Floating implants with ceramic implants and the BISS

Clinical application of a new implant stabilisation system

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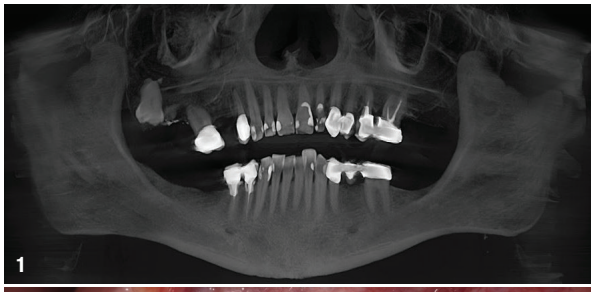
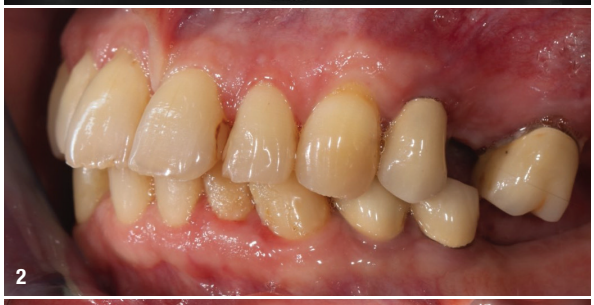
Bone atrophy is still seen as a challenge or even an obstacle to successful implant placement in both the upper and lower jaw, since osseointegration of the implant depends largely on rigid and motionless anchorage in the bone. Often, however, the bone is too soft or too severely reduced to allow stable placement of an implant. The latter problem is especially common in the sinus region. In a certain sense, this is paradoxical, as implantation is the most targeted and natural way of counteracting further bone loss. Progressive bone loss affects not only the stability, functionality and longevity of a planned dental prosthesis but also the extra-oral aesthetics. Bone loss can be caused by trauma and infection on the one hand and—more frequently—by generalised periodontal disease or tooth extraction on the other. Important bone parts such as the buccal lamella are often lost during extraction in particular. Perforation can also occur, negatively affecting the maxillary sinus. However, even in the case of an extraction without complications, increasing atrophy of the alveolar ridge occurs over time. In the maxillary posterior region, the absence of roots leads to increasing pneumatisation of the maxillary sinus with advancing age and thus to further bone loss.





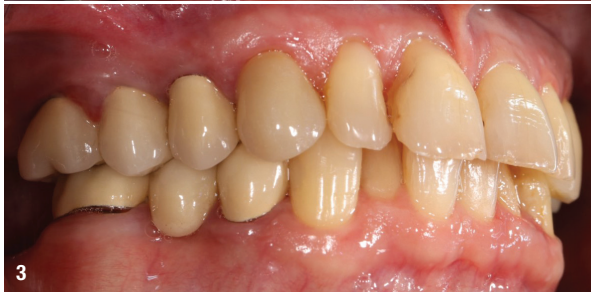


Fig. 1: Pre-op dental panoramic tomogram. Severe bone loss in the first and second quadrants. **Fig. 2:** Tooth #16 not worth preserving and generalised bone loss and severe vertical bone collapse in region #15. **Fig. 3:** Teeth #25 and 26 not worth preserving and generalised bone loss in the maxillary posterior region.

If the patient and the dentist decide in favour of an implant restoration despite the small volume of residual bone, the standard dental consensus for large multidimensional bone defects is still bone augmentation followed by late implant placement. In recent decades, various multistage guided bone regeneration techniques have basically fulfilled their purpose of restoring implantable space. However, these procedures often result in too much compression on the augmented surface, which can have a negative impact on adequate bone healing. On the one hand, this affects vascularisation: the more compressed the augmentation, the lower the probability of an efficient blood vessel supply developing, as there is insufficient space for the blood vessels to proliferate. Owing to their density, bone blocks are also often not connected to the blood supply, especially if the blood supply is coming centrally from the middle of the jaw and not peripherally, as is primarily the case in the dorsal mandible. On the other hand, it is often impossible to ensure the positional stability of the free augmentation and protect it against the effects of any forces it might sustain. For this reason, osteosynthesis plates, titanium-reinforced PTFE membranes or titanium mesh are used for space stabilisation.[1–5]

The problem with freely applied bone substitute materials is that the bone is frequently built up in the wrong location for reasons of simplicity. For example, there is often a lack of bone in the dorsal maxilla in the direction of the oral cavity (coronal) because the bone is increasingly modelled in the direction of the maxillary sinus by performing

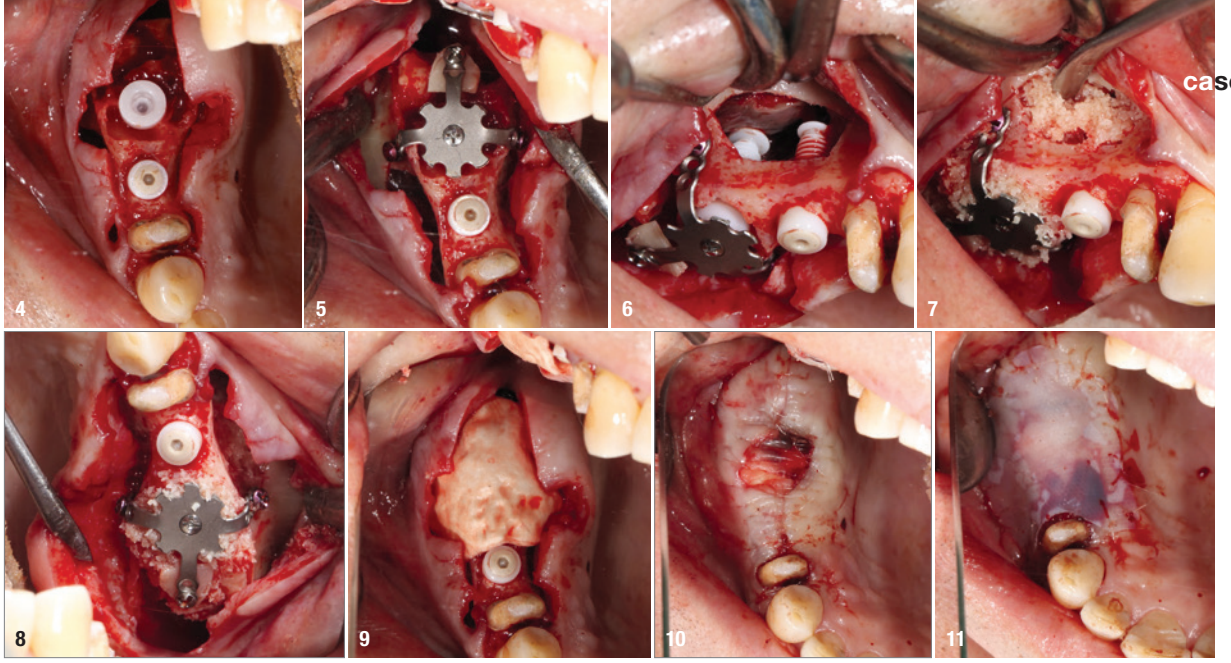


Fig. 4: Placement of two SDS ceramic sinus implants after external lift in regions #15 and 16. Implant #16, placed immediately, did not achieve sufficient primary stability in this case. **Figs. 5 & 6:** Fixation of a single-unit cage from the BISS using cortical screws in the surrounding bone to provide secondary stabilisation of implant #16, which was placed immediately and did not achieve primary stability, as a tent pole. Placement of a Khoury bone plate on the distal cage arm. **Figs. 7 & 8:** Allogeneic bone substitute material and autologous bone chips fill the space created. The volume should ideally be slightly over-modelled to allow for physiological shrinkage. **Fig. 9:** A resorbable collagen membrane protects the bone substitute material in the augmented space. The solid platelet-rich fibrin matrices overlying the bone substitute material promote wound healing and provide better soft-tissue management. **Fig. 10:** Surgical area after approximation of the wound edges using resorbable sutures. Apical mattress sutures ensured that there was no tensile stress in the soft tissue of the surgical site. **Fig. 11:** A PTFE membrane was temporarily sutured over the surgical site in accordance with the open healing protocol.

an external lift. As a result, the implant is located too far cranially, leading to an altered anatomy of the maxillary sinus area and an extended crown on the implant. This in turn is associated with an increased risk of loosening or fracture of the implant. Although positional stability of bone grafts can at least be ensured by certain established systems, these have invariably been associated with multiple surgical procedures. This not only significantly increases the likelihood of scar plate formation in the surgical area, but also places a significant burden on the surgeon's and, above all, the patient's time, financial and psychological resources. For these reasons, strategies for more immediate treatment options are desirable in the future in order to perform bone augmentation and implant placement as close together as possible.

Design, mechanics and functional principle of the concept

The BISS—Bone Implant Stabilization System—developed by the authors enables exactly this approach and pursues the goal of offering the patient implant-supported dental prostheses in almost any initial situation. The functional principles of the system have been proved scientifically in a range of studies.[1–20] They form the prerequisite for successful bone formation and will be illustrated in this section using the "tent pole umbrella" principle: a tent pole holds the required space in a stable position coronally and/or cranially, and an umbrella attached to it increases the volume. The larger the space created (shaded area), the more voluminous the bone gain.[21–25] The main component of the concept is the BISS cage, which embodies the umbrella according to the principle described and gives the body's own osteoinductive tissues, such as the periosteum and the Schneiderian membrane, space for regeneration. The cage consists of a titanium body and titanium arms. The body has one or more interfaces at its base—making it a single, double,

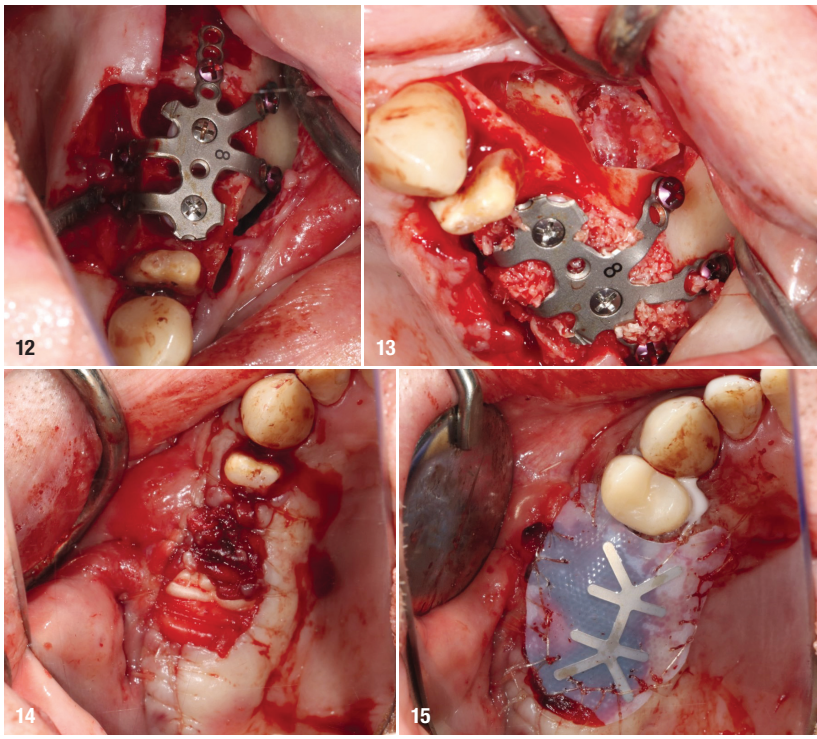


Fig. 12: Triple cage (used as a double cage) *in situ*. The primary stable implant #25 stabilised the cage in addition to the cortical screws so that the cage in turn could fix the floating implant #26 in the desired position. **Fig. 13:** Allogeneic bone substitute material and autologous bone chips fill the space created. Ideally, the volume should be slightly over-modelled to allow for physiological shrinkage. **Fig. 14:** Surgical area after approximation of the wound edges using resorbable suture material. **Fig. 15:** A titanium-reinforced PTFE membrane was temporarily sutured over the surgical area in accordance with the open healing protocol. Apical mattress sutures ensured that there was no tensile stress in the soft tissue of the surgical area.

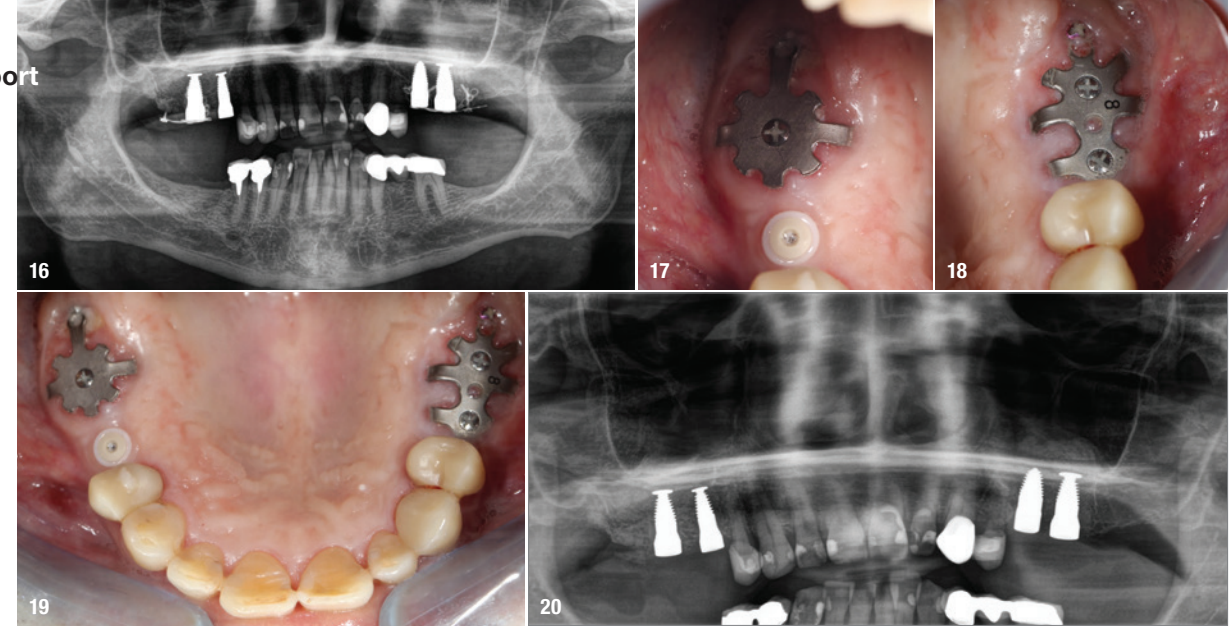


Fig. 16: Immediate post-op dental panoramic tomogram with BISS cage and SDS ceramic implants *in situ* in the first and second quadrants, respectively. **Figs. 17–19:** Almost eight weeks post-op and after removal of the PTFE membranes. **Fig. 20:** Five-month post-op dental panoramic tomogram. Dimensionally stable bone had been generated and all four implants had osseointegrated.

triple or quadruple cage. Umbrella screws can be used as tent poles; they are screwed firmly into the interfaces of the cages with their metric thread in the coronal–apical direction directly below the screw head and fixed in the bone with the self-tapping thread. In an ideal scenario, ceramic implants which can be firmly screwed in to the interfaces of the cage can be used as the tent poles instead of the umbrella screws.

Owing to their morphology, zirconium dioxide ceramic implants with aggressive apical threads offer the possibility of achieving unexpectedly high stability in 3D bone collapses. Depending on the bone situation, a distinction is made between two different application techniques with regard to the one-stage combination technique of cage and ceramic implants. If there is very little residual bone and the primary stability of the ceramic implants is not sufficiently achievable, they are stabilised secondarily by the cage. An implant of this kind can even be placed completely without bone contact ("floating implant") and osseointegrate in the long term. The arms can then be fixed to the residual bone with the cortical screws for stabilisation as often as required—both orally and buccally as well as between the implants on the coronal residual bone. In bone defects in which sufficient primary stability of the implants can be achieved, the implants stabilise the cage, which in this case is only used as the umbrella. In this situation, the arms can be bent into the desired position without being screwed to the bone. In any case, the arms should be shortened such that the last screw hole of the arm just touches solid bone. The system also offers the possibility of combining these techniques using umbrella screws, primary stable implants or floating implants within a cage with multiple interfaces.

A particular advantage is that the implants can be placed at the desired height or target position (corresponding to the prosthetic plateau at tissue level) without having to rely on bone in this area. The cavity created should ideally be filled with autologous bone chips or bone graft substitute, although allogenic bone substitute materials show the best results in large-volume augmentation.[13,26] According to the situation, the arms of the cage can always be bent, adapted and, if necessary, shortened in such a way that they best protect the bone substitute materials mechanically. Depending on the desired cavity anatomy, the arms can also serve as a holder for a bone disc screwed to them and thus increase the shielding effect in the sense of the Khoury technique. Because the ceramic implants are tissue-level implants with a tulip height of 3 mm (SDS Swiss Dental Solutions) and the prosthetic plateau is directly at the level of the inside of the cage when used simultaneously with the system, a physiological resorption of 3 mm is automatically taken into account by filling the cage completely to the top with bone substitute materials.

Perioperative aspects

Unlike a titanium implant, the ceramic implant heals in an immunologically neutral way.[27–36] Another decisive factor for successful healing and stabilisation is that the patient's bone metabolism is adequately adjusted. Therefore, micronutrients that are particularly relevant for sufficient bone metabolism, such as vitamin D_3, vitamin K_2 and magnesium, as well as the anti-inflammatory omega-3 fatty acid, the antioxidant vitamin C and a low low-density lipoprotein value as a pro-inflammatory marker, play an important role in the preoperative diagnosis.[37–48,20,49] Usually, primary coverage cannot be achieved in connection with the BISS insertion without traumatising the periosteum. Instead of vertical unloading incisions and periosteal slitting, Dr Alain Simonpieri's Soft Brushing Technique has proved to be an efficient and minimally invasive method for flap mobilisation. To avoid pressure on the augmentation, primary wound closure should not be attempted. It is thus recommended to cover the cage with a collagen membrane, several layers of advanced platelet-rich fibrin matrices and—for temporary protection—a PTFE membrane placed over the approximated wound

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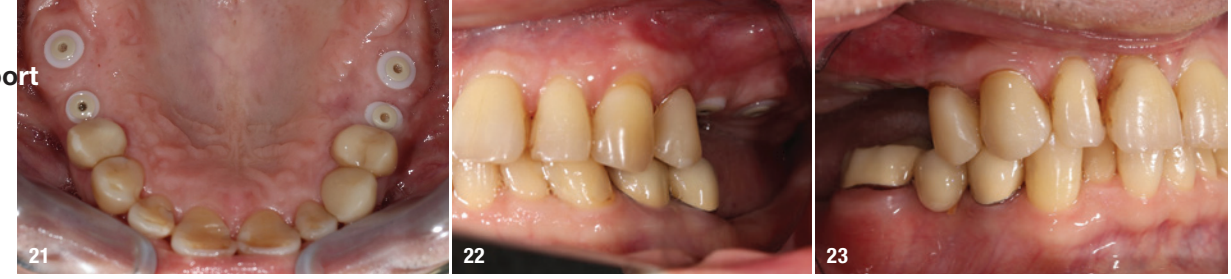


Figs. 21–23: After six months, all four ceramic implants had healed without irritation and could be provisionally restored or mechanically loaded.

margins as the final layer, according to Prof. Ghanaati's Open Healing Concept.[50,51] The PTFE membrane is sewn over the approximated wound margins on the alveolar ridge and should be removed after approximately one week or as soon as free epithelialisation of the wound margins over the augmentation is complete. It is important that the traction on the wound margins is completely

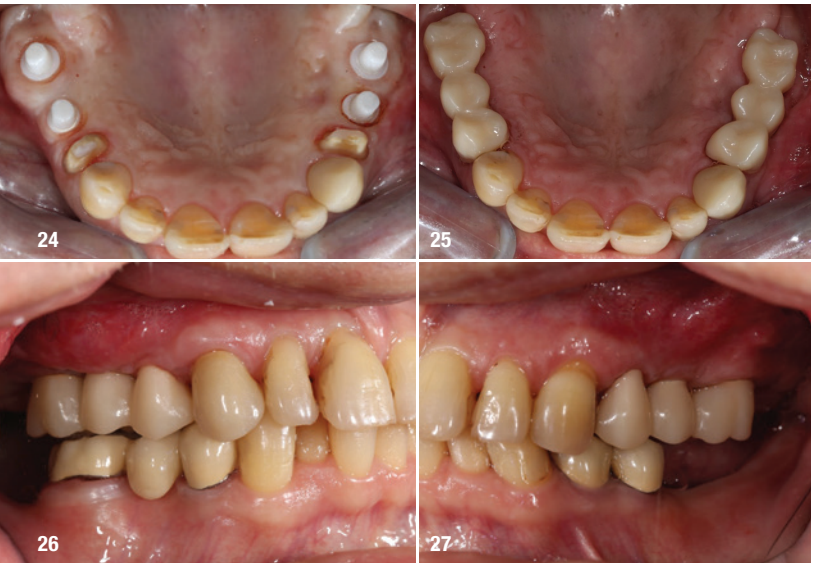


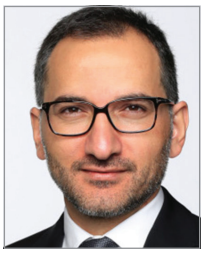
Fig. 24: The abutments were cemented on to the two-piece ceramic implants for the temporary restoration and additionally screw-retained. **Figs. 25–27:** After six months, the four stable ceramic implants were restored with long-term temporary restorations.

absorbed, which can best be achieved by placing a sufficient number of apical mattress sutures at least 10 mm above or below the wound margins. If this soft-tissue management protocol is used correctly, the main advantages are that patients usually experience very little swelling and pain, the vestibulum is preserved or even improved, and a fixed keratinised gingiva is created over the graft. The cage should be removed after four to six months. In this context, it is advisable to document the insertion day (photographs and sketches) so that the exact screw positions can be reproduced and the removal of the cage can be performed in a minimally invasive manner. For this reason, it is also recommended to remove all unnecessary arms on the day of insertion and to shorten the remaining arms as much as possible in order to make removal of the cage easier.

Conclusion

Physiological bone reconstruction follows certain biological laws. Provided that the patient's bone metabolism is functioning properly, bone growth can be supported by activating growth factors and by accelerating wound and bone healing. Because the Schneiderian membrane (endosteum) and the periosteum have osteoinductive effects, they help stabilise the volume over a defined period and maintain it in the long term, two of the most important measures of successful bone grafting. This, in turn, is based on adequate immobilisation of the graft and keeping it away from any compressive and tensile forces. The system presented here is capable of fulfilling these prerequisites and (re)generating high-quality bone when used correctly according to the tent pole umbrella principle. In addition, the combination of the BISS cage and ceramic implants provides an immediate solution for cases that appear unsuitable for (immediate) implant placement. The method, which can be implemented in a single session, not only reduces the psychological hurdle for the patient, but also has a number of advantages from a medical and health point of view. The healing period and the time until definitive restoration are shortened, and ineffective use of resources in terms of costs, time and effort, as well as repeated traumatisation of the tissue, can be specifically counteracted with the BISS system, which has been clinically proved to be successful multiple times. The guiding principle of the system can be summarised as follows: rather than first augmenting and then drilling away bone in order to place an implant after the graft has healed, bone is regenerated directly in the defect area.

about the authors



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