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"Drive slowly, we’re in a hurry."

That is how it is said a certain Winston Churchill, when late for an important meeting, once instructed his chauffeur. At Geistlich we understand the underlying meaning of this statement and are acting accordingly before launching the volume-stable Geistlich Fibro-Gide® collagen matrix. Over a year ago this product was awarded the CE mark certifying its marketability in Europe. Though a required confirmation, we at Geistlich consider the CE mark necessary but not sufficient to warrant a product launch. For this reason Fibro-Gide® is in a “pre-launch phase,” where it is undergoing the acid test of clinical experts before it is offered for general sale to all interested dentists.

At the same time we are preparing a wide range of training initiatives to carefully help prepare customers for the use of the product and to support their individual learning curves. Through our “blended learning” approach, customers can broaden and also strengthen their knowledge of the product’s attributes and learn clinical tips and tricks in traditionally formatted, hands-on courses or e-based modules.

We are proud to be able to take you along this new product path with us, and we wish you long-term success treating your patients.

Reto Falk
Director International Marketing Services

Mirko Zingg
Director International Product Management
SOFT TISSUE MANAGEMENT.

Recession coverage, gain of keratinized tissue and augmentation of soft tissue volume. A clinical update from gold standards and new alternatives.
A new volume stable soft tissue matrix enables soft tissue augmentation without using grafts from the palate. An overview of scientific data and new therapeutic options.

Soft tissue grafting procedures are increasingly performed for a number of indications in conjunction with dental implant therapy. Major clinical indications include recession coverage, gain of keratinized tissue and augmentation of soft tissue volume. These periodontal plastic surgical procedures have been recommended to establish short and long-term favorable biological, functional and esthetic outcomes around teeth, as well as in pontic and dental implant sites. At dental implant sites, soft tissue volume is augmented most often to limit peri-implant marginal bone loss in the non-esthetic zone, to counteract volume loss following tooth extraction and to regenerate the buccal contour.

Current concept
Current concepts for augmenting soft tissue volume in a vertical and/or buccal direction are based on the use of autologous tissue that is harvested most often from the palatal area. These transplants have a long tradition in dentistry, and numerous articles have been published documenting their effectiveness, safety and long-term stability. Limitations and disadvantages of autologous tissue grafts include:

› The height, length and thickness of the donor tissue vary according to anatomic dimensions of the palatal vault,
› Length and thickness are limited by anatomy, like a thick alveolar process, exostoses and the palatine nerves and blood vessels,
› For several weeks following surgery, patients often complain about pain and numbness, especially at the donor site.

In order to overcome these issues and reduce the morbidity due to graft harvest, research activities have focused on the development of soft tissue graft substitutes from various sources and for a number of clinical indications. For soft tissue volume augmentation a suitable biomaterial must provide volume stability over time and favorable biological behavior that allows normal modeling and remodeling processes.

Development of Geistlich Fibro-Gide®
Recently a 3-D stable, collagen matrix (Geistlich Fibro-Gide®) was developed. The biomaterial has been tested over ten-years in numerous in vitro, preclinical and clinical models that demonstrated:

› Favorable mechanical properties and biological attributes promoting the ingrowth of human fibroblasts,
› Favorable tissue integration and promotion of angiogenesis,
› Non inferiority to the gold standard autologous graft in terms of 2- and 3-D linear and volumetric gains.

In terms of critical evidence, in a recent randomized controlled clinical trial Geistlich Fibro-Gide® was evaluated for mucosal thickness augmentation around dental implants. Similar to previous studies, Geistlich Fibro-Gide® produced a volume increase non-inferior to autologous transplants and with relative stability over a three-month period. Apart from these favorable mechanical and biological attributes, patient morbidity, of importance to both patients and clinicians, was reduced for Geistlich Fibro-Gide® compared with traditional connective tissue grafts.

Developing concept
Patients and clinicians have long awaited a soft tissue substitute that not only delivers clinical performance but also addresses the major issues associated
A Frontal view of esthetic area – mucosal gray show-through of implant in position 11.  
B Probing in position 11 produces pus exudation.  
C Radiograph showing misfit of implant-borne crown 11 and marginal bone loss.  
D Implant-borne crown removed. Excess cement and failure of cementation visible.  
E Occlusal view of implant site reveals a major buccal tissue deficit.  
F–G A split-thickness pouch is prepared using a sharp blade and a microsurgical elevator.  
H Geistlich Fibro-Gide® is shaped and prospectively positioned.  
I Geistlich Fibro-Gide® is fixated on the palatal side of the implant with non-resorbable suture and placed in the buccal pouch. Blanched tissue area demonstrates augmentation.  
J Occlusal view following surgical procedure.  
K Buccal view following surgical procedure.  
L Final view after insertion of new implant. No more show-through of implant 11. Peri-implant tissues are healthy and do not bleed upon probing. (Lab work: Dental Technician Andrea Patrizi).
with autologous transplants. Given the benefits of Geistlich Fibro-Gide® and based on current knowledge and experience, clinicians will soon be able to offer a choice when an increase in mucosal thickness is desired. Having a choice will certainly increase the demand and broaden clinical indications, thereby improving therapies with dental implants and fixed-tooth-supported reconstructions.

Geistlich Fibro-Gide® is suitable for the following indications:

- Delayed implants with concomitant soft tissue augmentation (simultaneous approach),
- Delayed soft tissue augmentation at implant sites in conjunction with or prior to abutment connection, and
- Soft tissue augmentation of pontic sites.

Clinical handling and benefits of Geistlich Fibro-Gide®

Considering current knowledge, learning curve and experience associated with any innovative biomaterial, Geistlich Fibro-Gide® is suitable for various indications and offers favorable clinical handling. At the clinician’s discretion, Geistlich Fibro-Gide® can be cut and shaped to the appropriate size dry, wet or even in an intermediate condition, by pre-wetting it and then letting it dry for 30–60 seconds. Once placed at the desired site, Geistlich Fibro-Gide® quickly soaks up blood, slightly increasing its volume by 20–30%. If needed, the matrix can be sutured using resorbable or non-resorbable sutures to fix it in the desired position.

Preliminary feedback from patients receiving treatment with Geistlich Fibro-Gide® indicates only minimal pain. The majority of patients who had received an autologous connective tissue graft previously are enthused about and very satisfied with the matrix, primarily because no harvesting procedure is necessary and the clinical results fulfill the highest expectations. Apart from meeting patients’ demands, histologic data at three and four months post placement reveal a matrix body slightly degraded and yet fully integrated with new blood vessels and connective tissue.

As a clinician and researcher I believe that Geistlich Fibro-Gide® is a breakthrough in oral soft tissue regeneration.

“As a clinician and researcher I believe that Geistlich Fibro-Gide® is a breakthrough in oral soft tissue regeneration.”

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References

No painful graft harvest and very good color and texture match surrounding tissue. These are major advantages when performing a vestibuloplasty with Geistlich Mucograft® 3-D collagen matrix. Now there is long-term data over five years.

In the last few years peri-implant soft tissue regeneration has acquired particular relevance in implantology. Literature is beginning to show the emergence of a tendency for an implant to be healthy, if there is a fixed, keratinized peri-implant mucosa of at least two mm in width. According to the current literature, the methods for widening the peri-implant keratinized mucosa are all associated with an apically positioned flap or a vestibuloplasty. A secondary granulation of the resultant wound surface is not ideal due to postoperative morbidity and wound contraction with a high tendency for muscular reattachment.

Autologous grafts from the palate
Autologous soft tissue grafts from the palate – such as free mucosal grafts (FMGs) or a connective tissue grafts (CTGs) – are the gold standards for cov-
ering a wound surface. They reduce postoperative contraction and improve the regenerative result. Furthermore, autologous grafts show reproducible clinical results in terms of treatment, integration, shrinkage and long-term stability (Fig. 1). However, the following points are disadvantages of autologous tissue grafting:

1. Necessity for palatal harvest with additional surgical risks,
2. Patients’ harvest site morbidity,
3. Limited availability of the graft,
4. Prolonged surgery time, and
5. Poorly matched texture and color, when using FMGs. (Fig. 1)

The Geistlich Mucograft® 3-D collagen matrix
All these factors motivate the search for possible alternatives - chiefly absorbable collagen matrices. Their support for epithelial proliferation has already been demonstrated and is partly based on infiltration with fibroblasts and keratinocytes and the formation of blood vessels. The porcine Geistlich Mucograft® 3-D collagen matrix has proven effective in open healing in numerous preclinical and clinical studies and is a good alternative to autologous tissue (FMG and CTG). By using biomaterials as scaffold for ingrowth of soft tissue, there is no need to harvest autologous grafts.

Geistlich Mucograft® 3-D collagen matrix consists of compact and porous collagen layers and was specially developed for oral soft tissue regeneration. The compact collagen layer ensures the stability of the collagen matrix. Upon insertion it should face outwards the oral cavity, where it shields against mechanical insults from the oral cavity and provides adequate suturing.

When in direct contact with the wound bed, the porous matrix layer can biointegrate by rapidly stabilizing the blood clot and enabling invasion of local growth factors from the graft bed for cell proliferation, vascularization and new tissue formation.

**FIG. 2: VESTIBULOPLASTY WITH GEISTLICH MUCOGRAFT®**

| A | Clinical situation before treatment start |
| B | Macroscopic view of the 3-D collagen matrix with compact and cancellous layer. |
| C | Clinical situation immediately after inserting the collagen matrix. |
| D | Clinical situation 10-days after surgery. |
| E | After 3-months the freshly regenerated soft tissue has matured and exhibits keratinized morphology. The freshly regenerated soft tissue is comparable in texture and color to surrounding soft tissue. |
| F | Clinically stable situation after 5-years. Reduction in the width of the keratinized mucosa in the course of healing (5-years). “Over-augmentation” equivalent to anticipated shrinkage is recommended in order to avoid recurrence. |
Application and aftercare
When using Geistlich Mucograft®, patient selection criteria, patient compliance and surgical requirements should be followed, as they should for autologous soft tissue transplants. After being cut to the necessary shape and size, Geistlich Mucograft® 3-D collagen matrix is placed in a dry state on the recipient region on the periosteum. We recommend the periosteum be prepared as cleanly as possible with an apical periostal fixation of the mucosal split flap to ensure an optimum immobile integration of the matrix. (Fig. 2) No pretreatment of the collagen matrix is required. The collagen matrix should be fixed stably onto the periosteum with absorbable sutures, as gap-free as possible to ensure maximum vascularization from the graft bed. As soon as it is applied, the matrix is impregnated with blood from the graft bed with a consequent stabilization of the blood clot.3,4 (Fig. 2) After surgery the patient should be asked to treat the treatment site as gently as possible. Soft food should be

“Free mucosal grafts are contraindicated in the exposed esthetic zone.”
recommended for 14 days, and patients should avoid any mechanical manipulation in the area of the graft, especially during hygiene. Chemical plaque control can be achieved with antiseptic and antibacterial oral rinsing solutions for ten-days after surgery. If a further flap mobilization is planned in the region, we recommend waiting for at least three months for the soft tissue to mature. (Fig. 2)

Biological adaptation to the surrounding epithelium
Histological examinations of human tissue samples, which were taken three-to four-months after augmentation of the keratinized mucosa using free mucosal grafts or Geistlich Mucograft®, exhibit the characteristics of a multilayer keratinized squamous epithelium comparable to native local gingiva. Immuno-histological verification of the expression patterns of the keratinization markers of the oral mucosa demonstrate the keratinization of the oral mucosa generated with Geistlich Mucograft®. When using autologous mucosa from the palate, directly after healing and also long-term over five-years, the regenerated soft tissue in the target region shows no change in texture and color in comparison to the original graft. (Fig. 1) This effect, which is detrimental to esthetics, can be explained by the biological determination of the mucosa removed from the palate, which remains unchanged over time. This confirms the hypothesis that autologous mucosa from the palate is revascularized basally after grafting into the target region. Therefore, FMGs are contraindicated in the exposed esthetic zone. When using CTGs or Geistlich Mucograft® 3-D collagen matrix, a clinical appearance comparable to the surrounding tissue manifests after integration. The reason is that the biological information from the epithelium is absent, and an epithelial layer matching the target region forms after neo-epithelialization of the graft. (Fig. 3)

Long-term stability of the grafted mucosa
Measurements of the shrinkage of the augmentation zone over time have revealed that a substantial shrinkage reduces graft width and takes place from initial healing until three months after surgery. The regeneration result then stabilizes with only minimal changes. Shrinkage using autologous mucosa from the palate is approximately 33% after six months, and when using Geistlich Mucograft® there is no significant difference at approximately 42%. As for operation time, the literature concurs that using collagen matrices in comparison to using autologous transplants from the palate shortens operation time significantly by approximately 15–20 minutes. This, however, depends on the size of the region to be augmented and the number of grafts taken and is relative when small grafts are harvested. Regardless, in large vestibuloplasties the quantity of available autologous tissue is limited, which again justifies the use of harvest graft alternatives. Long-term data over five years reveals comparatively stable regeneration success between autologous mucosa from the palate and Geistlich Mucograft® 3-D collagen matrix. Initial shrinkage after six-months remains relatively unchanged for up to five-years. When using free mucosa grafts from the palate, the total shrinkage of the augmentation zone after five years is 40.65%, and with the Geistlich Mucograft® 3-D collagen matrix, it is 52.89%, with no significant difference. After five years with free mucosa grafts, the keratinized peri-implant soft tissue has a width of $8.4 \pm 2.4 \text{ mm}$ and $6.2 \pm 1.2 \text{ mm}$ with Geistlich Mucograft®. Anticipated shrinkage should be planned in order to avoid unsatisfactory results and disease recurrence. We recommend an “over-augmentation” equivalent to anticipated shrinkage. (Fig. 2)

References
In Periodontics, autogenous soft tissue grafts have been used broadly for a variety of indications, as root coverage of localized gingival recessions, tissue augmentation when there is insufficient keratinized tissue around teeth and volume augmentation around edentulous sites. As the know-how of tissue management around teeth has expanded, clinicians have opted to apply these principles to implants. In current implant dentistry the focus has shifted from osseointegration to the esthetics of implant restorations and how they integrate harmoniously with adjacent tissues.

**Importance of soft tissue volume around dental implants**

The physiologic changes that occur after tooth extraction, which have been wide-

**Sufficient soft tissue volume and keratinized tissue around implants are of importance for both the esthetics and function of implants. A clinical update on gold standards and alternatives.**

**FIG. 1: SOFT TISSUE AUGMENTATION WITH AUTOGENOUS GRAFT**

| A | Site 25 presents with an implant supported restoration. Patient complains of grayish color of the mucosa and poor esthetics. Diagnosis reveals no signs of peri-implant pathology. | B | Lateral image reveals significant ridge deformity. | C | Tunnel preparation is performed, and autogenous soft tissue from the tuberosity is grafted in the area. | D | Autogenous graft is fixed in the transition zone between implant shoulder and gingival margin. | E | Final reconstruction of implant in position 25 and full coverage restoration in 26. | F | Occlusal view 24-months after final restoration. | G | Lateral view revealing improved soft tissue contours. |
ly described in the literature, frequently create soft and hard tissue deficiencies that negatively influence the appearance of the prosthetic restoration and the peri-implant tissues. In the past, these clinical situations were treated primarily through bone regenerative techniques to regenerate ridge volume. However, more recently these bone regenerative interventions have been combined with soft tissue grafting to maximize volume gain and to restore the contours of the alveolar ridge. Moreover, it has been shown that tissue thickness is not only a key treatment goal for esthetics, since it significantly influences the translucency and color of the peri-implant tissues, but also a goal for peri-implant mucosa stability. Recent data have shown that thick tissues may be less prone to the initial bone loss that occurs with the establishment of the biologic width. For these reasons, soft tissue grafting around dental implants has become an important part of the routine interventions employed in the treatment of esthetically demanding situations.

**Use of autogenous soft tissue**

When treating these clinical indications, autogenous connective tissue grafts have been shown to increase soft tissue contours and, therefore, to improve the harmony between restorations and adjacent tissues. For harvesting these autogenous grafts the most used donor sites are the anterior and posterior parts of the palate, including the maxillary tuberosity. However, the origin of the graft may influence the thickness of the tissue grafted and, therefore, the selection must be based on the amount of tissue augmentation needed. (Fig. 1)

Although there is no clear evidence that graft composition influences volume gain and stability, clinicians are inclined to harvest autogenous grafts with greater proportions of lamina propria, since

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“There is great interest to develop alternatives to soft tissue grafts that might achieve similar outcomes with reduced morbidity.”

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it is believed that this tissue, compared with glandular or fatty tissue, will be more stable and less prone to volume change. Interestingly, graft thickness has been directly correlated with the amount of pain perceived by patients. Autogenous grafts are obviously associated with a greater number of post surgical complications, including bleeding and pain.

For these reasons, there is great interest in the scientific community to develop and test soft tissue substitutes that might achieve similar outcomes with reduced morbidity. To date numerous graft substitutes have been reported in the literature.

Allogeneic grafts have been used to increase the width of keratinized tissue with varying results and with significant tissue shrinkage. Collagen matrices have been used around teeth and implants and have proved to be effective in attaining a stable band of keratinized tissue with similar outcomes compared to autogenous connective tissue grafts.

For volume augmentation researchers are testing a new 3-D collagen matrix designed to serve as a possible substitute for autogenous grafts to increase the quantity of soft tissue around implants. A recent publication has shown promising results for this matrix when compared to autogenous connective tissue. (Fig. 2)

For the surgical approach to soft tissue volume augmentation, bilaminar techniques are the most common in the available literature, either in the form of conventional flaps or tunnel preparations. Conventional flaps allow for better access and graft fixation, while tunnel preparations have the advantage of not disturbing the interproximal tissue and, therefore, better preserving papillae height. Regardless of the surgical technique, it is important that the soft tissue graft or substitute be fixed in the area most likely to create a benefit: the transition zone from the implant shoulder to the gingival margin.

Importance of keratinized mucosa around dental implants

Besides the thickness of the peri-implant tissues, the width of keratinized tissue has received significant attention. Recent systematic reviews have pointed out that there is insufficient evidence to associate peri-implant bone levels with the width of keratinized tissue, although a reduced width of keratinized mucosa may be more prone to lingual plaque accumulation, bleeding on probing and buccal soft tissue recession. Recently published longitudinal studies have indicated that patients with minimal amounts of keratinized tissue are more prone to inflammation even with proper home and professional oral hygiene. Moreover, inadequate keratinized tissue has been associated with brushing discomfort. Considering the available data, clinicians should consider procedures aimed at preserving keratinized tissue. When there is significant displacement of the mucogingival junction after GBR procedures in order to facilitate access to oral hygiene in non-esthetic areas, keratinized tissue augmentation procedures should also be considered.

References
Recession coverage

A less invasive technique for greater success

Dr. Yoon Euy Hong, South Korea
Private Practice, Center for Oral Plastic Surgery

Different techniques and biomaterials can be used for recession coverage. When is the coronally advanced flap beneficial, when a tunneling approach?

Gingival recession takes place when the free gingiva migrates apical to the cementoenamel junction with concurrent displacement of the biologic width complex, including connective tissue, root cementum and alveolar bone. This is called clinical attachment loss. It is crucial to understand that this phenomenon increases tooth mortality. The etiology of gingival recession is diverse. However, if ideal periodontal flaps and grafts are selected, recession coverage can be beneficial for patients, providing satisfactory outcomes for recession coverage and gains in keratinized gingiva. Techniques in which connective tissue grafts or tissue biomaterials are used with coronally advanced flaps or tunneling procedures have been well-documented and proven to be effective.1

Tunneling technique vs. coronally advanced flap

In periodontal plastic surgery, the coronally advanced flap (CAF) has been used most widely for recession coverage and increasing keratinization, with or without connective tissue grafts or graft substitute biomaterials. The literature and the clinical community have supported the superior outcomes of CAF.2 The CAF includes vertical releasing incisions that allow predictable coronal advancement of the flap. However, the incisions delay post-surgical wound healing and tend to expose grafts. Therefore, many clinicians have considered alternative surgical techniques that avoid vertical incisions. The tunneling technique was first introduced by Zabalegui et al2 and can be used for periodontal plastic surgery in multiple adjacent defects. Advantages of tunneling techniques include the absence of vertical releasing incisions, intact papilla due to lack of papilla reflections and graft adaptability with increased blood supply2. All of these factors accelerate initial wound healing. However, tunneling techniques require operator skill and experience and are rather time consuming. The tunneling technique can minimize trauma to the gingiva, and the least traumatic surgical techniques are beneficial for patients and surgeons.

Clinical tips: flap technique

› The coronally advanced flap is preferred when dealing with thin mucosal tissue (thin biotype), since the preparation of a tunnel is likely to cause perforations or tearing of the gingiva. The coronally advanced flap is also recommended when a greater amount of coronal advancement is planned and if the scalloped nature of the free gingiva is absent – flatly contoured gingival zenith, such as in the lower anterior region.

› The tunneling technique is ideal when working with a thick biotype,
highly scalloped free gingiva and suitable keratinized tissue. The tunneling technique should also be considered if esthetics are critical and a mild to moderate coronal advancement is anticipated. One of the key factors for success is the proficiency of the periodontal surgeon.

**Connective tissue graft vs. biomaterial**

Connective tissue grafts help create keratinized gingiva, based on a study of tissue specificity by Karring and co-workers. In this epithelial differentiation study, Karring was able to demonstrate that free grafts harvested from the palate produced keratinized gingiva, whereas grafts transplanted from the non-keratinized alveolar mucosa produced alveolar mucosa. Advantages of connective tissue grafts include plasmatic circulation (capillary beds within the grafts) that help with high graft survival, outstanding color match after healing and dimensional stability. Disadvantages include patient morbidity, e.g. bleeding, delayed healing and pain, along with the secondary graft harvest sites. Accordingly, clinicians have been interested in developing a graft substitute. Such biomaterials not only avoid connective tissue graft harvest and associated morbidity but also provide unlimited supply with consistent quality. Working with such biomaterials, complete primary closure with a tension-free flap is recommended. Ideal biomaterials should act as scaffolding to promote ingrowth and regeneration by host cells, while remaining dimensionally stable. (Fig. 3)

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**“Ideal biomaterials should act as scaffold to promote ingrowth and regeneration by host cells.”**

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**FIG. 2: COMPLEX ORTHODONTIC CASE INCLUDING RECESSION COVERAGE AND INCREASE IN KERATINIZATION PRE-OP**

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<td>Pre-orthodontic situation.</td>
<td>Coronally advanced flap with vertical releasing incisions were performed on tooth 6 and 11 root cementum removed.</td>
<td>Connective tissue graft is applied and immobilized.</td>
<td>Complete primary wound closure with a tension-free flap.</td>
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<td>24 Months after recession coverage the orthodontic treatment started. Soft tissue complex traveled with orthodontic tooth movement.</td>
<td>Clinical results after 8 years. No re-entry interventions were performed.</td>
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Clinical tips: biomaterial
› When the connective tissue graft is chosen as a graft material, its availability must be determined prior to the intervention using bone sounding. Reiser emphasized the importance of the anatomy of the donor area and classified the vault dimension as shallow, medium or high.
› The collagen matrix Geistlich Mucograft should be handled, trimmed, positioned and sutured before the biomaterial becomes wet. Therefore, it is beneficial to finish any necessary preparation of the biomaterial extra- orally in order to minimize intra-oral working time. In this way the volumetric dimension is not compromised. The periodontal flap should be reflected without tension. A tension-free flap is critical for primary closure, and a passive flap will not compress the underlying Geistlich Mucograft collagen matrix.

Minimally invasive approach
A meticulous periodontal surgeon is always investigating advances in periodontal plastic surgery. How can we improve surgical techniques in order to improve predictability and reduce complications? Can the surgical time be shortened or post-surgical wound healing be accelerated? Minimally invasive surgery can be the answer. Shanelec and colleagues first introduced periodontal surgery using a microscope, which provided clinical benefits over conventional treatment.4 Cortellini and co-workers studied a minimally invasive surgical approach to periodontal surgery.7 Atraumatic flaps, harvest graft substitute biomaterials, use of microscopes and loupes (without increasing surgery time due to unfamiliarity), teamwork, proper armamentarium, surgical skill and experience can all help with the minimally invasive approach in periodontal plastic surgery.

Clinical tips: minimum invasion
These are the key factors for a minimally invasive approach to periodontal plastic surgery:
› Limited flap reflections
› Use of SM67 or SM69 blades (Swann-Morton)
› Use of 5–0 or 6–0 sutures
› Introduction of microscopes or loupes
› Use of specified instruments, such as tunneling instruments
› Combination of tunneling techniques and biomaterials.

References
Major bone augmentations with either Guided Bone Regeneration or a bone block increase bone volume significantly. But without proper flap techniques, wound dehiscences can jeopardize success.

Dental implant therapy is a well-documented and well-supported procedure with high predictability, particularly if hard tissue is optimal. But in cases with insufficient bone volume, a bone augmentation procedure is required. Many techniques have proved to be effective for horizontal and vertical hard tissue augmentation, such as Guided Bone Regeneration (GBR) or autogenous bone block grafts.\(^2\)\(^–\)\(^4\)

**Reducing flap tension**

Independent from the bone augmentation itself, primary wound healing appears crucial for a positive outcome. Unfortunately, complications associated with these procedures are not irrelevant. Studies report complication rates of 45% with vertical GBR\(^3\) or 29.8% with vertical block grafts.\(^4\) Flap tension for primary wound closure of mucoperiosteal flaps seems to be the most important factor.\(^5\) Minimal flap tension (lower than 5 gr) is associated with 100% primary wound closure, while increasing the flap tension increases the incidence of wound dehiscence. This means that soft tissue release is a crucial step in bone augmentation surgery. Clinically, three types of flaps can be released by periosteal incisions and coronal advancement—these are the lingual and vestibular flaps in the mandible, and the vestibular flap in the maxilla.

**Three types of released and advanced flaps**

The mandibular lingual flap is released by interrupting the thin periosteum layer with an elevator or dissector. (Fig. 1) The use of a blade may be avoided or limited to the mesial area of the mandible, where the periosteum is thicker.\(^6\) In the distal area the more superficial fibers of the mylohyoid muscle may be denuded.

**FIG. 1: MANDIBULAR LINGUAL FLAP MANAGEMENT**

| A | Full thickness lingual flap elevated. The periosteum is intact representing the inner face of the flap. Only in the apical and distal area (in the region of the 3rd molar) the superficial fibers of the mylohyoid muscle could be visible. |
| B | Release of the periosteum by the use of a non-cutting tool, such as an elevator or dissector. |
| C | Lingual flap elongated. If required, detaching the superficial fibers of the mylohyoid muscle from the flap, a secondary coronal flap advancement could be obtained. |
simply by elevating a full thickness flap, since the mylohyoid line is in a more cranial position. In some cases, detaching muscle fibers from the internal face of the flap may increase the coronal advancement of the flap.

The mandibular vestibular flap is released with a scalpel blade (15c). The tip of the blade should contact the superficial inner face of the flap starting from the vertical releasing incision and moves distally or mesially. (Fig. 2) The blade works with the cutting face upside down and the non cutting area facing the flap.

Once the periosteum is interrupted, the flap can be elongated with an elevator or dissector, avoiding damage to flap vessels.

The maxillary suture involves the entire thickness of the palatal flap and just the coronal periosteum layer of the vestibular flap. The needle engages the palatal flap seven to ten mm apical to the flap margin, then moves to the vestibular side and engages the periosteum on the coronal margin of the releasing periosteum incision. It then moves palatally again through the entire palatal flap.

Avoiding the killer loop effect

The surgeon should keep in mind that a released and elongated flap does not necessarily result in a correctly released flap. When the flaps are not optimally released, the suture lines, which are usually composed of horizontal mattress sutures and single sutures, may make the marginal part of the wound ischemic, which can result in necrosis. This “killer loop effect” of horizontal mattress sutures is amplified by increasing the residual flap tension at the end of the surgery. The application of a breaking force suture seems to reduce the marginal flap tension prior to the horizontal mattress. Two suturing technique employs a breaking force suture – one in the maxilla and one in the mandible.

FIG. 2: MANDIBULAR VESTIBULAR FLAP MANAGEMENT

| A | The mandibular vestibular flap is released with a scalpel blade. |
| B | The tip of the blade contacts the superficial inner face of the flap starting from the vertical releasing incision and moves distally or mesially. |
| C | The periosteum is interrupted. |
| D | The flap is elongated with an elevator or dissector avoiding damage to flap vessels. |

The mandibular vestibular flap is released in a manner similar to the mandibular vestibular flap, except that usually, once the periosteum is interrupted, the flap is elongated with a blade (instead of elevator or dissector) because the density of elastic muscle fibers inhibits coronal advancement.

The maxillary vestibular flap

The maxillary vestibular flap is released in a manner similar to the mandibular vestibular flap, except that usually, once the periosteum is interrupted, the flap is elongated with a blade (instead of elevator or dissector) because the density of elastic muscle fibers inhibits coronal advancement.

The breaking force suture involves just the periosteal layers without creating any killer loop effect, while leaving the vascularity intact. This suture can re-
duce the residual flap tension prior to wound closure by about 87%.

An alternative: The tunnel approach
Flap design can also be an opportunity to improve or simplify the primary wound closure and reduce the risk of dehiscence. The tunnel approach proposed by Khoury is one of these opportunities. The technique avoids any crestal incision in the area of the graft. A single vertical incision is made at the distal aspect of the mesial tooth closest to the defect. The flap is then elevated as a full thickness flap, tunneling around the defect. In this way there is optimal graft protection, and wound dehiscence is avoided by the continuity of the soft tissue over the graft. Visualization of the surgical field is obviously limited, and this must be taken into consideration. The anatomy of the defect must be analyzed preoperatively, and the bone defect should be quite smooth and regular without deep bone septa, which could interfere with the correct elevation of a full thickness flap. Nevertheless, many publications report limited or no soft tissue complications.

Soft tissue adheres more tenaciously to bone than dentin
Considering flap stability as a factor influencing flap tension, Werfully et al. (2002) demonstrated differences in flap adhesion to different substrates. Their study in dogs revealed that, at all healing times, the flap tensile strength at the flap-bone interface was at least twice that of the flap-dentin interface (after seven days: 5.08 N versus 1.82 N,

FIGS. 3, 4: BREAKING FORCE SUTURE I: MAXILLARY SUTURE – ILLUSTRATIONS AND CLINICAL CASE

| 3A Initial situation for a maxillary suture with the vestibular flap already elongated. | 3B–4A–B The needle engages the palatal flap seven to ten mm apical to the flap margin, then moves to the vestibular side and engages the periosteum on the coronal margin. It moves then palatally again through the entire palatal flap. | 3C–4C Suture is tied and the vestibular flap slips coronally. | 3D–4D Mattress sutures and single sutures are applied with no or minimal residual tension. |
This means that soft tissue is able to adhere more strongly and quickly to bone than to dentin. The difference is the favorable relationship between the underlying coagulum of the flap with bone, whereas the coagulum-dentin interface is more tenuous. Extrapolating these findings to augmentation, a key factor for stress reduction of the flap margins in early healing could be the capacity of the coagulum and the overlying flap to adhere to the graft material. It is reasonable to assume that the stability of the complex coagulum-flap interface is not optimal when a graft material is the interface (non-resorbable idrophobic PTFE membrane), which might explain the high complication rate associated with augmentation procedures. But for overall flap stability, the suture line is the key to maintaining primary wound closure.

**References**

MILESTONE STUDIES.

An update on soft tissue management with collagen matrices
INTRODUCTION  Soft tissue management implant therapy is of growing importance. Widening of keratinized tissue as well as recession coverage and volume augmentation around implants and under pontics are part of the therapy repertoire in many dental surgery practices.

Driven by patient quality of life, Geistlich has marketed two innovative collagen matrices that enable dentists to operate without soft tissue graft harvests. While Geistlich Mucograft® has been developed primarily as an alternative to free gingival grafts to be left exposed during healing, the new collagen matrix Geistlich Fibro-Gide® behaves like a connective tissue graft. Both matrices have been extensively investigated in multiple studies and have been compared to gold-standard autologous grafts. Do they perform as well as the gold-standard?

Patients more satisfied with collagen matrix
In order to gain keratinized tissue – e.g., prior to implant placement – dentists frequently use a combination of apically positioned flaps and free gingival grafts. However, as graft harvesting from the palate is associated with pain and bleeding, an alternative approach might be beneficial. The American researchers Michael McGuire and Todd Scheyer compared the 3-D collagen matrix Geistlich Mucograft® with autogenous free gingival graft in vestibuloplasties around teeth. Their randomized and controlled split-mouth study (30 patients with zones of insufficient keratinized tissue < 2 mm, with follow-up to six-months) achieved similar results for both treatment options. More than two-thirds (70%) of patients preferred the appearance of sites where the collagen matrix was used – due to better texture and color matches to the adjacent gingival tissue – and there was less pain with Geistlich Mucograft®.


Smart combination of tissue grafts and collagen matrices
After major bone augmentation procedures, large free gingival grafts are frequently needed to restore a healthy width of keratinized tissue. A prospective case series study by Urban et al. from 2015 (20 patients, follow-up twelve-months) evaluated a clever alternative to this approach: the combined use of a small free gingival “strip graft” and the porcine collagen matrix Geistlich Mucograft®. While the small autologous graft acts as a “cell donator” for new keratinized tissue, the collagen matrix extends the formation of new keratinized tissue to a larger area. Results: compared to baseline, at twelve months a significant increase in keratinized tissue of 6.33±2.16 mm on average in all treated sites and low graft contraction (43%). Patients reported no post-operative complications. This study shows that biological understanding of the regeneration process leads to good results – in this case understanding the origin of the “biologic information” for newly formed keratinized tissue.

The long-term proof

In German oral-maxillofacial surgeon Christian Schmitt’s study (14 patients, follow-up three-months), patients underwent augmentation of insufficient keratinized peri-implant mucosa with either Geistlich Mucograft® or a free gingival graft from the palate. During the 90-day study period, the two treatment alternatives showed similar clinical and histologic outcomes in terms of healing, overall shrinkage and increase in keratinized mucosa. But in the collagen matrix group, clinical color and texture were comparable to adjacent native mucosa. Using Geistlich Mucograft® also shortened the surgery time compared with free gingival graft therapy. Similar results were achieved over the long-term as shown in the publication by Schmitt et al. in 2016 (48 patients, follow-up five years). Vestibuloplasty with Geistlich Mucograft® resulted in favorable esthetic appearance of soft tissue with similar texture and color to adjacent areas five years after augmentation. Free gingival grafts, by contrast, were still distinguishable from the adjacent native gingiva.


Use for vestibuloplasty in cancer patients

Resection of oral cancer is often accompanied by anatomical deformities affecting teeth, bone and soft tissue. This, together with an impaired healing capacity, makes oral rehabilitation difficult. Can the collagen matrix Geistlich Mucograft® serve as an alternative to autologous grafts for a vestibuloplasty in these patients? A clinical study by Lorenz et al. 2017 (six patients, follow-up six months) revealed a complete epithelialization of the defect site after a mean healing period of three weeks without adverse reactions, transplant loss, severe pain, wound healing complications or persistent discomfort. The width of the attached peri-implant gingiva, starting from a baseline of less than 1 mm in each implant site, could be increased to a mean width of 4.4 mm immediately after vestibuloplasty and 3.9 mm six-months after vestibuloplasty.


“More than two-thirds of patients preferred the appearance of sites where the collagen matrix was used.”
McGuire MK, Scheyer ET 2014

Geistlich Fibro-Gide® not inferior to connective tissue graft

The first two preclinical studies on the new 3-D collagen matrix Geistlich Fibro-Gide® were published in 2011 by Thoma et al. (six dogs, two test groups, one control group, follow-up three-months). The authors investigated effectiveness of Geistlich Fibro-Gide® for ridge width gain compared with gold standard connective tissue grafts and also controls with no tissue augmentation. After three-months there was a volume gain of 1.4 mm for both Geistlich Fibro-Gide® and connective tissue graft, and a loss of 0.3 mm for the control. Based on histomorphometric analyses in the second publication with the same study design, application of Geistlich Fibro-Gide® resulted in favorable tissue integration toward both the covering flap and the underlying bone. This uneventful integration is special, because, according to the authors, in the past cross-linked collagen devices exhibited an increased rate of soft tissue complications when used as barrier membranes for Guided Bone Regeneration. The authors see the Geistlich Pharma AG research and collagen expertise used to cross-link Geistlich Fibro-Gide® as a possible reason for this improved clinical performance.


Less cross-linking, better stability

Cross-linking was also investigated in another pre-clinical study by Thoma et al. 2012 (14 mice, two collagen matrix prototypes, follow-up three and six weeks). The authors evaluated whether tissue integration, angiogenesis and matrix degradation in two different Geistlich Fibro-Gide® prototypes...
depended on the degree of chemical cross-linking. Two collagen matrices with high and low levels of chemical cross-linking were implanted in mice, approximately 10 mm above the hip socket, and analyzed at three and six-weeks. Both prototypes showed only minimal inflammatory reactions and favorable integration into the surrounding tissues. However, the authors reported that low chemical cross-linking enhanced angiogenesis compared with high cross-linking. Angiogenesis is expected to have a significant impact on healing outcome. In addition, volume stability of the low cross-linked collagen matrix was superior to the high cross-linked collagen matrix.

In conclusion: less cross-linked collagen matrices might be more favorable for soft tissue augmentation in terms of blood vessel formation, matrix integration and volume stability. Accordingly, the less cross-linked collagen matrix was later developed into Geistlich Fibro-Gide®.


Clinical study: Augmentation of soft tissue with matrix vs. graft

Thoma et al. 2016 demonstrated that Geistlich Fibro-Gide® and subepithelial connective tissue grafts lead to similar results when used to augment soft tissue around implants. In a randomized clinical trial (20 patients, two test groups, follow-up three-months), patients with insufficient tissue volume at single implants underwent soft tissue augmentation with Geistlich Fibro-Gide® or connective tissue graft. The results after three-months: median soft tissue thickness on the occlusal aspect increased by 1.8 mm for Geistlich Fibro-Gide® and 0.5 mm for connective tissue graft. Median soft tissue thickness on the buccal aspect increased by 1 mm for Geistlich Fibro-Gide® and 1.5 mm for connective tissue graft. Both, grafts and biomaterials, integrated well without any rejection reactions. Authors concluded that Geistlich Fibro-Gide® in soft tissue augmentation at single implants is as effective and well-tolerated as the gold standard connective tissue graft.


Good soft tissue response

Another pre-clinical study by Ferrantino et al. 2016 (six dogs, test and control groups, follow-up 90-days) examined the soft tissue response to the collagen matrix Geistlich Fibro-Gide® histologically at different time points. The matrix did not alter the healing process compared to the sham-operated sites. After four-days, the first small blood vessels were seen at the margins of Geistlich Fibro-Gide®. The number of blood vessels and mesenchymal-like cells increased over time. After 90-days, the residual collagen matrix was fully integrated in newly formed connective tissue.


Two matrices, two indications

The two collagen matrices Geistlich Fibro-Gide® and Geistlich Mucograft® were compared in a preclinical study by Thoma et al. published in 2015 (50 rats, four treatment modalities, follow-up two-months). Favorable soft tissue integration was achieved with both collagen matrices. While the compact layer of Geistlich Mucograft® delayed angiogenesis and connective tissue formation in a submerged healing situation, the spongious cross-linked matrix Geistlich Fibro-Gide® facilitated early vascularization and demonstrated matrix presence over a long time span. This is in line with the intended use of the two collagen matrices. While Geistlich Mucograft® demonstrates its best clinical performance when used for the gain of keratinized tissue in open healing situations, Geistlich Fibro-Gide® provides volume stability and new connective tissue formation when used in submerged healing situations.

HOPE FROM 3-D PRINTING.

Demand for human tissue is enormous. As a result, great hope is now being placed on computer-controlled “bio-printers”. In particular, considerable progress is being made with tissues that do not depend on capillaries and nerves.
“The number of people desperately awaiting organ transplants by far exceeds the number of available donor organs,” says Dr. Anthony Atala, Director of the Wake Forest Institute for Regenerative Medicine in Winston Salem, North Carolina. “Every day 21 US citizens fall victim to there being no such organ available to them. To rectify this shortfall, many research teams are currently endeavoring to construct living tissue with 3-D printers.”

First bio-printer at the turn of the millennium
In the mid 1980’s the US American Charles W. Hull developed a printer that enabled 3-D objects to be manufactured under the control of special “computer aided design” (CAD) software. At first the materials used were chiefly polymers, then, as of the beginning of the 90’s, nanocomposites, blended plastics and powdered metals. It was not long before medical researchers also turned their attention to this development: If a solid plaster or plastic ornament could be manufactured using a printer, should it not be possible to print a living organ? In 1999 scientists at the Wake Forest Institute used a 3-D printer for the first time to manufacture a scaffold for a human bladder. They coated the modeled scaffold with cells from their patients. Other groups followed by printing the first miniature kidneys in 2002 and the first blood vessels in 2010.

Like an inkjet printer
The operation of a bio-printer mirrors the operation of a normal 3-D printer. A computer controls extruders that construct desired structures from a polymer gel. Using a 3-D model, spray nozzles extrude a cellular suspension in the form of tiny droplets. The gel is usually based on an alginate composite. Every droplet deposited contains several thousand cells capable of regeneration. These cells are collected in advance by biopsy from the organ to be replaced and then multiplied in a liquid nutrient medium containing oxygen. Experiments have also been conducted with adult or induced pluripotent stem cells (e.g., from bone marrow). With appropriate growth factors designated by the researchers and by defining both viscosity and temperature of the matrix exactly, researchers encourage cells to organize themselves into functional tissue.

Research in full swing
Scientists throughout the world are currently working on methods for tissue-engineering human organs using 3-D printers. Most models, however, are still on the drawing board. In particular, building functional organs that rely on nutrient blood vessels and nerves is still a pipe dream in the view of researchers like Simon Hoerstrup, the Director of the Institute for Regenerative Medicine at the University of Zurich, where polymer scaffolds are subsequently coated with the patients’ own cells using a 3-D printer. In children with serious congenital heart defects, Dr. Hoerstrup intends to implant living, i.e., growing, heart valves after birth. What he has already shown can work in animal experiments on lambs is soon to be studied in the clinic with human babies. The development of less complex tissues like heart valves, blood vessels and cartilage that do not
need a direct supply of blood nutrient is already well ahead. For example, Swedish researchers recently made cartilage consisting of a new hydrogel biomaterial and human cells, which grew successfully in mouse skin.¹

Meanwhile, a team of researchers at the University of California in San Diego (UCSD) was successful using a 3-D printer to manufacture a small, functional system of blood vessels and implant it into live mice.² And a new hydrogel made from alginate, polyvinyl alcohol and hydroxyapatite was recently developed by scientists led by Stephanie T. Bendtsen at the Institute for Material Sciences, University of Connecticut. The alginate is designed to improve the properties of bones “printed” using 3-D printers.³ Finally, victims of serious burns and animal testing for cosmetics and drugs could benefit from a bilayer human skin sourced from a 3-D printer. A bio-ink for the printer cartridges containing blood plasma, fibroblasts and keratinocytes was developed by Spanish scientists, and the resulting bilayer skin grew without difficulty when implanted in mice.⁴

**New ears**

Using an experimental technique at the end of last year, Chinese researchers created a new ear by an unusual means.⁵ The patient lost an ear that had been damaged irreparably in a car accident. Dr. Wang Jihua, Director of Plastic Surgery at the Kunming Medical Second Hospital, printed a model of an ear using a 3-D printer and fashioned a new ear out of rib cartilage. This model was then implanted under the skin of the patient’s arm, so it could continue to grow for subsequent transplant onto the patient’s head. Doctors are also currently using 3-D printing techniques in Edinburgh, Scotland to make a new ear for a nine-year old girl afflicted by a congenital ear muscle abnormality. Using a 3-D printer, researchers created a mirror image of the normal ear out of plastic and used this template to model a new ear from rib cartilage. Initial surgery entailed the plastic ear being attached to the head beneath the skin in order to create the site and structure for the new ear. As soon as the skin has adapted, a second operation will allow the replacement ear to be attached in the desired position.

Be it ears, heart valves, skin, bone, kidneys or other tissues: 3-D technology could soon open up a new era in medicine.

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“The number of people desperately awaiting organ transplants by far exceeds the number of available donor organs.”

Dr. Anthony Atala | Wake Forest Institute for Regenerative Medicine

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BACKGROUND.
In June 2017 the Osteology Foundation published a new book for dental students and dentists who have not had any previous experience on the field of oral regeneration.

The 52-page book entitled “Oral Regeneration in a Nutshell” provides an overview of the basic principles, as well as the goals, indications and techniques of oral regeneration. Using illustrations and clinical pictures, the authors Prof. Christoph Hämmerle, Prof. Giulio Rasperini, PD Dr. Daniel Thoma and Dr. Nele Van Assche introduce the reader to the key aspects of periodontal regeneration, hard and soft tissue regeneration and alveolar ridge preservation. Further information about the book and how to obtain it is available online. In addition, the full content can be accessed on the Osteology Foundation’s online platform THE BOX.

www.oral-regeneration.org
Geistlich invested heavily to develop its latest product, the 3-D collagen matrix Geistlich Fibro-Gide®. Dr. Terance Hart, Chief Scientific Officer, and Dr. Mark Spilker, Deputy Chief Scientific Officer, talk about innovation, research pathways and strategic collaborations.

“Geistlich Fibro-Gide® is the latest product from Geistlich for regenerative dentistry. Why does Geistlich want to provide a new therapeutic solution?

Dr. T. Hart: We wanted to offer a product that regenerates soft tissue while also maintaining volume and providing excellent mechanical properties. Several of our key partners from universities and dental clinics highly appreciated the idea of a volume-stable collagen matrix that could be used for indications such as soft tissue augmentation around implants or under pontics. Currently many of those treatments are performed with autologous tissue, which always involves graft harvesting and, therefore, donor-site morbidity.

What was the most difficult part developing Geistlich Fibro-Gide®?

Dr. T. Hart: The most difficult part was combining the mechanical stability and handling of the matrix with cell biocompatibility and tissue regeneration. There is a fundamental trade-off between better mechanical properties and cellular recognition of the matrix. For example, by enhancing the mechanical stability with chemical cross-linking, the regenerative properties of the matrix are diminished. Cells read the hidden 3-D amino acid code that is written inside the collagen. Too much cross-linking destroys the code and makes the material biologically invisible to cells. Under cross-linking, on the other hand, does not allow for mechanical stability of the matrix, and it will be resorbed too quickly by the body through enzymatic hydrolysis. As you can imagine, much R&D time was spent trying to optimize all these conflicting factors.

Keyword: Cross-linking. The use of cross-linking was intentionally avoided in Geistlich Bio-Gide® and Geistlich Mucograft® in favor of improved tissue compatibility. How has this changed with Geistlich Fibro-Gide®?
“Geistlich has developed a minimal cross-linking approach that balances mechanical volume stability with cell compatibility.”

Dr. Mark Spilker | Deputy Chief Scientific Officer Geistlich Pharma AG

Dr. M. Spilker: All collagen is naturally cross-linked; otherwise, we would be soup! Synthetic cross-linking has advanced considerably in the past 20 years. For example, in the past cross-linking a collagen product with outdated aldehyde technology resulted in poor tissue compatibility. But Geistlich has now been able to develop a minimal cross-linking approach that balances mechanical volume stability with cell compatibility and tissue integration. Geistlich uses a natural and “soft” form of cross-linking in the sense that the cross-linked collagen can be integrated and then turned over by the body’s enzymes.

How many prototypes are tested in a development like this, before the ideal product is found?

Dr. T. Hart: For Geistlich Fibro-Gide®, Geistlich tested more than 1000 collagen matrix prototypes obtained under different preparation conditions and having different features. This is not so different from the Pharma industry where 1000 molecules are typically made in the lab to produce one clinical candidate.

Geistlich has more than 160 years of expertise in collagen. How does this help today?

Dr. M. Spilker: Collagen is a very complicated and vitally important macro molecule. Much about collagen is scientifically understood, but there is a great deal of collagen technology that rests in art, experience and expertise. Because of our heritage, we have built up considerable collagen art and expertise at Geistlich. To quote Isaac Newton, “if we now see further, it is because we stand on the shoulders of giants”. It is this sum of experience of sourcing, purifying and handling of natural collagens, beginning at Geistlich with glue and gelatin, that has directly led to Geistlich Bio-Gide®, Geistlich Mucograft® and now Geistlich Fibro-Gide®.

To what extent could experience gained from the development of Geistlich Mucograft® be used in the development of Geistlich Fibro-Gide®?

Dr. T. Hart: Geistlich Mucograft® was the first and very important step into the field of soft tissue regeneration, for example, to gain keratinized tissue. We learned a lot about the trade-off between volume stability, cell behaviour and tissue compatibility, as well as the necessity of delivering not only a biomaterial but also effective protocols that work in clinical practice.

What was it in the development and testing of the product and prototype that ultimately drove the decision to focus all efforts on this product and get it to market?

Dr. M. Spilker: When we received the histology showing the tissue integration and volume retention in the pre-clinical studies we knew we had something special. I am convinced that this is indeed a step forward in technology, and it has huge potential.

Is the research side of Geistlich Fibro-Gide® finished with the market launch?

Dr. M. Spilker: Definitely not. We have entered the phase where clinical research is the highest priority. Geistlich is now embarking on the clinical evaluations of Geistlich Fibro-Gide® in larger patient populations and with various clinical applications. Our key is to generate the clinical data that will directly benefit clinicians and their patients, for example, best practice cases, clinical guidelines and dos and don’ts. Although all of our products have been developed in close collaboration with key partners from universities and dental clinics, our large network of clinical partners contributes greatly during these pre-launch clinical phases.

The regulatory hurdles for new product approvals have grown in recent years. How does Geistlich Pharma deal with them?

Dr. T. Hart: For us, this is good. It has always been one of our core strengths. Geistlich has always developed our products in a very careful way, because we must convince ourselves that our products are safe and perform effectively for both patient and clinician. So the increasing regulatory hurdles for new product approvals have validated Geistlich’s evidence-based approach to the development of medical devices for the benefit of patient and clinician.
Two innovative solutions for soft tissue regeneration

Susanne Schick, Dr. Giselle Richterich | Geistlich Pharma AG

Microscopic Structure of Geistlich Mucograft®

Available sizes
> Rectangular matrix 15×20 mm
> Rectangular matrix 20×30 mm
> Geistlich Mucograft® Seal round matrix 8 mm

Treatment option
Can be used in submerged or open healing applications for soft tissue augmentation
> Gain of keratinized tissue¹-⁵
> Vestibuloplasty⁶-⁸
> Socket Seal⁹
> Recession Coverage¹⁰-¹⁸

Studies
Geistlich Mucograft® was clinically evaluated for augmentation of keratinized mucosa
> Around teeth¹-⁴
> Around implants or fixed prosthetic restorations¹,²
> Before implant placement⁵
> In vestibuloplasties with long-term follow-up⁶,⁷
> As socket seal after ridge preservation⁹
... where it was left for open-healing.
Geistlich Mucograft® is a predictable alternative to free gingival grafts.¹,²,⁴,⁶

Geistlich Mucograft® was also clinically evaluated for recessions
> In single recessions with coronally advanced flaps¹⁰-¹³
> In multiple recession coverage with coronally advanced flap¹⁴-¹⁸
... where it was used in a submerged situation. Geistlich Mucograft® is a predictable alternative to connective tissue grafts.¹¹,¹⁴

Composition
Reconstituted, native collagens type I and III. The compact structure is derived from native collagen, which permits suturing to the host mucosal margins and gives stability allowing open healing.
The underlying porous structure, which is specifically reconstituted from collagen fibers, allows tissue adherence favoring wound healing and supporting cell integration.

References Geistlich Mucograft®

In September 2017, Geistlich Pharma AG extended its soft tissue regeneration product portfolio. Geistlich's collagen experts developed a second 3-D collagen matrix named Geistlich Fibro-Gide®. But what are the differences between Geistlich Fibro-Gide® and Geistlich Mucograft®?

**Microscopic Structure of Geistlich Fibro-Gide®**

**Treatment option**
Can be used in submerged applications
> Gain of soft tissue volume around implants and under pontics¹

**Composition**
Reconstituted & cross-linked collagens type I and III. The spongious network of Geistlich Fibro-Gide® (indicated for submerged healing) allows angiogenesis, connective tissue formation and good volume stability of the collagen network.²⁻³

**Studies**
Clinical studies in the following indications are showing positive results:
> Soft tissue augmentation around implants after staged Guided Bone Regeneration³⁻⁵
> Soft tissue augmentation around implants together with Guided Bone Regeneration⁶

Geistlich Fibro-Gide® is proving to be a valuable alternative to autologous connective tissue grafts.³⁻⁵

**Available sizes**
> Rectangular matrix 15×20×6 mm
> Rectangular matrix 20×40×6 mm

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**References Geistlich Fibro-Gide®**
1 Instructions for Use. Geistlich Fibro-Gide®. Geistlich Pharma AG, Wolhusen, Switzerland

Disclaimer: Geistlich Fibro-Gide® is not available in every Country. Please contact your local distributor for further information.
Geistlich is the exclusive marketing partner for the innovative Yxoss CBR® titanium scaffold – a customized 3-D printed scaffold for major bone augmentations with particulate bone graft.

Major ridge deficiencies, especially vertical and combined defects, frequently require bone augmentation with a form-stable reinforcement, such as a form-stable membrane, titanium mesh, bone shield, bone blocks or the bony walls themselves in techniques such as interpositional grafting or distraction osteogenesis.

When increasing the bone more than 3.7 mm in combined defects, titanium meshes were also recommended in the last systematic review. The conventional titanium meshes are delivered as flat meshes which are then adapted to the defect intraoperatively. As all the other approaches these titanium meshes require a high level of surgical skills and their use is often time-consuming. Moreover, they are reported to be associated with a high risk for soft tissue dehiscences. However, using a space-making, form-stable grid or membrane offers several advantages, for example, the possibility of using particulate graft material and thus, avoiding time-consuming adaptation of block grafts to the defect morphology.

A customized 3-D printed solution
Unsatisfied with the disadvantages of the techniques available for major bone augmentation, about ten years ago Dr. Markus Seiler, Germany, envisioned a customized treatment of patients with complex alveolar ridge defects. Combining the advantages of titanium, 3-D imaging, planning tools and 3-D printing, Dr. Seiler’s company ReOss, Ltd. engineered and developed the 3-D printed, titanium-scaffold Yxoss CBR®. Today the 3-D printed Ti-grid Yxoss CBR® is being routinely used in his clinic and the innovation is now made available to the community of oral surgeons.

A new product in the Geistlich portfolio
Yxoss CBR® offers several advantages:

› Intuitive and customer-friendly online ordering system,
› Customized shapes for optimized defect fit,
› Opportunity for reduced surgery time,
› Smooth edges and surfaces to reduce the risk for soft tissue healing issues,
› Predefined breaking points for easy removal of the grid at the time of re-entry.

To date Yxoss CBR® is being used in clinics and several public hospitals across Germany, with more advocates daily. It fits the trend in digitalized clinical workflow perfectly and the aim of treating patients as individually as possible, while reducing morbidity and surgery time. In addition, Yxoss CBR® complements existing therapy solutions with Geistlich Bio-Oss® and Geistlich Bio-Gide®. That’s why Yxoss CBR® is now being exclusively marketed by Geistlich and officially introduced at the EAO in Madrid (2017).

References
FIG. 1: SURGICAL PROCEDURE
Clinical case kindly provided by Dr. Keyvan Sagheb und Dr. Eik Schiegnitz,
Department of Oral and Maxillofacial Surgery – Plastic Surgery University of Mainz

A | Situation showing the highly atrophied edentulous area. | B | CBCT scan of the defect showing the complex 3-dimensional defect configuration with a vertical component. | C | Modelling of the defect and elaborate design of Yxoss CBR®. | D | As a test, Yxoss CBR® is placed at the defect site and shows the high accuracy of the fit to the morphology. | E | Perforation of the corticalis to induce bleeding. | F | Filling of Yxoss CBR® with a mixture of Geistlich Bio-Oss® and autologous bone and optimal fit to the remaining bone. | G | Application of Geistlich Bio-Gide® to cover the defect site. | H | Primary wound closure with GoreTex suture. | I | Three-dimensional implant planning. | J | Re-entry 6 months after augmentation. Note the vital bone all the way up to the Yxoss CBR® scaffold without incorporation of Yxoss CBR® into the newly formed bone. | K | Implant placement in prosthetically correct situation. | L | Radiograph after implant placement. | M | Clinical situation after implant placement with final prosthetic restoration.
You just gave a presentation about Ridge Preservation here at the ITI World Symposium in Basel. When did you start using this technique?
Dr. Park: About five years ago. In the beginning I was skeptical: why should I preserve the ridge, if I could also wait and do implant placement with simultaneous GBR later on? But Ridge Preservation is a much less aggressive treatment compared to GBR and much more comfortable for patients. Also, recently I’ve come to believe that it is as much about soft tissue as hard tissue.

Under the label “Back to the Suture” you have an App and publish videos on YouTube. What’s your motivation?
Dr. Park: In my opinion, 50% of the success of a surgical treatment depends on the incision or flap design, the other 50% on the suturing. What you do in-between is much easier to learn. Many clinicians use the same suturing technique for everything, although there are better and more effective suturing techniques.

You use social media extensively for educational purposes...
Dr. Park: Yes. I am very dedicated to dental education, and I am trying to find the best way to deliver knowledge to my students. Nowadays it’s mobile devices and social media. I can create tiny bits of knowledge they can digest easily. Once I get their attention, it is easier to motivate them to learn more.

You work at the Dankook University in Cheonan. How many patients do you see in an average day?
Dr. Park: Between 25 and 30. You can see immediately why I am happy that my Open Healing Ridge Preservation shortens my chair time (laughs).

So, your work load does not leave very much room for research. On which topic would you like to do more research if you had more time?
Dr. Park: Dental stem cell research was one of my major interests. Now I do more clinical trials than bench-test research. Klaus Lang gave me very good advice during the Osteology Research Academy. He said, “Don’t waste your precious time with many studies; instead, do one, very good randomized clinical trial.” That’s what I am focusing on now.

Is there any time for hobbies?
Dr. Park (laughs): Like all Koreans I am an avid karaoke singer. And I like magic. I do lots of card and coin tricks for my kids. And somehow this also helps me with my lectures, because it’s all about surprise and misdirection and playing with the psychology of the audience. Everything is connected after all.

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Dr. Jung-Chul Park was awarded a PhD at the Yonsei University Dental College, Seoul, Korea in 2012 for his study of stem cells acquired from inflamed periodontal ligament. Also, he received the Andre Schroeder award in 2013 during his ITI scholarship at Eastman Dental Institute, London, UK. He is now Assistant Professor at the Department of Periodontology, Dankook University Dental College, Cheonan, Korea. He is also associate editor of the Journal of Periodontal and Implant Science, member of the Korean Dental Association and Academy of Periodontology, and author and co-author of several scientific publications and textbook chapters.
FOCUS
Minimally invasive approaches in regenerative dentistry

JOURNAL CLUB
Orthodontic treatments and biomaterials

OUT OF THE BOX
Regeneration of the retina with gene therapy

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