone augmentation in the maxillary sinus. However, there are known and well-documented complications that can occur. The most common intraoperative complications include perforation of the sinus membrane and bleeding. In this case, the possibility of intraoperative perforation coverage in a single-stage sinus lift and the subsequent prosthetic restoration are shown in detail.

Objective:

The practical procedure for an external sinus lift is described below using a case study. A 60-year-old female patient presented to our practice with non-preservable 27 and 28 and the desire for a fixed prosthesis in region 27. After extraction of 27 and 28, the free-end situation in the maxilla on the left was to be restored with an implant. We planned an external sinus lift and a single-stage procedure with a residual bone height of approx. 5 mm in region 27 based on the DVT and an intraoral scan of the initial situation (Figs. 1, 2).



Fig. 1: Initial OPG.

In terms of backward planning and a standardized workflow the implantation should be performed template-guided for optimal positioning of the implant. Implant position, diameter and implant axis were planned on the PC using the ICX®-Magellan X software (medentis medical GmbH, Bad Neuenahr/Ahrweiler, Germany).

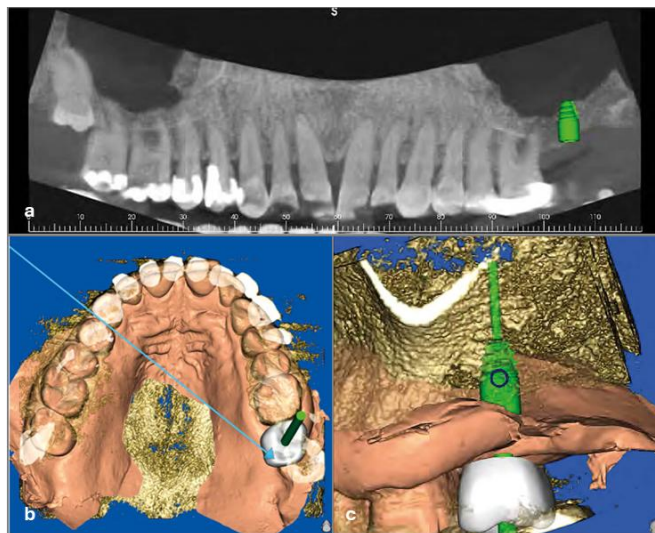


Fig. 2a-c: (a) Planning implant 27 - OPG reconstructed from CBCT data. (b) Backward planning - CBCT and IO scan matched, planned crown from occlusal. (c) Backward planning - CBCT and IO scan matched, planned crown from lateral.

Material and Methods:

In the first step, a mucoperiosteal flap was created to expose the lateral maxillary sinus wall via a crestal alveolar ridge incision in the area of the linea alba. To ensure a good overview, an intrasulcular extension of the flap mesially to region 24 was sufficient. Vertical incisions were not necessary. The bone window in region 27 was then prepared using rotary instruments.

After careful loosening of the Schneiderian membrane, an approx. 3 mm large perforation occurred. The Schneiderian membrane was mobilized further - mesially, distally and up to the medial maxillary sinus wall. This step is crucial. If there is insufficient visibility of the perforation, the lateral bone window may also need to be widened until the perforation is completely visible. The use of piezosurgical instruments is particularly helpful for perforations of the membrane, as they make it much easier to detach the membrane from the bone and also ensure a very good view of the surgical site thanks to constant irrigation with saline solution. Next, the perforation was covered with a Jason® membrane 15 x 20 mm (Straumann GmbH) and a PRF membrane.

The drill guide was then prepared using a template up to a drill diameter of 3.75 mm (ICX®, medentis medical GmbH, Bad Neuenahr/Ahrweiler, Germany) due to the soft bone (D4 according to Misch). The underpreparation of the drill collar achieves greater primary stability during implant placement. The bone substitute material (Straumann XenoGraft®) was mixed with autologous bone (50 %, Safescraper) and PRF (10 %) and inserted into the sinus.

A mixture of 50 % autogenous bone and 50 % xenogenic bone substitute material has a higher volume stability than pure bone and is considered the gold standard. The implant was then inserted (4.1 x 8 mm ICX®-Premium, medentis medical GmbH, Bad Neuenahr/Ahrweiler, Germany) very slowly and gently (Fig. 3). Slow insertion of the implant keeps the temperature of the bone low and contributes to osseointegration. During this process, the augmentation material is displaced and the Schneiderian membrane is raised a little further. Care must be taken here to avoid putting too much strain on the membrane. The implant was fitted with a cover screw for closed healing.

At the end of the operation, the lateral bone window was covered with another Jason® membrane. This was followed by a periosteal incision for further mobilization of the flap and fixation using sutures (Supramid® 4.0). The suture closure should be particularly tension-free, also with regard to postoperative swelling.



Fig. 3: OPG after final restoration.

After four months, the implant was exposed with an intraoral scan of the implant position and insertion of a gingiva former. A long-term temporary restoration to shape the emergence profile (PMMA crown on TiBase) was then fabricated using the InLab software (Sirona) and inserted.

After four weeks, another scan of the emergence profile was performed and the final restoration made of zirconium oxide (Katana™ Zirconia YML, Kuraray Noritake Dental Inc.) was fabricated and screwed into the mouth with a TiBase. The screw channel was then adhesively sealed with Teflon, Prime&Bond Uni and Ceram.

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Reference:

Strößner S. Komplikationsmanagement einer Membranperforation beim externen Sinuslift. Praktische Implantologie und Implantatprothetik | pip 1 | 2023. <https://frag-pip.de/fallstudie/komplikationsmanagement-membranperforation-externen-sinuslift/>

2.c.6 Cross-sectional analysis comparing prefabricated titanium to individualized hybrid zirconia abutments for cemented zirconia based fixed dental prostheses: a critical concept assessment

N. Neckel^{1*}; J. Pohl¹; S. Preissner¹, O. Wagendorf¹; C. Sachse¹; K. Vach²; M. Heiland¹; S. Nahles¹,
Charité-Universitätsmedizin Berlin 2024

Introduction:

Despite the differences in material properties and shapes among the different types of prefabricated titanium (pTiA) and individualized hybrid zirconia abutments (ihZiA), the biological and clinical relevance of materials and construction features remains vague. Yet, individualized ihZiA are increasingly implemented into daily routine aiming to satisfy rising expectations.

Objective:

The objective was to compare these two types of abutments in fixed dental prostheses (FDP).

Material and Methods:

This cross-sectional study examined 462 implants in 102 patients comparing pTiA (52 patients) to ihZiA (50 patients) for FDP.

All patients (n=102) included in the study had received implant-based cemented zirconia FDP from 2014 to 2016 mirroring the change in the general prosthetic concept from pTiA (until 2015) to hybrid zirconia abutments ihZiA (after 2015). The same surgeon and prosthodontist treated all patients (JP). Anamnestic data such as age, sex, opposing teeth/prosthetics, alcohol consumption, smoking, diabetes, medication, and the frequency of professional cleaning were documented, analyzed and accounted for as potential confounders. The patients were recruited in the context of the regular follow-up. All patients included had to be of full age (≥ 18 years) and gave informed consent to participate.

They had to have been restored with either pTiA ($\varnothing$ 5 mm with 4 or with a height of 7 mm, titanium grade 5 or 15° angled with a height of 7 mm, titanium grade 4, ICX® medentis medical GmbH, Bad Neuenahr-Ahrweiler, Germany) or ihZiA (yttrium stabilized zirconium oxide, Prettau®-Zirconia, Zirkonzahn GmbH, Gais, Italy bonded to a titanium (grade 5) base of $\varnothing$ 5,1 mm) supporting FDPs. Exclusion criteria were incapacity or unwillingness to give informed consent, immediately loaded implants, single-tooth implants, screw-retained FDP, nonattendance to follow-up and insufficient completion of the questionnaires. Using the respective questionnaires, patient OH-QoL was measured via the Oral Health Impact Profile-Germany (OHIP-G) 14 and 49 scores which were analyzed separately. One hundred and sixty-five implants with pTiA restorations and 154 implants with ihZiA restorations were placed in the molar and premolar region, whereas 79 of the pTiA group implants and 64 of the ihZiA group implants were located in the anterior region from canine to canine.

The implants (ICX®-Premium line, medentis medical GmbH, Bad Neuenahr-Ahrweiler, Germany) were placed under local anesthesia (articaine solution with an adrenaline concentration of 1:100 000). All implants were inserted epicrestally, and patients received perioperative prophylactic antibiotic treatment with amoxicillin/clavulanic acid 875/125 mg (2x/d) for five days. Patients allergic to penicillin received clindamycin 300 mg (1–1-1).

The closed healing time was up to six months in the maxilla and up to three months in the mandible. In cases that required augmentation, grafting with bone blocks (autologous bone), or maxillary sinus floor augmentation (autologous bone and xenogenic material), the closed healing period was another three months. The prosthetic superstructure of the bridges was designed with specialized prosthetic planning software (Modellier, Zirkonzahn GmbH, Gais, Italy) and manufactured from zirconium oxide (Prettau® Zirconia, Zirkonzahn GmbH, Gais, Italy). The bridges were cemented with an adhesive and self-adhesive cement (Rely X™, Unicem 2, 3 M, Saint Paul, USA).

These different treatment regimens were evaluated in terms of peri-implant health, radiographic bone loss, and oral-health related quality of life (OH-QoL) with special consideration of abutment type and superstructure design.

Results:

ihZiA showed significantly different design features than prefabricated pTiA, but the annual bone loss in both groups did not. Visible titanium in the esthetic zone negatively impacted OHIP 14 scores.

Abutment type	pTiA	ihZiA	p-value
Visible titanium (mm)	0.38±0.8	0.06±0.3	0.0008
Implant length (mm)	10.56±1.4	10.72±1.3	0.412
Implant diameter (mm)	3.76±0.2	3.80±0.2	0.826
Mod. plaque index	1.07±1.2	1.25±1.4	0.139
Mod. bleeding index	1.29±1.6	1.39±1.7	0.784
Probing depth	2.72±0.7	2.74±0.5	0.954
Implant shoulder – crown margin (mm)	1.88±0.9	2.62±0.9	<0.0001
Ellipse circumference (mm)	13.76±1.3	19.06±1.9	<0.0001
Abutment shell surface	22.97±11.5	45.65±16.9	<0.0001
Abutment truncated cone angle (°)	108.34±9.7	102.32±6.9	<0.0001

Tab. 1: Mean±standard deviation in the two subgroups

The combination of an emergence angle (EA) of <30° and a concave emergence profile (EP) as well as gingiva thickness (p=0,002) at the time of the prosthetic restoration significantly improved the annual peri-implant bone loss, independently of the abutment type.

Conclusion:

ihZiA showed comparable results to pTiA. To optimize the long-term outcome, not just material alone but generating adequate soft tissue thickness, minimizing the EA, and applying a concave EP seem to be the most relevant factors. To improve OH-QoL, particular attention must be paid to the esthetic zone.

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Reference:

Neckel N, Pohl J, Preissner S, Wagendorf O, Sachse C, Vach K, Heiland M, Nahles S. Cross-sectional analysis comparing prefabricated titanium to individualized hybrid zirconia abutments for cemented zirconia based fixed dental prostheses: a critical concept assessment. *Int J Implant Dent.* 2024 Mar 18;10(1):13. doi: 10.1186/s40729-024-00529-y. PMID: 38498247; PMCID: PMC10948712.

Table 3a in vitro-Studies ICX®-Active Master

Study-No.	Page	Study Location / Year	Timepoint Follow-Up in Months	Number of Subjects	Number of Implants	Endpoint (Survival rate [%])
3.a.1	88	Waltrop / Izmir, Turkey / Witten Herdecke University, 2021 D. Krischik; S.E. Tokgöz; A. van Orten; A. Friedmann; H. Bilhan	-	In vitro	11	Percussion Test (Perio-Test), Resonance Frequency-Analysis (RFA, Mega ISQ)
		Study Observative / Study Title	An In-Vitro-Evaluation of Primary Stability Values of two Differently Designed Implants to Suit Immediate Loading in Very Soft Bone			
		Research Results / Evaluation	The results of this study indicate that the thread design of the implants and an undersized preparation of the implant bed are important for increasing implant stability, so that safe stability values for immediate loading can be achieved even in very soft bone.			

Table 3c: Retrospective Studies ICX®-Active Master

Study-No.	Page	Study Location / Year	Timepoint Follow-Up in Months	Number of Subjects	Number of Implants	Endpoint (Survival rate [%])
3.c.1	90	Private Dental Practice von Sternberg, Hamburg, 2019 Dr. Dr. N. von Sternberg	16	76	140 (Maxilla: 73 / Mandible: 67)	98,6 %
		Study Observative / Study Title	Retrospective Analysis of 140 ICX®-Active Master Implants – “One Implant for all Bone Qualities”			
		Research Results / Evaluation	Rehabilitation of the partially edentulous or edentulous maxilla or mandible with the ICX® Active Master Implant System in combination with the ICX® Magellan Drill Guide is a suitable and predictable treatment option for conservative procedures (implantation in the healed bone) in all bone qualities.			
3.c.2	92	Dental Group Practice for Dentistry Waltrop, 2021 A. Van Orten, M.Sc., M.Sc.	4	1	10	100 %
		Study Observative / Study Title	Stereolithographically Prefabricated Surgical Templates and Bridges - A User-friendly Immediate Care Concept			
		Research Results / Evaluation	With good preliminary planning, a very good long-term temporary restoration can be fabricated for the patient within a short period of time, which can be used as an immediate restoration if the implants have sufficient primary stability. The use of multi-abutments also simplifies the subsequent reconstruction phase for the definitive restoration and makes it more comfortable for the patient, as it is no longer possible to continue working at implant level but at mucosa level.			
3.c.3	94	Faculty of Medicine Masaryk University & Dental Clinic St. Anne, Brno Czech Republic; 2022 Ass. Prof. P. Prachar / Dr. I. Tresnak / doc MUDr. S. Bartáková, Ph.D.	24	230	500	100 %
		Study Observative / Study Title	First Clinical Experience with the ICX®-Active Master Implant System: a 3-year Retrospective Study			
		Research Results / Evaluation	The ICX®-Active Master implant system has also developed into a safe and suitable alternative in the field of implantology for immediate and delayed indications, including immediate loading.			
3.c.4	95	Dental Practice Peterke Cologne, 2022 Dr. med. dent. N. Peterke	18	1	1	100 %
		Study Observative / Study Title	Aesthetic Implant Restoration after Cyst Removal			
		Research Results / Evaluation	The treatment is still a great success one and a half years after the operation.			
3.c.5	97	Dental Clinic Jankowsky, Poland, 2024 T. Jankowski, MD, PhD	24	1	4	100 %
		Study Observative / Study Title	The Significance of Keratinized Mucosa in Implant Therapy: Narrative Literature Review and Case Report Presentation			
		Research Results / Evaluation	After two years of observation, despite questionable hygiene, no symptoms of gingival inflammation were detected. Furthermore, there is limited information in the literature regarding the correlation between inadequate keratinized gingiva and the occurrence of peri-implantitis.			

3.a.1 An In-Vitro-Evaluation of Primary Stability Values for Two Differently Designed Implants to Suit Immediate Loading in Very Soft Bone

D. Krischik; S. E. Tokgöz; A. van Orten; A. Friedmann; H. Bilhan; Waltrap /Izmir, Turkey /Witten Herdecke University, 2021

Introduction:

The achievement of sufficient implant stability in poor quality bone seems to be a challenge. Most manufacturers develop special dental implants, which are claimed to show higher stability even in very soft bone.

Objective:

The aim of this experimental study was to compare two recently introduced dental implants with differing thread designs in very soft bone. The implants used were the ICX®-Active Master-Implant (3,75 x 12,5 mm, medentis medical GmbH, Germany) and the Conelog® ProgressiveLine Implant (3,8 x 11 mm, Camlog GmbH, Germany).

Material and Methods:

A total of 11 implants of each group were inserted in the part of the fresh bovine ribs, corresponding to very soft bone.

The ICX®-Active Master-Implant was placed according to the standard drilling protocol for soft bone (Group A) and the Conelog® Progressive-Line Implant was placed according to two different protocols: the original drilling protocol for soft bone (Group B1) and the alternative (undersized) drilling protocol for very soft bone (Group B2). After insertion, 2mm high gingiva formers were connected to the implants and the primary stability was first determined using an electronic percussion test (Periotest® M, Medizintechnik Gulden, Germany).



Fig. 1: The part of the ribs which was similar to type 4 was used in the study. **Fig. 2:** For each protocol implants were placed into the selected bovine ribs with a safe distance to each other by the same clinician. The probe of the Osstell Mentor was held 1 mm from the peg at a 90-degree angle.

Magnetic pegs were then installed on the implants instead of the gingiva formers and a resonance frequency analysis (RFA, Mega ISQ implant stability meter, Megagen, Switzerland) was performed. The average of two measurements for each method and implant was used for the statistical analysis.

Results:

The stability measurements showed the following order from highest to lowest stability: ICX®-Active Master implants (Group A) showed the highest primary stability (RFA: 71.39 ± 8.92 ; Periotest: -5.45 ± 1.69), followed by the Conelog®-Progressive-Line implants placed in very soft bone according to the undersized drilling protocol (group B2) (RFA: 68.55 ± 6.67 ; Periotest: -3.84 ± 1.91). Conelog®-Progressive-Line implants placed according to the original drilling protocol (group B1), achieved the lowest primary stability values (RFA: 61.93 ± 4.33 and Periotest: -1.7 ± 1.92).

The statistical evaluation of the resonance frequency analysis showed that the primary stability of the implants in group A was significantly higher than that of the implants in group B1. Other comparisons of the RFA values between the three different groups revealed no significant differences. The statistical analysis of the percussion tests showed significantly lower values for the implants of group A compared to the implants of group B1. No significant differences were found in the other comparisons of the percussion tests either.

	Group A Mean ± SD	Group B1 Mean ± SD	Group B2 Mean ± SD	p
RFA	71.39 ± 8.92	61.93 ± 4.33	68.55 ± 6.67	0.0181
PERIOTEST	-5.45 ± 1.69	-1.7 ± 1.92	-3.84 ± 1.91	0.0031

Tab. 1: Statistical evaluation of the mean stability values of each drilling protocol with standard deviation. Kruskal-Wallis test. SD: Standard deviation, RFA: Resonance frequency analysis

	Group A Mean ± SD 71.39 ± 8.92	Group B1 Mean ± SD 61.93 ± 4.33	Group B2 Mean ± SD 68.55 ± 6.67
Group A-p value	-	0.0161	0.438
Group B1-p value	0.0161	-	0.0181
Group B2-p value	0.438	0.0181	-

Tab. 2: Mean and standard deviation of RFA values in paired comparison for all three protocols. Mann-Whitney U test (2-tailed).

	Group A Mean ± SD -5.45 ± 1.69	Group B1 Mean ± SD -1.7 ± 1.92	Group B2 Mean ± SD -3.84 ± 1.91
Group A-p value	-	0.0021	0.082
Group B1-p value	0.0021	-	0.0331
Group B2-p value	0.082	0.0331	-

Tab. 3: Mean and standard deviation of Periotest values in paired comparison for all three protocols. Mann-Whitney U test (2-tailed).

	Group A Periotest		Group B1 Periotest		Group B2 Periotest	
	<i>p</i>	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>	<i>r</i>
Group A RFA	0.00	−0.980 *				
Group B1 RFA			0.00	−0.916 *		
Group B2 RFA					0.00	−0.909 *

Tab. 4: Correlation between RFA and Periotest values for all three protocols. Spearman correlation test (2-tailed).

Conclusion:

The results of this study suggest that the thread design of the implants as well as underdimensioned implant bed preparation are important for increasing implant stability, so that even in very soft bone safe stability values for immediate loading can be reached, as shown for the implants in group A and B2.

Future studies might be conducted to focus on the different primary stability values for immediate loading *in vivo* experiments. Future studies may be designed as prospective cohort study in order to determine lowest and safest primary stability values on type 4 and even very soft bone.

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Reference:

Krischik D; Tokgöz SE; van Orten A; Friedmann A; Bilhan H. *An In Vitro Evaluation of Primary Stability Values for Two Differently Designed Implants to Suit Immediate Loading in Very Soft Bone*. Dent. J. **2021**, 9, 5. <https://doi.org/10.3390/dj9010005>

3.c.1 Retrospective Analysis of 140 ICX®-Active Master Implants- „One Implant for all Bone Qualities “

Dr. Dr. Norman von Sternberg, Hamburg, 2019

Introduction:

The treatment of edentulous or partially edentulous patients with endosseous implants is now an integral part of the treatment spectrum in dental practices.

In November 2017, medentis medical expanded its portfolio to include the ICX®-ACTIVE MASTER implant system, which combines the proven ICX® internal hexagon connection and surface properties with a new thread design. The ICX®-Active Master implant is characterized by a compression thread, a tapered implant body and a self-tapping thread in the apex area. The compression thread leads to significantly improved primary stability and the implant can be used in all bone qualities, in fresh extraction sockets as well as in healed jawbone with guided or conventional surgical procedures and different loading protocols. Due to its design, the ICX®-Active Master implant is particularly suitable for immediate implant placement, immediate function and the treatment of patients with a qualitatively and quantitatively reduced bone supply.

Objective:

This report retrospectively evaluates the results of 140 ICX®-ACTIVE MASTER implants placed in patients with edentulous or partially edentulous maxillae and mandibles.

Material and Methods:

Between January 2018 and May 2019, a total of 140 ICX®-Active Master implants were placed in the author's private clinic to treat 76 patients with edentulous or partially edentulous upper and lower jaws.

Patients were followed up regularly every six to twelve months with a maximum follow-up period of 16 months (Fig. 1).

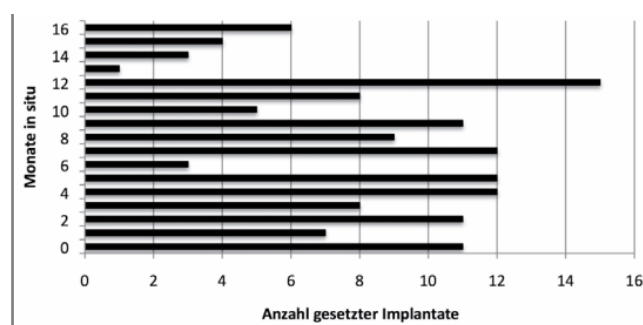


Fig. 1: Number of inserted ICX®-Active Master Implants and their time in situ (in months)

The ICX®-Active implants used in this retrospective analysis had dimensions with diameters of 3.75 mm, 4.1 mm and 4.8 mm and lengths of 8 mm, 10 mm, 12.5 mm and 15 mm. The implants were placed either conventionally or with the ICX®-Magellan drill guide according to the specified protocol. If necessary, sinus lift and bone augmentation procedures were performed simultaneously with implant placement. In general, the healing phase was either transgingival or covered using healing abutments or cover screws. Patients were restored with prosthetic components (single-tooth components, bridges, bars, screw-retained prostheses on ICX®-Multi-unit abutments) from the manufacturer's portfolio. In 96 percent of the patients, the ICX®-Active Master implants were inserted using the ICX®-Magellan drilling template (Fig. 2).



Fig. 2: Insertion of an ICX®-Active Master-Implant in the mandible using the ICX®-Magellan surgical guide.

Three implants were placed in combination with bone replacement material in fresh extraction sockets. A total of 73 implants were placed in the maxilla and 67 implants in the mandible in all bone qualities (D1 to D4) (Fig. 3), whereby five patients were treated with implants in the maxilla and mandible. The sinus lift procedure was performed in six patients (internal sinus lift: two patients, external sinus lift: four patients). Two patients underwent a bone split to prepare the implant site. The healing time was up to six months: 69 implants with submerged healing and 65 implants with transgingival healing. Six implants (in one patient) were immediately restored with a long-term temporary restoration.

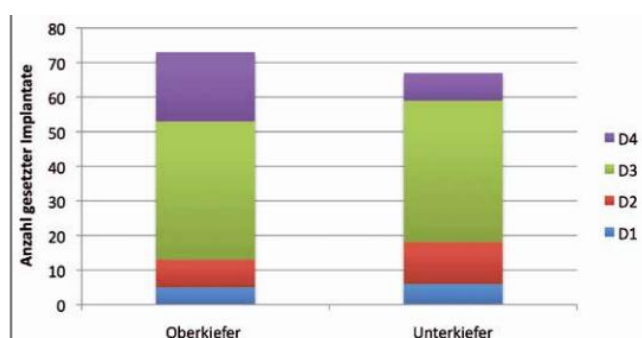


Fig. 3: Number of ICX®-Active Master-Implants placed in the maxilla and mandible and distribution of bone qualities (D1-D4).

Results:

Two implants were lost during the healing phase. This means that the implant survival rate was 98.6 percent in the period examined. The analysis of the two lost implants revealed: in one case, insufficient primary stability in the augmented bone is assumed to be the most likely reason.

In the other case, an inflammation of the neighboring tooth root may have spread to the inserted implant and the augmentation material. All other implants achieved high primary stability, even with poor bone quality. All prosthetically restored patients are very satisfied with their rehabilitation.

Conclusion:

In order to familiarize themselves with the new design and the resulting new properties of the ICX®-Active Master implant, the cases under observation were initially treated conservatively, i.e. implanted in the healed bone. Following the implantation of 140 ICX®-Active Master implants in this way, an implant survival rate of 98.6 percent has been achieved to date without any significant complications.

It can therefore be concluded that the rehabilitation of the partially edentulous or edentulous maxilla or mandible in all bone qualities with the ICX®-Active Master implant system in combination with the ICX®-Magellan Guide (medentis medical) is a suitable and predictable treatment option. Due to the positive experience gained in practice with the ICX®-Active Master implant system to date, immediate implantations are now increasingly being performed.

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Dr. Dr. Norman von Sternberg; Dentist, Specialist for Oral-, Maxillofacial and Plastic Surgery, Specialist for Oral Surgery; E-Mail: info@vonsternberg.eu; Homepage: <https://vonsternberg.eu/>

Reference:

Dr. Dr. Norman von **Sternberg**. Retrospektive Analyse eines Implantattyps. Ein Implantat für alle Knochenqualitäten. Z Oral Implant, © 15. Jahrgang **2/19**; https://vonsternberg.eu/wordpress/wp-content/uploads/2019/07/dgoi_02_19_mkt_medentis.pdf

3.c.2 Stereolithographically Prefabricated Surgical Templates and Bridges – A User-friendly Immediate Care Concept

Andreas van Orten, M.Sc., M.Sc. Waltrop, 2021

Material and Methods:

Case presentation: An 83-year-old male patient with limited general health (COPD, hypertension, adequately controlled type II diabetes) and currently receiving anticoagulant therapy (ASA 100, one tablet/day) presented to the implant consultation with the wish to optimize his total prosthetic restorations and, if possible, to aim for a palate-free restoration in the upper jaw. Both a fixed and a removable prosthetic solution appeared to be feasible without major hurdles. The improved cleanability of a superstructure that can be removed by the patient themselves led to the following plan: first a fixed long-term temporary restoration with consecutive bar-supported prosthetics after the healing phase.

The virtual planning of the implant placement was carried out with the aid of MAGELLAN X software, which made it possible to fuse the original X-ray and surface data as well as the data from the esthetic try-ins and the surgical templates to be created (Fig. 1 and 2). The bony availability and also the presence of sufficient soft tissue in terms of keratinization and attached mucosa enabled surgical planning without hard or soft tissue augmentation in both the maxilla and mandible (Figs. 3 and 4).

The surgical guides were tried in preoperatively. It is advantageous if these have occlusal support at at least three points as far apart as possible to enable stabilization during anchor pin fixation in the habitual final bite situation (Fig. 5). If this is not possible, careful manual tri- or quadrangular positioning should be performed. With virtual alignment of the anchor pin guides, both the patient and the practitioner benefit from good accessibility of the guides with a contra-angle handpiece. Traumatization of the corners of the mouth and interfering sleeve guides of the templates should be avoided.

The implant bed was prepared in both jaws without flap formation and according to the recommended drilling protocols. ICX®-ACTIVE-MASTER implants were placed in widths of 3.75 and 4.1 mm with a length of 10 mm, with all implants achieving an insertion torque greater than 35 Ncm and radiofrequency analysis values above the threshold value of 65 for immediate restoration. In the cases in which the insertion torque was expected to be too high, the implant was sometimes screwed out and back in several times, which meant that in the case of conical implants often the desired insertion torque can be approximated arbitrarily in terms of the use of expansion screws. As no leveling of the alveolar ridge was performed, insertion depths of bone level up to a subcrestal placement of 2 mm were achieved to ensure sufficient peri-implant bone width (Fig. 6).

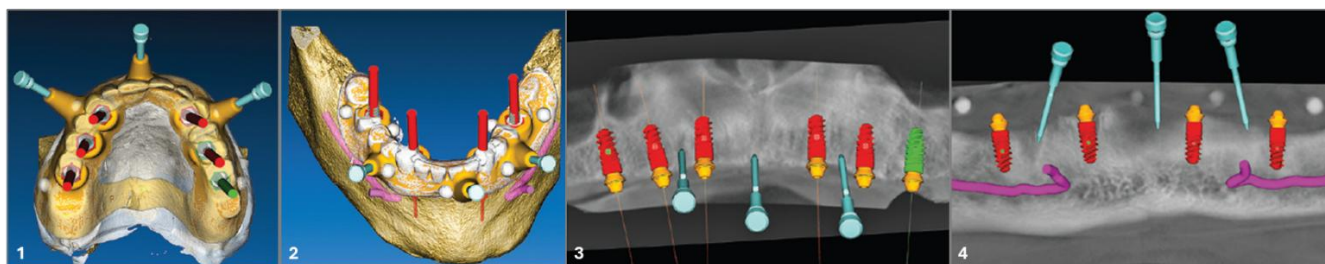


Fig. 1+2: Fused data set of the maxilla and mandible. Fig. 3+4: Surgical planning in the maxilla and the mandible with anchor pins.

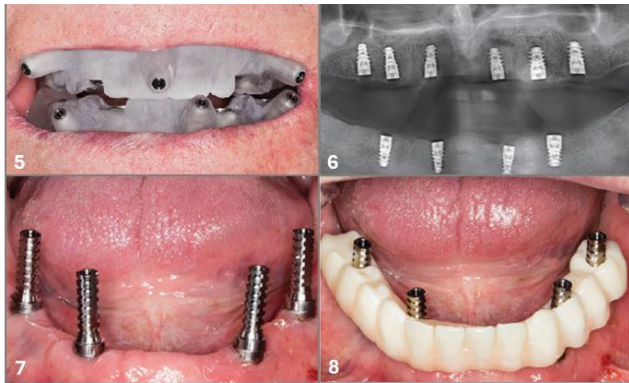


Fig. 5: Magellan Surgical Guides before anchor pin fixation in situ. **Fig. 6:** Postoperative X-ray control. **Fig. 7:** Multi-Prosthetic Abutments in situ. **Fig. 8:** Intraorally bonded PMMA-Supraconstruction.

At deep or angulated insertion consecutive selective bone ablation can be performed with a self-centering "Bone profiler" to avoid collision of the abutments with bony overhangs and ensure a correct positioning of the abutments. As the implants were not angulated, only straight abutments (ICX®-Multi Abutment) in heights of 3 to 5 mm as intermediate structures with a torque of 30 Ncm were inserted. The long-term temporary restoration was carried out with prefabricated PMMA superstructures ("Smile Bridge"), which were fabricated by the laboratory with individualized gingiva-colored composites.

In order to compensate for any transfer inaccuracies and to ensure a passive fit, the tertiary structures screwed onto the multi-abutments (multi-prosthetic abutment; Fig. 7) were cemented intraorally using adhesive cementation with the aid of PMMA primer and dual-curing luting composites (ICX®-ROYAL Base; Fig. 8).

The finishing (shortening of the prosthetic abutments, filling of blisters and defects with ICX®-ROYAL Dentin, polishing) was carried out extraorally and was followed by a further modification of the occlusal surface before insertion after determining the jaw relationship.

A combination of Teflon tape and light-curing filling composites is usually recommended for closing the screw channels.

Conclusion:

Generally, with good preliminary planning, a very good long-term temporary restoration can be fabricated for the patient in a short period of time, which can be used as an immediate restoration if the implants have sufficient primary stability. The use of multi-abutments also simplifies the subsequent reconstruction phase for the definitive restoration and makes it more comfortable for the patient, as it is no longer possible to continue working at implant level but at mucosa level. The use of multi-abutments, which is popular with many practitioners "One abutment at one time" concept, which can be considered sensible from a bone-protective perspective. Support for the patient in cleaning and maintaining the fixed long-term temporary restoration should be planned as closely as possible and can then be individually adapted if compliance and dexterity are good. In the case presented here, the definitive restoration was placed after an uncomplicated healing phase after four months using CAD/CAM-fabricated bar restorations.

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Reference:

Van Orten A. Stereolithographisch präfabrizierte chirurgische Schablonen und Brücken – Ein anwenderfreundliches Sofortversorgungskonzept. Implantologie Journal 1+2/21

3.c.3 First Clinical Experience with the ICX®-Active Master Implant System: A 3-year retrospective Study

Assistant Professor Prof. Patrik Prachar; Faculty of Medicine, Masaryk University / Dental Clinic St. Anne, Brno, Czech Republic, 2022

Objective:

The aim of this retrospective study was to report on the clinical experience with the ICX®-Active Master implant system. The design of the implant corresponds to modern findings in the modelling of final elements. It corresponds to minimum bone stress in close connection with the implant

Material and Methods:

This study retrospectively evaluated clinical data from patients treated with the ICX®-Active Master implant system. Patients received at least on implant in the maxilla or mandible and were used ICX®-Active Master, ICX®-Narrow and ICX®-Active White implants. The implant primarily suits the indications of immediate implantation and immediate load in a manner similar to that during use in cases with bone availability of poorer quality and quantity.

Results:

The authors evaluated experience with 500 implants inserted at 4 different sites in an age range from 18 to 82 years. 286 implants were inserted in 125 men, and 214 implants in 105 women. Implants were used in all bone qualities (D1-D4). The diameters of the implants were 3,3mm, 3,75mm, 4.1mm and 4.8mm with length of 10mm, 12.5mm and 15mm. The evaluation period is currently two years with 100 % success rate.

	Number of Implants	Maxilla (Upper Jaw)	Mandibula (Lower Jaw)	Augmentation	Immediate Implantation
Total	500	325	175	130	133
Men	286	154	132	69	71
Women	214	139	75	61	62

Tab.1: Statistic data of inserted implants over a period of three years

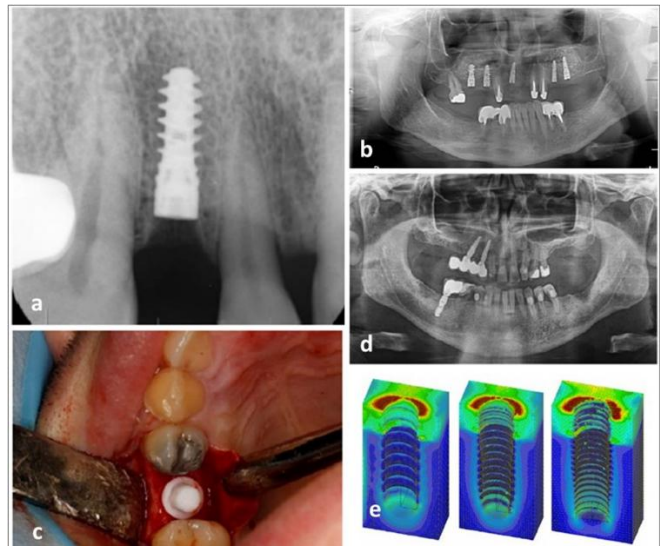


Fig. 1a-e: (a) Delayed implantation for lateral incisor-subcrestal implantation; (b) Implantation jointly with bilateral sinus augmentation; (c) Ceramic implant from in situ after insertion; (d) ICX®-Active Master-Implants 1,5 years after implantation; (e) Illustration of modelling of final elements with use of various types of threads.

Conclusion:

In spite of its use not only in conventional indications, but also in immediate and delayed indications, including immediate loading, the ICX®-Active Master has become a safe and suitable alternative in the field of implantology.

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Reference:

Patrik Prachar*, Ivan Tresnak* and Sonia Bartakova. *First Clinical Experience with the ICX-Active Master Implant System: A 3-year Retrospective Study*. Mod Res Dent. 7(1). MRD. 000659. 2022. DOI: 10.31031/MRD.2022.07.000659

3.c.4 Aesthetic Implant Restoration after Cyst Removal

Dr. med. dent. Niko Peterke, Cologne, 2022

Case Description:

The 29-year-old patient came to our practice with complaints of pressure on her root-filled tooth 21 and wanted the cause to be clarified. As a child, she had suffered trauma to her left central incisor. The tooth had been root-filled and resected about ten years previously. There was a suspicion of a radicular cyst leading to the question whether the anterior tooth was worth preserving. Clinically, tooth 21 was pressure-dolent and sensitive to percussion.

Diagnostics:

Radiographically (OPG), a round, sharply defined mass was found cranial to the filled tooth root. Based on the different planes in the CBCT a brightening of approx. 4 x 10 x 4 mm in size could be detected. A radicular cyst was suspected (*Fig. 1a+b*).



Fig. 1a+b: (a) In the sagittal plane in the CBCT, the suspected diagnosis made with the OPG is confirmed. (b) Together with the coronal plane, the extent of the radicular cyst can be calculated, approx. 10 x 4 x 4 mm.

Tooth 21 had to be removed and the not inconsiderably large bone defect cranial, lateral, medial and dorsal to the tooth root was initially to be augmented after extraction.

The patient was then informed about the findings, the suspected diagnosis and the resulting surgical consequences as well as the various options for a prosthetic/implant prosthetic restoration. She opted for a single-tooth implant. The implant should only be implanted after successful, closed healing of the augmentation.

Surgery:

An impression of the maxilla was taken before the extraction in order to be able to fabricate a clamp prosthesis in the in-house laboratory. Tooth 21 was successfully removed (*Fig. 2*), the mass was sent for histological clarification. After the flap preparation the large bone defect was systematically augmented with synthetic CEM (CompactBone® S) and a MucoMatrixX® (both dentegris). Due to the large cyst lumen and the high esthetic requirements in the maxillary anterior region, the bone was allowed to heal for four months (*Fig. 3a+b*) before implant placement.

After analyzing the 3D data from the CBCT following the healing phase, the implant site was digitally analyzed with Sidexis (Sirona) and an implant system was selected. The ICX®-Active Master Bonelevel implant (3.75 x 10 mm, 40 Ncm) has an active thread and therefore achieves maximum primary stability in the compromised bone. The prosthetic restoration is uncomplicated. The implant healed closed for just under four months (*Fig. 4+5*). After uncover, a displacement flap was formed to improve shaping of the labial soft tissue and a titanium abutment was inserted (*Figs. 6, 7*). An impression was then taken after the impression post had been placed.

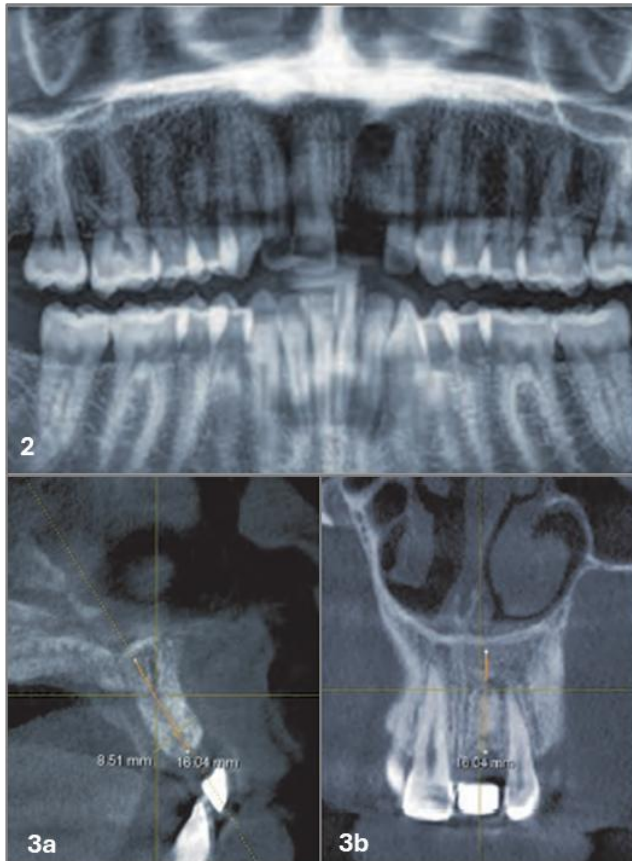


Fig. 2: Condition after cystectomy and augmentation of the bony defect (socket preservation), closed healing. **Fig. 3a+b:** (a) The quality and volume of the augmented bone can be analyzed in the sagittal plane. (b) Four months later, the analysis of the implant bed shows that it can be implanted.

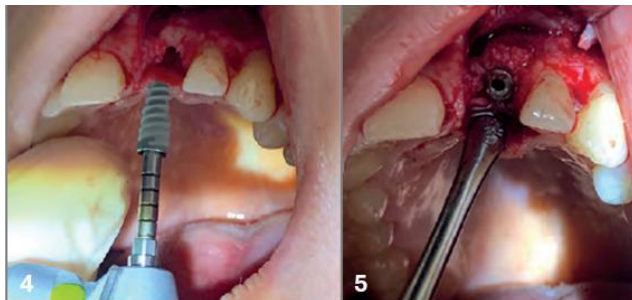


Fig. 4: Insertion of a bone-level implant with platform switch and active thread for maximum primary stability: ICX®-Active Master (3.75 x 10mm, 40 Ncm). **Fig. 5:** Augmentation of the alveolar ridge using a synthetic CEM (CompactBone® S) and MucoMatrixX®, closed healing.

Until the final crown was completed, the patient was treated with a single-tooth temporary made of composite. The analog model was scanned in the dental laboratory, the new glass-ceramic crown was planned using CAD/CAM and placed seven days later.

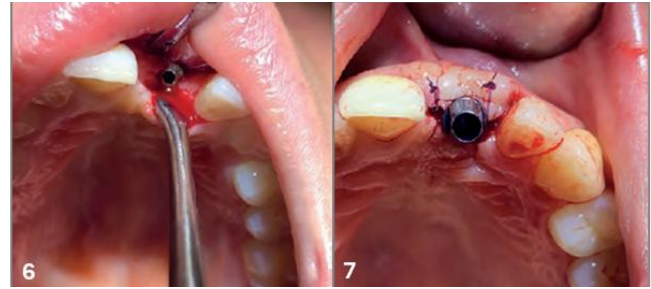


Fig. 6: Careful exposure of the implant after four months. **Fig. 7:** Insertion of a titanium abutment, sliding flap for esthetic shaping of the gingiva.



Fig. 8: X-ray check almost 1.5 years after the operation: successful rehabilitation.

The treatment is also a great success one and a half years after the operation (Fig. 8).

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Peterke N. Ästhetische Implantatversorgung nach Zystenentfernung. *Praktische Implantologie und Implantatprothetik* | pip 4 | 2022

3.c.5 The Significance of Keratinized Mucosa in Implant Therapy: Narrative Literature Review and Case Report Presentation

T. Jankowski, MD, PhD, Dental Clinic Jankowscy, Poland, 2024

Introduction:

Implant treatment in patients who require teeth extraction due to periodontitis presents a significant challenge. The consideration of peri-implantitis is crucial when planning the placement of dental implants. The predictability of implant treatment relies on the suitability of both hard and soft tissue quality.

Objective:

The aim of this article is to present a case report demonstrating a secure treatment protocol for implant procedures in patients with periodontitis requiring the extraction of all teeth, soft tissue management targeted at increasing the keratinized mucosa zone, and the provision of a reliable prosthetic solution. The secondary objective is to review the relevant literature regarding the significance of keratinized mucosa surrounding dental implants and its association with the occurrence of peri-implantitis.

Case Description:

A 65-year-old female with generalized periodontitis, stage IV grade C and very poor oral hygiene came for treatment and rehabilitation of the lower jaw. CBCT revealed periodontal lesions and labio-lingual ridge dimensions in the region of teeth 34–44 from 8.0 to 10.2 mm.



Fig. 1: Initial intraoral photographs: (a) right lateral view; (b) left lateral view; (c) frontal view.

The first surgery included teeth extraction and periodontal lesions enucleation with simultaneous placement of four implants (Diameter: 3,75 mm, Length: 10mm; ICX®-Active Master, medentis medical GmbH, Bad Neuenahr-Ahrweiler/Germany) in the positions of teeth 32, 34, 42, 44. Primary Stability. Moreover, 6 mm high healing screws were fixed to the implants.



Fig. 2: Surgical procedure: (a) implant insertion; (b) bone augmentation; (c) flap repositioning and suturing



Fig. 3: Two months post-op intraoral photographs: (a) frontal view; (b) occlusal view.

Bone defects resulting from periodontal lesions removal were augmented by bovine-derived xenograft (Bio-Oss® 0,25-1 mm; Geistlich; Wolhusen, Switzerland) mixed with autogeneous bone collected from the left side of the mandible using a scraper, outside implantation area.

The second-stage surgery involved increasing the keratinized mucosa using two free gingival grafts.

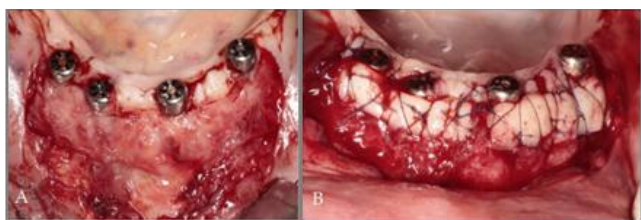


Fig. 4: Soft tissue augmentation procedure: (a) preparation of the recipient site; (b) free gingival grafts stabilized by mattress sutures between residual KM and periosteum.



Fig. 5: Clinical evaluation of soft tissue healing: (a) 2 weeks after augmentation; (b) 2 months after augmentation



Fig. 6: Follow-up clinical photographs: (a-c) 4 months after first surgery – the prosthetic restoration's finalization; (d, e) 24 months after bar-retained overdenture delivery

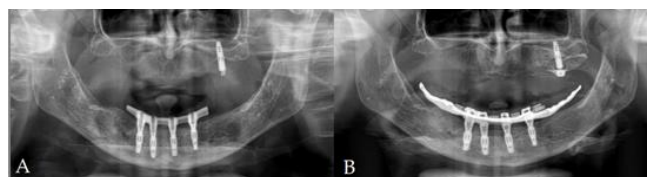


Fig. 7: Orthopantomogram (OPG): (a) 4 months after first surgery – the prosthetic restoration's finalization; (b) 24 months after bar-retained overdenture delivery

Conclusion:

The present case report described the treatment process of the patient with periodontitis, including immediate implantation in the infected region, soft tissue augmentation using free gingival grafts and the ultimate placement of a bar-retained overdenture for final restoration. After two years of observation, despite questionable hygiene, no symptoms of gingival inflammation were detected. Furthermore, there is limited information in the literature regarding the correlation between inadequate keratinized gingiva and the occurrence of peri-implantitis.

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Reference:

Jankowski T; Jankowska A; Kazimierczak N; Kazimierczak W; Janiszewska-Olszowska J. The Significance of Keratinized Mucosa in Implant Therapy: Narrative Literature Review and Case Report Presentation. J. Clin. Med. 2024, 13, 3501. <https://doi.org/10.3390/jcm13123501>

Table 5c: Retrospective Studies ICX®-Zygoma implant system

Study-No.	Page	Study Location / Year	Timepoint Follow-Up in Months	Number of Subjects	Number of Implants	Endpoint (Survival Rate [%])
5.c.1	100	Milan, 2018 F. Grecchi	60	10	22	100 %
		Study Observative / Study Title	Retrospective Evaluation of 10 Clinical Cases Treated between October 2012 and September 2014 with the ICX®-Zygoma Implant System			
		Research Results / Evaluation	The rehabilitation of the (severely) atrophied, partially or completely edentulous maxilla using the ICX®-Zygoma implant system from medentis medical GmbH in combination with standard implants under an immediate or 2-stage loading protocol is a suitable and predictable treatment option.			
5.c.2	102	University of Milan, 2020 F. Goker; E. Grecchi; M. Del Fabbro; F. Grecchi	41,75 (6-89)	Total: 110, medentis medical ICX®-Zygoma (Full Thread): 18, Noris Medical Ltd. (Partial Thread): 92	Total: 302, medentis medical ICX®-Zygoma (Full Thread): 41, Noris Medical Ltd. (Partial Thread): 261	98,34 %
		Study Observative / Study Title	Clinical outcome of 302 zygomatic implants in 110 patients with a follow-up between 6 months and 7 years			
		Research Results / Evaluation	In cases of severely atrophic posterior maxilla, zygomatic implant surgery can be considered as an effective and safe alternative to conventional implants and bone grafting procedures.			
5.c.3	104	University of Milan, 2020 F. Goker; E. Grecchi; E.G. Mancini; M. Del Fabbro; F. Grecchi	55 (44-84)	9	19	100 %
		Study Observative / Study Title	Zygomatic Implant Survival in 9 Ectodermal Dysplasia Patients with 3.5 to 7-year Follow Up			
		Research Results / Evaluation	Zygomatic surgery can be considered as a viable and safe alternative to conventional treatment modalities for oral rehabilitation of ectodermal dysplasia syndrome patients.			
5.c.4	106	University of Milan; 2022 F. Goker; F. Grecchi; E. Grecchi; M. Del Fabbro; E.L. Agliardi; F.R.P. Buccellato; A. Greco Lucchina; A.B. Gianni; C. Mortellaro	93	Total: 35, medentis medical ICX®-Zygoma (Full Thread): 17, Noris Medical Ltd. (Partial Thread): 18	Total: 87, medentis medical ICX®-Zygoma (Full Thread): 39, Noris Medical Ltd. (Partial Thread): 48	100 %
		Study Observative / Study Title	Clinical outcomes of fully and partially threaded zygomatic implants in a cohort of patients with a minimum 7.5year-follow-up			
		Research Results / Evaluation	Zygomatic implants can be considered a safe alternative to conventional implant placement and bone grafting in the oral rehabilitation of patients with severely atrophied maxillary bone.			
5.c.5	108	University of Milan; 2022 F. Goker; E. Grecchi; M. Del Fabbro; A. Tedesco; A. Borgonova; A. Bedendo; F. Grecchi	34,3 ± 25,5	Total: 32 medentis medical: 2	Zygoma-Implants: 34, medentis medical: 2	100 %
		Study Observative / Study Title	Oral rehabilitation with unilateral zygomatic implants: A case series of 32 patients			
		Research Results / Evaluation	Unilateral implant placement of Zygoma implants for oral rehabilitation of partially edentulous posterior maxillary patients with severely atrophic bone and/or previous implant failures can be considered a successful alternative to the use of conventional dental implants in conjunction with advanced bone grafting procedures.			
5.c.6	110	University of Milan; 2022 F. Grecchi; E. Grecchi; M. Del Fabbro; F. Goker	38,5	8	Conventional Implants: 32, Zygoma-Implants: 15	Conventional Implants: 100 %, Zygoma-Implants: 93,3 %
		Study Observative / Study Title	Simultaneous Le-Fort I osteotomy and zygomatic implant placement			
		Research Results / Evaluation	Simultaneous Le-Fort I osteotomy in conjunction with zygomatic / conventional dental implant placement can be considered a valuable treatment option for the rehabilitation of patients with extremely atrophic edentulous maxilla and esthetic problems in the face.			

5.c.1 Retrospective Evaluation of 10 Clinical Cases Treated between October 2012 and September 2014 with the ICX®-Zygoma Implant System

F. Grecchi; Milan, 2018

Introduction:

Zygomatic implants have been documented as an alternative for the rehabilitation of the partially or fully edentulous atrophic maxilla with both the classical 2-stage and immediate loading protocols. Zygomatic implants avoid grafting and sinus lift procedures and enable the immediate loading of the implants after surgery due to the favourable characteristics of the zygomatic bone. Therefore, zygoma implants contribute to a shorter and more comfortable treatment. In addition, zygoma implants are an alternative treatment option in cases where reconstructive treatment failed. In general, one to two zygoma implants are placed in combination with one to four standard implants in the anterior region.

Objective:

This report retrospectively evaluates the treatment outcome of 10 patients with partially or fully edentulous atrophic maxilla rehabilitated with ICX®-Zygoma implants (medentis medical GmbH).

Material and Methods:

Between October 2012 and September 2014, 10 patients (5 men, 5 women) with partial (4 patients) or complete (6 patients) edentulous atrophic maxilla were rehabilitated at the Studio Dr. Francesco Grecchi and in Hospital (IOG Milano), Milan, with a total of 22 ICX®-Zygoma implants (full thread, medentis medical GmbH) and a total of 27 standard implants. Subjects' average age was 50,8 ranging from 23 to 75 years at the time point of implant placement. Three of these 10 patients suffered from ectodermal dysplasia. One patient was diagnosed with a hyper-enlargement of the maxillary sinuses. In two patients, previous treatment with conventional implants failed, with

one of them being diagnosed with an asymptomatic chronic sinusitis treated with functional endoscopic sinus surgery (FESS) and grafting. In 5 patients, previous reconstructive therapy failed. The following risk factors were diagnosed: heart disease, asymptomatic chronic sinusitis, absence of adherent gingiva (in 2 patients) and previous breast neoplasm.

Surgery was performed by Dr. Francesco Grecchi according to the manufacturer's protocol. 4 patients received 2 Zygoma implants in combination with 2 standard implants, 4 patients received 2 Zygoma implants in combination with 4 standard implants, one patient received 2 Zygoma implants in combination with 3 standard implants and 1 patient received 4 Zygoma implants only. In 9 patients, the surgical protocol involved the extrasinus approach, whereas the extramaxillary approach was applied in one patient. In all patients, the Zygoma implants were inserted bilaterally. The following Zygoma implant lengths were used: 35 mm (3 implants), 40 mm (6 implants), 45 mm (6 implants) and 50 mm (7 implants). Loading of the implants was performed either immediately (3 patients) or in a 2-stage procedure (7 patients) with screw-retained prostheses on ICX®-Multi-unit abutments (0°/17°/30°/35°). Patients were followed on a regular basis every 6 months, with an average follow up time of 49 months (shortest follow up period: 39 months, longest follow up period: 62 months).

Results:

The average implant residence time at the last follow up was 4 years. At that time point, all ICX®-Zygoma implants were in function, giving a Zygoma implant survival rate of 100 % after an average of 4 years. None of the standard implants failed, resulting in a standard implant survival rate of 100 %.

Mucositis was diagnosed in two patients (premolar 24 (zygoma implant and canine 13 (zygoma implant)) which was successfully treated with laser therapy. In one patient, the inferior prosthesis fixed to Multi-unit abutments was unscrewed initially since an accurate oral hygiene could not be achieved due to inconvenient prosthesis design. One patient showed emergence of the implants in the palate which was due to the extreme narrowness of the palate itself; without problems of prosthetic dimensions. All other patients were fully satisfied with their rehabilitation and maintained good oral hygiene Figure 1 shows the radiographic pictures of a patient successfully rehabilitated with 2 ICX®-Zygoma implants in combination with 4 conventional implants.



Fig. 1a: Radiographic picture of patient with partially edentulous atrophic maxilla before intervention



Fig. 1b: Radiographic picture after insertion of 2 ICX®-Zygoma implants in combination with 4 conventional implants

Conclusion:

During an average follow up period of 4 years, a zygoma implant survival rate of 100 % was achieved. Complications were minor and successfully treated with the patients being very satisfied with their final prosthetic rehabilitation and oral hygiene. Therefore, it can be concluded that the rehabilitation of the (severely) atrophied, partially or completely edentulous maxilla using the ICX®-Zygoma implant system from medentis medical GmbH in combination with standard implants under an immediate or 2-stage loading protocol is a suitable and predictable treatment option.

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Reference:

Grecchi F. Retrospective Evaluation of 10 Clinical Cases Treated between October 2012 and September 2014 with the ICX Zygoma Implant System (medentis medical GmbH). 2018.

5.c.2 Clinical outcome of 302 zygomatic implants in 110 patients with a follow-up between 6 months and 7 years

F. Goker; E. Grecchi; M. Del Fabbro; F. Grecchi; University of Milan, 2020

Introduction:

Zygomatic implant surgery is considered as a safe and successful alternative to the conventional implant surgery with bone grafts for patients with severe atrophic maxilla.

Objective:

The aim of this retrospective clinical case series was to report clinical outcome of zygomatic implants with a follow-up between 6 months and 7 years.

Material and Methods:

A total of 110 patients with 302 zygomatic implants were included in this study. The zygomatic implants used in this study were either partially threaded (92 patients, 261 unthreaded crestal long body implants with 12.5 mm apical threaded part, Noris Medical Ltd., Israel), or fully threaded (18 patients, 41 ICX®-Zygoma implants, Medentis medical GmbH, Ahrweiler, Germany). The intra and postoperative complications and survival rate of zygomatic implants were evaluated.



Fig. 1: The representative intraoperative and intraoral view of the patient with partially threaded quad zygomatic implants inserted.



Fig. 2: The representative postoperative panoramic radiographic image of the patient showing quad zygomatic implants inserted.

Results:

The study included 110 consecutively treated patients with an age range of 21 to 76 years (mean 57.35 years, SD 10.42). The overall zygomatic implant survival rate was 98.34%. There were five implant failures in four patients. One intraoperative and 17 postoperative complications developed in 18 patients. There were no drop-outs and the median follow-up of the patients was 41.75 months (with a range of 6-89 months).

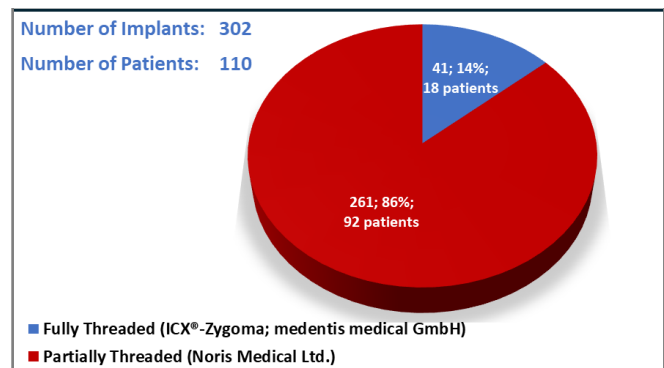


Fig. 3: Graphical Summary of the Zygomatic implants used in this study.

Conclusion:

According to the results, in cases of severely atrophic posterior maxilla, zygomatic implant surgery can be considered as an effective and safe alternative to conventional implants and bone grafting procedures.

Patient	Characteristics	Failed implants/ total no of implants	Success %
Gender	Male	1/144	99.3
	Female	4/158	97.4
Reason for ZI	Severe atrophic maxilla	1/201	99.4
	Previous implant failure	4/101	96.0
Smoking habits	Smoking	1/11	90.9
	No smoking	4/291	98.6
Age	<60 years	4/59	93.2
	>60 years	0/243	100

Patient	Characteristics	Failed implants/ total no of implants	Success %
Loading	Immediate	5/254	98.0
	Delayed	0/48	100
Type of prosthesis	Removable prosthesis with bar	0/5	100
	Toronto	3/266	98.8
	Ceramic Toronto	0/4	100
	Total fixed resin	1/9	88.8
	Ceramic Bridge	1/15	93.3
	Resin bridge	0/3	100

Tab. 1 (left): Implant-based success rates for comparison of gender, reason for ZI, age and smoking status., ZI: zygomatic-Implant. **Tab. 2:** Implant success rates for comparison of loading and prosthesis type.

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Reference:

Goker F, Grecchi E, Del Fabbro M, Grecchi F. *Clinical outcome of 302 zygomatic implants in 110 patients with a follow-up between 6 months and 7 years.* Clin Implant Dent Relat Res. **2020** Jun;22(3):415-423. doi: 10.1111/cid.12909. Epub 2020 Apr 14. PMID: 32291961

5.c.3 Zygomatic Implant Survival in 9 Ectodermal Dysplasia Patients with 3.5 to 7-year Follow Up

F. Goker; E. Grecchi; E.G. Mancini; M. Del Fabbro; F. Grecchi; University of Milan, 2020

Objective:

Ectodermal dysplasia syndrome is a complex group of genetic disorders identified by the abnormal development of the ectodermal structures. The aim of this retrospective clinical case series report was to evaluate the outcomes of the ectodermal dysplasia syndrome patients that underwent zygomatic implant surgery.



Fig. 1: The initial intraoral image of an ectodermal dysplasia patient.

Material and Methods:

A total of 9 ectodermal dysplasia syndrome patients aged between 21 to 56 years (mean age 36.8) with severely atrophic maxilla were included in this study. All the patients were treated with a total of 19 zygomatic implants (Noris Medical Ltd., Israel or Medentis medical GmbH, Ahrweiler, Germany) using the "extra-sinus approach". The mean follow-up of the patients was 55 months (with a range of 44 to 84 months). The implant survival rate was evaluated as a primary outcome. The intra and postoperative complications were evaluated as additional criteria for success.

Results:

The overall implant survival rate was 100 % without any complications. Final or provisional prosthesis were delivered on the same day of surgery, which resulted in an improvement of the quality of life of the patients.

Conclusion:

According to the results of this study, zygomatic surgery can be considered as a viable and safe alternative to conventional treatment modalities for oral rehabilitation of ectodermal dysplasia syndrome patients.

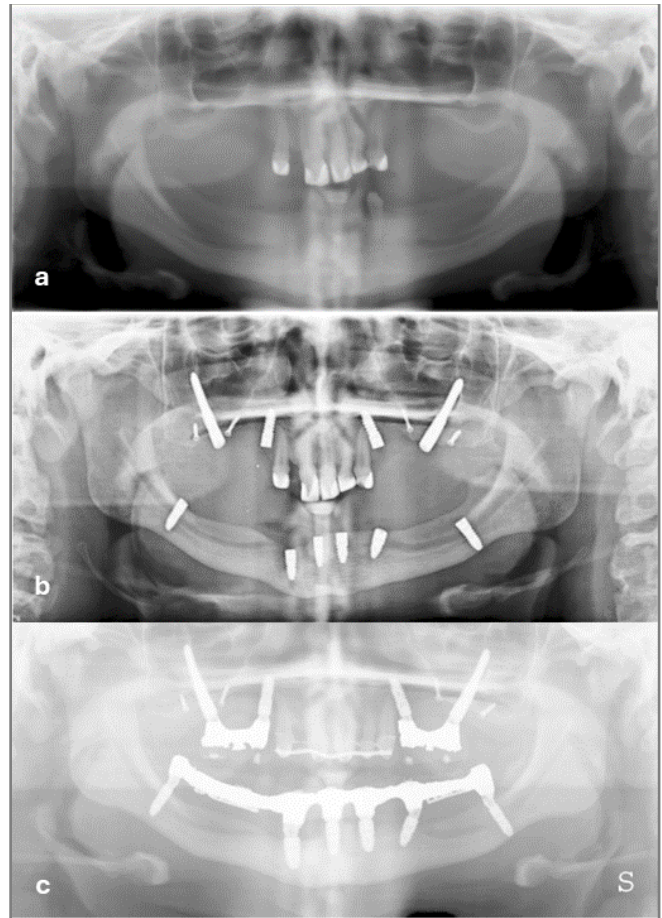


Fig. 2a-c: (a) The initial panoramic x-ray image of the patient (b) The panoramic x-ray image of the same ectodermal dysplasia patient 18 months after implant insertion surgery. Note: The conventional implants in the lower jaw of this patient were inserted using the technique of bypass of the inferior alveolar nerve. In this case, the position of the nerve was superficial, situated rather buccally in the mandibular bone and insertion of the implant was possible without damaging the nerve (c) The panoramic x-ray image of the patient 26 months after implant surgery.



Fig. 3: The intra-oral view of the patient 18 months after implant surgery. Front view.

Patient	Age	Gender	N. ZI	N. CI	ZI location	Total follow up	ZI Survival %	Complications
1	51	F	2	4	16, 26	52	100	None
2	47	F	2	4	16, 26	60	100	None
3	21	F	2	4	16, 26	55	100	None
4	56	F	2	4	16, 26	46	100	None
5	25	M	2	2	16, 26	65	100	None
6	52	M	4	2	16, 26, 13, 23	44	100	None
7	27	M	2	2	16, 26	84	100	None
8	23	M	2	3	16, 26	77	100	None
9	29	F	1	4	26	51	100	None

Tab. 1: Patient demographics and data regarding the implant success. ZI: Zygomatic implant, CI: Conventional Implants, N: Number

Patient	Loading	Prosthetic type	Antagonist dentition	Prosthesis Survival %	Complications
1	Immediate	toronto (resin)	Implant supported fixed prosthesis	100	None
2	Immediate	toronto (resin)	Natural teeth	100	None
3	Immediate	toronto (resin)	Natural teeth	100	None
4	Immediate	fixed (resin)	Implant-supported fixed prosthesis	100	None
5	Delayed	toronto (resin)	Toronto resin	100	None
6	Delayed	toronto (resin)	Implant-supported fixed prosthesis	100	None
7	Delayed	toronto (resin)	Removable prosthesis	100	None
8	Delayed	toronto (resin)	Implant-supported fixed prosthesis and natural teeth	100	None
9	Delayed	toronto (resin)	Natural teeth-supported fixed prosthesis	100	None

Tab. 2: Data regarding the prosthetic treatment

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Reference:

Goker, Funda & Grecchi, Emma & Del Fabbro, Massimo & Tedesco, Andrea & Borgonovo, Andrea & Bedendo, Attilio & Grecchi, Francesco. (2022). Oral rehabilitation with unilateral zygomatic implants: A case series of 32 patients. International journal of oral implantology (Berlin, Germany). 15. 181-190.

5.c.4 Clinical outcomes of fully and partially threaded zygomatic implants in a cohort of patients with minimum 7,5 years follow-up

F. Goker; F. Grecchi; E. Grecchi; M. Del Fabbro; E.L. Agliardi; F.R.P. Buccellato; A. Greco Lucchina; A.B. Gianni; C. Mortellaro; University of Milan, 2022

Objective:

The aim of this retrospective case series report was to evaluate the results of oral rehabilitation with extra-sinus zygomatic implant surgery with a minimum follow-up of 7.5 years.

Material and Methods:

A total of 35 patients with 87 zygomatic implants were included. The zygomatic implants used in this study were either partially threaded (18 patients, 48 unthreaded long body implants with 12.5 mm apical thread, Noris Medical Ltd., Israel), or fully threaded (17 patients, 39 ICX®-Zygoma implants, Medentis medical GmbH, Ahrweiler, Germany). The mean follow-up period of the patients was 93 months. The zygomatic implant survival and complications were evaluated as criteria for success.

Results:

There were no implant failures. Overall success rate without complications for zygomatic implant was 88.5%. Complications developed in 4 patients (1 cutaneous fistula and 3 mucositis). According to the results on an implant basis, patients with previously failed conventional implants had greater probability of complications. Patients with quad zygomatic implants had higher incidence of complications than those with two zygomatic implants. Fully threaded implant design was associated with higher incidence of mucositis than partially threaded design. No relation was found between implant success and smoking, prosthesis type, and antagonist dentition. When conducting the analysis using the patient as unit, only the antagonist dentition showed significant difference, the worst outcome being associated with the Toronto resin prosthesis.

Conclusion:

Zygomatic implants can be considered as a safe alternative to conventional implant insertions and bone grafting procedures in oral rehabilitation of patients with severely atrophic maxillary bone.



Fig. 1: The intra-operative and intraoral view of one of the patients with partially threaded quad zygomatic implants inserted.

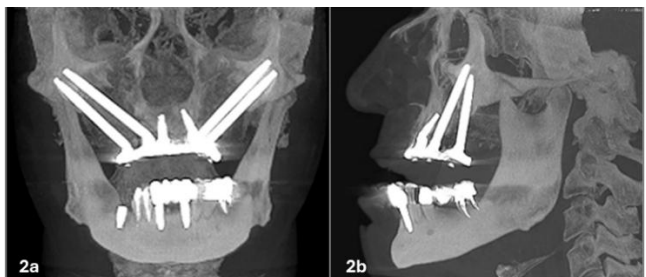


Fig. 2 a+b: The postoperative radiographic frontal and profile image of the patient showing quad ZI's. (a) frontal image (b) profile image. ZI= zygomatic implant

Variable	Characteristics	Complications/Total number of implants	Success %	p-value
Gender	Male	2/45	95.5	0.03*
	Female	8/42	80.9	
Reason for ZI	Severe atrophic maxilla	4/63	93.6	0.02*
	Previous implant failure	6/24	75.0	
Antagonist dentition	Toronto Resin	6/48	87.5	0.07
	Fixed bridge/implant and/or natural teeth	4/29	86.2	
	Removable prosthesis	0/6	100	
	Toronto zirconium	0/4	100	
Number of ZI+I	1ZI+1I	0/1	100	0.04*
	Total result for 1ZI	0/1	100	
	2ZI+0I	0/12	100	
	2ZI+2I	4/12	66.6	
	2ZI+3I	0/6	100	
	2ZI+4I	0/20	100	
	Total result for 2 ZI	4/50	92.0	
	3ZI	-	-	
	3ZI+1I	-	-	
	3ZI+2I	-	-	
	Total result for 3 ZI	-	-	
	4ZI	6/24	75.0	
	4ZI+1I	0/4	100	
	4ZI+2I	0/8	100	
	4 ZI + 3I	-	-	
	Total result for 4 ZI	6/36	83.3	
ZI location	13 or 23 (canine)	3/19	84.2	0.23
	16 or 26 (first molar)	7/68	98.7	
Type of prosthesis	Toronto Zirconium	0/4	100	0.13
	Toronto Resin	10/72	86.1	
	Ceramic Bridge	0/11	100	
Implant design	Full threaded ZI	8/39	79.4	0.02*
	Partially threaded ZI	2/48	95.8	
Smoking	yes	0/4	100	0.61
	No	10/83	87.9	
Total		10/87	88.5	

Tab. 1: Implant-based ZI complication rates according to different characteristics, ZI: zygomatic-Implant, I: conventional implant, *p < 0,05.

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Reference:

Goker F, Grecchi F, Grecchi E, Del Fabbro M, Agliardi EL, Buccellato FRP, Greco Lucchina A, Gianni AB, Mortellaro C. *Clinical outcomes of fully and partially threaded zygomatic implants in a cohort of patients with minimum 7.5-year follow-up.* Eur Rev Med Pharmacol Sci. 2022 Dec;26(3 Suppl):35-44. doi: 10.26355/eurrev_202212_30793. PMID: 36591883.

5.c.5 Oral rehabilitation with unilateral zygomatic implants: A case series of 32 patients

F. Goker; E. Grecchi; M. Del Fabbro; A. Tedesco; A. Borgonova; A. Bedendo; F. Grecchi; University of Milan, 2022

Objective:

Zygomatic implants are successful alternatives to conventional dental implants for oral rehabilitation of patients with severely atrophic maxillae; however, the use of unilateral zygomatic implants needs to be studied further to validate their efficacy. The present investigation aimed to evaluate unilateral zygomatic implant placement in the oral rehabilitation of partially edentulous patients with extremely atrophic maxillary bone and/or previous implant failures.

Material and Methods:

This retrospective clinical study included patients with partially edentulous maxillae who underwent unilateral zygomatic implant insertion. The primary outcome was implant survival. Intraoperative, postoperative and prosthetic complications were also assessed based on patients' clinical records.

Results:

A total of 32 patients (34 zygomatic implants) with a mean age of $60,45 \pm 8,74$ years (range 47 to 78 years) were included in the study. The mean follow-up period was $34,3 \pm 25,5$ months, and the overall implant survival rate was 100 %. No intraoperative or post-operative complications developed in any of the patients, and no prosthesis failures or complications were recorded.

Conclusion:

The results indicate that unilateral zygomatic implants for oral rehabilitation of patients with partially edentulous posterior maxillae with severely atrophic bone and/or previous implant failures can be considered a successful alternative to use of conventional dental implants associated with advanced bone grafting procedures.

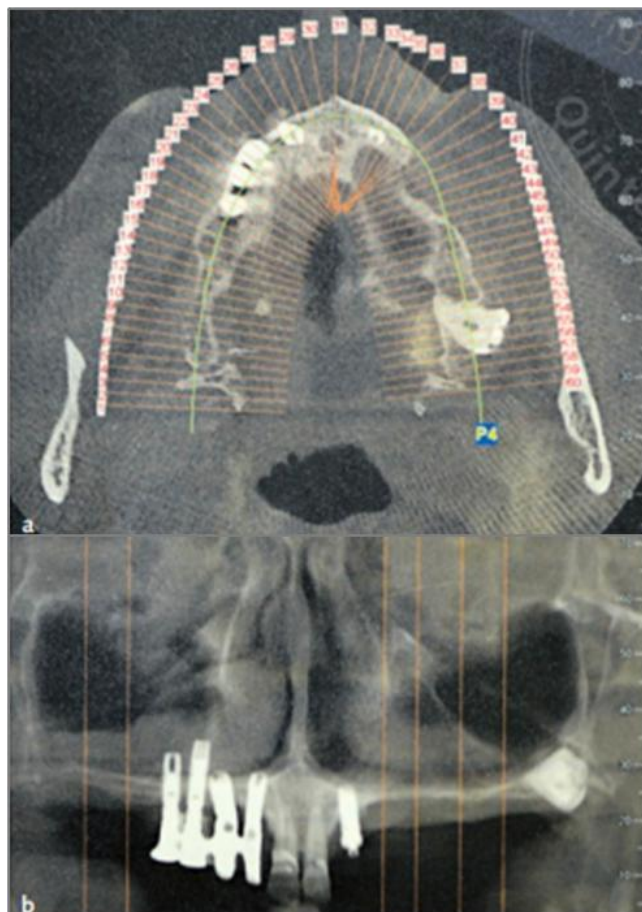


Fig. 1a-b: Preoperative radiographic images of a patient showing the left side of a partially edentulous and severely atrophic posterior maxilla. Note the presence of the maxillary central incisors, and conventional implants in the maxillary lateral incisor, right canine and first and second premolar positions. An impacted maxillary left third molar can also be seen, which was later extracted. The patient was seeking a unilateral oral rehabilitation with a fixed prosthesis on the maxillary left side that could be delivered in a short time and at a low cost, and insisted on keeping the existing natural maxillary central incisors and fixed dental prosthesis on the right side of the maxilla.

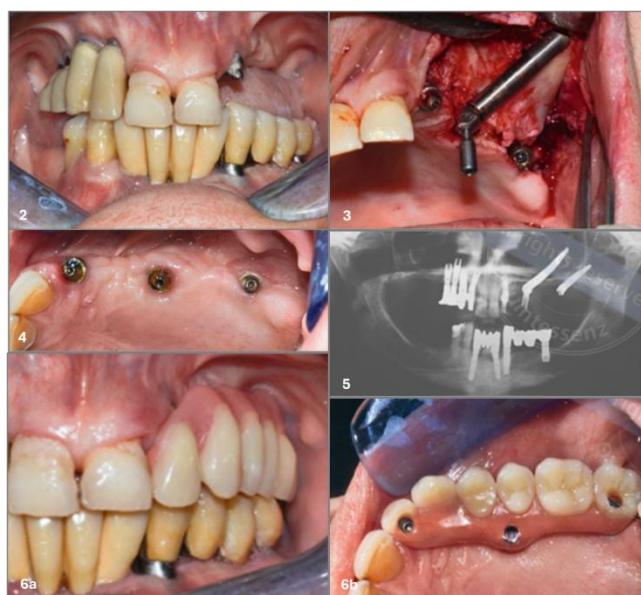


Fig. 2: Preoperative intraoral view of the same patient showing the partially edentulous and severely atrophic posterior maxilla. After clinical and radiographic examinations, delivery of a unilateral fixed prosthesis with insertion of one ZI and one pterygoid implant was planned. **Fig. 3:** Intraoperative intraoral view of the same patient showing unilateral insertion of one ZI and one pterygoid implant. **Fig. 4:** Postoperative intraoral view of the same patient after some tissue healing. **Fig. 5:** Postoperative panoramic radiograph of the same patient showing unilateral insertion of one ZI and one pterygoid implant. **Fig. 6a+b:** Unilateral implant-supported fixed prosthetic rehabilitation for the same patient. The patient did not want the contralateral maxillary site and maxillary central incisors to be included in the treatment protocol. (a) frontal view; (b) occlusal view

Characteristic		Number of ZIs (N = 34)	Number of patients (N = 32)
Age, y	≤ 65	18	18
	> 65	16	14
Sex	Male	18	17
	Female	16	15
Reason for ZIs	Severely atrophic maxilla	19	17
	Previous implant failure	15	15
Smoking	Smoker	3	3
	Ex-smoker	2	2
	Non-smoker	29	27
General health status	Hypothyroidism	1	1
	Healthy	33	31
Bruxism	Yes	1	1
	No	33	31

Tab. 1: Patient Demographics.

Characteristic		Number of ZIs (N = 34)	Number of patients (N = 32)
Loading	Immediate	29	27
	Delayed	5	5
Prosthesis type	Prosthesis with bar	1	1
	Toronto resin bridge	7	5
	Toronto ceramic bridge	1	1
	Ceramic bridge	22	22
	Resin bridge	3	3
Antagonist dentition	Fixed bridge on natural teeth and/or implants	29	28
	Partial removable prosthesis	5	4

Tab. 2: ZI distribution according to prosthesis type, loading and antagonist dentition.

Implant	Length, mm	Diameter, mm	Brand	Location	Osteotomy approach
1	37.5	4.2	Noris Zygomatic (Noris Medical)	Maxillary right first molar	Conventional
2	37.5	4.2	Noris Zygomatic	Maxillary left first molar	Conventional
3	35.0	4.2	Noris Zygomatic	Maxillary left first molar	Conventional
4	40.0	4.2	Noris Zygomatic	Maxillary right first molar	Conventional
5	40.0	4.2	Noris Zygomatic	Maxillary right first molar	Conventional
6	37.5	4.2	Noris Zygomatic	Maxillary left canine	Conventional
7	37.5	4.2	Noris Zygomatic	Maxillary left first molar	Conventional
8	40.0	4.0	NobelZygoma (Nobel Biocare)	Maxillary right first molar	Conventional
9	40.0	4.2	Noris Zygomatic	Maxillary right first molar	Conventional
10	40.0	4.2	Noris Zygomatic	Maxillary right second molar	Conventional
11	40.0	4.3	JD (JDentalCare)	Maxillary right first molar	Conventional
12	37.5	4.2	Noris Zygomatic	Maxillary right first molar	Conventional
13	40.0	4.3	JD	Maxillary right first molar	Conventional
14*	35.0	4.2	Noris Zygomatic	Maxillary right first molar	Conventional
15*	42.5	4.2	Noris Zygomatic	Maxillary right first premolar	Conventional
16	37.5	4.2	Noris Zygomatic	Maxillary right first molar	Conventional
17	37.5	4.2	Noris Zygomatic	Maxillary right first molar	Conventional
18	42.5	4.2	Noris Zygomatic	Maxillary right first molar	Conventional
19	50.0	4.3	Noris Zygomatic	Maxillary left second premolar	Piezosurgery
20	35.0	4.0	ICX-Zygoma (Medentis Medical)	Maxillary left first molar	Piezosurgery
21	30.0	4.0	ICX-Zygoma	Maxillary right first premolar	Piezosurgery
22	35.0	3.5	Noris Zygomatic	Maxillary right first molar	Piezosurgery
23	40.0	4.3	Noris Zygomatic	Maxillary right second premolar	Piezosurgery
24*	47.5	4.3	Noris Zygomatic	Maxillary left canine	Piezosurgery
25*	40.0	4.3	Noris Zygomatic	Maxillary left first molar	Conventional
26	37.5	3.5	Noris Zygomatic	Maxillary left second premolar	Piezosurgery
27	30.0	4.2	Noris Zygomatic	Maxillary left first molar	Conventional
28	45.0	4.3	Straumann Zygomatic (Straumann)	Maxillary left first molar	Conventional
29	45.0	4.3	Straumann Zygomatic	Maxillary left first molar	Conventional
30	40.0	4.3	Straumann Zygomatic	Maxillary right first molar	Conventional
31	32.5	4.2	Noris Zygomatic	Maxillary right first molar	Conventional
32	32.5	4.2	Noris Zygomatic	Maxillary left first molar	Conventional
33	45.0	4.2	Noris Zygomatic	Maxillary right first molar	Conventional
34	47.5	4.2	Noris Zygomatic	Maxillary left first molar	Conventional

Tab. 3: ZI-Data

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Reference:

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5.c.6 Simultaneous LeFort I osteotomy and zygomatic implant placement

F. Grecchi; E. Grecchi; M. Del Fabbro; F. Goker; University of Milan, 2022

Objectives:

The aim of this retrospective study was to evaluate the outcomes of simultaneous LeFort I osteotomy and zygomatic/dental implant placement for oral rehabilitation of patients with extremely atrophic/dysmorphic edentulous maxilla.

Material and Methods:

Simultaneous LeFort I osteotomy and zygomatic/dental implant placement was performed with patient-specific anatomical models and surgical guides produced through three-dimensional virtual planning methods.

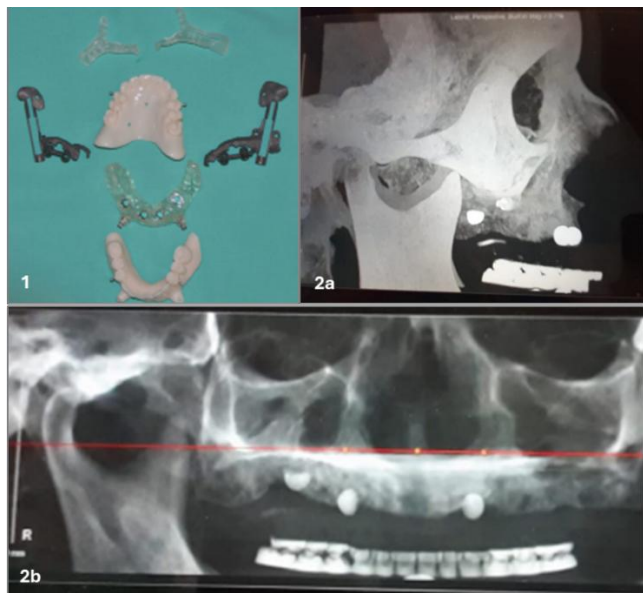


Fig. 1: Custom-made/patient-specific surgical templates and guides produced with the aid of CAD/CAM technology. **Abb. 2:** Preoperative radiographs, showing the situation of the patient with edentulous maxillary bone and dysmorphia due to maxillary hypoplasia: (a) lateral view; (b) panoramic view.

All patients received their final prosthesis, with immediate loading, on the day after surgery. The primary outcome variables were the implant survival rate, and the incidence of intra/ postoperative complications.

In total, 15 zygomatic implants and 33 conventional dental implants were inserted in eight patients. The zygomatic implants used in this study were Zygomatic Noris® (Noris Medical Ltd., Israel), and the dental implants were Noris® (Noris Medical Ltd., Israel) or ICX® (Medentis Medical GmbH, Neuenahr/Ahrweiler, Germany). The mean follow-up of the patients was 38.5 months. The implant survival rate was 93.3% for zygomatic implants and 100% for dental implants. No intra/postoperative complications were observed.

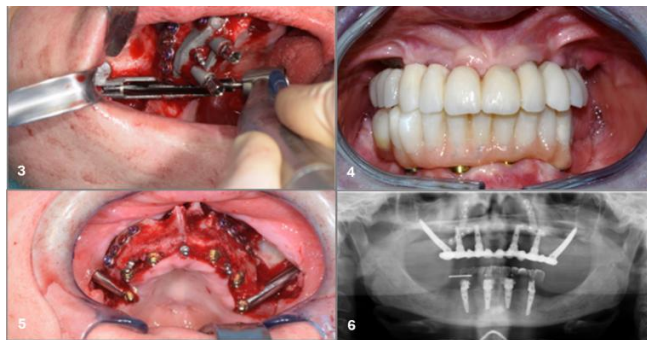


Fig. 3: Intraoperative view of the patient, showing the implant insertion guide. **Fig. 4:** Postoperative intraoral view of the patient after delivery of the final prosthesis, showing occlusion. **Fig. 5:** Intraoperative view of the patient after insertion of four conventional and two zygomatic implants. **Fig. 6:** Panoramic X-ray of the patient after delivery of the final prosthesis. Note that zygomatic implants in association with orthognathic surgery were chosen in this case due to the atrophic situation of the posterior sectors, in association with severe dysmorphism of the maxilla. Given the severe hypoplasia of the maxilla, it was necessary to support the lip with a large and bulky gingival flange in order to achieve a desirable and esthetic prosthetic rehabilitation. Alternative treatments would have provided esthetic and functional results, for example improved chewing, but not to the extent achieved here. The rehabilitation options were discussed with the patient, and consequently planned according to their request for a better esthetic result.

Results:

The implant survival rate was 93.3% for zygomatic implants and 100% for dental implants. No intra/postoperative complications were observed.

Patient	Characteristics	Failed ZI/total no. of ZI	Implant survival %	p-value	Patients with ZI failure/total patient number	Implant survival %	p-value
Gender	Male	0/2	100	0.87	0/1	100	0.875
	Female	1/13	92.3		1/7	85.7	
Reason for surgery	Severe atrophic maxilla	1/12	91.6	0.80	1/7	83.3	0.875
	Ectodermal dysplasia	0/3	100		0/1	100	
Smoking habits	Smokers	0/2	100	0.87	0/1	100	0.875
	Non-smokers	1/13	92.3		1/7	85.7	
Age	<60 years	1/13	92.3	0.87	1/7	85.7	0.875
	>60 years	0/2	100		0/1	100	
Antagonist dentition	Natural teeth/implants	1/8	87.5	0.53	1/4	75	0.5
	Fixed bridge	0/5	100		0/3	100	
	Toronto	0/2	100		0/1	100	
Final prosthesis type	Toronto	0/2	100	0.87	0/1	100	0.875
	Fixed-bridge prostheses with screws	1/13	92.3		1/7	85.7	
Number of ZI + I	I2I + 5I	0/1	100	0.93	0/1	100	0.875
	Z2I + 4I	1/14	92.8		1/7	85.7	

Tab. 1: Implant success rates according to patient characteristics, based on zygomatic implant number / based on patient number.

Age	Sex	Smoker	Reason for surgery (ZAGA preop)	ZAGA postop	Dental implant number	ZI number	Length of ZIs	ZI locations	Survival (months)	Antagonist dentition	Prosthesis type	Comp.	Survival % DI (n/total)	Survival % ZI (n/total)
1	58	F	No	Atrophic maxilla 2 (ZAGA 2)	4	2	37.5 42.5	26 16	29 11 (fail)	Natural teeth and implants with ceramic crowns	Fixed zirconia bridge with screws	No	100	50
2	36	M	No	Atrophic maxilla 2 (ZAGA 3)	4	2	40 40	26 16	48	Natural teeth	Fixed resin composite bridge with screws	No	100	100
3	61	F	No	Atrophic maxilla 4 (ZAGA 4)	4	2	37.5 32.5	26 16	56	Natural teeth and implants with ceramic crowns	Fixed resin composite bridge with screws	No	100	100
4	64	F	Yes	Atrophic maxilla 4 (ZAGA 4)	4	2	37.5 40	26 16	23	Toronto (resin)	Fixed resin composite bridge with screws	No	100	100
5	29	F	No	Ectodermal dysplasia (ZAGA 3)	2	5	37.5	26	58	Fixed bridge	Toronto (resin)	No	100	100
6	56	F	No	Atrophic maxilla 2 (ZAGA 3)	4	2	42.5 45	26 16	53	Implants with ceramic crowns	Fixed resin composite bridge with screws	No	100	100
7	57	F	No	Atrophic maxilla 3 (ZAGA 3)	4	2	40 42.5	26 16	9	Fixed bridge	Fixed resin composite bridge with screws	No	100	100
8	54	F	No	Atrophic maxilla 2 (ZAGA 3)	4	2	32.5 32.5	26 16	18	Fixed bridge	Fixed resin composite bridge with screws	No	100	100

Tab. 2: Patient demographics and data regarding zygomatic and dental implant survival; ZI: zygomatic implant, DI: conventional dental implant, Comp: complication

Conclusions:

Simultaneous LeFort I osteotomy associated with zygomatic/dental implant surgery can be considered as a valuable treatment option for rehabilitation of patients with extremely atrophic edentulous maxilla and esthetic issues of the face.

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Table 6c- Further Retrospective Studies

Study-No.	Page	Study Location / Year	Timepoint Follow-Up in Months	Number of Subjects	Number of Implants	Endpoint (Survival rate [%])
6.c.1	113	Platinum Dental Clinic, Breslau, Poland, 2023 Dr. A. Nowicki; Dr. K. Osypko	12	1	4	100 %
		Study Observative / Study Title	Digital Workflow in Full Mouth Rehabilitation with Immediate Loading, Intraoral Welding and 3D-printed Reconstructions in a Periodontal Patient: A Case Report			
		Research Results / Evaluation	The workflow presented made it possible to provide the patient with one type of restoration at each stage of treatment and to achieve the desired esthetic effect with adequate wearing comfort even in the early stages. A fully digital workflow is a reliable treatment method even in complex cases.			

6.c.1 Digital Workflow in Full Mouth Rehabilitation with Immediate Loading, Intraoral Welding and 3D-printed Reconstructions in a Periodontal Patient: A Case Report

Dr. A. Nowicki; Dr. K. Osypko, Platinum Dental Clinic, Wroclaw, Poland, 2023

Introduction:

Complex implant reconstructions in patients with residual dentition due to periodontitis is a challenging task in many aspects.

Objective:

This study shows a full digital workflow combining 3D printing, guided implant placement, intraoral scanning and welding with immediate loading and digital smile design.

Methods:

An analog impression was taken to validate the passive fit of final restorations. The whole treatment plan was divided into three stages. The first stage included an intraoral scan of baseline dentition.



Fig. 1a-c: (a) Orthopantomogram (OPG) of baseline dentition; Intraoral View of Upper - (b) and Lower Jaw (c).

Then the extraction of all teeth was performed, implanting four temporary implants and providing the patient with removable temporary prosthesis

(two implants in the maxilla and two implants in the mandible; ICX®-mini; diameter: 2.9mm; length: 10mm, medentis medical GmbH, Bad Neuenahr-Ahrweiler/Germany; Fig. 2a, b).

The machined ICX®-mini implants with smooth surface and a tip with ball-head attachment are sufficient for temporary, mucosa-supported immediate restoration during the healing phase of permanent implants.

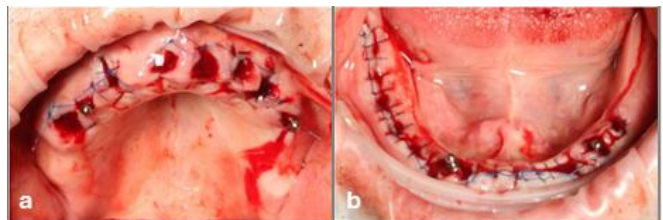


Fig. 2a-b: Intraoral view of upper (a) and lower jaw (b) after extractions and placement of temporary implants for proper retention of printed temporary restorations

Matrices for ball-head abutments were placed in 3D-printed temporaries in order to achieve proper retention (Fig. 3a, b).

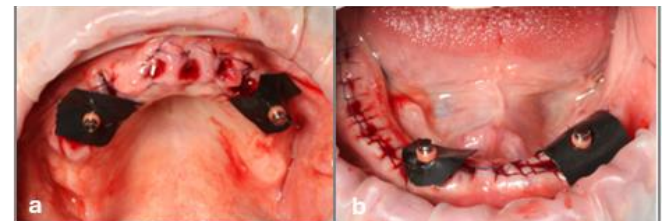


Fig. 3a-b: Temporary implant region covered with a rubber piece to prevent the fixing material from entering the wound. Upper (a) and lower jaw (b)

Due to the healing process (4 Months) and possible prosthetic field aberrations, teeth were blocked with flat cusps, while group guidance and three-point occlusal contact in both arches were chosen (Fig. 4a, b).



Fig.4a-b: Photographs of 3D-printed temporary restorations; intraoral view (A) and extraoral view with a smile (B).

The second stage was to scan the removable temporaries, implanting 10 implants (6 implants in the maxilla, 4 implants in the mandible; ROOTT, Trate Ag, Root, Switzerland) and multi-unit abutments (MUA), and create a rigid construction via the intraoral welding of titanium bar and by fixing it to the 3D-printed temporary reconstructions (designed with DSD) as a form of immediate loading (Fig. 5a, b).

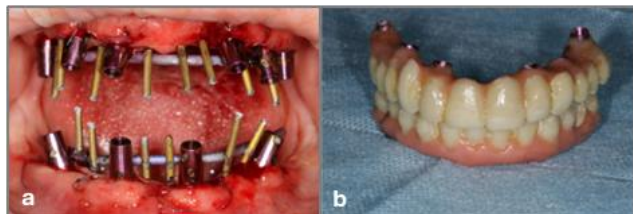


Fig.5a-b: (a) Implants with MUA and AM abutments welded intraorally with 2.0 mm titanium wire allowing the obtention of a rigid framework. (b) New 3D-printed temporary reconstruction connected with rigid welded framework and MUA as long-term fixed reconstruction for implant integration healing period.

The third stage included the scanning of screw-retained temporary reconstructions, then scanning from the MUA level and creating final reconstruction.



Fig.6: OPG 6 months after placing implants and immediate loading with welded long-lasting temporary reconstruction.

Results:

The presented workflow enabled the delivery of some sort of restoration to the patient at every moment of the treatment and to sustain the required esthetic effect with decent comfort of use even in the early stages.

Conclusion:

A full digital workflow is a reliable treatment method even in complex cases.

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Reference:

Nowicki A; Osypko K. *Digital Workflow in Full Mouth Rehabilitation with Immediate Loading, Intraoral Welding and 3D-Printed Reconstructions in a Periodontal Patient: A Case Report.* Reports **2023**, 6, 52. <https://doi.org/10.3390/reports6040052>

Ongoing Studies

Two further studies with ICX®-Implant Systems are planned for 2023, including a prospective study under the direction of Prof. Dr. Susanne Nahles at Charité Universitätsmedizin Berlin (Department of Oral and Maxillofacial Surgery). The aim of this study is to compare the osseointegration of ICX®-Active Liquid Implants and ICX®-Standard Implants (ICX®-Active Master and ICX®-Premium). The study is designed for an observation period of several years and comprises a study population of 19 patients and 87 implants and abutments (study title: "Prospective study with split-mouth design on improved osseointegration with dental implants after radiotherapy of an oral carcinoma").

Study Location:	Charité Universitätsmedizin Berlin, Klinik für Mund-, Kiefer- und Gesichtschirurgie
Head of Study:	Prof. Dr. Susanne Nahles
Type of Study:	Prospective
Study Duration:	since 04/2021
Study Title:	"Prospective Study with split-mouth Design on improved osseointegration with dental implants after radiotherapy of oral carcinoma"
Number of Patients:	19/20
Number of Implants:	87
Number of Abutments:	ICX®-Active-Master → 25 Multi-Unit, 6 Direct; ICX®-Active Liquid: 25 Multi-Unit, 2 Direct
Type of Treatment:	Conventional Loading
Endpoints:	Comparison of Osseointegration of ICX®-Active Liquid Implants and ICX®-Standard Implants (ICX®-Active Master, ICX®-Premium)

In addition, a Post-Market Clinical Follow-up (PMCF) study with ICX®-Zygoma-Implants is currently being conducted under the direction of Professor Dr. Dr. Peter Maurer. The aim of this non-interventional, multi-center study is to investigate the safety and performance of the ICX®-Zygoma-Implants within the intended purpose, i.e. for the treatment of patients with an atrophic, edentulous or partially edentulous maxilla, in routine clinical practice (implant survival rate, implant performance in terms of prosthesis attachment for restoration of chewing function, aesthetics and phonation of the patient; user satisfaction, patient satisfaction). The study is designed for an observation period of 15 years and comprises a study population of 214 patients and 299 implants and abutments (Study Title: "Post-market clinical follow-up study to evaluate the long-term safety and performance of the ICX®-Zygoma-Implant System used in everyday practice").

Study Location(s):	St. Wendel (Prof. Dr. Peter Maurer); Freudenberg (Dr. Tim Nolting); Universität Bonn (Prof. Dr. Dr. Enkling)
Head of Study:	Prof. Dr. Dr. Peter Maurer
Type of Study:	Post-Market Clinical Follow-up-Study (PMCF)
Study Duration:	15 Years
Study Title:	"Post-market clinical follow-up study to evaluate the long-term safety and performance of the ICX®-Zygoma-Implant System used in everyday practice"
Number of Patients:	2 / 214
Endpoints:	Implant Survival Rate (%); User Satisfaction, Patient Satisfaction

Results of the User Observations 2022-23:

In order to obtain a broader view of the entire ICX® implant system, medentis medical has started to collect data from many users from the customer base via the ImpDat dental software, similar to the procedure with Prof. Dr. Susanne Nahles' group.

The first data set of 109 patients with a total of 797 implants was collected over a period of 11 years (Prof. Dr. sc. Robert Čelić - 97 patients with 575 implants, Dr. Tamás Asztalos - 12 patients with 222 implants), which serves as a basis for the follow-up of the ICX®-Implant System and will be continuously expanded (*Fig. 1A*).

The following implants, healing caps, cover screws and abutments were used in this case series:

Used Implant Groups	Used Cover Screws	Used Healing Caps	Used Abutments
ICX®-Premium TL Implant, different dimensions	ICX®-Cover Screw, sterile, different dimensions	ICX®-Healing Cap, conical (Partial Thread), different dimensions	ICX®-Abutment, different dimensions
ICX®-Active Master Implant, different dimensions			ICX®-Abutment BL, different dimensions
ICX®-Premium Implant, different dimensions			ICX®-Maximus Abutment, different dimensions
DaVinci XL Implant, different dimensions			ICX®-Plastic-Abutment, different dimensions
			ICX®-Multi Abutment, different dimensions
			ICX®-Aesthetic Abutment, different dimensions
			ICX®-TL Abutment, different dimensions
			ICX®-Adhesive Base, different dimensions
			ICX®-Plastic Bar-Abutment, different dimensions
			ICX®-Bar Abutment, different dimensions

No intraoperative complications were documented in 81.7 % of the 109 patients, bleeding occurred in only 2.3 % of patients, 3.1 % had pain and swelling was documented in around 13 % (*Fig. 1B*).

When looking at late complications, it is also noticeable that seven out of nine cases of late complications such as implant failure and peri-implantitis occurred in patients with systemic diseases (e.g. AIDS, malignant tumor) or other risk factors (e.g. poor oral hygiene, smoking) (*Fig. 1C*). Conversely, no late complications occurred in 31 of 34 patients with systemic diseases (data not shown). With only three implant failures within the observed time frame, the overall failure rate of 0.4% is significantly lower than the failure rate of 2.4 % documented by Zaoh *et al.* 2022 (*Fig. 1D*).

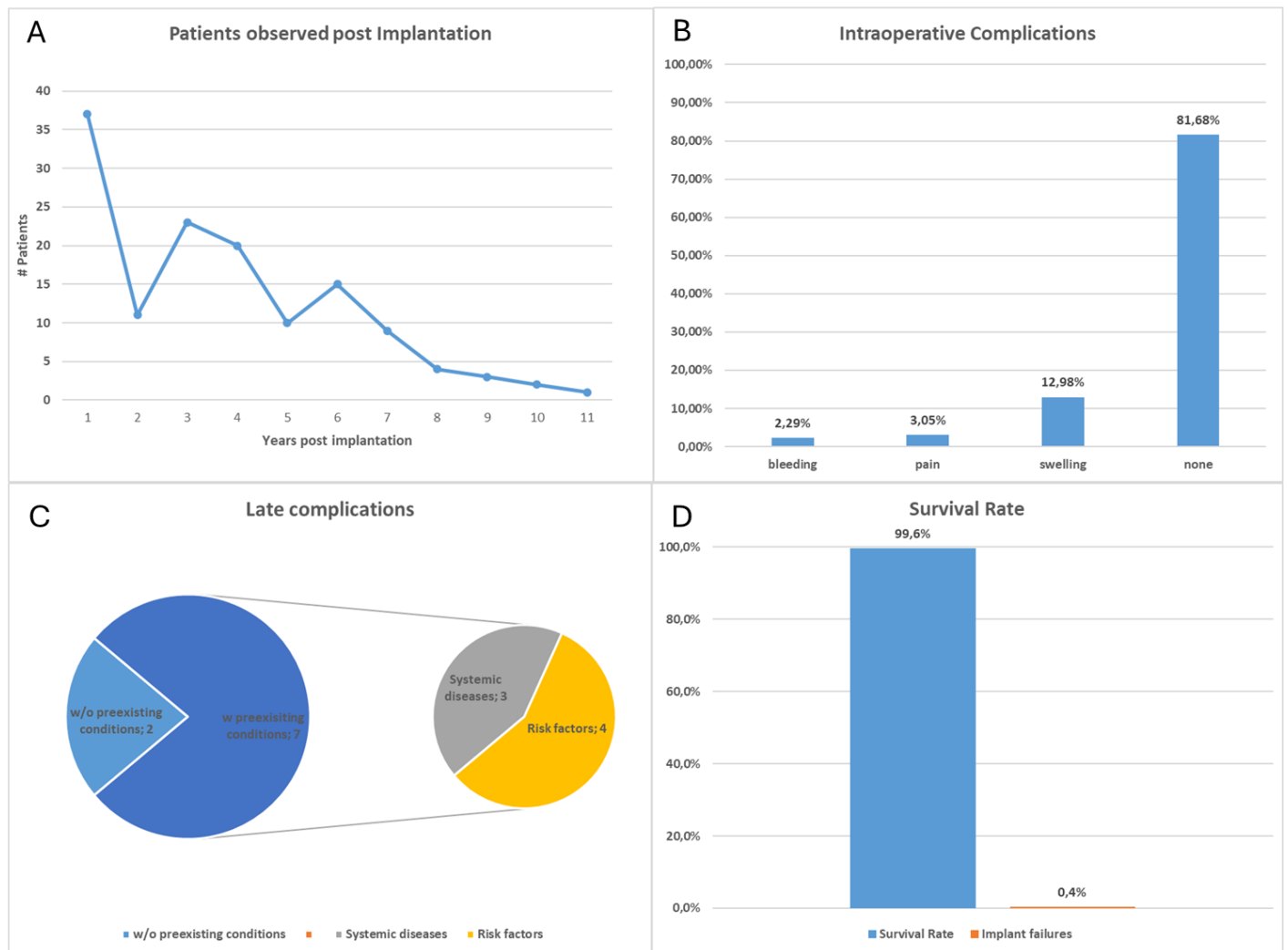


Fig. 1: ICX® implant system Case series:

A) Number of patients observed in the respective years after implantation. **B)** Incidence of intraoperative complications in the 109 patients observed. **C)** Number of patients with late complications (including implant failure), separated by pre-existing conditions (allergy, AIDS, malignant tumor) and risk factors (oral hygiene, smoking). **D)** Survival rate of the implants in the 109 patients observed.

The data set described is a strong indication of the safety of the ICX® implant system. In all cases, a final treatment with superstructures was performed, resulting in restoration of chewing function and esthetics, which is the performance of the system.

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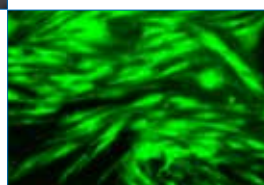
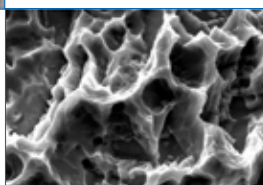
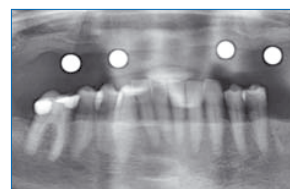
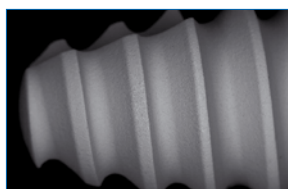
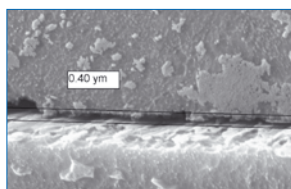
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