mucoderm®
3D-regenerative tissue graft
Scientific basics and clinical cases

soft tissue

native
stable
three-dimensional
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. Beside 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 doctors 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 does the attached gingiva provide protection against mechanical traumas, but 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. Moreover, such situations may be a cause of 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 rehydration
- Easy handling
- Thickness ~1.2 to 1.7 mm

 Handling Tips

Handling of the mucoderm®
General product handling

Rehydration
A sufficiently long rehydration of mucoderm® prior to application is necessary. Rehydration 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 rehydration time.

Trimming
The size and shape of the matrix should be adapted to the size of the defect. After rehydration, mucoderm® can be easily trimmed to the desired size with a scalpel or scissors. Cutting or rounding the edges of the matrix after a brief rehydration can prevent the perforation of the gingival tissue during the flap closure.

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.

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 closure is recommended for flaps.
Scientific results

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 tomography.

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

The viability assay proved the high biocompatibility of the mucoderm® three-dimensional collagen matrix.

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

Scientific results

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In vitro testing

MTT assay gingival fibroblasts

MTT assay endothelial cells

MTT assay osteoblasts

Gingival fibroblasts on mucoderm®

HUVEC cells on mucoderm®

Osteoblasts on mucoderm®

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

After only two weeks, mucoderm® shows 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 increasingly homogeneous cell distribution can be observed. After eight weeks, 20% of the original matrix volume remain available as a scaffold for the formation and reorganization of connective tissue.

After 12 weeks, mucoderm® is 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®

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

Biomechanics and rehydration of mucoderm®

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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 a cause of further discomfort to 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 the coverage of 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 the success of the treatment.

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 as compared to those of mandibular defects. mucoderm® can be used in combination with all mucogingival surgery techniques, including the coronally advanced flap 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 the 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)

Potential benefits of mucoderm® are:
- Significant coverage of the roots
- Increased thickness of the marginal tissue
- Enhanced acceptance for surgical procedures

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

Product Specifications
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Handling Tips
- for the tunnel technique a prolonged rehydration of the mucoderm® is recommended (ten to 20 minutes)
- fixation of the matrix can be done with single button-interrupted or cross-sutures

Clinical situation three months after treatment: significant root coverage and increased thickness of marginal tissue

The flap is repositioned over the mucoderm® matrix and sutured

Gingival recession at tooth 13 before the treatment with mucoderm®; FST of a previous surgery for root coverage visible

mucoderm® is rehydrated and cut to shape for placement over the root

A subepithelial pouch is prepared by a partial thickness incision; mucoderm® is placed in the pouch

After the positioning of mucoderm®, the flap is fixed to completely cover the graft

Clinical situation three months after treatment: significant root coverage and increased thickness of marginal tissue

Situation after gingival plastic for leveling of the FST

Rehydrated and trimmed mucoderm® is checked to fit into the defect; mucoderm® is placed over the roots by pulling it through the tissue tunnel

Handling Tips
- Exposure of the mucoderm® matrix 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® graft 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 Case by**

Dr. Raluca Cosgarea, University of Marburg, Germany and Prof. Dr. Dr. Anton Sculean, University of Bern, Switzerland

Using a microsurgical blade and tunneling knives, mucoperiosteal flaps were raised beyond the mucogingival junction at each involved tooth. Rehydration of mucoderm® for about five minutes in sterile saline or blood and adapting its shape according to the width of the recession defects. 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 the mucoderm® matrix completely.

Stable clinical situation at 24 months post-surgery.
Recession coverage with a coronally advanced flap technique in combination with mucoderm® and Straumann® Emdogain®

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 absorbs 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 an implantation, 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 graft. 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 an additional stress for the patient and may cause further post-operative discomfort, an increased risk of swelling, post-operative bleeding, paresthesia, and inflammation. 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 a vestibuloplasty. Following rehydration 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 a 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.

Augmentation of the attached gingiva with mucoderm®

Results from a clinical study

Dr. Dr. Andres Stricker, Konstanz, Germany

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-operatively.

Six months post-operatively, 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.

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Treatment with mucoderm® to increase the peri-implant keratinized mucosa

Lack of sufficiently 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 situation one week post-operative: Secondary epithelization and newly formed capillary vessels detectable.

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.

Fixation of the buccal flap to the exposed periosteum deep in the vestibular fold. Fixation of mucoderm® with resorbable monofilament (Monolac) single and cross-typed sutures.

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

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 APPLICATION OF MUCODERM®

CLINICAL CASE BY
Dr. Attila Horváth, Semmelweis University, 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 design.
CBCT planning for navigated implantology

Modified “sausage technique”: Horizontal ridge augmentation (GBR) with a combination of autologous bone particles and cerabone® covered with Jason® membrane and fixed by resorbable periosteal sutures

Pre-operative clinical view of the surgical site

Mandibula ridge found to be thinner than expected; placing the implants is not feasible

Post-operative clinical view six months after GBR

Newly generated mandibular ridge at the time of the re-entry

Flap closure with 6/0 monofil continuous sling sutures

Appropriate amount of bone for standard-size implants

Thick mucoderm® (~three millimeters) ready for gingival augmentation

Clinical view three weeks after the second surgery

Gingival contour five months after implantation; 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 situation before surgery, vestibular view

Clinical situation before surgery, crestal view

Situation after implantation, demonstrating a buccal defect

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

Implant exposure and membrane removal four months post-operative

Abutment insertion

A new soft tissue augmentation with mucoderm®

Wound closure and mounting of provisional prosthesis

Situation after long-term healing with provisional prosthesis

Definite restoration 15 months after implantation and stability of root coverage in region 23

Definite restoration 15 months after implantation

X-ray control 15 months post-operative

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

Ridge augmentation with later soft tissue augmentation with mucoderm®

CLINICAL APPLICATION OF MUCODERM®

CLINICAL CASE BY
Dr. Stefan Scherg, Karlstadt, Germany

GBR and simultaneous soft tissue augmentation with mucoderm®

CLINICAL APPLICATION OF MUCODERM®
Studies have shown that the initial thickness of the mucosa plays an important role in the etiology of early bone loss around dental implants. 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 xenogeneic soft tissue matrix, such as mucoderm®, helps to avoid soft tissue harvesting from the palate. For simultaneous implant placement and soft tissue augmentation, mucoderm® can be applied as a “poncho” over the healing cap. In that indication, mucoderm® should be covered by vital tissue (flap) to guarantee the revitalization of the matrix by ingrowing cells and blood vessels. Prevention of tension is crucial for a complication-free wound healing.

**mucoderm®** for the thickening of periimplant soft tissue mucosal thickening around bone level implants

**CLINICAL CASE BY**

Dr. Algirdas Puisys, Vilnius, Lithuania

Incision in the center of the edentulous ridge and raising a full-thickness flap buccally and lingually

Bone preparation for Straumann® Bone Level implant placement

Implant insertion and contouring crestal bone with a straight handpiece

Rehydrated mucoderm® perforated and pulled over the healing cap

The margins of the flap are adapted and sutured leaving the abutment open

Situation one week post-operatively and after suture removal

Wider healing abutment after four months

Smooth emergence profile visible after the removal of the healing abutment

Final restoration five months post-operatively

Stable clinical situation after five years

**Indications for mucoderm®**

- Periodontology
  - mucoderm® is indicated for guided tissue regeneration procedures and for periodontal plastic surgery
  - 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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**References**


Innovation.
Regeneration.
Aesthetics.

soft tissue

education

hard tissue

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