muco
derm®

3D-REGENERATIVE TISSUE GRAFT

Scientific basics and clinical cases
Periodontal surgery and soft tissue grafts

Importance of periodontal plastic surgery

The growing demand for aesthetic procedures has recently led to an increase in the importance of periodontal plastic surgery, resulting in the development of new surgical techniques and concepts. Gingival recessions as well as reductions of the mucosa around pontics/dental implants or the reduced width of the keratinized gingiva may have a significant impact on the patient’s aesthetics. Besides aesthetic reasons, several indications require the treatment of soft tissue deficiencies.

Clinical consequences of soft tissue reduction

Despite the ongoing debate about the meaning of keratinized gingiva, most scientists and clinicians agree that a sufficiently broad band of keratinized tissue exerts a positive effect on the tooth health and long-term prognosis of dental implants. Not only the attached gingiva does provide protection against mechanical traumas, it also acts as a barrier against the penetration of bacteria and food particles. Studies have demonstrated that a reduction in the width of the keratinized gingiva is associated with an increased risk of infections, loss of attachment, and higher plaque accumulation. Such situations may favor gingival recessions, which in turn may lead to hypersensitivity of tooth roots, root caries, and, at worst, tooth loss.

Mucosal- and connective tissue grafts

Today, modern techniques of the plastic-aesthetic periodontal surgery ensure a satisfactory regeneration of soft tissue deficiencies in the majority of cases. Free mucosal- and subepithelial connective tissue grafts, both commonly harvested from the palate, are frequently used. Despite their clinical success, their use is associated with significant disadvantages. For instance, when harvesting autologous tissue a second surgical site is created, which may result in increased post-operative pain as well as a higher risk of infections and complications. In addition, the quality of the harvested tissue varies from patient to patient, and its limited availability may be an issue, particularly for the correction of larger soft tissue defects or multiple recessions.

In order to overcome these issues, allogenic and xenogenic acellular collagen matrices have been developed. mucoderm® is a xenogenic matrix produced by botiss that offers a valid alternative to autologous soft tissue grafts.
mucoderm®
3D-regenerative tissue graft

mucoderm® is a natural, non-cross-linked tissue matrix, consisting of collagen type I and III and strongly resembling the native structure of the human dermis. In a natural enzymatic process mucoderm® is integrated into the surrounding tissue and replaced by the patient’s own connective tissue. The natural collagen network of mucoderm® that results from the multistep purification process acts as a scaffold for soft tissue cells and blood vessels.

During the healing process, mucoderm® is vascularized and integrated into the surrounding tissue. For a broad range of indications mucoderm® serves as a safe alternative to autologous connective tissue grafts.

Natural, three-dimensional collagen structure
The mucoderm® matrix is made of pure porcine collagen without any artificial/chemical cross-linking. Scanning electron microscopic pictures of mucoderm® show its rough and open-porous collagen network that acts as a guiding structure for soft tissue cells and blood vessels.

Properties
- Native collagen matrix
- Fast vascularization and integration
- Soft tissue graft avoiding the need for autograft harvesting
- Complete remodeling into patient’s own tissue in ~six to nine months
- Rapid hydration
- Easy handling
- Thickness ~1.2 to 1.7 mm

Handling of the mucoderm®
General product handling

HYDRATION
A sufficiently long hydration of mucoderm® prior to application is necessary. Hydration should be performed in a sterile saline solution or blood for five to 20 minutes, depending on the technique used and the desired flexibility of the matrix—the flexibility of the mucoderm® graft increases with hydration time.

TRIMMING
The size and shape of the matrix should be adapted to the size of the defect. After hydration, mucoderm® can be easily trimmed to the desired size with a scalpel or scissors. Rounding off the edges following brief hydration of the matrix can prevent a perforation of the gingival tissue during flap closure.

For the coverage of multi-recession defects, the surface of mucoderm® can be extended by cutting the matrix on alternating sides (mesh-graft technique) and pulling it.

EXPOSURE
mucoderm® should only be left for open healing, if a revitalization from the surrounding or underlying wound bed is ensured. Exposure should always be avoided when used for recession coverage. Open healing is feasible in the case of a vestibuloplasty, if mucoderm® is sutured to the periosteum.

HANDLING TIPS
- Hydration from five to 20 minutes
- Trimming use a scalpel or scissors to cut to desired shape
- Exposure mucoderm® should only be left for open healing, if a revitalization from the surrounding or underlying wound bed is ensured
- Fixation suturing of mucoderm® helps to prevent micromovements

FIXATION
When a split-thickness flap is used, a close contact between the periosteal wound bed and the immobilized mucoderm® matrix should be ensured by suturing the matrix to the intact periosteum using single-interrupted- or crossed sutures.

SUTURING
A tension-free flap closure is always recommended.
mucoderm® is characterized by an open porous collagen structure

Visualization of the open porous collagen structure of mucoderm® by the innovative synchrotron-based x-ray tomography².

The unique structure of the matrix strongly resembles that of the human dermis and supports the ingrowth of cells and blood vessels, thereby promoting a fast tissue integration of mucoderm®.

Biocompatibility proved by MTT in vitro viability assay³

The viability assay confirmed the high biocompatibility of the mucoderm® three-dimensional collagen matrix in vitro.

The MTT test demonstrated a significantly higher viability of gingival fibroblasts, endothelial cells, and osteoblasts on mucoderm® compared to the control at day six in vitro (p<0.05).

In vitro testing

Gingival Fibroblasts on mucoderm®
HMEC cells on mucoderm®
Osteoblasts on mucoderm®

Biomechanics and hydration of mucoderm®

The hydration protocol and its influence on the biomechanical properties of mucoderm® were analyzed in a study of Prof. Dr. Adrian Kasaj⁴. mucoderm® demonstrated optimal mechanical properties after ten to 20 minutes hydration. A rehydration in blood can improve the biomechanical properties of mucoderm®. Notably, prolonged hydration (30 to 60 minutes) showed only minor effects on the biomechanical properties of the collagen matrix.

After only two weeks, mucoderm® showed an extensive ingrowth of blood vessels as well as an inflammation-free healing with superficial cell invasion. In the following four to eight weeks, a continuous degradation with an increasing homogeneous cell distribution can be observed. After eight weeks, 20% of the original matrix volume remained as scaffold for the formation and reorganization of connective tissue.

After 12 weeks, mucoderm® was almost completely replaced by newly formed connective tissue (please note that a period of one month in rats corresponds to approximately three months in humans).

Tissue integration and degradation of mucoderm®

Results from Prof. Dr. Dr. Daniel Rothamel after subcutaneous implantation of mucoderm® in rats²

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Application of mucoderm® in plastic-aesthetic periodontal surgery

Gingival recessions are not only an aesthetic issue. They can also lead to clinical problems, such as root hypersensitivity, cervical root caries, and root abrasion. Today, autologous connective tissue grafts are considered the “gold standard” for the treatment of periodontal recessions; however, harvesting is often associated with pain and discomfort for the patient. The application of a regenerative tissue graft avoids autologous connective tissue harvesting, thereby enhancing the patient’s acceptance for a surgical procedure.

The correct application and handling of the graft material is a prerequisite for aesthetically optimal, clinical results.

The following application guidelines, based on clinical results, have been developed together with Prof. Dr. Adrian Kasaj, specialist for Periodontology at the Department of Operative Dentistry and Periodontology at the University of Mainz.

Selection of patients
mucoderm® offers a safe and effective alternative for covering recession defects, especially when patients do not agree to undergo palatal autograft harvesting. Nevertheless, expectations concerning the clinical and aesthetic outcome of the surgery should be carefully considered and discussed with the patient. Compliance with the post-operative treatment plan, as well as an unimpaired or controlled state of health, are indispensable for a successful treatment.

Product Specifications
Regardless of the applied technique, the clinical success of the treatment of Miller class I/II defects is more predictable than that of class III/IV defects. In principle, a complete recession coverage can only be obtained for Miller class I/II defects. Likewise, the predictability and success rate for the treatment of defects in the maxilla are higher than those of mandibular defects. mucoderm® can be used in combination with all mucogingival surgical techniques, including the coronally advanced flap, envelope technique, and tunnel techniques.

Post-operative treatment
After surgery it is necessary to avoid any mechanical trauma of the treated site. Patients should be instructed not to brush their teeth at the respective side for four weeks following surgery. Plaque accumulation can be prevented by rinsing with a 0.2% chlorhexidine solution. Post-operatively, the patient should be recalled weekly for plaque control and healing evaluation.

CLINICAL CASE BY
Prof. Dr. Dr. Adrian Kasaj, University of Mainz, Germany

RECESSION COVERAGE WITH THE MODIFIED CORONALLY ADVANCED FLAP TECHNIQUE (ZUCCHELLI TECHNIQUE)

- Contact of mucoderm® with the periosteal wound bed and immobilization should be ensured by suturing the matrix to the periosteum using single-interrupted- or crossed sutures
- Rounding off the edges of a briefly hydrated matrix prevents damage of the gingival tissue during flap closure

CLINICAL APPLICATION OF MUCODERM®
**Clinical Situation at Three Months:** Significant root coverage and increased thickness of marginal tissue.

The flap is repositioned over the mucoderm® and sutured.

 Gonzalez recession at tooth 13 before the treatment with mucoderm®; previous surgery with FGG is visible.

**Handling Tips**
- For the tunnel technique, a prolonged hydration of mucoderm® is recommended (ten to 20 minutes).
- Fixation of the matrix can be done with single interrupted or cross-sutures.

**Handling Tips**
- Exposure of mucoderm® should always be avoided in the treatment of gingival recessions. Make sure that the repositioned flap completely covers the mucoderm® matrix. Achieving primary closure over the mucoderm® allows blood vessels to penetrate and incorporate the soft tissue graft material. Early exposure may lead to soft tissue graft failure.

**Clinical View Before Treatment**
- Preparation of roots by scaling and planning with sonic scaler.
- Conditioning of roots with 24% EDTA gel for two minutes.
- Sulcular incisions around teeth 22 to 25; a partial-thickness dissection by undermining the papillae using tunneling instruments.

**Handling Tips**
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- Fixation of the matrix can be done with single interrupted or cross-sutures.

**Handling Tips**
- Exposure of mucoderm® should always be avoided in the treatment of gingival recessions. Make sure that the repositioned flap completely covers the mucoderm® matrix. Achieving primary closure over the mucoderm® allows blood vessels to penetrate and incorporate the soft tissue graft material. Early exposure may lead to soft tissue graft failure.
COVERING OF MULTIPLE RECESSIONS IN THE LOWER JAW WITH THE MODIFIED TUNNEL TECHNIQUE AND MUCODERM®

Clinical situation before surgery: multiple recessions

Using a microsurgical blade and tunneling knives, mucoperiosteal flaps were raised beyond the mucogingival junction at each involved tooth.

Hydration of mucoderm® for about five minutes in sterile saline or blood and adapting its shape according to the width of the recession defects.

For a tension-free coronal movement of the flap all muscle insertions and collagen fibres were cut. Mucoderm® is pulled into the tunnel by mattress sutures and fixed to the inner aspect of the flap.

Mucoderm® was fixed at the CEJ of each treated tooth by means of sling sutures. The tunnel flap was moved coronally and fixed by sling sutures, to cover completely the mucoderm® matrix.

Stable clinical situation at 24 months post-surgery.

CLINICAL CASE BY
Prof. Dr. Dr. Adrian Kasaj, University of Mainz, Germany

RECESSION COVERAGE WITH THE CORONALLY ADVANCED FLAP TECHNIQUE
IN COMBINATION WITH MUCODERM® AND STRAUMANN® EMDOGAIN®

Initial situation with recessions at teeth 13 and 14

Lateral view of baseline situation

Root surface conditioning with 24% EDTA gel

Preparation of a flap with vertical releasing incisions

Application of Straumann® Emdogain® to the root surface

Hydrated mucoderm® cut-to-shape, adapted to the donor bed, and sutured to the periosteum

Coronal repositioning and suturing of the flap over mucoderm® and the roots

Healing after six weeks

Clinical situation three months post-operative

Clinical situation three months post-operative, lateral view

Multiple gingival recessions at teeth 21, 22 and 23 prior to surgery

Sulcular incision from teeth 21 to 23

Preparation of a split-full-split thickness flap and de-epithelialization of the anatomical papillae

Application of Emdogain® to the conditioned root surfaces

Adaptation of the hydrated and cut-to-shape mucoderm®, and suturing to the periosteum

Repositioning of the flap over mucoderm® and the root surface

Wound closure, occlusal view

Healing four weeks after surgery

Clinical situation eight weeks post-operative

Satisfactory coverage of the roots and thickening of the marginal gingiva, nine months post-operative

Handling Tip
Emdogain® can be directly applied to the tooth roots and then covered with mucoderm®. Alternatively, mucoderm® may be coated with Emdogain® prior to application.

ATTACHED GINGIVA—protection of teeth and implants

Under healthy conditions, the teeth are lined by a band of attached gingiva of about five millimeters in width, which is anchored to the underlying alveolar bone and cementum through connective tissue fibers. This particular arrangement creates a barrier around the teeth, protecting the tooth roots against penetration of bacteria and food particles.

Moreover, the attached gingiva reduces the mechanical strain from the lip-, cheek-, and mimic muscles, shielding the teeth from the strain. A reduction or lack of attached gingiva may cause root recessions and inflammation (periodontitis), which may lead to bone resorption and tooth loss. Likewise, a sufficient width of the attached gingiva around the dental implants may improve their survival by facilitating the plaque control in the peri-implant area and preventing recessions at the implant. In particular, prior to or immediately after implant placement, an augmentation of the attached gingiva is indicated.

AUGMENTATION OF THE ATTACHED GINGIVA

The current standard technique to widen the attached gingiva is the vestibuloplasty, which is performed in combination with a free mucosal graft7. Following the preparation of a mucosal flap, the soft tissue graft is fixed to the exposed periosteum (donor bed) and left for open healing.

- However, the harvesting of the graft presents additional stress for the patient and may cause further post-operative discomfort, an increased risk of swelling, post-operative bleeding, paraesthesia, and inflammation8. In some cases, post-operative discomfort may persist for several weeks.

- The application of a xenogenic collagen matrix, such as mucoderm®, can avoid the painful harvesting procedure and consequently increase the patient’s acceptance of the treatment plan.

APPLICATION OF MUCODERM®

IN PLACE OF A FREE MUCOSAL GRAFT

The mucoderm® matrix may be applied instead of a free mucosal graft for the coverage of the prepared donor bed during vestibuloplasty. Following hydration and shaping, the matrix is adapted to the periosteum and fixed with sutures.

- A close contact between the periosteum and mucoderm® is essential to ensure fast integration and revitalization of the matrix by the ingrowth of blood vessels and cells. Mucoderm® serves as a scaffold for the formation of connective tissue and is completely remodeled into the patient’s own tissue within weeks following surgery.

RESULTS FROM A CLINICAL STUDY

Dr. Dr. Andres Stricker, Konstanz, Germany9

Dr. Dr. Andres Stricker investigated the efficiency of mucoderm® for the augmentation of keratinized peri-implant gingiva. The width of the keratinized gingiva as well as the health of the peri-implant tissue and the patient morbidity were assessed up to 12 months post-operative.

At six months post-operative, a significant widening of the attached gingiva and improved health of the peri-implant tissue were observed. The clinical situation was stable and could be confirmed after 12 months.
CLINICAL CASE BY Dr. Attila Horváth, Semmelweis University, Budapest, Hungary

TREATMENT WITH MUCODERM® TO INCREASE THE PERI-IMPLANT KERATINIZED MUCOSA

Lack of sufficient keratinized mucosa is visible as a result of considerable horizontal ridge augmentation.

The split-thickness flap was prepared; the buccal peri-implant mobile mucosa was positioned apically, creating an immobile periosteal recipient bed.

The xenogenic dermal matrix (mucoderm®) was trimmed and rehydrated in sterile saline.

mucoderm® was immobilized with modified deep periosteal and superficial mattress sutures to attain a tight contact to the periosteum.

No allergy, rejection, suppuration, or ulceration were detected; following maturation of the graft, three Straumann SLActive® implants were inserted according to the prosthetic indication.

Sufficient peri-implant keratinized mucosa and deep vestibulum were achieved around all implants.

Six months after insertion of the xenogenic dermal matrix, the new peri-implant keratinized mucosa showed matured and stable properties.

CLINICAL CASE BY Dr. Bálint Mólnar and Prof. Dr. Péter Windisch, University of Budapest, Hungary

AUGMENTATION OF THE ATTACHED GINGIVA WITH MUCODERM®

Full arch reconstruction of insufficient vestibular depth and lack of keratinized tissues. Application of mucoderm® with an apically repositioned split thickness flap.

Insufficient keratinized mucosa and extremely shallow vestibulum on the edentulous maxilla following bilateral sinus floor elevation and horizontal GBR therapy.

Apically repositioned flap by palatal incision along the maxilla. Split-thickness flap preparation with an intact periosteal layer over the augmented bone.

mucoderm® fixed to the periosteum with single and cross-sutures.

Clinical situation one week post-operative: secondary epithelization and newly formed capillary vessels detectable.

Two weeks post-operative: secondary healing continued over mucoderm® treated areas, remaining sutures were removed.

Clinical situation four weeks post-operative: secondary healing completed.

Clinical situation six months post-operative: excellent tissue maturation, favourable color and thickness of the newly formed soft tissue around the implants.

**RIDGE AUGMENTATION AND LATER SOFT TISSUE AUGMENTATION WITH MUCODERM®**

- CBCT planning for navigated implantology
- Modified “sausage technique”: Horizontal ridge augmentation (GBR) with a combination of autologous bone particles and cera-bone® covered with Jason® membrane and fixed by resorbable periosteal sutures
- Newly formed mandibular ridge at the time of the re-entry
- Periosteum closed over the submerged implants and covered with mucoderm®, flap is sutured to the dermal matrix (6/0 monofil sutures), mucoderm® partially left uncovered
- Gingival contour five months after implant placement; sufficient amount of keratinized gingiva around implants
- Periosteum closed over the submerged implants and covered with mucoderm®, flap is sutured to the dermal matrix (6/0 monofil sutures), mucoderm® partially left uncovered

**CLINICAL CASE BY**
Dr. Dávid Botond Hangyási, Dentalstory Private Practice, Hódmezővásárhely, and University of Hódmezővásárhely-Szeged, Hungary

**GBR AND SIMULTANEOUS SOFT TISSUE AUGMENTATION WITH MUCODERM®**

- Clinical situation before surgery, vestibular view
- Clinical situation before surgery, occlusal view
- Situation after implant placement, demonstrating a buccal defect
- Augmentation with maxresorb® and covering with a non-resorbable PTFE membrane

**CLINICAL CASE BY**
Dr. Stefan Scherg, Karlstadt, Germany

- Fixation of the membrane with titanium pins
- Soft tissue thickening of the buccal side with mucoderm® and recession treatment of tooth 23
- Additional placement of mucoderm®, crestally and lingually
- Fixation of mucoderm® and suturing of the flap

- Implant exposure and membrane removal four months post-operative
- Abutment insertion
- New soft tissue augmentation with mucoderm®
- Wound closure and mounting of provisional prosthesis
- Situation after long-term healing with provisional prosthesis
- Final restoration 15 months after implant placement and stable root coverage of tooth 23 and stability of root coverage in region 23
- Final restoration 15 months after implant placement
- X-ray control 15 months post-operative
Periimplant soft tissue thickening

Studies have shown that the initial thickness of the mucosa plays an important role in the etiology of early bone loss around dental implants\(^{11}\). It has been demonstrated that a thickness of 2 mm or less increases the risk of crestal bone lack.

In order to prevent bone loss and to improve the long-term stability of dental implants, it is recommended to thicken the periimplant soft tissue in cases of thin gingiva biotypes. Soft tissue thickening can be performed prior or simultaneously to implant placement. The application of a xenogenic soft tissue matrix, such as mucoderm\(^{\circledR}\), helps to avoid soft tissue harvesting from the palate. For simultaneous implant placement and soft tissue augmentation, mucoderm\(^{\circledR}\) can be applied as a “poncho” over the healing cap. In that indication, mucoderm\(^{\circledR}\) should be covered by vital tissue (flap) to guarantee revitalization of the matrix by ingrowing cells and blood vessels. Prevention of tension is crucial for a complication-free wound healing.

**mucoderm\(^{\circledR}\) for the thickening of periimplant soft tissue**

**MUCOSAL THICKENING AROUND BONE LEVEL IMPLANTS\(^{12}\)**

**CLINICAL CASE BY**

Dr. Algirdas Puisys, Vilnius, Lithuania

- Periimplant soft tissue thickening
- Bone preparation for Straumann\(^{\circledR}\) Bone Level implant placement
- Implant insertion and contouring crestal bone with a straight handpiece
- Hydrated mucoderm\(^{\circledR}\) perforated and pulled over the healing cap
- The margins of the flap are adapted and sutured leaving the abutment open
- Situation after suture removal, one week post-operative
- Wider healing abutment after four months
- Smooth emergence profile visible after removal of the healing abutment
- Final restoration five months post-operative
- Stable clinical situation after five years

**Indications for mucoderm\(^{\circledR}\)**

mucoderm\(^{\circledR}\) is indicated for guided tissue regeneration procedures as well as for periodontal and recession defects for periodontal plastic surgery.

It can be used in conjunction with:
- Coronally advanced flap technique
- Laterally advanced flap technique
- Envelope technique
- Tunnel technique

**PERIODONTOLOGY**

mucoderm\(^{\circledR}\) is indicated for:

- Guided tissue regeneration procedures
- Periodontal and recession defects
- Periodontal plastic surgery

It can be used in conjunction with:
- Coronally advanced flap technique
- Laterally advanced flap technique
- Envelope technique
- Tunnel technique

**Implantology, Oral Surgery and CMF**

- Soft tissue augmentation in combination with GBR
- Widening of the attached gingiva
- Closing of extraction sockets (socket seal technique)
- Thickening of the periimplant soft tissue

**Product Specifications**

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