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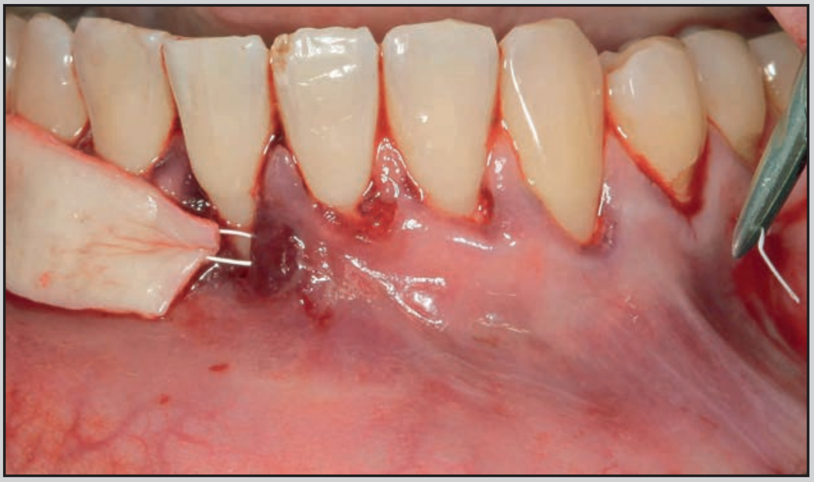
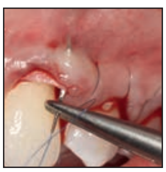



Root Coverage Using a Novel Porcine Acellular Dermal Matrix: Case Reports of Different Minimally Invasive Techniques with a 3-Year Follow-up



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A recently released commercially available novel porcine acellular dermal matrix (PADM) appears to possess acceptable biologic and clinical properties to be considered as an acceptable soft tissue replacement material. The aim of these three case reports is to present the treatment of multiple gingival recession by means of different variations of the tunnel and PADM as well as the clinical outcomes obtained at 3 years postoperatively. The healing outcomes demonstrated only minor surgical complications, with minimal patient-reported discomfort. At 3 years postoperative, ideal functional and esthetic outcomes were observed. PADM seems to be a promising xenogeneic soft tissue substitute. Further studies with a higher number of patients and defects are necessary to confirm the present findings. Int J Periodontics Restorative Dent 2023;43:47–54. doi: 10.11607/prd.5769

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Several techniques for gingival recessions treatment are available today.[1–3] The coronally advanced flap in combination with subepithelial connective tissue grafts (CTGs) is widely seen as the gold standard of root coverage.[2,4] During the last two decades, microsurgical procedures were successfully established supporting uneventful and accelerated wound healing.[3,5] The development of innovative tunnel instruments enabled less-invasive tunnel techniques. By avoiding superficial incisions, these perioplastic procedures minimize surgical trauma and increase postoperative patient comfort.[6–8]

In patients with a thin phenotype, CTGs are commonly used for soft tissue volume augmentation and attached gingiva gain.[9,10] Unfortunately, harvesting autogenous grafts from the palate necessitates an additional surgical site, thus increasing patient morbidity and the surgical treatment time.[11,12] In addition, the donor site might have a limited tissue quantity,[12] limiting the number of multiple recessions that could be treated in a single appointment.

To overcome these problems, the use of allogenic soft tissue substitutes for gingival recession treatment was introduced about 30 years ago.[13,14] An acellular dermal matrix (ADM) allograft was first used in

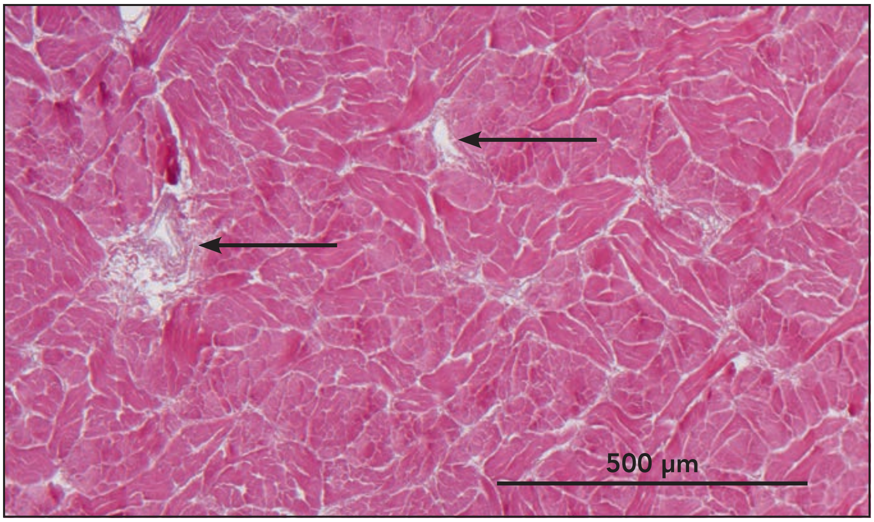

Fig 1 *Histologic view of the native PADM (NovoMatrix, BioHorizons) after unpackaging and before soft tissue grafting (h&e stain, ×10 magnification). The arrows point to visible vessel remnants.*

1994 for the treatment of burn patients (AlloDerm, LifeCell). The tissue processing maintains tissue integrity and supports tissue regeneration by allowing rapid revascularization, fibroblast repopulation, and a minimal inflammatory response, and it is ultimately transformed into host tissue.[15–17] ADM provides acceptable esthetics and predictable results in the treatment of gingival recession defects.[18,19] These procedures result in outcomes similar to CTG procedures and are stable up to 5 years postoperatively.[20,21] Xenogeneic soft tissue substitutes could be deemed more favorable than allogeneic matrices as they avoid legal issues associated with the clinical use of human ADMs in most European countries. The enzymatic processing method of this material removes cells and the primary component that causes immunologic rejection while conserving the structural integrity of collagen, elastic fibers, vascular channels, and ground substance (Fig 1). This paper presents three case reports using a novel porcine ADM (PADM: NovoMatrix, BioHorizons), utilizing different variations of the tunnel technique for root coverage.

Materials and Methods

All surgical procedures were performed by the primary investigator (G.I.), an experienced oral surgeon and periodontist. Three to five days ahead of surgery, each patient received debridement and tooth polishing by a dental hygienist. Oral antibiotic therapy (500 mg amoxicillin, thrice daily) was initiated the evening before surgical therapy and continued for 7 days to prevent bacterial infection. Immediately before surgery began, 600 mg ibuprofen was administered, and venous blood samples were obtained in two glass-coated plastic tubes with white caps (9 mL) for preparation of leukocyte-platelet–rich fibrin (L-PRF; IntraSpin, Intra-Lock). The preparation protocol followed a centrifuge rotational speed of 2,700 rpm for 12 minutes. The surgeries were performed under local anesthesia (1:200,000 Artinestol, Merz Dental). The procedures started with scaling and root planing (7/8 Younger-Good curette, Hu-Friedy) of the denuded root surfaces and was followed by conditioning using ethylenediaminetetraacetic acid gel (PrefGel, Straumann) for 2 minutes.

Case Reports

Case Report 1: Minimally Invasive Tunnel Technique

Patient

A 25-year-old nonsmoking woman presented with advanced gingival recessions in the regions of right to left maxillary second premolars over a period of 8 years. The clinical evaluation revealed Miller Class II recessions buccal to tooth 13 (6 mm) and tooth 23 (5 mm) and Miller Class I recessions (1 to 2 mm) at teeth 12, 22, 24, and 25 (FDI tooth-numbering

Fig 2 *Case 1: MITT.* (a) *The preoperative situation shows deep Miller Class II recessions at sites 13 and 23 (FDI tooth-numbering system) and shallow Miller Class I recessions at sites 12, 14, 15, 22, 24, and 25.* (b) *The graft and mucosal flap were fixated up to the CEJ using 6-0 singular sling sutures.* (c) *Clinical situation after tension-free wound closure.* (d) *The patient received extraoral taping for 5 days.* (e) *Excellent soft tissue healing was seen after suture removal at 4 postoperative weeks.* (f) *Intraoral view at 3 months postoperative.* (g) *Stable clinical outcomes were seen at 3 years postoperative.*

system) (Fig 2a). The patient exhibited a thin phenotype with a 4-mm keratinized tissue width. Slight signs of gingivitis were noted.

Treatment protocol

The surgical procedure selected was the minimally invasive tunnel technique (MITT; Fig 2) and was performed according to Zuhr et al.[8] At the deep recession buccal to tooth 13, the gingiva was dissected from the bone surface via a sharp intrasulcular incision using a microblade (Keydent Micro Blade Tunnel, American Dental Systems) and subsequently by blunt preparation using tunnel instruments (Allen Oral Plastic Kit, Hu-Friedy). The gingiva and mucosa of the adjacent teeth were mobilized from the margin, dissecting a continuous subperiosteal tunnel. The blunt flap preparation was carried out carefully to avoid mucosal tissue perforation and papilla detachment. The remaining collagen fibers and muscle attachments were further dissected using 15C scalpel blades to provide tension-free wound closure. In the same manner, the soft tissue around teeth 23 to 25 was mobilized, and a tunnel was prepared. The PADM was washed in two bowls filled with sterile saline solution for a minimum of 5 minutes in each bowl, then wetted with L-PRF. After separating the PADM into two strips (measuring 7 to 8 mm vertically), one piece was placed in the space of the right-side tunnel using a Younger-Good curette. In the same manner, the second graft was positioned and fixed into the tunnel of the contralateral side. The overlying gingival tissues were advanced coronally and fixed to the grafts (Fig 2b) and adapted in overcorrection to the cementoenamel junction (CEJ) using sling sutures (6-0 Seralene, Serag-Wiessner) (Fig 2c). Extraoral mobilization of the wound region was achieved using an extraoral tape (Fixomull stretch, BSN Medical) applied over the wound area for 5 days (Fig 2d).

Fig 3 *Case 2: LCTT.* (a) *The preoperative situation shows a deep Miller Class II recession at site 41 and shallow Miller Class I recessions at sites 31, 33 to 35, and 43 to 45.* (b) *Intraoperative view after lateral tunnel preparation and graft insertion using 4-0 polytetrafluoroethylene sutures.* (c) *Clinical view after tension-free wound closure.* (d) *Favorable soft tissue healing was seen after suture removal at 4 postoperative weeks.* (e) *Intraoral view at 3 months postoperative.* (f) *Stable clinical outcomes were seen at 3 years postoperative.*

Case Report 2: Laterally Closed Tunnel Technique

Patient

A 34-year-old woman presented multiple buccal Miller Class I gingival recessions (1 to 2 mm) associated with teeth 31, 33, 34, 43, and 44 and a pronounced 6-mm buccal Miller Class II recession in the region of tooth 41 (Fig 3a). The patient presented with a thin phenotype, with an attached gingiva width < 3 mm and without a keratinized surface. Most of the teeth showed signs of incipient gingivitis. The patient had observed progressive recession around tooth 41 in the previous 6 months.

Treatment Protocol

The laterally closed tunnel technique (LCTT; Fig 3) was first described by Sculean and Allen.[22] Starting from the deep buccal recession at tooth 41, the gingiva and mucosa were dissected from the bone surface with a sharp intrasulcular incision using a microblade (Keydent) followed by blunt preparation using previously described tunnel instruments (Allen Oral Plastic Kit). The soft tissue of the adjacent teeth was mobilized from the gingival margin, preparing a continuous mucoperiosteal tunnel from tooth 34 to 44. Further dissection was performed using a 15c scalpel blade to facilitate tension-free wound closure. Subsequently, a 4-0 polytetrafluoroethylene suture (Seramon, Serag-Wiessner) starting from the fixed mucosa in the region of tooth 35 was passed through the tunnel, without capturing the soft tissue, and emerged at tooth 41 (Fig 3b). The PADM graft (7- to 8-mm width) was engaged with a horizontal mattress suture, which was then passed back to the tooth 35 region; by drawing both suture ends, the graft was pulled through the tunnel. The PADM was positioned and drawn into the tunnel of the contralateral side in the same fashion. Next, the soft tissue margins of the deep recession at tooth 41 were adapted, and the tunnel was laterally closed using interrupted sutures (6-0 Seralene). The PADM was fixed together with the covering soft tissue, positioned in overcorrection to the CEJ, with singular sling sutures (Fig 3c). Extraoral mobilization of the wound region was achieved as previously described in Case 1.

Case Report 3: Coronally Positioned Pouch Technique

Patient

A 28-year-old nonsmoking woman developed multiple Miller Class I recessions (1 to 2 mm) in the mandible from the left to the right second premolar as well as a pronounced

Fig 4 *Case 3: CPPT.* (a) *The preoperative situation shows a deep Miller Class II recession at site 41 and shallow Miller Class I recessions at sites 31 to 35 and 42 to 45.* (b) *A papilla base incision was made at sites 33 to 43, and a sharp split-flap preparation was made using 15c scalpel blades.* (c) *Clinical view after tension-free wound closure.* (d) *Uneventful soft tissue healing was seen after suture removal at 4 postoperative weeks.* (e) *Intraoral view at 3 months postoperative.* (f) *Stable clinical outcomes were seen at 3 years postoperative.*

7-mm buccal Miller Class II recession at tooth 41 (Fig 4a). The soft tissue phenotype was extremely thin, with an attached gingival width < 3 mm and without a keratinized surface. At tooth 41, the patient complained of root sensitivity to cold temperatures and oral hygiene procedures.

Treatment Protocol

The coronally positioned pouch technique (CPPT; Fig 4) is a modification of the technique described by Zucchelli et al.[23] First, a precise papilla-base incision was performed using a 15c blade in tooth areas 33 to 43. The use of tunnel instruments was not feasible due to the extremely thin mucosa and strong fixation of the periosteum to the alveolar surface. Sharp supra-periosteal dissection of the mucosa enabled mobilization of a tension-free intact flap without perforating the thin tissue and produced a pouch (Fig 4b). Moreover, easy access was opened to tunnel the mucosa in tooth regions 34/35 and 44/45 with blunt dissection, followed by placement of the PADM. The soft tissue margins of the deep recession at site 41 were adapted together using interrupted sutures (6-0 Seralene), and the PADM was fixed together with the covering soft tissue, positioned in overcorrection to the CEJ, with sling sutures (Fig 4c). The patient was taped extraorally.

Postoperative Care and Wound Healing

All patients were instructed to rest and use a mouthrinse twice daily (Salviathymol N, MEDA Pharma) for 5 days, followed by the use of 0.2% chlorhexidine gluconate solution (Chlorhexamed Forte, GlaxoSmithKline) for 2 to 3 weeks. After the first 5 postoperative days, patients were informed to carefully perform oral hygiene in the wound area with a soft brush for 3 weeks, followed by regular toothbrushing. Postoperatively, all patients showed minor swelling and pain without signs of bleeding. After uneventful healing, the sutures were removed after 4 weeks (Figs 2e, 3d, and 4d).

Results

In the three case reports presented herein, a novel PADM facilitated tension-free flap closure over the graft material and optimized root coverage of 24 Miller Class I and II recessions (Figs 2c, 3c, and 4c). Swelling during early and progressive healing period was minimal. Postoperative wound healing in all cases was considered as uneventful (absence of infections, suppuration,

Table 1 Descriptive Statistics at Baseline, 3 Months, and 3 Years

		Baseline		3 mo				3 y			
Patient no.	Tooth no.[a]	PD, mm	REC, mm	PD, mm	REC, mm	CAL gain, mm	REC Cov, %	PD, mm	REC, mm	CAL gain, mm	REC Cov, %
1	12	1	1	1	0	1	100	1	0	1	100
	13	2	6	2	0	6	100	2	0	6	100
	14	2	3	2	1	2	67	2	1	2	67
	15	2	1	2	0	1	100	2	0	1	100
	22	1	1	1	0	1	100	1	0	1	100
	23	2	5	1	0	6	100	1	0	6	100
	24	2	3	2	1	2	67	2	1	2	67
	25	2	1	2	0	1	100	2	0	1	100
2	31	1	2	1	0	2	100	1	0	2	100
	33	2	1	2	0	1	100	2	0	1	100
	34	2	1	2	0	1	100	2	0	1	100
	41	3	6	1	0	8	100	1	1	7	88
	43	1	1	1	0	1	100	1	0	1	100
	44	2	3	1	1	2	67	1	1	2	67
3	31	2	3	1	0	4	100	1	0	4	100
	32	2	2	1	1	2	50	1	0	3	100
	33	1	1	1	0	1	100	1	0	1	100
	34	1	3	1	1	2	67	1	1	2	67
	35	1	1	1	0	1	100	1	0	1	100
	41	2	7	1	1	7	86	1	1	7	86
	42	2	1	1	0	2	100	1	0	2	100
	43	2	1	2	0	1	100	2	0	1	100
	44	1	1	1	0	1	100	1	0	1	100
	45	1	2	1	0	2	100	1	0	2	100
Mean		1.67	2.38	1.33	0.25	2.42	91.83	1.25	0.25	2.42	93.42

CAL = clinical attachment level; PD = probing depth; REC = midvertical recession; REC Cov = root coverage.
[a]FDI tooth-numbering system.

allergic reactions, and signs of graft rejection). No flap dehiscence or exposure of graft was noted.

At suture removal, all sites demonstrated complete root coverage (Figs 2e, 3d, and 4d). The patients who received LCTT and CPPT approaches initially showed slight soft tissue discoloration and uneven surface texture. Initial healing was slightly faster using the MITT approach.

At 3 months postoperative (Figs 2f, 3e, and 4e), average midvertical recessions (RECs) decreased from 2.38 mm to 0.25 mm, and the average probing depth (PD) decreased from 1.67 mm to 1.33 mm (Table 1). These treatment modalities resulted in a mean clinical attachment level (CAL) gain of 2.42 mm and a mean root coverage percentage (%RC) of 91.83%. Complete root coverage (CRC) was achieved in 75.0% of sites. No discolorations or surface texture irregularities were observed.

At 3 years postoperative (Figs 2g, 3f, and 4f), the mean REC (0.25 mm), CAL gain (2.42 mm), and CRC (75% of sites) were stable (Table 1). Mean %RC was increased minimally to 93.42%. No discolorations or surface texture irregularities were observed.

Discussion

The present case reports demonstrate the use of a novel PADM utilizing three different flap techniques of root coverage with a 3-year follow up; two techniques were modified tunnel procedures[8,22] and one technique was a modified coronally advanced flap.[23] All techniques accomplished successful root coverage in multiple Miller Class I and II shallow and/or deep recessions. By avoiding vertical releasing incisions, the subsequent envelope flaps are known to provide greater wound stability in multiple recessions.[23] MITT requires adequate sulcular access for tunnel site preparation, primarily found in the maxilla and posterior mandible. Moreover, the maxillary region generally has thick gingival tissue that facilitates blunt tissue dissection using special tunnel instruments.[24] The tunnel site preparation allows submerged placement of the grafts in an immobile recipient bed and provides both passive flap advancement to the CEJ and avoidance of soft tissue retraction.[25]

Recently, the use of a novel surgical technique to predictably treat narrow and deep isolated mandibular Miller Class I, II, and III recessions was published.[24] LCTT seems to be a favorable technique to treat recession defects in anterior mandibular sites with thin gingival tissue and/or flat vestibule, based on the published case reports. The deep recession provides access for tunnel preparation and graft placement. The lateral approximation of the tissue margins bordering the root allows tension-free wound closure. Surgery time performing CPPT was approximately 25% shorter, and the subjective technique sensitivity seems to be lower compared to MITT and LCTT. This is especially true in shallow recession sites with narrow roots involving multiple teeth in the mandibular incisor region, where the intrasulcular access is often limited. Leaving the papilla on the bony base enhances the blood supply and could minimize loss of papilla height.[26]

In all three of the present cases, PADM provided excellent functional and esthetic outcomes for root coverage over a period of 3 years. These results are similar to those reported for the use of CTGs[7,8,20,21,23,27] and ADM allografts.[14,15,18–21,25,27] An important advantage of PADM is the unlimited supply of soft tissue grafting material.[13,14] This allows multiple recessions to be treated in one surgical procedure. A major advantage of the PADM used in the present study is the handling characteristics: The soft tissue substitute is delivered hydrated with a thickness of 1.0 to 1.5 mm and requires a wash in two different bowls of sterile saline solution for 5 minutes per bowl. This provides a tissue rigidity that facilitates placement in prepared tunnels and allows fixation with 6-0 microsurgical sutures without tearing the graft material. Immobile graft fixation seems to be an important success factor for root coverage.[25,27]

PADM undergoes a processing method to remove cells and immunologic rejection components while conserving the structural integrity of major dermal matrix components.[28,29] In vitro and preclinical studies confirm the low immunologic and foreign body response and high degree of collagen deposition and organization with PADM.[28,29] Very recent in vitro data have provided evidence for a highly efficient immediate adsorption of growth factors involved in early wound healing (TGF-β1, FGF-2, PDGF-BB, GDF-5, and BMP-2) by PADM, followed by a delayed release of the growth factors from the deeper layers of the matrices.[30] The efficient adsorption and sustained growth factor release, coupled with a dramatic increase in the expression of genes encoding the angiogenic factors FGF-2 and VEGF-A in cells grown on PADM, indicates an accelerated vascularization that supports wound healing. The positive outcomes described in the present study may have also been favorably influenced by using L-PRF.

Conclusions

Within the limitations of the present case reports, it can be concluded that the use of this novel PADM for root coverage, in combination with L-PRF, appears to provide long-term stable and esthetic outcomes when used in conjunction with various types of tunnel approaches.

Controlled clinical trials are necessary to provide evidence to support the favorable outcomes of PADM in root coverage in the reported cases.

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