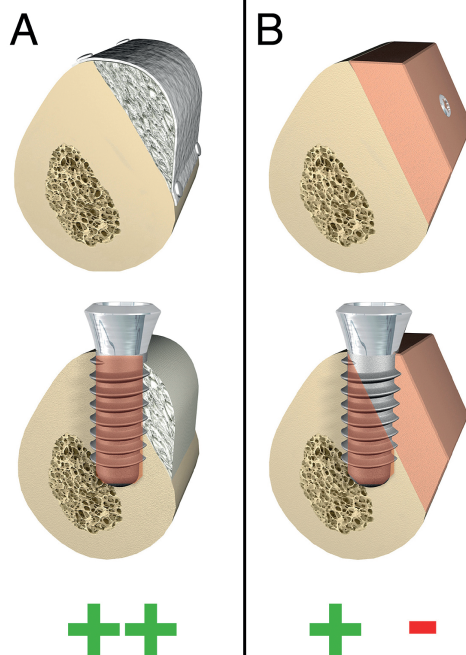
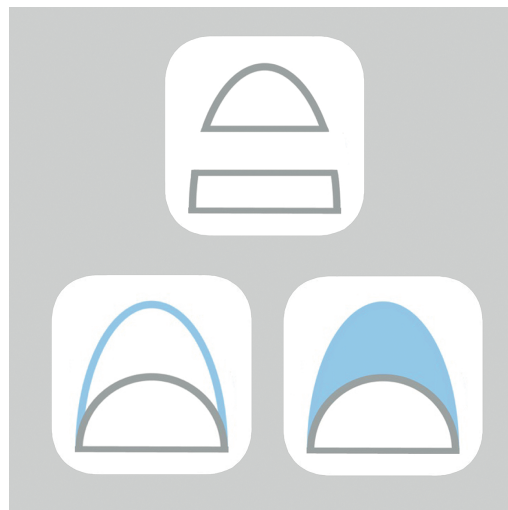


# Vertical bone augmentation procedures—Part II

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Adequate alveolar bone at the desired implant site and bony support of the gingival soft tissue is the prerequisite for a successful dental implantation and ideal aesthetic outcome. Complex augmentations are challenging and represent a

hotspot of research. This article discusses complex bone augmentation techniques and their alternatives. This work is a sequel of the publication "Vertical bone augmentation procedures—Part I" published in *implants* 4/2013 that takes into account other publications.<sup>1-3</sup>

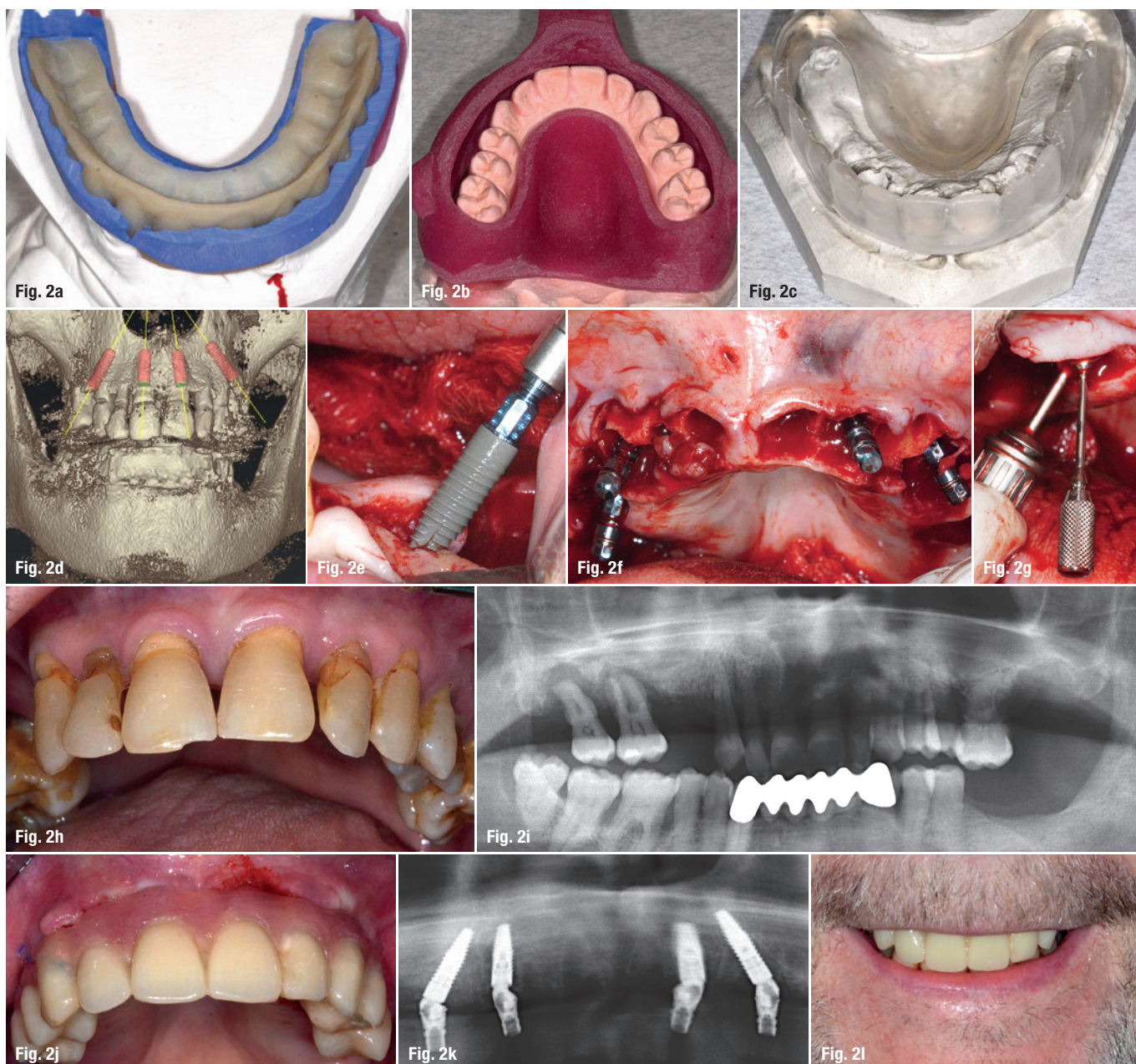


Institut Straumann AG is one of the few global implant companies which, along with the Scandinavians, pioneered the field of implant dentistry. Straumann provides a classic range of tissue-level implants and modern bone-level implants. Implants from this company are some of the few that have a scientifically proven improved third surface technology, the SLActive surface, in addition to general sandblasting and acid etching providing better osseointegration by hydrophilisation.<sup>4</sup> It is the only company that offers this triple technology for all implants. The company also offers Roxolid, a metal alloy made of titanium and zirconium, with an increased fracture strength as well as good osseointegration.<sup>5</sup>

At the IDS in 2015, the company launched a second version of the bone-level implants with the same prosthetic connection. The BLT, Bone Level Tapered, implant was introduced to supplement the BL implant line. Based on the ten years' experience with the BL implant, the apex of the implant was tapered, which leads to an increase in the primary stability with no increase of pressure at the marginal implant interface.<sup>6</sup> The angle of the tip was selected so that the tapered tip is longer at 5 mm than other tapered implants and therefore achieves better site-relieving stability. The remaining body has parallel walls and allows a calculable site pressure in complex augmented situations.

Tissue level concepts are well known.<sup>7</sup> This concept has the drawback of a supragingival material edge that cannot be reliably avoided. It has a classic design that achieves very good marginal bone preservation over a very long period. Nevertheless, correctly restored modern bone-level implants can achieve adequate

**Fig. 1:** Comparison of the shell (A) and block techniques (B).



**Fig. 2:** Fixed immediate restoration with angled implants Straumann Pro Arch: **a-c)** laboratory preparation; **d)** dental Wings planning; **e&f)** Straumann BLT implantation; **g)** Pro Arch multi-unit abutment; **h-l)** situation before and after the restoration.

success and therefore dominate the market across the board.<sup>8</sup> Not all systems meet the ideal requirements to preserve marginal bone, however. Five essential elements contribute to this:

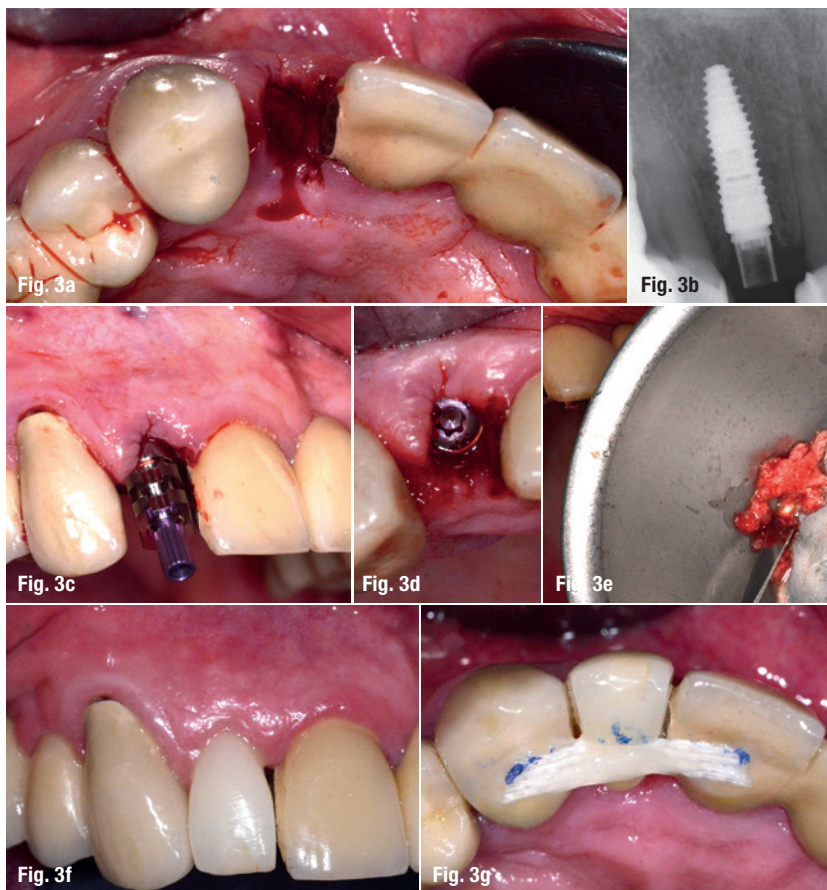
1. Conical connection to prevent microleakage.
2. Triple treated surface to optimise the transition from primary to secondary stability.
3. Platform switching to accommodate the biologic width.
4. Reduced-waist design transition to the abutment to favour contraction of the gingiva.
5. Prospective clinical trials that document the outcome.

This case series features applications of the Straumann BLT system.

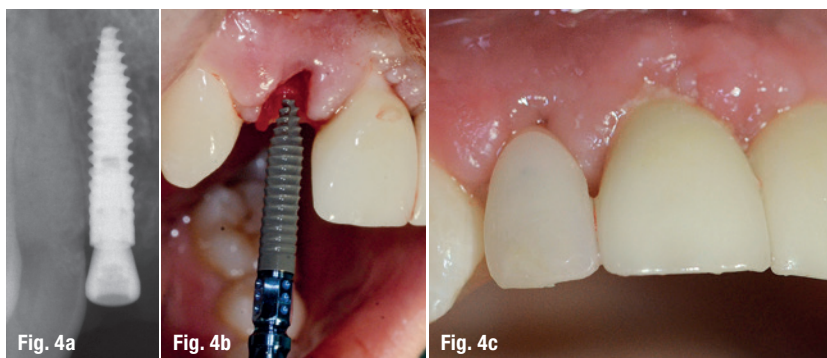
### Principles of bone healing and augmentation

To understand bone healing and the options for augmentation of complex defects, refer to the previous publications.<sup>1-3</sup> We also repeat essential knowledge of the previous article (*implants* 4/2013). In summary, the following applies:

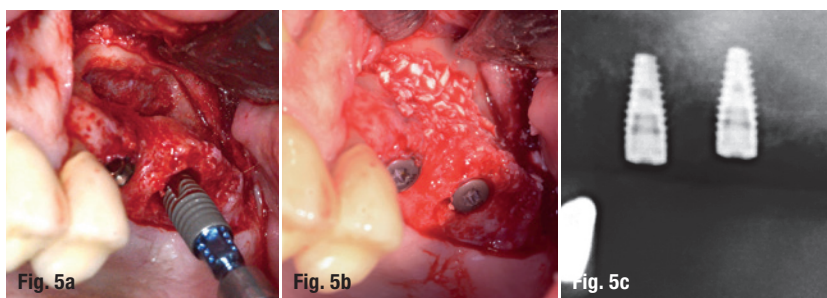
- Overall, there are three different techniques (Fig. 1):
- Shell techniques: stable GBR with alloplastic shells, bone shell techniques
  - Block techniques: solid blocks or blocks with inter-connecting pore system (autologous, allogeneic, xenogeneic or alloplastic)
  - Osteotomy techniques: distraction osteogenesis, sandwich techniques and bone splitting



**Fig. 3:** Immediate implantation and load-free restoration in the anterior region in the upper jaw: **a)** atraumatic tooth extraction to preserve soft tissues; **b)** positioning of the angled implant (Straumann BLT SLActive); **c)** impression taking; **d)** cover screw; **e)** particulate augmentation with autogenous bone; **f)** fixed interim restoration; **g)** stabilisation on the adjacent teeth with Ribbond.



**Fig. 4:** Immediate implantation and load-free restoration in the anterior region on the lower jaw: **a)** Straumann BLT 2.9 mm; **b)** positioning of the implant; **c)** interim restoration with immediate implant crown.



**Fig. 5:** Direct sinus floor elevation: **a)** osteoplastic window and implant insertion (Straumann BLT SLActive); **b)** inserted implant and augmentation with Geistlich BioOss; **c)** radiographic check.

A detailed description of these various techniques and the meaningful options are discussed in more detailed articles because many new technical issues have arisen and current developments are still being integrated into this field since the original review article was published in 2013. The current situation is:

Autogenous bone is the best material if it is applied either as particles or as fresh cancellous bone. Analogously to the gap healing of fractures, there are four phases:<sup>9-12</sup>

- aseptic inflammation leading to chemotaxis of pluripotent cells,
- loose replacement tissue (soft callus),
- specific tissue differentiation (mineralisation to hard callus),
- remodelling to functional restitution of the bone.

A useful complex augmentation technique is the shell technique.<sup>2,13-17</sup> There are a number of different applied techniques of this concept: autologous shells (Khoury shells), lactide membranes (Iglhaut technique), metal-reinforced PTFE membranes, titanium membranes and under some conditions allogeneic bone shells as well. The Yxoss titanium grid from ReOss/Geistlich and the 3-D adapted membranes (Draenert-modified Iglhaut technique) are some of the modern 3-D-based improvements.<sup>2</sup>

Incisions should, where possible, avoid large openings and the risk of dehiscence.

### Augmentation techniques and alternatives

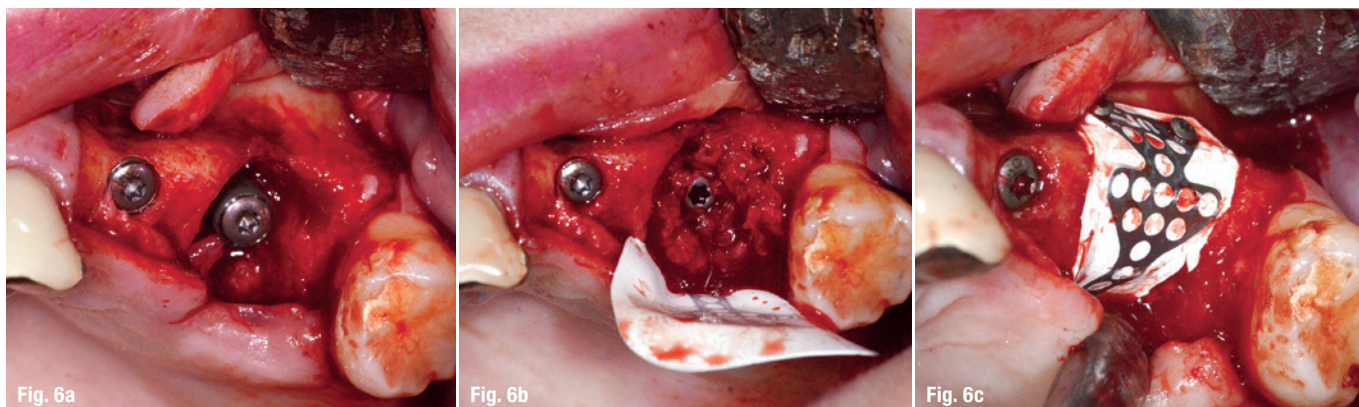
#### The bone defect after tooth loss

In pre-prosthetic surgery prior to dental implantation, a bone defect is a common indication for surgical treatment.<sup>18</sup> Edentulism leads to bone resorption in the jaws.<sup>19-21</sup> Analogous to the indications for bone augmentation, complex bone defects can be differentiated specifically by indication. There are in principle five applications that can be differentiated:

- complete edentulism in one jaw
- the anterior jaw region
- indirect and direct sinus floor elevation
- alveolar ridge augmentation in the posterior teeth of the upper jaw
- alveolar ridge augmentation in the posterior teeth of the lower jaw

#### Complete edentulism in one jaw

With a completely edentulous jaw, the pressing question when planning an implant prosthetic restoration is whether a fixed or removable prosthesis will be used because this has a considerable influ-



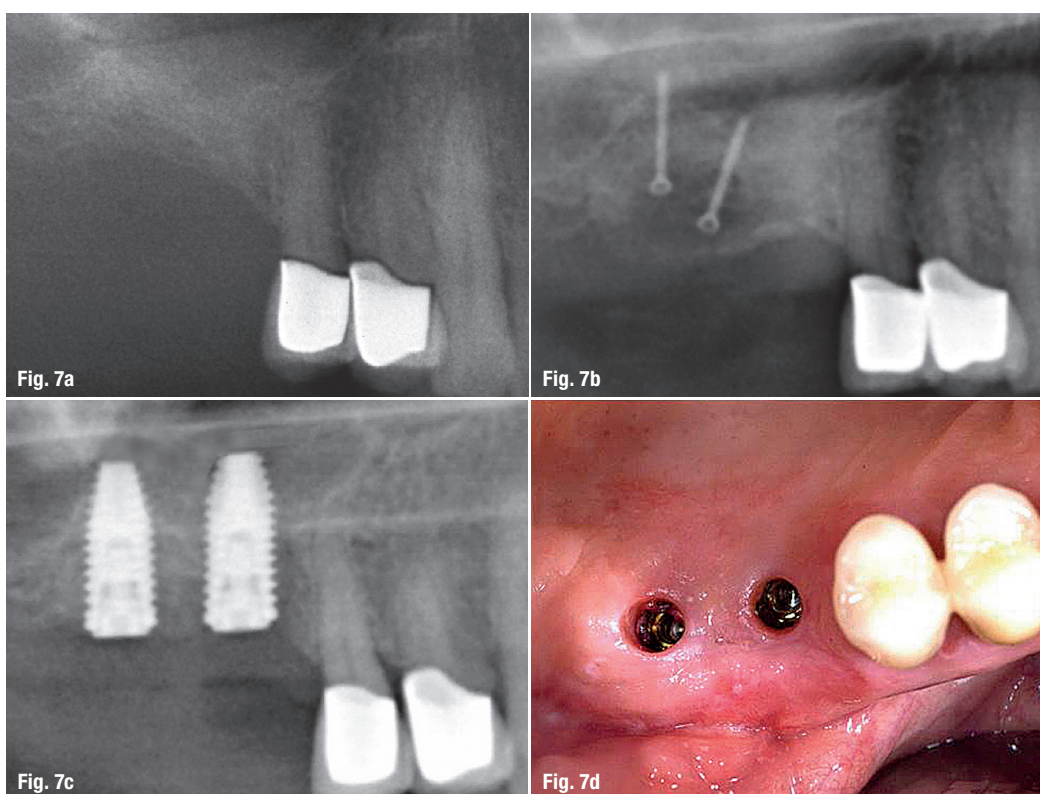
**Fig. 6:** Stable GBR technique with titanium PTFE mesh: **a)** horizontal defect situation; **b)** simultaneous implant insertion (Straumann BLT SLActive), autogenous bone augmentation and Neoss PTFE membrane as the shell; **c)** closed and fixed with KLS Martin osteosynthesis screws.

ence on the need for augmentation. The question of the resorption status of the jaw is also important because narrowing of the alveolar ridge and vertical resorption does not occur locally or in isolation but is associated with resorption-related prognathism and a relative transversal narrowing of the upper jaw. Because checking the basis for the prosthetic and surgical planning is difficult because of the lack of options for orientation to the remaining teeth, 3-D planning checks may be useful. All augmentation techniques can be applied according to the desired prosthetic concept and the defect situation given. Alternative to augmentations can be the application of angled implants.

**Augmentation alternative in complete edentulism**

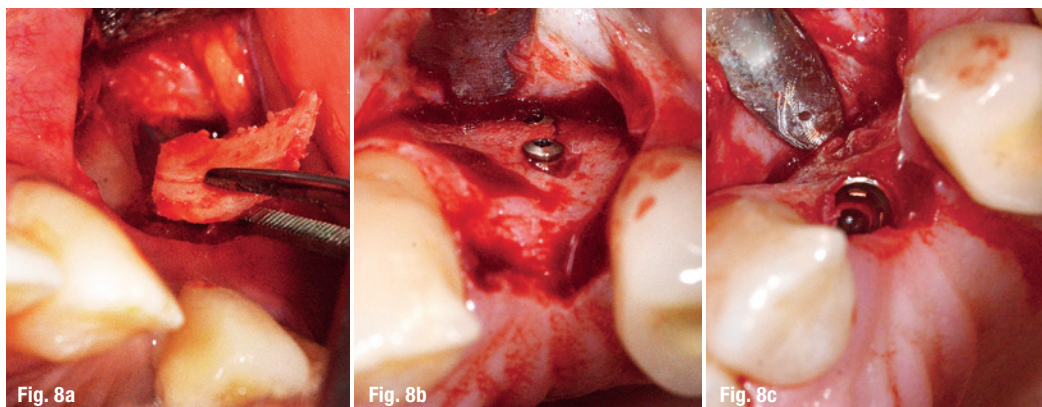
The analogous names for these restorations are scientifically "all-on" restorations or the brand modifi-

cations derived from this, "All-on-4" (Nobel Biocare) or "Pro Arch" (Straumann). Angled implants are one option to avoid the maxillary sinus and the inferior alveolar nerve while still achieving a broad support polygon with no vertical bone augmentation.<sup>22-25</sup> They are therefore an option for cases in which bone augmentation is not possible and, where applicable, also for immediate load indication (Figs. 2a-l). The restoration must be splinted. Experience supports the data in the literature and shows good results. It is recommended for this application to interlock over an implant bridge, which allows a mechanically favourable force distribution. Alternatively, a bar restoration is possible for a removable prosthesis and for certain bite heights makes sense in principle. The technique was and is still hotly debated. For the correct indication and when carried out correctly, the method is, however, a good option for certain patient groups.



**Fig. 7:** Autologous shell using the Khoury technique: **a)** defect situation in the upper right jaw; **b)** status after three months regio 26 and 27; **c)** another three months after implant insertion; **d)** result after soft tissue management.

**Fig. 8:** Autologous shell using the Gellrich technique: **a)** removal of the chip; **b)** status after three months regio 24; **c)** implant insertion (Straumann BLT SLActive).



**The anterior region**

After the loss of anterior teeth, there is a rapid loss of alveolar bone, particularly in the vertical and sagittal directions.<sup>19,20</sup> Initially, the anterior bone is resorbed as a result of the thin vestibular bone lamellae and this later changes to vertical losses. In most cases, bone augmentation is necessary if a sensible immediate implantation has been missed.<sup>26</sup> A sensibly planned immediate implantation is to be preferred. Anatoform implant designs can optimise this approach.<sup>27</sup> An immediate loading concept is also possible and can preserve and even restore the buckle bone without a complex bone augmentation, applying autologous bone chip augmentation only (Figs. 3a–g).<sup>28–32</sup> Results that contradict these data must also be discussed in terms of the implant design and the biomaterial surfaces.<sup>33–35</sup> In the anterior mandible and the pos-

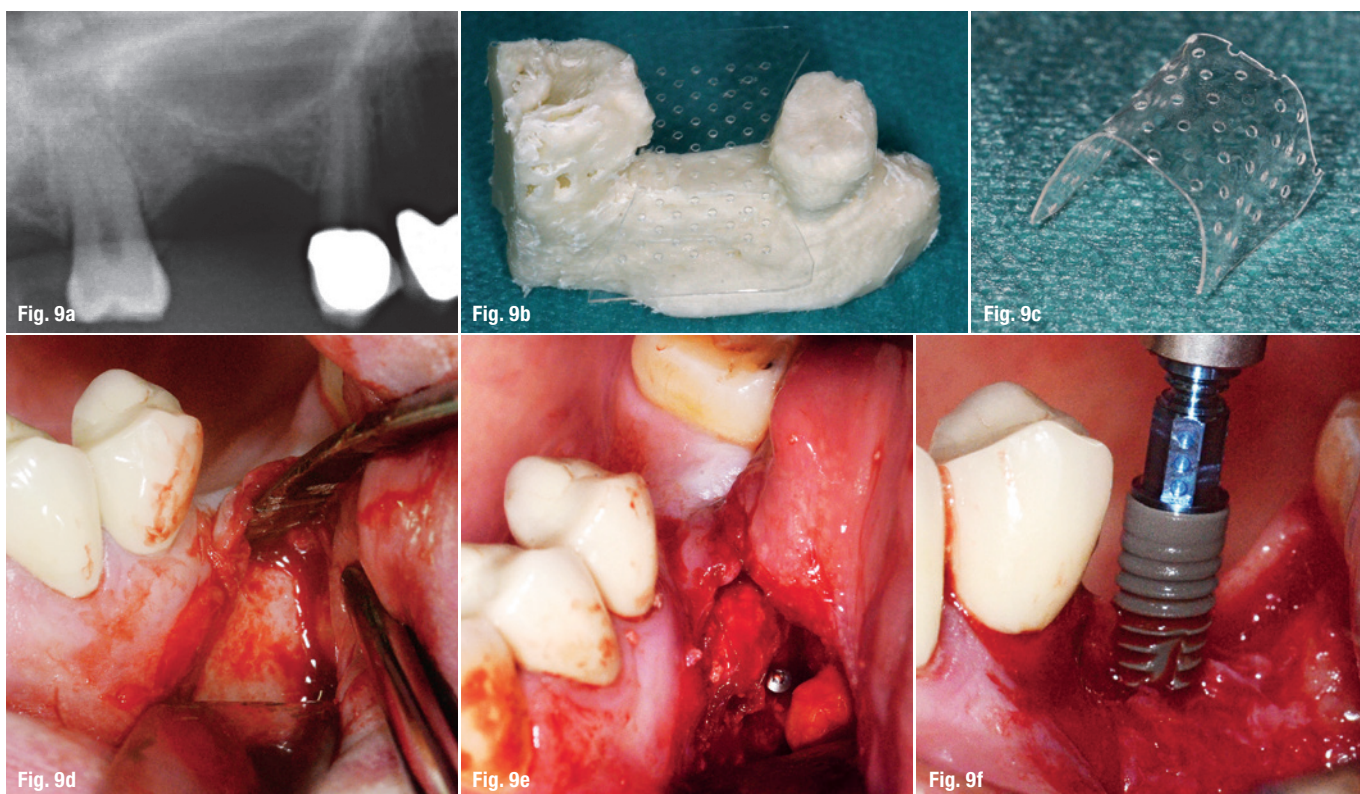
terior mandibular incisor regions low-profile implants with a diameter of 3 mm or less are indicated and are one possible option for a single crown restoration (Figs. 4a–c).

**Indirect and direct sinus floor elevation**

When posterior teeth are lost from the upper jaw, there is initially an expansion of the maxillary sinus with bone resorption proceeding from the cranial to the caudal direction with no change in the alveolar ridge height and this must be treated by elevating the maxillary sinus floor with corresponding augmentation (sinus floor elevation).<sup>36</sup> Two techniques are differentiated here:

- Direct sinus floor elevation is carried out transversally with the sinus membrane being preserved (Figs. 5a–c).<sup>37,38</sup>

**Fig. 9:** **a)** Panoramic radiograph; **b)** 2-D cutting of the membrane; **c)** 3-D thermally shaped shell; **d)** tunnel approach regio 16; **e)** inserted shell with particulate augmentation and screw fixation; **f)** implant insertion during the woven bone phase (Straumann BLT SLActive).



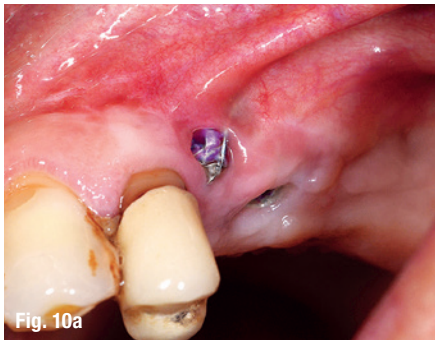


Fig. 10a

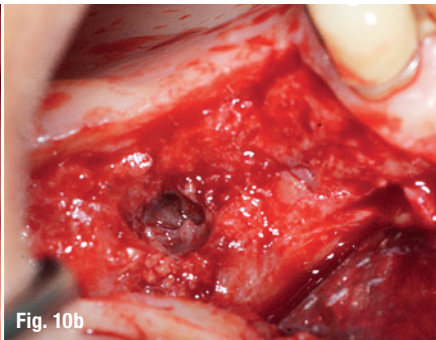


Fig. 10b

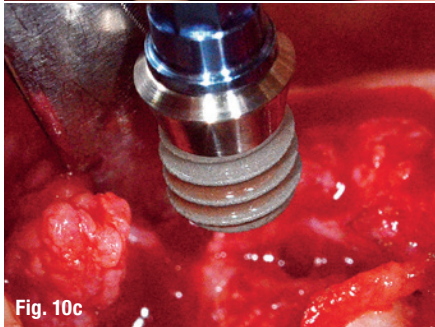


Fig. 10c

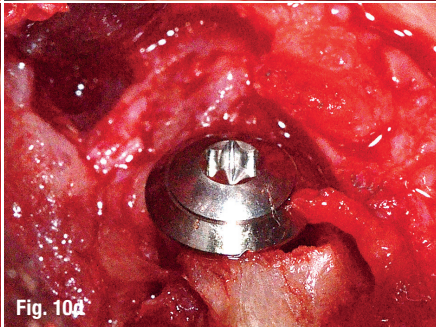


Fig. 10d

**Fig. 10:** Short implant "Shorty": **a)** complication after pre-treatment elsewhere; **b)** defect after removal of the titanium membrane and implants; **c)** the patient requested a solution that did not involve augmentation: 4 mm Ultra-Shorty (Straumann ITI 4.1/4 mm SLActive); **d)** the inserted implant.

– The indirect Summers technique.<sup>39,40</sup> With this technique the sinus floor is indirectly elevated using osteotomes with a crestal approach via the drill hole access.

#### Complex alveolar ridge augmentation

In the case of a true loss of alveolar ridge, vertical bone augmentation, or lateral ridge augmentation for large lateral defects, may be indicated. For minor complex defects, a shell technique using a PTFE membrane, with simultaneous implantation where applicable (Figs. 6a–c). For medium-sized and large vertical defects, particularly with a free-end situation, the autologous shell technique is useful (Figs. 7a–d; Figs. 8a–c). 3-D shell techniques are advantageous and shorten surgery times with a better fit (Figs. 9a–f).<sup>2</sup> This complex and difficult indication requires more extensive discussions elsewhere.

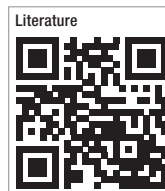
#### Ultra-short implants as alternatives in the posterior region

In cases of low bone height and if bone augmentation is refused, a restoration can be carried out with short implants (Figs. 10a–d). The basic idea behind this technique is the known force distribution in the first 5 mm of the marginal bone.<sup>41,42</sup>

Numerous studies have demonstrated long-term success, in particular when considering the complications associated with vertical bone augmentation as alternative.<sup>48–51</sup> A splinted prosthetic restoration with implants of normal length appears useful.<sup>43–46</sup>



Author details



Literature

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