Istvan Urban

Vertical 2

THE NEXT LEVEL

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OF HARD AND SOFT TISSUE AUGMENTATION

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Preface

It has been almost 5 years since the publication of my first book, *Vertical and Horizontal Ridge Augmentation: New Perspectives* by Quintessence Publishing in 2017. That book has enjoyed great success and has been translated into 12 languages, helping the guided bone regeneration (GBR) technique to be practiced successfully worldwide.

The reader might expect this book to be a second edition. It is not. I had a lot more to share, and this book delves more into the details where the devil lives. I anticipate that you will read this book armed with the knowledge from the first book as regards the anatomy, principles of mandibular surgery, anterior maxillary defect types and their treatment options, and soft tissue reconstruction after bone grafting. It is important that you please review this information from the first book before reading this new one.

Parts of this book are like watching a surgical video with me, where I stop the video at the most important parts (sometimes frame by frame) and discuss with you, the reader, what I am thinking and doing at that step, and what my next step will be. At the same time, I discuss the reason for each of these steps.

In addition, the greatly appreciated ‘Lessons learned’ sections are again included in this book. I consider these sections to be very important, since one can always identify a part of the procedure that one could have done better. These sections also help to emphasize the most important learning objectives of the case.

Please note that one could describe this book as a kind of atlas, a ‘show-and-tell,’ so to speak, where in many places the images, drawings, radiographs, charts, and tables tell the story. For this reason, some chapters contain a minimum of text, and the figures are not always ‘called out’ in the text in a way you may be accustomed to. The idea was to keep things as clear and simple as possible; the figure legends always explain exactly what is going on.

The section on the mandible is more detailed in this book than it was in my first book; also, it focuses on larger defects as well as different surgical steps in native, fibrotic, and scarred tissue types around the mental nerve during flap advancement. The section on the posterior maxilla will hopefully help to solve many issues such as the management of complications of sinus grafting and the lack of buccal, crestal or nasal bony walls of the posterior maxilla before bone grafting.

This book sheds light on the detail in treating the anterior maxilla that has not been published previously. You are finally getting the ‘complete package,’ including treatment options such as the

fast track, the safe track or the technical track of soft tissue reconstruction in conjunction with bone grafting. Questions are answered such as: What options do I have when there are multiple implants in regenerated bone and I would like to reconstruct the papilla? The Ice-cube and Iceberg connective tissue graft techniques are the best options, but how do I actually do them, and how do I choose between the two techniques?

I have great expectations for this book, and I really wish that I had had this knowledge two decades ago. I could have had the most perfect cases today. That is what I am expecting for you, dear reader – to make the most perfect cases based on the principles described in this book.

At the same time, as I have said elsewhere, I like to keep procedures simple, repeatable, and biologically sound. The techniques presented here are not overcomplicated – they are simple treatment strategies with lower complication rates and more predictability in the final outcome. Therefore, I would like to welcome you and thank you for reading this book, and remind you of a quote by Leonardo da Vinci: “Simplicity is the ultimate sophistication.”

Some of the cases in this book were not finalized by the time of publication. For additional material and to see the final clinical outcomes of these cases, please scan the QR code on the right or go to the following link:
https://www.quint.link/vertical2mat

Acknowledgments

I would like to thank my family for their love and endless support, and our two sons, Isti and Marci, for their existence, spirit, and positive outlook on life. You make our life complete. As a child (and ever since), my parents never interfered in any of the decisions I made, as they believed in the development of the individual with only minimal guidance. I believe they were right, and I thank them for that.

My teachers, who were my teachers during my training, continue to be my teachers and will remain my teachers. Special thanks to Dr. Henry Takei for his inspiration and unsurpassed qualities as a humanitarian, both as an educator and as a periodontist. Special thanks also to Dr. Jaime Lozada for his belief in me as a student at Loma Linda University and his confidence that I would go on to do vertical ridge augmentation. I would also like to thank Dr. Sascha Jovanovic for introducing me to performing GBR in a biologically sound way. Thanks also to Dr. Joseph Kan, Dr.Perry Klokkevold, Dr. Anna Pogany, Dr. Bela Kovacs, and Dr. Lajos Patonay, and to all my other teachers. Without meeting all of you and being your student, there would be much less to say in this book.

I would like to express my appreciation to Quintessence Publishing, specifically to the management, Horst Wolfgang Haase and Christian Haase.

I would like to express my gratitude to Ms. Krisztina Szample for creating the schematic drawings, and to Denes Doboveczki for assisting in the photography for this book.

I would also like to thank Ms. Jacqueline Kalbach of The Avenues Company for her support in the preparation of my manuscripts, and of this book.

Istvan Urban
2021

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Introduction

1

The biology of vertically and horizontally augmented bone

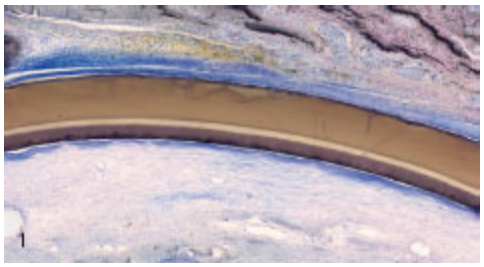
Vertical bone growth is very challenging, both biologically and technically. A recent meta-analysis by Urban et al[1] found that, regardless of the technique, about 4.5 mm of vertical bone gain was achieved in the included studies. However, complications occur least frequently when the guided bone regeneration (GBR) technique is used. The results of this study indicate the advantage of using GBR. The technical challenge of GBR is discussed extensively in this book, while the biologic challenge that may play a role in limiting vertical bone gain is discussed in this chapter. Based on the author's experience, the amount of vertical bone gain is not limited by biology, but more by the clinician's abilities.

The biologic background of vertical bone gain was investigated by the author in preclinical settings.

The histology of polytetrafluoroethylene (PTFE) membranes in an in vivo setting

The mucogingival tissue is primarily characterized by a moderate vascularized fibrotic reaction that surrounds the PTFE membrane. The membrane is usually internally and externally surrounded by connective tissue that is rich in fibers and poor in cells, with the fibers oriented parallel to the membrane. Membrane pores, if present, show the presence of a highly vascularized matrix of connective tissue and a dense network of collagen fibers that penetrates across the pores to fix on the internal side of the membrane or, in some cases, to the newly formed bone.

The inner layer, which is composed of expanded PTFE (e-PTFE), is always placed against the bone of the lingual and buccal sides. A slight number of macrophages admixed with a few lymphocytes, polymorphonuclear cells, giant cells/osteoclasts, and plasma cells were observed around the membrane. Deep at the lingual side of the ridge, the membrane was often in direct contact with the bone tissue, even showing slight signs of osteointegration (Figs 1-1 to 1-4).



Figs 1-1 and 1-2 Parallel-oriented fibers around the membranes.

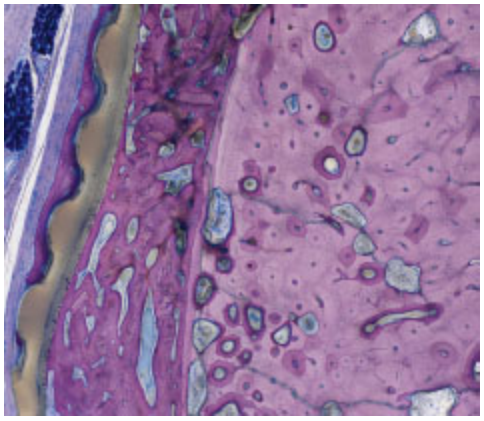


Fig 1-3 The membrane shows signs of osseointegration on both sides. Note the excellent biocompatibility of the polytetrafluoroethylene (PTFE) membrane.

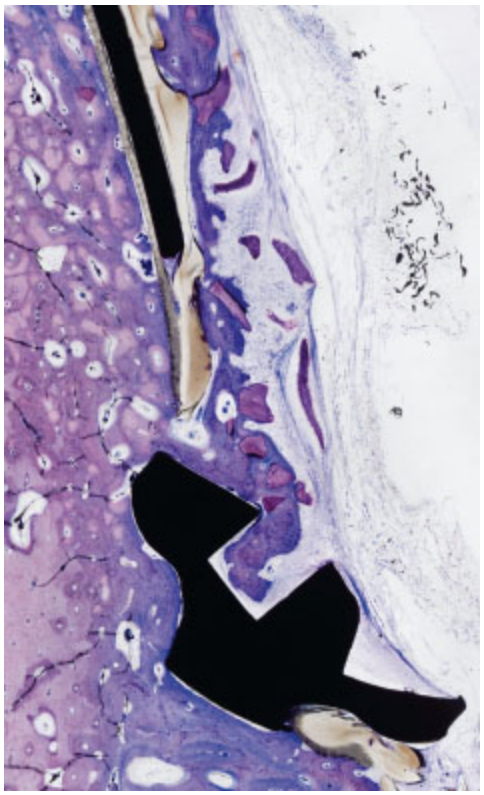
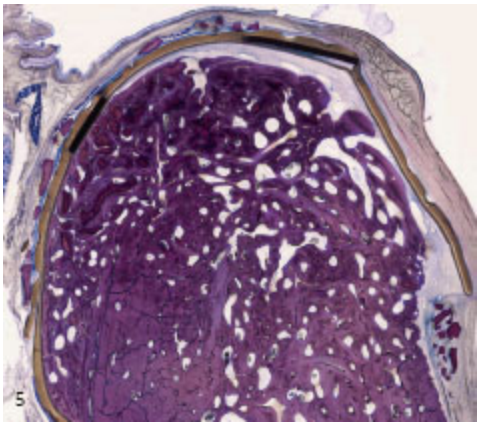
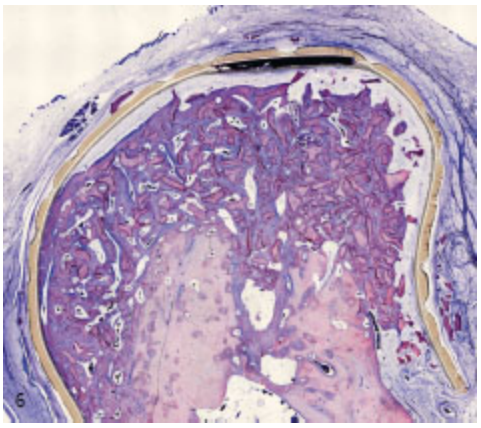


Fig 1-4 When compared with titanium, the PTFE-membrane demonstrated similar biocompatibility.





Figs 1-5 and 1-6 Histologic results of vertical augmentation. Note the excellent new bone formation and the well-incorporated xenograft particles.

Bone growth using a xenogenic bone graft

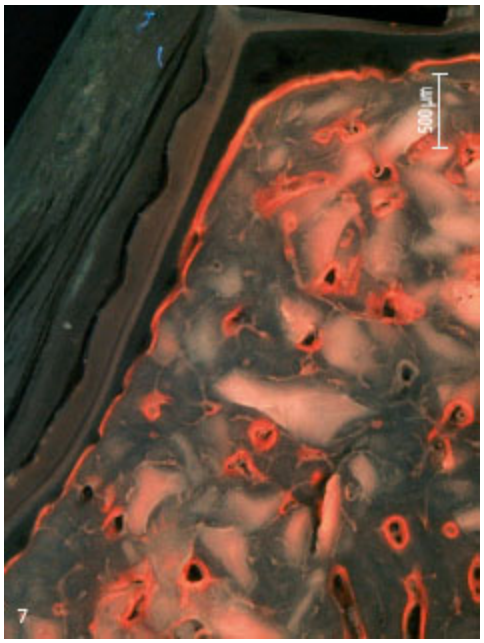
In a preclinical in vivo setting, a chronic vertical defect was treated using a xenograft. After 17 weeks of healing, the following was found: Emerging from the defect bed, the bone growth of a moderate to marked amount showed similar signs of remodeling, resulting in significant vertical ridge augmentation. The bone filler was markedly osteointegrated, showed slight signs of degradation, and demonstrated definite signs of osteoconduction (bone growth on the surface of the granules). The newly formed bone harbored numerous osteoblasts (Figs 1-5 and 1-6).

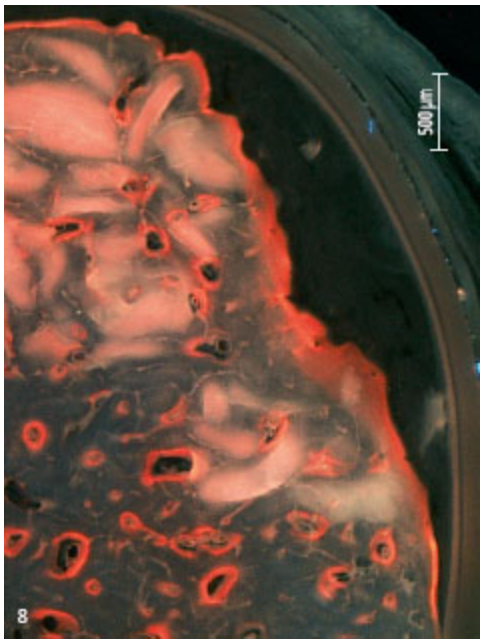
The epifluorescence analysis showed a marked grade of mineralization activity at different time points (OTC and XO), respectively. The signs of mineralization activity were visible at the newly

formed and remodeled harversian systems (numerous concentric labeled rings). The outer circumferential bone lamellae were not fully formed, as is shown by their irregular shape. Two distinct and spaced lines of labeling (first OTC, then XO) indicated a marked vertical bone growth (Figs 1-7 to 1-10).

Figures 1-9 and 1-10 show that the xenograft particles are well incorporated in the newly formed trabecular bone. These images also demonstrate the phases of bone formation and maturation.

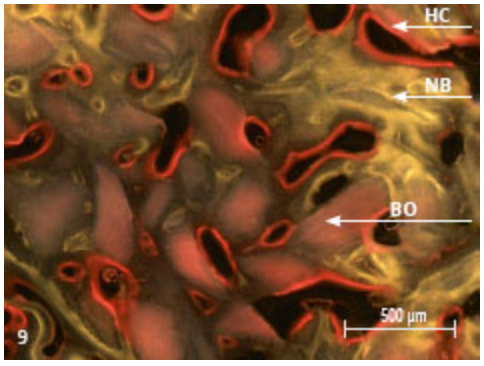
In the first phase, the newly formed ridge is present, but the cortical bone and the lacunae are not fully developed. This is referred to as ‘baby bone’ (Figs 1-11 and 1-12).

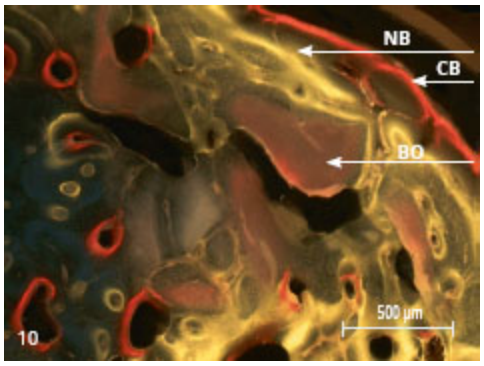




Figs 1-7 and 1-8 Epifluorescence analysis of a well-developed and mature bone after vertical augmentation.

In the next phase, the bone starts to further mature and corticalize, after which the outer layer becomes smooth and gains its final shape. Although the bone was good enough for the placement of implants, it would need about 3 more months to fully develop.





Figs 1-9 and 1-10 Epifluorescence analysis demonstrating the haversian canals and the cortical bone formation of the newly formed bone. The images demonstrate the incorporation of a biomaterial into the newly formed bone and the different time points of bone maturation. BO: anorganic bovine bone mineral; HC: haversian canal; NB: new bone; CB: cortical bone.

The healing time was 6 months (Figs 1-13 and 1-14). The implants were placed about a millimeter subcrestally. A tissue level implant placed into the bone with the polished collar 1 mm into the bone would be an excellent choice in the posterior region. The same patient had the other side grafted 10 months earlier. Due to scheduling issues, one side healed for longer than the other, but now the two phases of maturation can be compared. The ridge defects were similarly narrow (Figs 1-15 to 1-21).

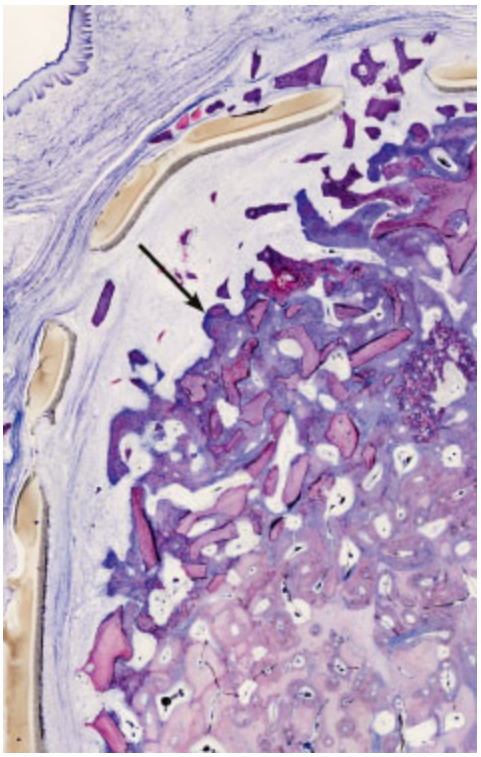


Fig 1-11 The outer surface of the ‘baby bone’ demonstrating irregularity and less maturity than the inner layer of the newly formed bone. This outer layer, referred to in this book as the ‘smear layer’ (see arrow), is about 1.5 mm in width. It will be remodeled and ‘shredded off’ during maturation.

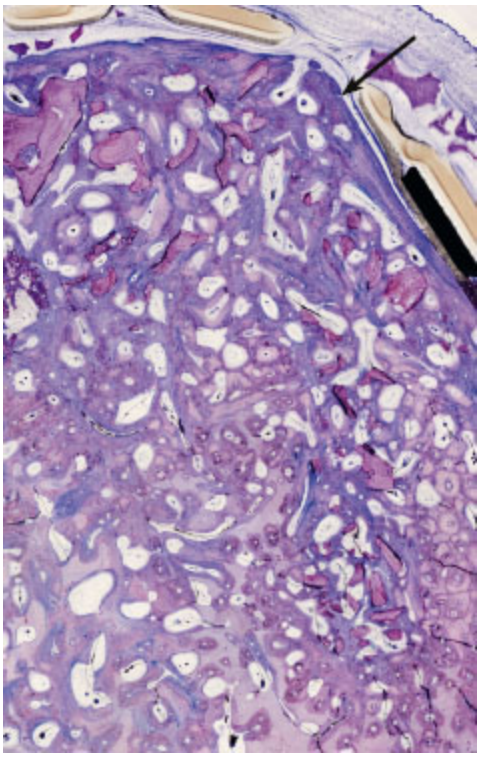
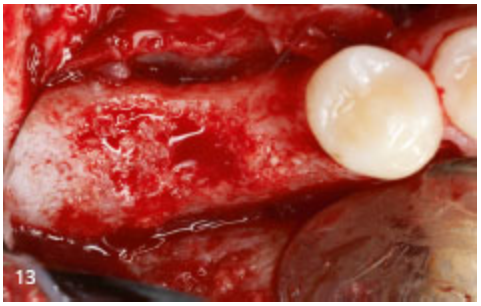
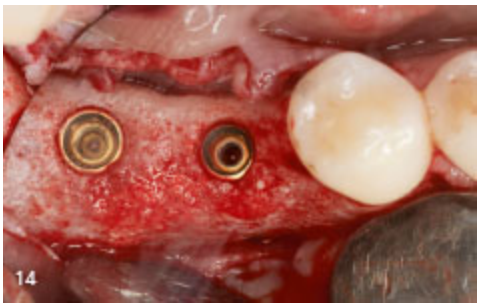


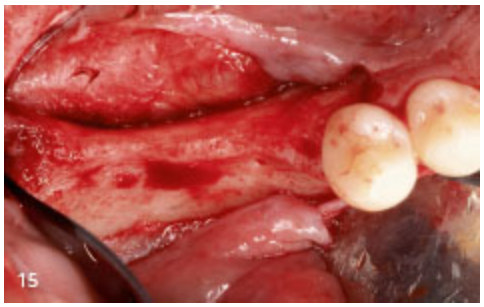
Fig 1-12 Image showing an area where corticalization has begun.

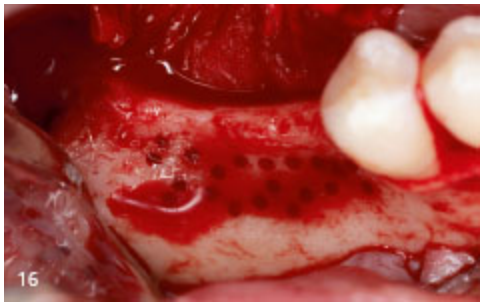




Figs 1-13 and 1-14 Clinical example of a posterior mandibular ridge augmentation using the Sausage

technique. Note that some of the area is corticalized, whereas other parts are still in maturation.





Figs 1-15 and 1-16 Occlusal and labial views of a narrow posterior mandibular ridge.

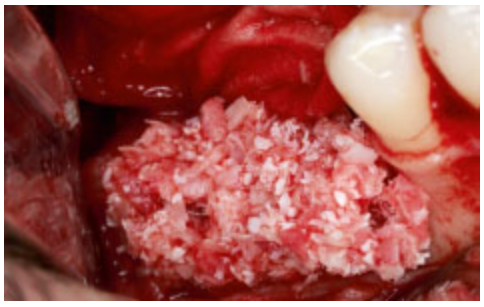
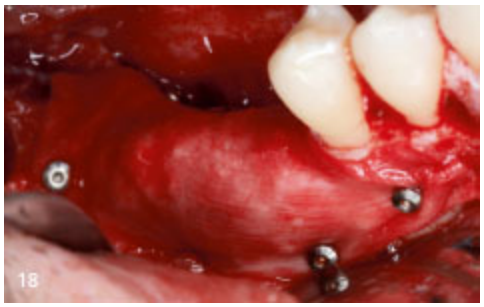
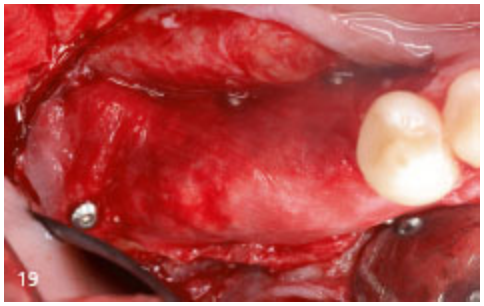


Fig 1-17 Labial view of the graft consisting of a 1:1 ratio of autogenous bone mixed with anorganic bovine bone mineral (ABBM).





Figs 1-18 and 1-19 Labial and occlusal views of the fixated and stretched collagen membrane in place.

In this book, the smear layer will be highlighted, especially in the anterior maxilla chapters where it will be modified and preserved using the Mini Sausage technique as a secondary bone graft protecting the newly formed ridge.

The clinician should bear in mind that the smear layer will be either lost or modified. In most posterior cases, it is allowed to be shredded off, placing the implants deeper into the bone, whereas in the esthetic region, the Mini Sausage technique is used to prevent its resorption. These clinical procedures are exciting, and knowing the biology and dynamics of bone formation is essential to success.

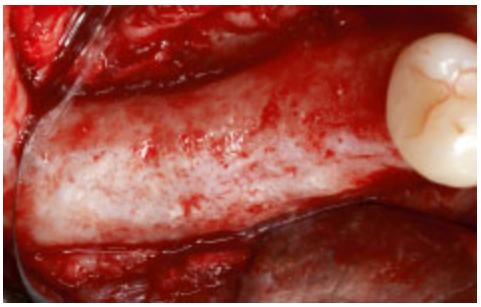


Fig 1-20 Occlusal view of the mature, corticalized, newly formed ridge.

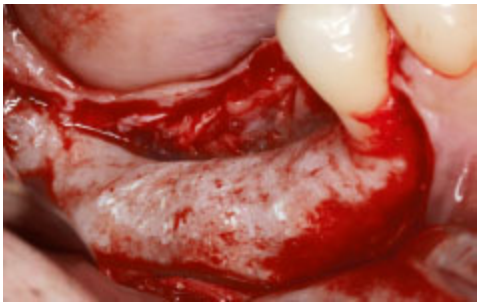


Fig 1-21 Note the excellent cortical bone formation.

Dense versus perforated membrane

The use of a membrane in GBR has been evaluated successfully for decades in multiple clinical and preclinical investigations. The role of the membrane has been determined to exclude competing cells such as fibroblasts. The clinical experience demonstrated that an important role of the membrane is to stabilize the bone graft. This has been well demonstrated in the Sausage technique using a collagen membrane and titanium pins for immobilization. In the author's experience, the Sausage technique has resulted in the best bone quality and is usually faster and better than PTFE

membranes. The native collagen membrane allows transvascularization and a possible accumulation of osseoinductive stimuli from the periosteum. In addition, the fast resorption of the collagen may also play a part in the maturation of the graft, since the periosteum holds vessels as well as mesenchymal cells that can turn into bone-forming cells. Therefore, a perforated membrane might help in bone formation. The goal is to develop ‘sausage-like’ bone quality faster.

One idea was to perforate PTFE membranes to allow faster bone maturation. In several preclinical investigations, different aspects of this idea were investigated, as is shown in the following subsections.

I. Dense vs perforated membrane using bone morphogenetic protein-2 (BMP-2) as a graft

The osseoinductive action of BMP-2 depends on the presence of mesenchymal cells. The question is: How important are these types of cells in the periosteum versus the bone surface and the blood clot?

Dense versus perforated membrane was compared in a chronic vertical defect (Figs 1-22 to 1-24). The results demonstrated significantly more bone fill when using the perforated membrane. The non-perforated membrane usually demonstrated appositional bone formation from the host bone with a lack of bone formation under the membrane (Figs 1-25 to 1-27). These results demonstrated that the communication with the periosteum might be

important when a graft containing BMP-2 is being used, such as autogenous particles.

II. Perforated vs non-perforated membranes using an osteoconductive graft material

This experiment focused on the vascularization and bone formation activity of the newly formed bone. A xenogenic bone graft was used without any growth factors or autogenous bone. The perforated membrane was used with and without a collagen membrane covering the non-perforated membrane (Figs 1-28 to 1-31). Each group demonstrated a similar amount of bone formation as well as soft tissue invagination (Figs 1-32 to 1-34). However, when the vascularized area of the regenerated ridge was examined, the perforated group demonstrated a tendency toward better vascularization (Fig 1-35 and Table 1-1).

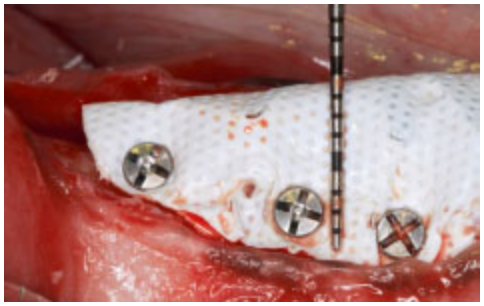


Fig 1-22 Labial view of a dense membrane fixated around a chronic vertical defect.