Pre-clinical \textit{(in vitro \& in vivo)} studies

   

   The present study evaluated the effect of an enamel matrix derivative (EMD) and platelet-rich fibrin (PRF)-modified porcine-derived collagen matrix (PDCM) on human umbilical vein endothelial cells (HUVEC) in vitro.

   MATERIALS AND METHODS: PDCM (mucoderm®) was prepared to 6 mm (±0.1 mm) diameter discs. PDCM samples were incubated with either EMD, PRF, or control solutions for 100 min at 4 °C before the experiments. Cell-inducing properties of test materials on HUVEC cells were tested with cell proliferation assays (MTT, PrestoBlue®), a cytotoxicity assay (ToxiLight®), a Boyden chamber migration assay, and a cell attachment assay. Scanning electron microscopy (SEM) imaging was performed to determine the surface and the architecture of the modified matrices.

   RESULTS: Cell proliferation was elevated in the EMD and PRF groups compared with control (p each ≤0.046). PRF modification increased HUVEC migration ability by 8-fold compared with both control and EMD groups (p each <0.001). Both treatments significantly promoted the cell attachment of HUVEC to PDCM, as assessed by direct cell counts on the matrices (p each <0.001).

   CONCLUSIONS: HUVEC cell characteristics were overall improved by EMD- and PRF- modified PDCM. Adsorbed bioactive molecules to the PDCM surface may have contributed to a more preferable environment to surrounding cells.

   2. Three-dimensional scanning electron microscopy of maxillofacial biomaterials.
   

   Report on a method of 3-dimensional scanning electron microscopy (3D-SEM) to visualize maxillofacial biomaterials. 3D visualization of mucoderm®, Mucograft®, and maxgraft®.
3. **Comparison of Two Porcine Collagen Membranes Combined with rhBMP-2 and rhBMP-9 on Osteoblast Behavior in vitro.**

Investigation of bone-inducing properties of two types of collagen membranes in combination with recombinant human bone morphogenetic protein (rhBMP)-2 and rhBMP-9 on osteoblast behavior.

**MATERIALS AND METHODS:** Porcine pericardium collagen membranes (PPCM) and porcine dermis-derived collagen membranes (PDCM) were coated with either rhBMP-2 or rhBMP-9. The adsorption and release abilities were first investigated via enzyme-linked immunosorbent assay up to 10 days. Moreover, murine bone stromal ST2 cell adhesion, proliferation, and osteoblast differentiation were assessed by MTS assay; real-time polymerase chain reaction for genes encoding runt-related transcription factor 2 (Runx2); alkaline phosphatase (ALP); and osteocalcin, ALP assay, and alizarin red staining.

**RESULTS:** Both rhBMP-2 and rhBMP-9 adsorbed to collagen membranes and were gradually released over time up to 10 days. PPCM showed significantly less cell attachment, whereas PDCM demonstrated comparable cell attachment with the control tissue culture plastic at 8 hours. While both rhBMPs were shown not to affect cell proliferation, collagen membranes combined with rhBMP-9 significantly increased ALP activity at 7 days and ALP mRNA levels at either 3 or 14 days compared with the control tissue culture plastic. Furthermore, rhBMP-9 increased osteocalcin mRNA levels and alizarin red staining at 14 days compared with the control tissue culture plastic.

**CONCLUSION:** The results from this study suggest that both porcine-derived collagen membranes combined with rhBMP-9 accelerated the osteopromotive potential of ST2 cells. Interestingly, rhBMP-9 demonstrated additional osteogenic differentiation compared with rhBMP-2 and may serve as a suitable growth factor for future clinical use.

4. **Healing of localized gingival recessions treated with a coronally advanced flap alone or combined with an enamel matrix derivative and a porcine acellular dermal matrix: a preclinical study.**
This study aimed to evaluate the effects of a porcine acellular dermal matrix (PADM) with or without an enamel matrix derivative (EMD) on gingival recession defects treated with a coronally advanced flap (CAF) in dogs.

MATERIALS AND METHODS: Miller class II gingival recession defects (5 mm wide and 7 mm deep) were surgically created on the labial side of bilateral maxillary canines in 12 dogs. After 8 weeks of plaque accumulation, the 24 chronic defects were randomly assigned to one of the following 4 treatments: CAF, CAF with PADM (CAF/PADM), CAF with EMD (CAF/EMD), and CAF with EMD and PADM (CAF/EMD/PADM). The animals were sacrificed 10 weeks after surgery for histologic evaluation.

RESULTS: In all groups, root coverage was obtained to a varying degree. PADM was well incorporated in gingival connective tissue in the CAF/PADM and in the CAF/EMD/PADM groups. The height of newly formed bone was significantly greater in the CAF/EMD/PADM group than in the CAF and CAF/PADM groups. New cementum with periodontal ligament-like tissue was predominantly found in the CAF/EMD and CAF/EMD/PADM groups. The CAF/EMD/PADM group showed the greatest amount of new cementum among the groups examined, although the difference was not statistically significant.

CONCLUSION: Within the limitations of the present study, it can be concluded that CAF/EMD/PADM treatment may promote periodontal regeneration in gingival recession defects.

CLINICAL RELEVANCE: The present results suggest that the combination of EMD and PADM in conjunction with CAF may represent a promising approach for treating single Miller class II gingival recessions.

5. The influence of various rehydration protocols on biomechanical properties of different acellular tissue matrices.


This study evaluated the influence of different rehydration media and time-periods on biomechanical and structural properties of different acellular collagen matrices (ACMs).

MATERIALS AND METHODS: Specimens of three ACMs (mucoderm®, Mucograft®, Dynamatrix®) were rehydrated in saline solution (SS) or human blood for different time-periods (5 - 60 min). ACMs under dry condition served as controls. Biomechanical properties of the ACMs before and after different rehydration periods were determined by means of tensile testing. ACMs properties were further characterized using Fourier transform-infrared-spectroscopy (FTIR) and different scanning calorimetry.

RESULTS: At dry conditions, mucoderm® presented the highest tensile strength (TS), whereas Dynamatrix® showed the maximum elastic modulus (EM, p each ≤ 0.036). Rehydration in SS and blood resulted in significant TS changes of mucoderm® (p each ≤ 0.05). Concerning EM, mucograft® showed significantly decreased values after rehydration in SS compared to Dynamatrix® and mucoderm® after
10 min (p each ≤ 0.024). mucoderm® hydrated for 5 min in blood displayed nearly double TS and a significantly increased EM after 60 min (p = 0.043) compared to rehydration in SS. TS and EM values of Dynamatrix® and Mucograft® were not altered following rehydration in blood versus saline solution (p each ≥ 0.053). FTIR analysis confirmed the recovery of the graft protein backbone with increased rehydration in all samples. DSC measurements revealed that tissue hydration decreased thermal stability of the investigated ACMs.

CONCLUSION: Our findings demonstrated that the rehydration protocol affects the biomechanical properties of ACMs.

CLINICAL RELEVANCE: Clinicians should be aware of altered handling and mechanical properties of ACMs following different rehydration protocols.


Here, we studied the ability of two collagen membranes and a collagen matrix to adsorb the activity intrinsic to enamel matrix derivative that provokes transforming growth factor-beta (TGF-β) signaling in oral fibroblasts.

MATERIAL AND METHODS: Three commercially available collagen products were exposed to enamel matrix derivative or recombinant TGF-β1, followed by vigorous washing. Oral fibroblasts were then either seeded directly onto the collagen products or were incubated with the respective supernatant. The expression of the TGF-β target genes interleukin 11 and proteoglycan 4 was evaluated by real time PCR. To study the fraction of enamel matrix derivative proteins binding to collagen, we used proteomic analysis.

RESULTS: Enamel matrix derivative or TGF-β1 provoked a significant increase of interleukin 11 and proteoglycan 4 expression of oral fibroblasts when seeded onto the collagen products and when incubated with the respective supernatant. Gene expression was blocked by the TGF-β receptor I kinase inhibitor SB431542. Amelogenin bound most abundantly to gelatin coated culture dishes. Incubation of palatal fibroblasts with recombinant amelogenin, however, did not alter expression of interleukin 11 and proteoglycan 4.

CONCLUSIONS: These in vitro findings suggest that collagen products adsorb a TGF-β receptor I kinase-dependent activity of enamel matrix derivative and make it available for potential target cells.
7. Soft tissue volume alterations after connective tissue grafting at teeth: the subepithelial autologous connective tissue graft versus a porcine collagen matrix - a pre-clinical volumetric analysis.


This study evaluates a porcine collagen matrix (CM) for soft tissue thickening in comparison to the subepithelial connective tissue graft (SCTG).

MATERIAL AND METHODS: In eight beagle dogs, soft tissue thickening was performed at the buccal aspects of the upper canines (SCTG and CM). Impressions were taken before augmentation (i1), after surgery (i2), after one (i3), three (i4) and ten month (i5). Casts were optically scanned with a 3D scanner. Each augmented region (unit of analysis) evaluated (primary outcome variable: volume increase in mm (3); secondary outcome variables: volume increase in percent, mean and maximum thickness increases in mm).

RESULTS: 3D tissue measurements after surgery revealed a significant higher volume increase in the CM (86.37 mm (3) ± 35.16 mm (3)) than in the SCTG group (47.65 mm (3) ± 17.90 mm (3)). After 10 months, volume increase was non-significant between groups (SCTG:11.36 mm(3) ± 9.26 mm(3) ; CM: 8.67 mm(3) ± 13.67 mm(3) ). Maximum soft tissue thickness increase (i1-i5) was 0.66 mm ± 0.29 mm (SCTG) and 0.79 mm ± 0.37 mm (CM) with no significant difference.

CONCLUSIONS: Ten months after soft tissue thickening, the CM is statistically non-inferior to the SCTG in terms of soft tissue volume and thickness increase. Further 3D studies are needed to confirm the data.


The aim of this study was to analyze the influence of a novel PDCM on endothelial progenitor cells (EPC) in vitro. EPC were isolated from human peripheral blood, cultured and transferred on the PDCM (mucoderm®). Tissue culture polystyrene surface (TCP) served as control. Cell viability of EPC on PDCM was measured by a MTT and PrestoBlue® assay. Migration ability was tested using a Boyden migration assay. A ToxiLight® assay was performed to analyze the influence of PDCM on adenylate kinase (ADK) release and apoptosis rate of EPC. Using the MTT assay, EPC cultured on PDCM demonstrated a significantly increased cell viability compared to the control group at days 3, 6 and
According to the PrestoBlue® assay, EPC showed a significant increase of cell viability compared to the control group at 48, 72, and 96 h (p each <0.001). In the Boyden migration assay, a significantly increased EPC migration ability could be observed after 3-12 days (p each ≤0.001). No significantly increased apoptosis rate of EPC on PDCM could be observed with exception after 96 h (p each >0.05). Overall, our results suggest a good biocompatibility of PDCM without any cytotoxic effects on EPC, which might support a rapid revascularization and therefore a sufficient ingrowth of the PDCM.


Report on synchrotron-based X-ray tomographic microscopy (SRXTM) to image 3D-CMs in native tissue probes.  
MATERIAL AND METHODS: SRXTM of 3D-CMs (mucoderm®, Mucograft®) was performed at the TOMCAT beamline of the Swiss Light Source (SLS) at the Paul Scherrer Institute (Villigen, Switzerland).  
RESULTS: SRXTM combines the advantages of high-resolution scanning electron microscopy (SEM) imaging with the low resolution reconstructions of micro-CT (μCT) imaging. It may be used to non-destructively visualize and analyze structures within the 3D-CMs without the need of serial sectioning and reconstruction.  
CONCLUSION: High-resolution SRXTM is a useful tool in analyzing the topology and morphometry of structures in 3D-CMs. The outcome justifies the efforts in sophisticated data processing.


In this study, the tissue reactions to two new porcine dermis-derived collagen membranes of different thickness were analyzed. The thicker material (mucoderm®) contained sporadically pre-existing vessel skeletons and fatty islands. The thinner membrane (collprotect®) had a bilayered structure (porous and occlusive side) without any pre-existing structures. These materials were implanted subcutaneously in mice to analyze the tissue reactions and potential transmembranous
vascularization. Histological and histomorphometrical methodologies were performed at four time points (3, 10, 15 and 30 days). Both materials permitted stepwise connective tissue ingrowth into their central regions. In the mucoderm® matrix, newly built microvessels were found within the pre-existing vessel and fatty island skeletons after 30 days. This vascularization was independent of the inflammation-related vascularization on both material surfaces. The collprotect® membrane underwent material disintegration by connective tissue strands in combination with vessels and multinucleated giant cells. The histomorphometric analyses revealed that the thickness of mucoderm® did not decrease significantly, while an initial significant decrease of membrane thickness in case of collprotect® was found at day 15. The present results demonstrate that the two analyzed collagen membranes underwent a multinucleated giant cell-associated vascularization. Neither of the materials underwent transmembraneous vascularization. The micro-vessels were found within the pre-existing vessel and fatty island skeletons. Additional long-term studies and clinical studies are necessary to determine how the observed foreign body giant cells affect tissue regeneration.


The aim of the present study was to compare the biodegradation and tissue integration of native, differently processed and cross-linked collagen scaffolds in rats.

METHODS: Four experimental porcine collagen matrices of 1.0 mm thickness, developed for soft tissue augmentation procedures, were tested. Based on the same native dermal Type I and III collagen, native (ND, mucoderm® prototype), specifically defatted (DD), ethylene dioxide cross-linked (ECL) and dehydrothermally cross-linked (DCL) dermis collagen (AAP/Botiss Biomaterials, Berlin, Germany) were evaluated. Two specimens of 1 × 1 cm were fixed around a non-absorbable spacer using non-absorbable sutures. After rehydration, specimens (N = 8) were randomly allocated in unconnected subcutaneous pouches on the back of 40 Wistar rats. Rats were divided into five groups (1, 2, 4, 8 and 12 weeks), including eight animals each. After each period, eight rats were sacrificed and explanted specimens were prepared for histological analysis. The following parameters were evaluated: membrane thickness as a sign of biodegradation and volume stability, cell ingrowth, vascularization, tissue integration and foreign body reaction.

RESULTS: Biodegradation pattern of the non-cross-linked collagen scaffolds differed only slightly in terms of presence of inflammatory cells and cell invasion into the matrix. In terms of biodegradation, ECL displayed a considerable slower resorption than ND, DCL and DD. Chemical cross-linking using ethylene dioxide showed a significant higher invasion of inflammatory cells.
CONCLUSION: Within the limits of the present study it was concluded that the processing techniques influenced the collagen properties in a different intensity. Dehydrothermal cross-linking and special defatting did not notably change the biodegradation pattern, whereas cross-linking using ethylene dioxide led to significant higher volume stability of the matrix. However, ECL showed an increased inflammatory response and compromised tissue integration. Therefore, ethylene dioxide seems to be not suitable for stabilization of collagen matrices for soft tissue augmentation procedures.

13. In vitro and in vivo characterization of porcine acellular dermal matrix for gingival augmentation procedures


The aim of the present study was to investigate the in vitro responses of four different oral cell lines cultured on a novel PADM. Furthermore, tissue reaction to PADM was evaluated histologically after subcutaneous implantation in mice.

MATERIAL AND METHODS: Human gingival fibroblasts (HGF), human osteoblast-like cells, human umbilical vein endothelial cells and human oral keratinocytes (HOK) were cultured and transferred on to the PADM. A tissue culture polystyrene surface served as the control. The viability of all tested cell lines on PADM was measured by using the 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyl tetrazolium bromide colorimetric assay and PrestoBlue® reagent. The ToxiLight® assay was performed to analyze the effect of PADM on adenylate kinase release. PADM was implanted into nude mice subcutaneously and subjected to histological analysis after 21d.

RESULTS: Using 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyl tetrazolium bromide colorimetric assays, all tested cell lines cultured on PADM demonstrated a significant increase of viability compared to the control group (each p < 0.001) with the exception of HGF and HOK after 3 d (each p > 0.05). According to the PrestoBlue® analysis, all cell lines demonstrated a significant increase of viability compared to the control group at the particular points of measurement after 18 h (HGF p < 0.01; human osteoblast-like cells, human umbilical vein endothelial cells, HOK each p < 0.001). No significant cytotoxic effects of PADM on the tested cell lines could be observed, as assessed by changes in adenylate kinase release. Subcutaneous implantation of PADM into nude mice demonstrated good integration with surrounding tissues and significant revascularization of its collagen structure.

CONCLUSION: Overall, the results suggest that PADM is a promising substitute for autogenous soft tissue grafts in periodontal surgery.
Clinical studies and case series

14. Use of bovine bone mineral, titanium mesh, and cross-linked collagen membrane in single implant site development at a maxillary central incisor tooth site: a 3 year follow-up case report.


Purpose: It can be extremely challenging to replace a hopeless tooth in the maxillary central incisor area with an implant restoration, especially when the bony housing of the tooth is severely damaged. This article describes the unique anatomical, biological, and surgical considerations in the treatment of such a case.

MATERIALS AND METHODS: In the reconstruction of a safe housing around the implant, obliteration of the incisive canal was followed by the use of bovine bone mineral (BBM) and titanium mesh layered with a cross-linked collagen membrane. The soft tissue was augmented with a xenogeneic soft tissue matrix (mucoderm®) and further enhanced by a novel technique, the radial cuts technique.

RESULTS: Functional and esthetic implant restoration was successfully achieved. Follow-up of the patient took place for 2 years post-implant loading and 3 years post-ridge augmentation, after which the stability of the implant and surrounding tissue was demonstrated.

CONCLUSION: Enhanced functional and esthetic results may be achieved when BBM and Ti-mesh layered with a soft collagen membrane are utilized as augmentation materials in the esthetic zone. The key factors for success in this case were combining the advantages of the different materials with a carefully considered sequence of procedures.


This case series aimed to clinically and histologically evaluate porcine-derived membrane used for vertical thickening of thin soft tissues. Twenty porcine-derived collagen membranes and bone-level
implants were placed in 20 patients. After 2 months, thickened soft tissues were measured and biopsy samples were harvested. All xenografts healed successfully. The average thickness of the thin soft tissue before vertical thickening was 1.65 ± 0.36 mm, while tissue thickness increased to 3.45 ± 0.52 mm after the procedure (P < .001). The mean thickness increase was 1.8 ± 0.13 mm. Histologic analysis showed complete integration of the graft and no differences (P = .4578) in vascularization between the host (39.74 ± 17.15 vessels/mm²) and graft (30.43 ± 11.26 vessels/mm²). It can be concluded that porcine-derived membrane can be used for vertical soft tissue thickening with substantial gain in tissue height.

16. Clinical evaluation of Miller class I and II recessions treatment with the use of modified coronally advanced tunnel technique with either collagen matrix or subepithelial connective tissue graft: A randomized clinical study.


AIM: To compare outcomes of modified coronally advanced tunnel technique (MCAT) combined with either collagen matrix (CM) or subepithelial connective tissue graft (SCTG) in the treatment of Miller class I and II multiple gingival recessions in the mandible.

MATERIALS AND METHODS: The study encompassed 91 recessions in 29 patients for whom MCAT was combined with mucoderm® on one side of the mandible and SCTG on the contralateral one. The following clinical parameters were measured: gingival recession height (GR) and width (RW), probing depth (PD), clinical attachment level (CAL), width of keratinized tissue (KT), gingival thickness (GT), mean (MRC) and complete root coverage (CRC) and Root Coverage Esthetic Score (RES).

RESULTS: The MRC proportions on the CM- and SCTG-treated sides were 53.20% and 83.10%, respectively. CRC was achieved in 9 out of 45 (20%) gingival defects treated with mucoderm® and 31 out of 46 (67%) treated with SCTG. There were statistically significant differences in MRC, CRC, GR, RW, KT, GT and RES between CM- and CTG-treated sides.

CONCLUSIONS: Modified coronally advanced tunnel technique leads to reduction in gingival recession both when combined mucoderm® and SCTG, of which the latter is more efficient as far as root coverage and aesthetic parameters are concerned.

17. Treatment of multiple maxillary adjacent class I and II gingival recessions with modified coronally advanced tunnel and a new xenogeneic acellular dermal matrix.

Evaluation of the treatment of maxillary Miller Class I and II multiple adjacent gingival recessions using the modified coronally advanced tunnel technique (MCAT) combined with a new porcine acellular dermal matrix (PADM).

MATERIALS AND METHODS: Twelve patients exhibiting at least six adjacent maxillary Miller Class I and II gingival recessions were consecutively treated by means of MCAT and a PADM. Recession depth (RD), recession width (RW), probing pocket depth (PD), keratinized tissue height (KT), clinical attachment level (CAL), mean root coverage (RC), and complete root coverage (CRC) were recorded.

RESULTS: At 12 months, CRC was obtained in 43% of the 100 gingival recessions, while the mean RC measured 84.35%. Mean RD reduction was $3.16 \pm 0.75$ mm ($P < 0.001$), mean RW reduction was $1.73 \pm 0.65$ mm ($P < 0.001$), while the gain of CAL was $3.26 \pm 1.33$ mm ($P < 0.001$). All patients were satisfied with the esthetic appearance and would undergo the same surgery again.

CONCLUSION: Within their limits, the present results indicate that treatment of Miller Class I and II multiple gingival recessions using PADM in conjunction with the MCAT could be successfully used as an alternative to connective tissue grafts, with the advantage of avoiding the discomfort and morbidity of connective tissue harvesting.

CLINICAL SIGNIFICANCE: The modified coronally advanced tunnel technique using the new porcine acellular dermal matrix represents a clinically and esthetically satisfactory treatment of multiple Miller Class 1 and 2 recession defects.

18. The Use of a Novel Porcine Derived Acellular Dermal Matrix (mucoderm®) in Peri-Implant Soft Tissue Augmentation: Preliminary Results of a Prospective Pilot Cohort Study.


Objective: Over the years, several techniques have been proposed for soft tissue augmentation around dental implants in order to improve keratinized mucosa width (KMW). Recently, a porcine derived acellular dermal matrix (mucoderm®) has been proposed as autogenous graft substitute in order to avoid palatal harvesting and obtain comparable results to connective tissue grafts, in terms of aesthetics and function. The aim of this study is to present the one-year follow-up results of this matrix in peri-implant soft tissue augmentation procedures.

MATERIALS AND METHODS: Twelve patients were enrolled in this pilot prospective study: a dental implant was placed in the upper premolar area and, at implant uncovering after eight weeks, the matrix was inserted. KMW gain was considered as primary outcome variable.

RESULTS: After one month from matrix insertion, mean KMW was $7.86\pm3.22$ mm (100%), with no statistically significant intragroup variations ($p>0.05$). No membrane exposures or wound healing
complications occurred during postoperative phase and, after one year, mean KMW was 5.67±2.12 mm (72.13%).

CONCLUSION: The results of the present pilot study indicate that by placing a mucoderm® membrane during implant surgery the keratinized tissue width can be augmented, and the width remains stable for the assessment period of 12 months. Further studies with greater power and longer investigation period are needed to confirm the suggestion for clinical use.

Rossi AL, Capilupi V, Palombo D, Chiapasco M. 2018. DENTAL CADMOS; 86(5):400-413.

The aim of this prospective cohort study is to test the performance of a new xenogenic collagen matrix as a socket sealing material, to allow second-intention healing of post-extractive sockets filled with a xenogenic bone substitute or with an immediate submerged implant.
MATERIAL AND METHODS: 10 patients were recruited, presenting with a single-rooted tooth scheduled for extraction. After atraumatic tooth removal, the post-extractive alveolus received either a socket preservation procedure or an immediate submerged implant.
RESULTS: In both cases, the gingival margins of the alveolus were sealed with a xenogenic collagen matrix (mucoderm®, botiss dental, Zossen, Germany). The following parameters were evaluated: a) exposed surface of the matrix at the end of surgery (T0); b) soft tissue healing at 1, 4, 6, and 8 weeks from surgery (T1-4); c) histological aspect of gingiva samples, harvested 20 weeks after surgery (T5); d) aesthetic performance provided by the socket sealing material (T4).


Evaluation of the performance of a natural 3D collagen matrix used for covering post-extractive sites to preserve the keratinized mucosa’s portion above the alveolus in preparation of an implant–prosthetic rehabilitation.
MATERIAL AND METHODS: 17 patients that needed avulsion of a monoradicular tooth in the maxilla or mandibular site. The operative procedure of socket sealing associated to a post-extractive implant insertion or ridge preservation were carried out. Stimulation of soft tissue regeneration and the quality of the newly formed tissue were evaluated.

RESULTS: At final clinical control (8 weeks) nearly all had complete closure of the wound and showed total keratinization and integration of the newly formed tissue. Histologies confirmed correct regeneration of the keratinized gingival tissue.

DISCUSSION/CONCLUSION: The application of the xenogenic collagen membrane mucoderm® in covering of post-extractive sites seems to allow a correct regeneration and integration of the keratinized gingival tissue above the alveolus, from biological and aesthetical point of view.


Taba M; Suzuki K; Irie M; Faria P; Messora M; Palioto D; Souza S; Novaes Jr. A. 2018. Clin Oral Implant Res (29):17; p.315. eposter


Coronally advanced flap plus connective tissue graft (CTG) is the gold standard therapy for root coverage. The bioabsorbable porcine collagen matrix (PCM) has been widely used in periodontal and mucogingival surgery as a substitute for CTG and has achieved similar results. The PCM has the advantage of availability overcoming the limitations of donor site in autograft.

The aim of this study is to investigate the use of PCM (mucoderm®) in root coverage procedures combined with extended coronally positioned flap (ECAF) in comparison to the CTG associated with the ECAF.

MATERIALS AND METHODS: Sixteen adult patients, non-smokers, presenting bilateral Miller Class I or II gingival recessions. Clinical parameters, probing depth, clinical attachment level, recession height and keratinized tissue height (KTH) and thickness (KTT) were recorded at baseline and 3 months after the surgical procedures by a blinded examiner.

RESULTS: The PCM group showed a significant reduction in recession height average of 2.07 ± 1.05 mm (P < 0.05). The average reduction in the CTG group was 2.41 ± 1.16 mm (P < 0.05). The average amount of root coverage was not different between PCM (62%) and CTG (75%) groups (P > 0.05). KTH gain was 1.08 ± 1.04 mm in PCM group and 0.98 ± 0.71 mm in CTG control (P > 0.05). KTT gain was 0.35 ± 0.38 mm in the PCM group and 0.49 ± 0.36 mm in the CTG group (P > 0.05).

CONCLUSION: and Clinical Implications: In this preliminary short time evaluation, both treatments showed a significant reduction in recession height. Considering no significant differences were observed between CTG and PCM groups for recessions height, width and thickness of keratinized tissue, it can be speculated that mucoderm® can be used as an alternative to CTG for the treatment of gingival recessions.

The aim of this study was to determine the treatment outcome of the use of a porcine monolayer collagen matrix (mCM) to augment peri-implant soft tissue in conjunction with immediate implant placement as an alternative to patient's own connective tissue.

MATERIALS AND METHODS: A total of 27 implants were placed immediately in 27 patients (14 males and 13 females, with a mean age of 52.2 years) with simultaneous augmentation of the soft tissue by the use of a mCM. The patients were randomly divided into two groups: Group I: An envelope flap was created and mCM was coronally covered, and group II: A coronally repositioned flap was created and the mCM was covered by the mucosa. Soft-tissue thickness (STTh) was measured at the time of surgery (T0) and 6 months postoperatively (T1) using a customized stent. Cone beam computed tomographies (CBCTs) were taken from 12 representative cases at T1. A stringent plaque control regimen was enforced in all the patients during the 6-month observation period.

RESULTS: Mean STTh change was similar in both groups (0.7 ± 0.2 and 0.7 ± 0.1 mm in groups I and II respectively). The comparison of STTh between T0 and T1 showed a statistically significant increase of soft tissue in both groups I and II as well as in the total examined population (p < 0.001). The STTh change as well as matrix thickness loss were comparable in both groups (p > 0.05). The evaluation of the CBCTs did not show any signs of resorption of the buccal bone plate.

CONCLUSION: Within the limitations of this study, it could be concluded that the collagen matrix used in conjunction with immediate implant placement leads to an increased thickness of peri-implant soft tissue independent of the flap creation technique and could be an alternative to connective tissue graft.

CLINICAL SIGNIFICANCE: The collagen matrix used seems to be a good alternative to patient’s own connective tissue and could be used for the soft tissue augmentation around dental implants.


This case report describes a technique for aesthetic single implant placement with simultaneous bone grafting and soft tissue thickening. At the time of implant surgery, allogenic (maxgraft®, botiss biomaterials, Germany) and xenogenic bone substitute (cerabone®, botiss biomaterials, Germany) was used for bone grafting, soft tissues were augmented simultaneously with collagen tissue matrix derivate membrane (mucoderm®, botiss biomaterials, Germany). After 4 months during second stage
surgery the implant was exposed. Subsequently healing abutment was replaced with provisional crown for gingival contouring. An individual zirconia abutment was made and a cemented full-ceramic crown was placed for final restoration. The 12-month follow-up check-up revealed a pleasing aesthetic treatment outcome, as well as clinically healthy peri-implant soft tissues. Radiological examination showed a stable bone crest with minor bone remodelling around the implant platform. The use of a collagen tissue matrix derivate, simultaneously with GBR, in the aesthetic area can provide excellent results, by establishing and maintaining facial bone wall and thick soft tissue in aesthetic area.

24. Changes of the peri-implant soft tissue thickness after grafting with a collagen matrix.

The aim of this study was to determine the treatment outcome of the use of a porcine monolayer collagen matrix (mCM) to increase soft-tissue volume as a part of implant site development. 
MATERIAL AND METHODS: Implants were placed in single sites in 27 patients. In the test group, mCM was used for soft-tissue augmentation. No graft was placed in the control group. Soft-tissue thickness (STTh) was measured at the time of surgery (T0) and 6 months postoperatively (T1) at two sites (STTh 1, 1 mm below the gingival margin; STTh 2, 3 mm below the mucogingival margin).
RESULTS: Significant increases (P < 0.001) in STTh (STTh 1 = 1.06 mm, 117%; STTh 2 = 0.89 mm, 81%) were observed in the test group. Biopsy results showed angiogenesis and mature connective tissue covered by keratinized epithelium.
CONCLUSION: Within the limitations of this study, it could be concluded that mCM leads to a significant increase of peri-implant soft-tissue thickness, with good histological integration and replacement by soft tissue and may serve as an alternative to connective tissue grafting.


Evaluation of the clinical efficacy of a new porcine acellular dermal matrix (PADM) for the treatment of Miller Class I, II, and III multiple gingival recessions using the modified coronally advanced tunnel technique (MCAT).
METHOD AND MATERIALS: Twelve non-smoking, systemically healthy patients presenting at least two adjacent Miller Class I, II, or III gingival recessions (GR), with a minimal depth of 2 mm, were treated
Relevant Publications – mucoderm®

 consecutively with MCAT in conjunction with PADM. At baseline and 12 months postoperatively, complete root coverage (CRC, e.g. 100% root coverage), mean root coverage (RC), recession depth, recession width, attached gingiva (AG), keratinized tissue (KT), periodontal pocket depths (PD), and clinical attachment level (CAL) were evaluated. The main outcome variable was CRC.

RESULTS: Postoperative healing was uneventful in all cases, without any matrix loss or exposure or infection. Statistically significant improvements (P < .0001) were observed 12 months postoperatively in 53 of the included 54 GR (98.15%). Twenty two recessions (40.74%) showed CRC while the mean RC measured 73.20 ± 27.71%. Mean GR reduction was 2.06 ± 1.18 mm while the gain of AG amounted to 0.84 ± 0.73 mm and of KT to 0.69 ± 0.51 mm, respectively. There were no statistically significant changes for PD at 12 months; CAL showed a significant decrease (P < .05) at 12 months from 3.77 ± 1.28 mm to 2.30 ± 1.02 mm.

CONCLUSION: PADM in conjunction with MCAT may be successfully utilized for the treatment of Miller Class I, II, and III multiple adjacent GR.

26. Gingival recession coverage: Do we still need autogenous grafts?

   More recently, 3D collagen matrices of human and porcine origin have been introduced as possible alternatives to autogenous connective tissue grafts in recession coverage procedures. This paper aims to give an overview on the possible use of collagen matrices as soft tissue substitutes and a possible alternative to connective tissue grafts in the surgical treatment of gingival recession defects.

27. Tunnel Technique With Collagen Matrix Compared With Connective Tissue Graft for Treatment of Periodontal Recession: A Randomized Clinical Trial.

   The aim of this study is to compare efficacy of the tunnel technique for root coverage using collagen matrix (CM) versus connective tissue graft (CTG) for treatment of multiple recessions of Miller Classes I and II over a short period of time.

   METHODS: Twenty-eight patients were enrolled in the study. Patients in the control group were treated with the tunnel technique using CTGs, whereas patients in the test group were treated with the tunnel technique using xenogeneic CM. Clinical recordings were obtained at baseline and after 3 and 6 months. Percentages of average recession coverage (ARC) and complete recession coverage (CRC) were evaluated 3 and 6 months after surgery.
RESULTS: Significant decreases were recorded in both groups of recession parameters compared with baseline measurements. Mean recession depth (0.21 versus 0.39 mm) and recession area (0.31 versus 0.53 mm²) after 6 months were significantly higher in the test group (P <0.05). Mean keratinized tissue width (KTW) increased at a similar rate in both groups (1.0 versus 0.8 mm for control and test groups, respectively). ARC after 6 months was 95% in the control group and 91% in the test group (P <0.05), and CRC was 71.4% (10/14) in the control group and 14.3% (2/14) in the test group (P <0.05).

CONCLUSION: Xenogeneic CM combined with tunnel technique leads to satisfactory ARC and increase in KTW similar to CTG, but yields lower unsatisfactory CRC.

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The purpose of the investigation is to introduce a method of vestibuloplasty for edentulous jaws by which the dentures are better held in place and retained. The use of xenoderm grafts with early insertion of the prostheses subsequent to surgical manipulation shows excellent results.

MATERIAL AND METHODS: Patients were divided into two groups - with the first group the prosthesis was made prior to surgery and placed on the 7th day after removal of sutures. With the second group the prostheses were made following a complete healing of soft tissue, i.e. 1 month after surgery. With both groups xenoderm grafts were applied to cover the open wound surface area.

RESULTS: The post-operative period for both groups of patients proceeded normally and without complications. For the group with early prosthetic loading due to the method of vestibuloplasty it was possible to maintain the depth of the vestibule.

CONCLUSION: The method proposed by the authors using xenoderm grafts and early loading on the newly-formed vestibule has proved a success and implies further in-depth application with larger group of patients.
29. Extensive keratinized tissue augmentation during implant rehabilitation after Le Fort I osteotomy: using a new porcine collagen membrane (mucoderm®).


The aim of this study was to test a new collagen matrix (mucoderm®) positioned during oral implant abutment connection. A patient previously treated with Le Fort I for bone augmentation and 8 implants showing minimal amount of keratinized tissue was selected for an extensive keratinized tissue augmentation and deepening of the oral vestibule by apically positioning a split palatal flap and palatal grafting with mucoderm®.

Clinical data at 9 and 14 days and 1 and 2 months showed resorption of the collagen graft, augmentation of the keratinized tissue around the implants, and deepening of the vestibule, with minimal morbidity and reduced surgical treatment time. However, some vestibular keratinized tissue contraction was evident. The new collagen matrix may be a promising material as a substitute for an autologous gingival/connective tissue graft. Despite the preliminary results of this innovative article, before drawing any general conclusion, the benefit of the procedure should be further evaluated by prospective clinical trials.

30. Options to avoid the second surgical site: a review of literature.


Periodontal plastic surgical procedures involving soft tissue grafts harvested from the palate have two surgical sites; a recipient site and another donor site. Many patients are apprehensive about the soft tissue graft procedures, especially the creation of the second/donor surgical site in the palate. In the past decade, newer techniques and products have emerged, which provide an option for the periodontist/patient to avoid the second surgical site. MucoMatrixX, Alloderm®, Platelet rich fibrin, Puros® Dermis and Mucograft® are the various options available to the practicing periodontist to avoid the second surgical site. Use of these soft tissue allografts in an apprehensive patient would decrease patient morbidity and increase patient’s acceptance towards periodontal plastic surgical procedures.

*Study refers to MucoMatrixx, which is a private label of mucoderm®.