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Reconstruction of Three-Dimensional Alveolar Defects by using a Customised Lattice Structure (Yxoss CBR®) in 100 cases

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Objectives

Missing or reduced buccal bone plates as well as a reduced vertical dimension still represent challenges in bone augmentation and require a three-dimensional reconstruction[1,2]. Modern individualised dentistry intends to provide new therapeutic concepts based on CAD/CAM technology and 3-dimensional printing. The aim of this study was to establish a protocol for the clinical application of a patient-specific titanium lattice structure (Yxoss CBR®) for customised bone regeneration.

Methods

A three-dimensional projection of each patient's bony defect was generated and individualised titanium lattice structures were designed by using CAD/CAM procedures and rapid prototyping. The lattice structures were installed by using a mixture of autogenous bone graft harvested from various intraoral donor sites and Bio Oss® particles in a 1:1 ratio. Implant placement was performed simultaneously with lattice structure insertion or after a healing period of 6 months combined with the removal of Yxoss CBR®. 100 lattice structures were installed with this technique during the last two years. Evaluation concerning sizes, different defect regions, augmentation site, healing difficulties, and soft tissue management was performed, see also **Figure 1 A-J**.

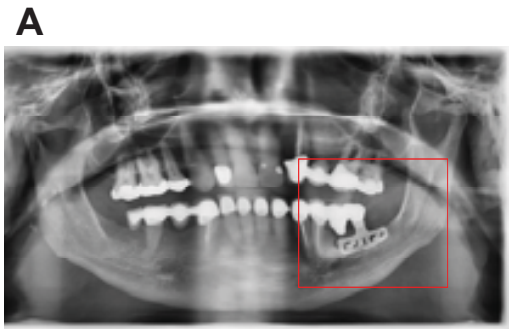

Figure 1: (A)-(C) After removal of a blade implant with periimplantitis, clinical and radiological diagnosis showed an atrophic segment of the posterior mandible. The high vertical and transversal deficit as well as the challenging soft tissue situation made a functionally and esthetically satisfying implant placement impossible.

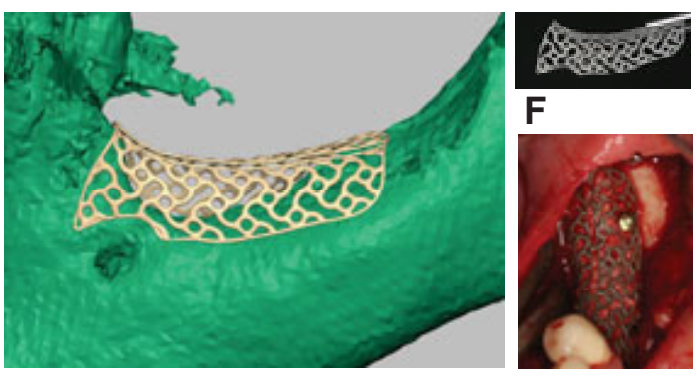

Figure 1: (D)-(F) A patient-specific lattice was designed using CAD/CAM technology by generating a 3D-model of the bony defect after the acquisition of Cone-Beam Computed Tomography (CBCT) data with minimum artifacts from conventional DICOM files. Yxoss CBR® was placed using a mixture of autogenous bone graft and Bio Oss® particles.

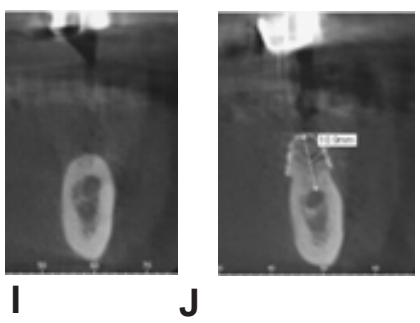

Figure 1: (G) and (H) The prefabricated titanium lattice structrue was inserted with a passive tension-free fit keeping the biological precautions (1.5 mm to the adjacent teeth or nerve structures). After a healing period of 6 months, titanium structure was removed. A new CBCT dataset was collected to verify the bone augmentation volume and to plan implant surgery.
In the cross-sectional reconstruction, vertical gain was obvious.

Figure 1: (I) and (J): The augmented bone volume was of stable dimension, well- vascularized and without any signs of inflammation. After removal of the lattice structure, implant placement was performed.

Results

This study evaluated 100 customised lattice structures in 89 patients with 174 inserted implants. Tobacco abuse was documented in 5.3% and periodontitis in 28.1%. No patient suffered from diabetes mellitus. The size of the lattice structure was designed to replace 1-2 teeth (52%), 3-4 teeth (37%) and >5 teeth (11%). Bone loss geometry was horizontal (5%), vertical (5%), and three-dimensional loss occurred in 90% of cases.
Augmentation site was in the upper jaw (62%) and in the lower jaw (38%) **(Figure 2)**.
<u>Localisation had no influence on dehiscence probability.</u>
Procedures in various sextants showed no differences compared to non-overlapping procedures (p=0.6). Size did not influence the probability of dehiscence, see **Figure 3.**

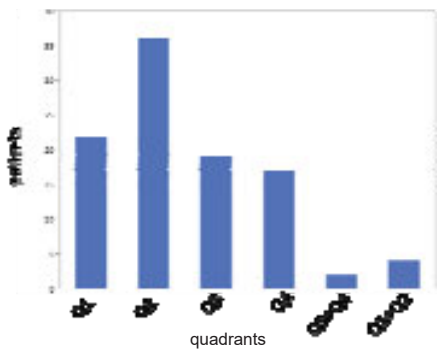

Figure 2: Distribution of Yxoss CBR® in various quadrants (Q)

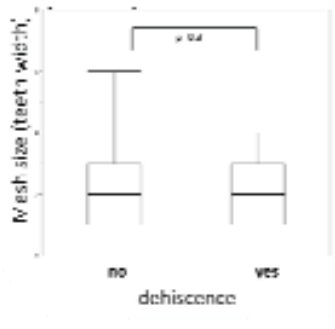

Figure 3: Size did not influence dehiscence probability.

Dehiscence occurred in 20% (**see Figure 4**). This had no influence on implant placement procedures. Implant placement was possible in 98% of cases.
<u>Risk factors did not influence dehiscence probability.</u>
Risk factors such as age and sex (p=0.08, p=0.02), tobacco abuse (p=0.2), periodontitis (p=0.2) and gingiva morphotypes were not relevant for the occurrence of dehiscence.
<u>Defect geometry correlates with dehiscence probability.</u>
Cases with horizontal defects showed significantly lower dehiscence compared to vertical defects (17% vs. 83%, p=0.02). Comparisons between horizontal to combined and vertical to combined defects showed no significant differences.

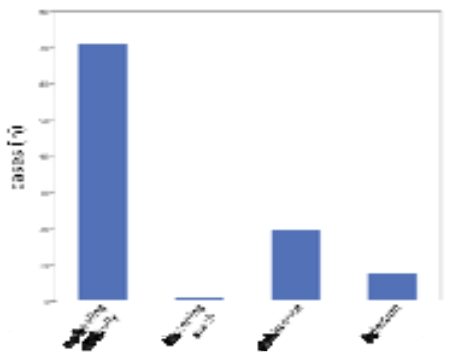

Figure 4: Wound healing difficulties occured in 29 % of the cases, inculding loosening of the mesh (1%), dehiscence (20%), and infection (8%). In 71% of the cases no healing difficulties were found.

Conclusion

This study presents a novel, patient-specific, customised lattice structure made of titanium (Yxoss CBR®) which is introduced for shaping and rebuilding a bone defect in complex cases. Results demonstrated this protocol to be a successful and predictable procedure for rebuilding an atrophied bone defect. No serious complication was seen during the healing period and an exposure did not lead to augmentation loss. Implants could be placed in 98 % of cases as planned. This protocol facilitated and shortened surgery time.

1 Merli, M. *et al.* Fence technique for localized three-dimensional bone augmentation: a technical description and case reports. *The International journal of periodontics & restorative dentistry* **35**, 57-64, doi:10.11607/prd.2029 (2015)
2 Jung, G. U., Jeon, J. Y., Hwang, K. G. & Park, C. J. Preliminary evaluation of a three-dimensional, customized, and preformed titanium mesh in peri-implant alveolar bone regeneration. *Journal of the Korean Association of Oral and Maxillofacial Surgeons* **40**, 181-187, doi:10.5125/jkaoms.2014.40.4.181 (2014)

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