The jaw is often so atrophied that implants are laterally exposed or only insufficiently integrated into the alveole. In such cases, shell-type augmentation is a must. The SonicWeld Rx® system (KLS Martin Group) pursues a radically new basic concept for implanting resorbable osteosynthesis materials, membranes and pins. The system was launched in 2005 and initially recommended for the higher regions of the neurocranium where the loads involved are low, especially for the surgical correction of cranial malformations (craniosynostoses) in infants and babies. In 2006, the system received approval for midface traumas as well, and since June 2007 all augmentative procedures in the OMF area are covered. SonicWeld Rx® is an innovative procedure for fixing resorbable pins and membranes. It uses an ultrasound generator that generates pulses of an exactly defined frequency focused with a sonotrode. Upon placing a SonicPin Rx made of 100% amorphous poly-D-L-lactic acid (PDLLA) and activating the sonotrode, the ultrasonic vibrations cause the pin surfaces to liquefy at the edges, thus enabling the pin to glide into the pre-drilled hole. It is the change effected in its aggregate state that lets the pin penetrate into the bony cavities and anchor itself in a way that would never be possible for conventional bone screws. Therefore, the term “bone welding” in the sense of “welding in” is a highly adequate description of the process involved. Interestingly, SonicPins can take hold in any type of bone, hard cor-

Guided Bone Regeneration – Procedure with a Selected System

Although resorbable membranes and pins have been available for Guided Tissue Regeneration (GTR) for some time, these materials tend to be hard to fix and do not provide the kind of stability needed for the shell technique. For advanced augmenta-tion procedures, however, it should be possible to perform implant insertion and augmentation simultaneously to avoid a second operation.

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tical just as much as fragile or cancellous bone structures. The procedure actually originated in the lumber industry, where thermoplastic pins are used for creating highly stable wood-to-wood connections. The stability is essentially due to a real “interlock” created between the pin and the surrounding material. The liquefied pin penetrates into all of the surrounding cavities and anchors itself inseparably. Besides, the pin head bonds with the implant carrier (e.g., a Resorb-x® membrane 0.1 or 0.3 mm thick) to create a locking mechanism resulting in a three-dimensionally stable construction that is strong enough to serve as augmentation formwork or shell. The PDLLA basic material absorbs the surrounding body fluids and stores the water contained in them. The water works as a catalyst, continuously breaking down the molecular chains into ever simpler structures until they are finally transformed into CO₂ and water.

Material and Method

Application options in preprosthetic augmentation: Since 2007, we have used the system described above for preprosthetic jaw augmentations or reconstructions. In 34 patients (48–72 years of age), maxillary and/or mandibular augmentation was performed either with a mixture of Cera-sorb® or Ostim® and autologous bone, or exclusively with autologous bone grafts. Altogether 18 sinus floor elevations and augmentations were performed with membranes, whereas plates and pins were used for 24 lateral augmentations, defect reconstructions and dental implant insertions, 6 maxillary sinus wall reconstructions and 7 bone block fixations. Two-time implant insertion (by a second intervention) was necessary in five cases.

Results

In our sinus floor elevations and augmentations, the 0.1-mm membrane has proved to be sufficiently stable to serve as a protective shell for the filled-in bone mass. The obvious procedure is to insert the pin in a first step and then to weld the appropriately pre-shaped membrane in place on the pin (Fig. 1). It was also possible to create irregular membrane shapes by welding several part membranes together (Figs. 2 and 3). In all cases, both the pins and the membranes could be firmly anchored. No pin fracture occurred. In four patients with lateral augmentation, oral mucosa perforation occurred four weeks after the operation, at a time when the primary wound healing process had already been completed, however. Such perforation was caused by the relatively rigid membrane cutting like a saw into the mobile mucosa after the augmentate had sintered, due to the fact that the edge of the membrane had not been sufficiently smoothened. After shortening the membrane through the perforation, the proper healing process was resumed. To avoid such problems, a newly developed product is now available in the form of a smoothing sonotrode. Moreover, adaptation or shaping of the membrane in a sterile physiological saline solution at a temperature of 70°C (158°F) is very helpful as well, as the membrane can still be slightly shaped even inside the mouth with a warm preparation swab to prevent such complications. Even filling large defects across three to four tooth widths was easily possible (Fig. 2). While using the membrane for tent-like coverage over the alveolar

![Fig. 1: Defect in region 23, situation after osteotomy of a retained and displaced tooth 23; fixation of the membrane and the pins before augmenting the defect.](image)

![Fig. 2a: Extremely atrophied maxilla prior to implant insertion. – Fig. 2b: Condition after implant insertion, with implants exposed. – Fig. 2c: Augmentation and shell-type fixation of the membrane as support for the augmentate.](image)
crest from vestibular all the way to lingual or palatal is not a recommended option (because perforation of the mucosa is very likely due to lack of vascularization of the augmentate from the mucosa), the method presented here can nonetheless be used for “tent-like” solid protection of the augmentate against the tensile forces from muscles or ligaments. It was possible to fix the bone onlays in place either horizontally or vertically by using SonicPins Rx of appropriate length. To this end, a gliding hole is created through the onlay graft using a special drill with adjustable drilling depth according to pin length. This ensures that the graft is fixed only in the carrier bone where the ultrasonic waves from the generator cannot be refracted. In this way, pressure-free appositioning of the grafts is possible. The reconstruction of maxillary sinus wall defects with bone grafts was easily possible as well, fixing them in place either with a membrane and pins, or with a resorbable plate and pins, or with a lag screw as an overlapping graft. Welding the graft in place with a membrane may be the best option if there are additional alveolar process defects that need to be augmented as well (Fig. 3).

As the 0.1-mm membrane has proved sufficiently stable, it should be given preference over its 0.3-mm counterpart. In five cases, two-time implant insertion was performed after three to four months in a second procedure. At that time, the membrane was identifiable only in fragments and no membrane or pin removal was necessary in any of these cases. Also, there was no evidence of swelling caused by biodegradation, nor were such symptoms reported by the patients.

Discussion

To users, the SonicWeld Rx® procedure offers a whole range of significant advantages: In most cases, no second operation is required, which spares patients considerable additional physical strain and financial burden. Thanks to their three-dimensional infiltration into the bone structure (material-tissue interdigitation), the pins provide excellent stability coupled with easy insertion. During this process, the pin remains fully intact, even though it fills the bone cavities (the so-called trabecular structure) completely. The pin head can bond itself to membranes as well as to osteosynthesis plates to create a rigid, load-resistant whole (Abdel-Galil and Loukota 2008, Buijs et al. 2009, Pilling et al. 2007). The resulting stability is particularly important where three-dimensional anchorage of flat-spread structures is required. The ease with which the membranes and pins can be fixed in place led to shorter operating times. Good biocompatibility and a reliable degradation process, owing to the special properties of the initial PDLLA material, could be confirmed (Pilling et al. 2007). The transparency of the membrane, along with the fact that it is welded in place only after pin placement, guarantees an excellent view of the surgical site at any time. No wrinkling, shifting or displacement of the membrane has been observed even in large augmentations (Volz 2007). Volume retention and reliable augmentation can thus be guaranteed. However, precise membrane adaptation, edge avoidance and optimal wound closure are crucial factors for the success of the procedure presented here. Beginners should therefore expect a learning curve to master the technique. All in all, this procedure offers new and varied application opportunities in augmentative and reconstructive surgery.

A bibliography is available from the editor on request.

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