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Posted Date: 4 March 2026

doi: 10.20944/preprints202603.0282.v1

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Article

Patient-Reported Outcomes After Multiple Recession Coverage with Modified Coronally Advanced Tunnel Technique and Bilaminar Subepithelial Connective Tissue Graft: A Retrospective Analysis

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Highlights

- MCAT combined with SCTG achieved predictable and comparable root coverage at 12 months, regardless of the adjunctive biomaterial used.
- The use of patient-reported outcome measures (PROMs) revealed clinically meaningful differences in early postoperative pain and swelling between treatment groups.
- Cross-linked hyaluronic acid was associated with a significantly greater clinical attachment level gain compared with other adjunctive approaches.
- Patient satisfaction and willingness to recommend the procedure were high across all treatment modalities.
- Integrating PROMs with clinician-reported and esthetic outcomes provides a more comprehensive and patient-centered evaluation of periodontal plastic surgery.

Abstract

Background: Patient-reported outcome measures (PROMs) complement clinician-assessed endpoints by capturing pain, swelling, functional limitations, and satisfaction from the patient perspective after periodontal plastic surgery. This study compared PROMs after coronally advanced tunnel (MCAT) with a subepithelial connective tissue graft (SCTG) combined with different adjunctive biomaterials. Methods: In this retrospective comparative cohort study, 64 consecutively treated patients (275 gingival recession defects) underwent MCAT + SCTG physiological saline with one of three adjuncts: 24% EDTA, enamel matrix derivative (EMD) or cross-linked hyaluronic acid (HA). PROMs included pain and swelling assessed on a 0–100 mm visual analogue scale (VAS) and binary symptom items on postoperative days 1, 2, 4, 7, and 14, as well as patient satisfaction and willingness to recommend the procedure. Clinical and professional esthetic outcomes (Root Coverage Esthetic Score, RES) were assessed at 12 months. Results: In 64 patients (275 recession defects), all treatments (EMD, EDTA, HA and SCTG + saline) produced significant reductions in recession height and width at 12 months ($p < 0.0001$), with no intergroup differences in mean or complete root coverage. CAL improved in all groups, with a significantly greater gain in the HA group ($p = 0.0183$). Early postoperative pain and edema differed between groups, while patient-reported satisfaction was high in all groups. Professional esthetic outcomes were generally favorable, with significant intergroup differences for several esthetic parameters and the overall esthetic score. Conclusions: MCAT + SCTG provided predictable root coverage across adjunctive approaches; however, PROMs identified clinically meaningful differences in short-term patient morbidity. Incorporating PROMs alongside clinician-reported outcomes enables a more comprehensive, patient-centered assessment of treatment success.

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1. Introduction

Gingival recession (GR) refers to the apical migration of gingival tissue, exposing the root surface beyond the cementoenamel junction (CEJ). Recent studies have shown that two-thirds of the global population is affected by gingival recession, and its prevalence increases with age [1,2]. Various factors predispose to the occurrence of gingival recession, including incorrect toothbrushing technique, smoking, poor oral hygiene, orthodontic treatment as well as gum morphology [3,4]. Some studies point to gingival inflammation as the main factor in the development of gingival recession (REC) [2], but the etiology is usually multifactorial, and the appearance is attributed to multiple interacting factors [5].

Nowadays, life expectations are high, involving esthetic demands, therefore, gingival recession treatment can cause a challenge [6]. Society wishes to preserve its natural dentition into old age, and by treating gingival recessions, it is possible to avoid dentin hypersensitivity, predisposition to root caries, and even tooth loss [7,8].

Given that GR therapy is frequently undertaken for esthetic reasons and symptom relief, treatment success should be evaluated not only by clinician-assessed root coverage but also by outcomes perceived by patients. Patient-reported outcome measures (PROMs) capture domains directly relevant to individuals undergoing periodontal plastic surgery, including postoperative pain and swelling, functional limitations, and satisfaction with esthetic integration, thereby complementing objective clinical indices [9,10]. This patient-centered perspective is particularly justified in contemporary minimally invasive root coverage approaches, such as tunnel-based techniques and MCAT with SCTG, which aim to preserve papillary integrity and vascular supply and may therefore influence early morbidity and perceived healing even when clinical endpoints appear comparable [11–14]. In parallel, biologically driven adjuncts—including root surface conditioning and the use of EMD or cross-linked hyaluronic acid—have been introduced with the intent to optimize the wound environment and soft-tissue integration, with plausible implications for patient-experienced recovery and comfort [15–20]. Notably, topical HA has been associated with improved pain control and epithelial wound healing at palatal donor sites, supporting the rationale for incorporating PROMs when comparing protocols that differ in biomodification and adjunctive materials [21].

Among the available surgical options, SCTG remains a widely accepted approach for root coverage due to its predictable efficacy and favorable influence on gingival thickness (GT) and keratinized tissue width (KTW). The modified coronally advanced tunnel (MCAT) combined with SCTG is often considered a reference approach for GR management, particularly for multiple adjacent recessions [22]. However, outcomes may depend not only on the choice of technique and graft, but also on technical details of graft handling.

Therefore, the objective of this study was to evaluate patient-reported esthetic outcomes and overall patient experience after root coverage procedures, while also providing an objective professional assessment of esthetics and determining the 1-year stability of clinical results according to adjunctive root surface biomodification (EDTA or EMD) and application of cross-linked HA, compared with MCAT + SCTG saline. All interventions were performed using the same surgical approach (MCAT combined with SCTG) to manage multiple gingival recessions classified as RT1 and RT2. The primary clinician-assessed outcomes were mean root coverage (ARC) and complete root coverage (CRC). Secondary outcomes included changes in gingival recession reduction (GR) and width (RW), gain in clinical attachment level (CAL), increases in GT and KTW, and variation in the root coverage esthetic score (RES). PROMs were incorporated to capture postoperative morbidity, perceived healing, and satisfaction with esthetic and functional outcomes, thereby complementing clinician-reported parameters and enabling a comprehensive assessment of therapeutic effectiveness.

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2. Materials and Methods

2.1. Study Design

This retrospective review of a randomized clinical trial consisted of 64 consecutively treated patients, 40 of whom were female and 24 were male, with a mean age of 30.17 years, ranging from 19 to 56. The study was conducted in accordance with the Declaration of Helsinki (1975), including the amendments adopted in Tokyo in 2004, and received approval from the Bioethics Committee of the Medical University of Warsaw (KB/208/2017; KB/119/2021) and registered with ClinicalTrials.gov (NCT03354104; NCT05045586). Participants were enrolled from patients who had been referred to the Department of Periodontology and Oral Mucosa Diseases at the Medical University of Warsaw between January 2018 and April 2020 for EDTA and EMD group, April 2021- May 2022 for HA. A single examiner (NMC) qualified patients with multiple gingival recessions for inclusion in the study, and all participants provided written informed consent. They received instruction in the roll-toothbrushing method, along with professional prophylaxis and polishing. In each case, gingival recessions in one quadrant were managed using SCTG combined with the MCAT technique.

In 20 participants, root surfaces were conditioned with 24% EDTA followed by EMD, while in the remaining 20 they were treated with 24% EDTA alone. In the haluronic acid group, 24 patients received application of HA directly on the root surface. All participants were monitored for 12 months (Figure 1).

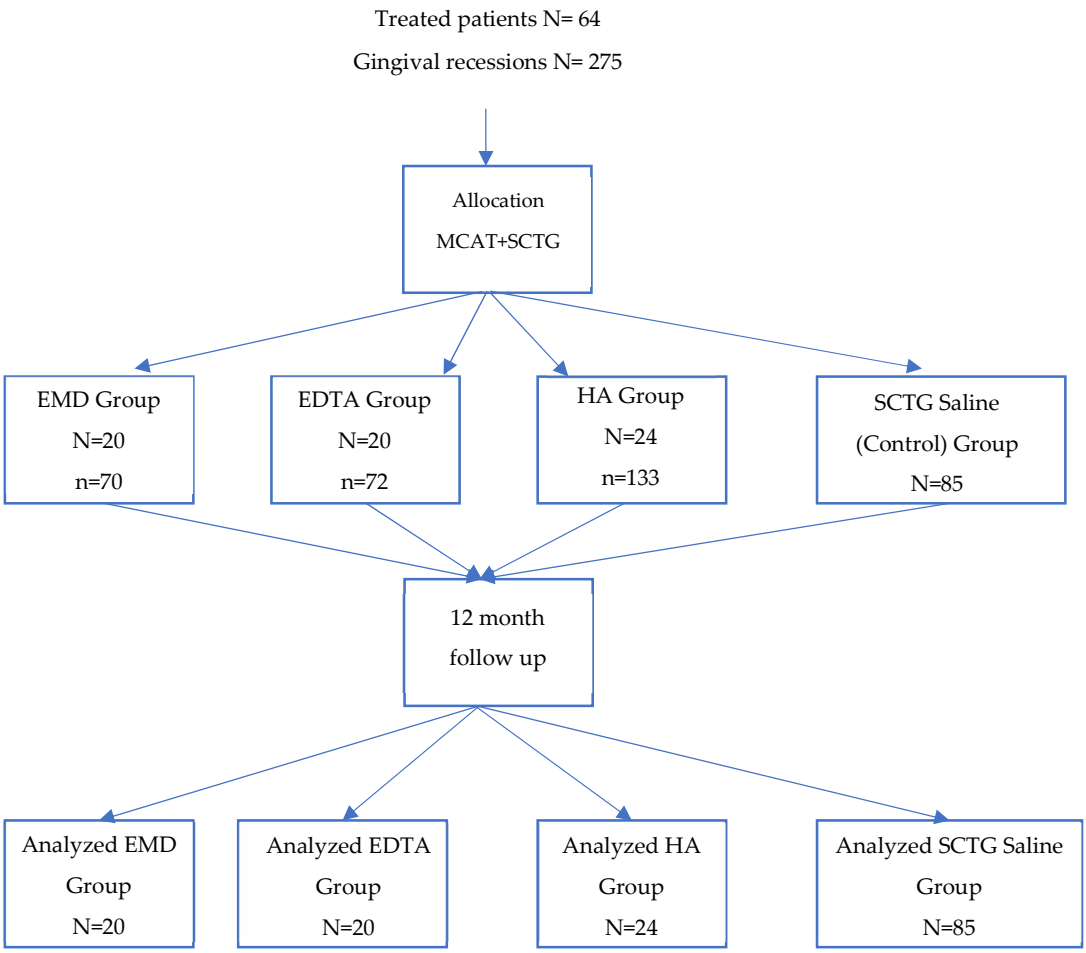

Figure 1. CONSORT Flowchart of the Study. [1]EMD enamel matrix derivative, [2]EDTA ethylenediaminetetraceticacid, [3] HA hyaluronic acid, [4] N number of patients, [5]n number of defects.

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2.2. Patient Population

A patient was qualified for the study if the following criteria were met: (1) at least two adjacent gingival recessions of type RT1s and/or RT2s and more than 1 mm deep in the maxilla or mandible [40]; (2) full-mouth plaque score (FMPS) <15% and full-mouth bleeding on probing (FMBOP) <15%; (3) no systemic diseases affecting healing; (4) age≥18 years.

The exclusion criteria were: (1) no detectable cemento-enamel junction (CEJ); (2) gingival recessions type RT3; (3) active periodontitis; (4) cervical area with caries lesions or restorations; (5) use of medications affecting periodontal status; (6) smoking; (7) pregnancy or lactation.

Based on improvements in the percentage of root coverage and the standard deviation of measurement differences not exceeding 30% [23], the required sample size for comparing outcomes across the groups was estimated at 12 participants per arm. This calculation ensured an 80% power to detect a true intergroup difference of 20 percentage points. To compensate for potential attrition, however, 20 subjects were ultimately enrolled in each treatment group.

2.3. Clinical Parameters

Clinical examinations were performed at baseline and 12 months after surgery by a single blinded examiner (NMC). A total of five patients not included in the trial, with more than two adjacent GR, were used to calibrate the examiner, who documented all GR recordings for each patient at 24-hour intervals. The calibration was accepted when more than 90% of the measurements were repeatable within 1.0 mm of each other, and in more than 75% of the cases the measurements were the same. Using a periodontal probe (UNC probe 15 mm, Hu-Friedy, Frankfurt, Germany), all the clinical parameters were measured under local anesthesia. The records included in the trial were: (1) Gingival recession height (GR), measured from the free gingival margin to the cemento-enamel junction (CEJ); (2) recession width (RW) at the level of the CEJ; (3) probing pocket depth (PPD), defined as the distance from the free gingival margin to the base of the gingival sulcus; (4) clinical attachment level (CAL), measured from the CEJ to the base of the sulcus; and (5) keratinized tissue width (KTW), recorded as the distance between the free gingival margin and the mucogingival junction (MGJ) ; (6) Gingival thickness (GT) was assessed 3 mm apical to the gingival margin using a size 25 ISO endodontic spreader (Poldent, Warsaw, Poland) with a silicon stopper, which was inserted perpendicularly to the gingival surface until contact with the alveolar bone or root surface was achieved.

2.4. Patient-Reported Outcomes

To assess patient-reported outcomes, all participants completed a postoperative questionnaire. Pain and swelling were rated using a 0–100 mm visual analogue scale (VAS), where 0 indicated no pain/swelling and 100 the worst imaginable pain/swelling, on postoperative days 1, 2, 4, 7, and 14. Additional items were recorded as dichotomous (Yes/No) responses (e.g., bleeding, ecchymosis, and other symptoms, if applicable). At 12 months, patients rated overall satisfaction with the treatment outcome (0–100 mm VAS) and answered whether they would recommend the treatment to another person.

- “Gingival color”
- “Gingival contour”
- “Recession coverage”
- “How satisfied are you with the results of the surgery?”
- “Would you decide again to go for the treatment performed?”
- “Would you recommend the treatment to another person?”

Patients responded to the predefined items using a dichotomous (Yes/No) response format.

Postoperative pain and swelling were recorded by the patients on days 1, 2, 4, 7, and 14 following surgery using binary (yes/no) responses, indicating the presence or absence.

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2.5. Professional Aesthetic Evaluation

One experienced periodontist (NMC) evaluated all the results at a follow-up visit 12 months after the procedure. Prior to scoring, the doctor participated in training sessions on the Root Coverage Esthetic Score (RES) using a series of pre- and post-treatment images of gingival recessions managed with different surgical approaches. No time limit was imposed for the assessments.

According to the RES system, five variables were evaluated: (1) gingival margin level (GM), (2) marginal tissue contour (MTC), (3) soft tissue texture (STT), (4) muco-gingival junction alignment (MGJ), and (5) gingival color (GC). The gingival margin level accounted for 60% of the total RES, whereas the remaining four variables contributed 40% overall (10% each for MTC, STT, MGJ, and GC). GM was scored on a 0/3/6 scale, while each of the other variables was rated on a binary 0–1 scale. The maximum (optimal) esthetic score achievable for complete root coverage (CRC) was 10 points.

A score of 0 was assigned when the postoperative gingival margin was at the same level as, or more apical to, the baseline recession depth (i.e., failure of the root coverage procedure), irrespective of color match, the presence of scarring, gingival margin configuration, or MGJ position. In addition, partial or complete loss of the interproximal papilla (resulting in a "black triangle") following treatment was also scored as 0.

2.6. Surgical Phase

An experienced surgeon (BG) performed all periodontal procedures using the MCAT technique, which was described by Zuhr et al. [12]. Before surgery, a statistician who was not part of the study used random number generator software to allocate GR cases to different treatment modalities. Right before the surgery, the operator discovered the allocation of treatment, which was concealed in sealed and opaque envelopes. The patient did not receive information on treatment allocation.

Following administration of local anesthesia using 4% articaine hydrochloride with epinephrine (1:100,000) (Ubistesin Forte 1.7 mL, 3-M ESPE, Saint Paul, MN, USA), the exposed root areas were instrumented using Gracey curettes (Hu-Friedy, Chicago, IL, USA). A full-thickness flap was elevated up to the mucogingival junction (MGJ), after which a split-thickness flap was created beyond the MGJ through supraperiosteal dissection. The buccal portions of the papillae were then separated from the periosteum. The free gingival graft was harvested from the palatal area. Subsequently, an SCTG was obtained by removing the outer layer extraorally. The harvested graft had a thickness of no more than 1 mm and a width of approximately 4 mm. Hemostasis at the donor site was achieved using a sponge, which was stabilized with cross-mattress non-resorbable sutures (Seralon 4/0, 18 mm, 3/8, Serag-Wiessner GmbH & Co. KG, Neila, Germany).

In the EDTA group, the exposed root surfaces were treated with 24% EDTA (PrefGel®, Straumann, Basel, Switzerland) for 2 minutes and subsequently rinsed with sterile saline solution.

For the EMD group, the root surfaces were treated with 24% EDTA for 2 minutes, rinsed with sterile saline, dried with cotton pellets, and then coated with EMD (Emdogain®, Straumann, Basel, Switzerland).

For the HA group, the root surfaces were treated by covering them with cross-linked hyaluronic acid (HA; hyaDENT BG, Bioscience, Germany), and the graft was subsequently inserted into the tunnel.

In both treatment sites, a single-piece SCTG was inserted into the prepared tunnel. The graft was initially immobilized at the CEJ using resorbable sling sutures (PGA Resorba 6/0, 11 mm, 3/8; RESORBA Medical GmbH, Nürnberg, Germany). Subsequently, the coronally advanced tunnel flap was positioned to achieve complete coverage of the SCTG. Final stabilization of both the flap and graft was obtained with non-resorbable monofilament sling sutures (Seralon 6/0, 12 mm, 3/8; Serag-Wiessner GmbH & Co).

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2.7. Post-Surgical Phase

The participants were informed to take 400 mg of ibuprofen after the procedure, another dose 6 hours later and an additional one, if required afterwards. Subsequent tablet administration was undertaken if clinically indicated. The patients were asked to avoid brushing, chewing or flossing in the perioperative area during the first 14 days. For the first 2 weeks it was recommended to gently rinse the mouth using 0.2% chlorhexidine digluconate solution twice a day for 1 min.

Two weeks after the surgical procedure, the sutures were removed, and patients were advised to use a soft toothbrush for mechanical cleaning of the treated site, applying the rolling technique. Postoperative evaluations were scheduled at 1, 2, and 4 weeks, and subsequently at 3, 6, and 12 months. At each appointment, reinforcement of oral hygiene practices and the provision of professional plaque control were undertaken. In addition, during the postoperative phase, patient-reported outcome measures (PROMs) were systematically collected to evaluate patient-perceived morbidity and benefits of treatment, including pain and swelling/discomfort, functional limitations, and satisfaction with esthetic and functional outcomes, as described above.

2.8. Statistical Analyses

The statistical analyses were performed in R (R Foundation for Statistical Computing, Vienna, Austria). Continuous variables are presented as mean ± standard deviation (SD) or median (with interquartile range, IQR), as appropriate, and categorical variables are presented as counts and percentages.

Because multiple recession defects were nested within patients and PROMs were measured repeatedly over time, inferential analyses were conducted using mixed-effects regression models with a random intercept for patient. For recession-level continuous outcomes (e.g., changes in recession depth, keratinized tissue width, and CAL), linear mixed-effects models were fitted; for binary outcomes (e.g., complete root coverage), generalized linear mixed-effects models with a logit link were used. PROMs measured on VAS were analyzed using linear mixed-effects models that included fixed effects for treatment group, postoperative day, and their interaction; binary PROM items were analyzed using logistic mixed-effects models. Estimated marginal means were used for pairwise comparisons with Holm adjustment for multiple testing. Results are reported as mean differences (for continuous outcomes) or odds ratios (for binary outcomes), along with 95% confidence intervals (CI). Model assumptions were assessed using residual diagnostics; a two-sided p-value < 0.05 was considered statistically significant.

3. Results

3.1. Clinical Outcomes

A total of 64 patients and 275 gingival recession defects were included in the EMD, EDTA and HA groups. No significant intergroup differences were observed in sex distribution or tooth type ($p = 0.187$ and $p = 0.373$, respectively). The mean age differed significantly between the groups ($p < 0.001$), with the highest mean age recorded in the HA group. The distribution of recession types according to the Cairo classification also differed significantly among the groups ($p < 0.001$), with a higher proportion of RT2 defects in the HA group compared with the EMD and EDTA groups (Table 1).

Table1. Characteristics for the study groups.

Variables	EMD[1] (N[4]=20, n[5]=70)	EDTA[2] (N=20, n=72)	HA[3] (N=24, n=133)	Saline (N=85, n=366)	*p*
Sex (n)					0.187
Women	11	10	19	55	

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Men	9	10	5	30	
Age (mean, SD[6])	28.47 (4.45)	29.02 (4.31)	32.54 (6.67)	33.74 (5.43)	<0.001
Tooth type (n)					0.373
Incisors	15	16	42	98	
Canines	16	17	23	75	
Premolars	33	32	45	146	
Molars	6	7	23	47	
Type o GR[7] according to Cairo (n, %)					<0.001
RT1[8]	47(67.14%)	49(68.06%)	59 (44%)	239 (65.20%)	
RT2	23(32.86%)	23(31.94%)	74 (56%)	127 (34.80%)	

[1]EMD enamel matrix derivative, [2]EDTA ethylenediaminetetraceticacid, [3]HA hyaluronic acid, [4]N number of patients, [5]n number of defects, [6]SD standard deviation, [7]GR gingival recession,[8]RT recession type.

At 12 months, all treatment modalities (EMD, EDTA, HA and SCTG + saline) demonstrated a significant reduction in gingival recession height and width compared with baseline (all $p < 0.0001$), with no significant intergroup differences at either baseline or follow-up (Table 2). The mean percentage of average and complete root coverage was comparable among the groups (all intergroup $p > 0.05$).

Clinical attachment level significantly improved in all groups, and a significantly greater CAL gain was observed in the HA group ($p = 0.0183$). An increase in KTW and GT was recorded in all groups, with no clinically relevant differences between the tested treatments at 12 months. All participants attended their control visits after 12 months.

All the clinical results at the baseline and after 12 month follow-up period are available in Table 2.

Table 2. Clinical parameters (mean and standard deviation) at baseline and 12 months after surgery.

KERRYPNX	Baseline	12 Months	*p*
GR[1] EMD[2] (mm)	1.98(1.11)	0.21(0.45)	<0.0001*
GR EDTA [3]	1.82(1.23)	0.26(0.72)	<0.0001*
GR HA[4]	1.77(1.13)	0.12(0.48)	<0.0001*
GR Saline	1.76(1.37)	0.21(0.42)	<0.0001*
p	*0.4163*	0.8871	
ARC[5] EMD (%)		94.00(20.12)	brak
ARC EDTA		89.08(31.76)	brak
ARC HA		84.32(34,46)	brak
ARC Saline		90.4(25.13)	brak
p	brak	0.8871	
CRC[6] EMD (%)		64(91.43)	brak
CRC EDTA		65(90.28)	brak
CRC HA		92,12(28,14)	brak
CRC Saline		84.67(37.67)	brak
p	brak	0.9743	
GR red[7] EMD (mm)		1.78(0.99)	brak
GR red EDTA		1.56(1.18)	brak
GR red HA		1,65(1.09)	brak
GR red Saline		1.92(1.07)	brak
p	brak	0.3029	
RW[8] EMD (mm)	2.99(1.33)	0.56(1.23)	<0.0001*
RW EDTA	2.76(1.87)	0.52(1.26)	<0.0001*
RW HA	3.24(1.88)	0.35(129)	<0.0001*
RW Saline	2.55(1.67)	0.53(1.2)	<0.0001*
p	0.4163	0.8871	

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PPD[9] EMD (mm)	1.47(0.52)	1.76(0.69)	0.0204*
PPD EDTA	1.45(0.59)	1.66(0.68)	0.0342*
PPD HA	1.42(0.54)	1.42(0.53)	0.9982
PPD Saline	1.48(0.51)	1.72(0.7)	0.0198*
p	0.8294	0.7661	
CAL[10] EMD (mm)	2.56(1.59)	1.22(0.67)	0.0049*
CAL EDTA	2.66(1.65)	1.33(0.78)	0.0104*
CAL HA	3.08(1.28)	0.50(0.85)	<0.0001*
CAL Saline	2.44(1.68)	1.24(0.82)	0.0183*
p	0.3195	0.4178	
CAL gain EMD (mm)		2.13(1.12)	brak
CAL gain EDTA		1.45(1.10)	brak
CAL gain HA		2.58(1.54)	brak
CAL gain Saline		1.63(1.38)	brak
p	brak	0.0183	
KTW[11] EMD (mm)	2.75(1.33)	3.51(1.31)	<0.0001*
KTW EDTA	3.01(1.32)	3.67(1.02)	0.0018*
KTW HA	2.80(1.38)	3.57(1.49)	0.2092
KTW Saline	2.85(1.33)	3.82(1.01)	0.0119*
p	0.4107	0.3274	
KTW gain EMD (mm)		0.76(0.99)	brak
KTW gain EDTA		0.79(1.01)	brak
KTW gain HA		0.68(1.40)	brak
KTW gain Saline		0.91(1.05)	brak
p	–	0.0124	
GT[12] EMD (mm)	1.16(0.34)	2.05(0.62)	<0.0001*
GT EDTA	1.33(0.47)	1.93(0.63)	<0.0001*
GT HA	1.68(0.72)	2.54(0.74)	0.0351*
GT Saline	1.28(0.34)	2.21(0.63)	<0.0001*
p	0.1689	0.0276	
GT gain EMD (mm)		0.66(0.55)	brak
GT gain EDTA		0.63(0.57)	brak
GT gain HA		0.81(0.79)	brak
GT gain Saline		0.73(0.61)	brak
p	–	0.0458	

[1]GR gingival recession height,[2]EMD enamel matrix derivative,[3]EDTA ethylenediaminetetraaceticacid,[4] HA hyaluronic acid,[5]ARC average root coverage, [6]CRC complete root coverage, [7]GRred gingival recession reduction, [8]RW gingival recession width,[9]PPD probing pocket depth,[10]CAL clinical attachment level,[11]KTW keratinized tissue width,[12]GT gingival thickness,*statistically significant (p≤0.05).

3.2. *Patient-Reported Outcomes*

Postoperative pain was common in all groups in the early phase and declined over time. The proportion of patients reporting pain differed significantly among groups on the 1st, 2nd and 7th postoperative days (p = 0.016, p = 0.024 and p = 0.033, respectively), but not on the 4th or 14th days. Mean VAS pain scores showed a similar pattern, with significant between-group differences on days 1, 2 and 7 (p = 0.020, p < 0.0001 and p = 0.003), and no significant differences on days 4 and 14 (p = 0.241 and p = 0.286).

Edema was almost universal during the first postoperative days. The proportion of patients reporting edema differed significantly among groups on the 2nd, 4th and 14th days (p = 0.011, p = 0.001 and p = 0.001), but not on days 1 and 7. VAS scores for edema remained significantly different between groups at all time points (p ≤ 0.023), indicating persistent differences in swelling intensity across treatment modalities (Table 3).

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Table 3. P-analysis between groups (EDTA, EMD, HA, Saline).

	p 1st day	p 2nd day	p 4th day	p 7th day	p 14th day
Pain – N[1] answering "yes" (%)	0.016	0.024	0.662	0.033	0.117
Pain – VAS[2] mean (SD[3])	0.020	<0.0001	0.241	0.003	0.286
Edema – N answering "yes" (%)	0.334	0.011	0.001	0.091	0.001
Edema – VAS mean (SD)	0.023	<0.0001	<0.0001	0.004	0.008

[1]N number of patients,[2]VAS Visual Analoque Scale ,[3]SD standard deviation, *statistically significant (p≤0.05).

Overall, patient-reported outcomes were highly favorable across all treatment groups (EMD, EDTA, HA, and SCTG saline). A high proportion of patients answered "yes" to all questionnaire items, including satisfaction with gingival color and contour, perceived recession coverage, overall satisfaction with treatment, willingness to undergo the procedure again, and willingness to recommend the treatment to others. Mean VAS scores were consistently high across all groups, generally ranging from approximately 76 to 90 points.

Statistically significant intergroup differences were observed for the perception of recession coverage ($p = 0.0177$) and for willingness to recommend the treatment to another patient ($p = 0.0142$). No significant differences among groups were found for gingival color, gingival contour, overall satisfaction with the treatment outcome, or willingness to undergo the treatment again (all $p > 0.05$) (Table 4).

Table 4. Results of patient questionnaire for evaluation of esthetics and overall satisfaction.

Question	EMD[1] (n[5] =70)		EDTA[2] (n = 72)		HA[3] (n=133)		SCTG (n =366)		*p*
	N[4] answering "yes" (%)	VAS[6] mean (SD[7])	N answering "yes" (%)	VAS mean (SD)	N answering "yes" (%)	VAS mean (SD)	N answering "yes" (%)	VAS mean (SD)	
Gingival color		81.5 (13.03)	20 (100%)	83.23 (13.35)	23 (95%)	79.8 (11.52)	84 (99%)	83.18 (11.90)	0.0796
Gingival contour		80.2 (14.89)	19 (95%)	81.89 (14.90)	24 (100%)	82.1 (13.36)	83 (98%)	83.04 (13.22)	0.2606
Recession coverage		75.8 (15.04)	19 (95%)	75.01 (19.57)	24 (100%)	82.9 (10.85)	83 (98%)	80.41 (14.63)	0.0177 *
"How satisfied are you with the results of the surgery?"	19 (95%)	83.0 (12.53)	18 (90%)	78.89 (23.11)	24 (100%)	87.4 (8.87)	82 (96%)	84.29 (14.42)	0.1812
"Would you decide again to go for the treatment performed?"	19 (95%)	84.2 (15.02)	18 (90%)	81.33 (16.61)	24 (100%)	86.9 (9.46)	82 (96%)	84.78 (13.40)	0.5395
"Would you recommend the treatment to another person?"	18 (90%)	80.8 (17.96)	18 (90%)	77.49 (16.74)	24 (100%)	87.02 (7.81)	81 (95%)	84.00 (13.90)	0.0142 *

[1]EMD enamel matrix derivative,[2]EDTA ethylenediaminetetraceticacid,[3] HA hyaluronic acid,[4] N number of patients,[5]n number of defects,[6]VAS Visual Analoqque Scale,[7]SD standard deviation,*statistically significant (p≤0.05).

3.3. Professional Aesthetic Evaluation

At 12 months, the professional aesthetic assessment revealed comparable outcomes among the EMD, EDTA, HA and SCTG + saline groups for gingival margin (GM) and mucogingival junction (MGJ) scores, with no significant intergroup differences ($p = 0.7982$ and $p = 0.1241$, respectively). In contrast, statistically significant differences between the groups were detected for marginal tissue contour (MTC; $p = 0.0143$), soft tissue texture (STT; $p = 0.0264$), gingival color (GC; $p = 0.0187$) and the overall esthetic score (RES; $p = 0.0091$). Overall, all treatment modalities demonstrated high professional esthetic ratings (Table 5).

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Table 5. Evaluation of esthetic outcomes after 12 months—mean (standard deviation).

	GM[4]	MTC[5]	STT[6]	MGJ[7]	GC[8]	RES[9]
EMD[1]	5.62(1.01)	0.98(0.11)	0.95(0.16)	0.98(0.32)	1.00(0.00)	9.65(0.97)
EDTA[2]	5.50(1.07)	0.83(0.21)	0.83(0.21)	0.91(0.33)	0.89(0.30)	8.88(1.22)
HA[3]	5.75(0.83)	0.90(0.30)	0.96(0.20)	0.92(0.28)	0.98(0.14)	9.51(1.01)
Saline	5.57(1.02)	0.85(0.23)	0.86(0.24)	0.90(0.35)	0.85(0.3)	8.93(1.24)
p	0.7982	0.0143*	0.0264*	0.1241	0.0187*	0.0091*

[1]EMD enamel matrix derivative,[2]EDTA ethylenediaminetetraceticacid,[3] HA hyaluronic acid,[4]GM gingival margin,[5]MTC marginal tissue contour,[6]STT soft tissue texture,[7]MGJ mucogingival junction alignment,[8]GC gingival color,[9]RES Root Coverage Esthetic Score,*statistically significant ($p \leq 0.05$).

4. Discussion

In the present study, patient-reported outcomes demonstrated that all evaluated MCAT + SCTG protocols were associated with generally favorable patient experience; however, relevant differences were observed between adjunctive approaches during the early postoperative period and in long-term patient-perceived esthetic outcomes. Early healing was characterized by protocol-dependent variations in postoperative discomfort and functional limitations, whereas at 12 months the protocols differed primarily with respect to patient satisfaction with the esthetic result and overall treatment benefit. Importantly, patient-rated esthetic perception did not fully align with professional esthetic assessments, indicating that patient-centered and clinician-based evaluations capture distinct and complementary dimensions of treatment success.

From a patient-centered perspective, several modifiable adjuncts can be considered to potentially improve subjective experience and satisfaction after MCAT + SCTG. These include the chemical root surface biomodification with 24% EDTA (alone or followed by enamel matrix derivative; EDTA+EMD), and the use of biologically active agents such as EMD or cross-linked hyaluronic acid (HA). As mechanical root instrumentation was standardized in all groups, any differences in PROMs are more plausibly attributable to these adjunctive choices rather than to mechanical root preparation.

Alongside the growing emphasis on patient-centered outcomes, increasing esthetic expectations have shifted clinical evaluation from purely clinician-based success criteria toward a broader assessment of patient experience and perceived benefit. In the present study, PROMs revealed that adjunctive protocols differed in their impact on early postoperative morbidity and on patient-perceived esthetic outcomes, despite comparable clinician-assessed results. These findings are in line with previous reports indicating that patient perception of discomfort, recovery and esthetic satisfaction represents an important and distinct dimension of treatment success that is not fully captured by conventional clinical indices [9–13]. Moreover, the observed divergence between professional esthetic scores and patient-reported esthetic satisfaction further supports earlier observations that clinician-based evaluation systems and PROMs describe complementary, but not interchangeable, aspects of therapeutic outcome [14,15].

The differences observed in patient-reported outcomes may be partly explained by the clinical properties of the adjunctive agents applied in the present study. Root surface conditioning with EDTA and the application of enamel matrix derivative are intended to promote a more favorable root–soft tissue interface, which may facilitate early wound stabilization and contribute to improved patient comfort during the initial healing period [16]. In addition, the use of hyaluronic acid as an adjunct may support a more favorable early healing course and patient perception of soft-tissue quality, which is consistent with the higher patient-rated esthetic outcomes observed in the present analysis [17–21]. Collectively, these adjunct-specific clinical properties may have contributed to the protocol-dependent differences in early postoperative experience and in patient-perceived esthetic benefit noted in this study.

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In this retrospective comparative cohort study of 64 patients (275 recession defects) treated with MCAT + SCTG combined with various adjunctive modalities, all protocols yielded favorable clinical improvements at 12 months, with no postoperative complications. However, PROMs differentiated protocols during the early postoperative period and in patient-perceived esthetic domains, suggesting that patient-centered "treatment burden" and perceived benefit may vary even when long-term clinician-measured endpoints converge [24,25].

Pain and swelling decreased over time in all groups, yet between-group differences were observed during the first postoperative week. Such findings are clinically relevant because the initial recovery phase is the time window in which symptoms and functional limitations are most salient to patients and most likely to influence treatment acceptance and willingness to repeat surgery [26,27]. From a patient-centered standpoint, these short-term differences may represent a significant component of comparative effectiveness, particularly when the underlying surgical approach is predictable and long-term clinical outcomes are generally consistent across protocols. In this context, adjuncts intended to optimize the wound environment (e.g., HA) or root–soft tissue interface (e.g., EDTA/EMD) could theoretically contribute to differences in early symptom trajectories; nonetheless, causal inferences cannot be made from the present non-contemporaneous cohort comparison.

Patient-rated esthetic outcomes at 12 months were high overall but varied by adjunct, whereas professional esthetic evaluation (RES/MTC) favored a different protocol. This divergence highlights that professional indices prioritize predefined components of soft tissue integration, whereas patients may value global appearance, perceived naturalness, comfort, and subjective stability differently [26–29]. Therefore, PROMs should not be treated as redundant to professional scores; rather, both perspectives are needed when esthetics and patient experience are dominant success criteria.

The pattern of results suggests that adjuncts may differentially influence dimensions of "success" within an otherwise predictable surgical framework. For example, one protocol may be associated with superior professional esthetic scoring, while another may provide a more favorable early morbidity profile and higher patient-rated esthetics. Clinically, this supports the integration of PROMs into treatment planning and shared decision-making—especially for patients who prioritize rapid recovery or are concerned about postoperative discomfort [26,30].

The present findings should be interpreted with caution, particularly when comparing outcomes across different studies and treatment cohorts. Because the groups were non-contemporaneous, causal inferences regarding the effects of the investigated adjunctive biomaterials cannot be drawn, and the observed differences may partly reflect period- and context-related bias, including the operator learning curve, progressive refinement of surgical protocols, changes in perioperative management and evolving patient counseling strategies [31]. Baseline imbalances between cohorts (e.g., age and distribution of recession types) further limit comparability and may confound both patient-reported and esthetic outcomes, which are influenced by demographic and psychosocial factors in addition to clinical variables [26,29].

The use of study-specific PROM instruments and VAS scales limits external validity and cross-study comparability and is prone to recall, response-shift and measurement bias. In addition, incomplete PROM data and non-random missingness may distort between-group and between-study comparisons if symptom severity influences response rates [32]. The relatively small and uneven group sizes also restrict statistical power to detect modest but clinically relevant differences. Finally, the treatment of multiple recession defects within the same patient introduces clustering, which may bias comparisons if intra-patient correlation is not adequately accounted for, while PROMs should be analyzed primarily at the patient level rather than at the defect level [25,33].

Future investigations should therefore be based on adequately powered, prospective, contemporaneous randomized controlled trials with balanced baseline characteristics, standardized and validated outcome measures, predefined strategies for missing-data handling, and appropriate statistical models accounting for clustered data, to enable more robust inter-study comparisons and support causal interpretation.

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Despite these limitations, the present results demonstrate that PROMs can reveal differences in early postoperative experiences and patient-perceived aesthetics, complementing clinician-assessed outcomes. Prospective studies with contemporaneous cohorts, standardized and validated PROM instruments, transparent reporting of completion rates, and analytic strategies accounting for clustering are warranted to confirm whether the observed PROM advantages persist and to clarify their clinical relevance over time.

5. Conclusions

Within the limitations of this retrospective study, MCAT combined with SCTG provided predictable root coverage and stable 12-month clinical outcomes in the treatment of multiple RT1 and RT2 gingival recessions, regardless of the adjunctive protocol used. While primary clinical outcomes were comparable among groups, patient-reported outcome measures (PROMs) revealed significant differences in early postoperative pain and swelling, indicating that patient-perceived morbidity varied between treatment modalities despite similar objective results. Overall esthetic satisfaction and treatment acceptance were high across all groups. These findings highlight the importance of incorporating PROMs alongside clinical parameters to achieve a more comprehensive, patient-centered evaluation of periodontal plastic surgery outcomes. Further prospective studies are required to confirm these observations.

Author Contributions: Conceptualization, Bartłomiej Górski.; methodology, Nela Molga-Chlipała.; Nela Molga-Chlipała X.X.; validation, Bartłomiej Górski, Nela Molga-Chlipała, Małgorzata Wyszyńska-Pomian.; formal analysis, Nela Molga-Chlipała.; investigation, Nela Molga-Chlipała.; resources,Nela Molga-CHlipała; data curation, Nela Molga-Chlipała writing—original draft preparation, Nela Molga-Chlipałą writing—review and editing, Małgorzata Wyszyńska-Pomian, Bartłomiej Górski.; visualization Nela Molga-Chlipała ;supervision, Małgorzata Wyszyńska-Pomian.; project administration, Bartłomiej Górski.; funding acquisition, Nela Molga-Chlipała. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki (1975), including the amendments adopted in Tokyo in 2004, and received approval from the Bioethics Committee of the Medical University of Warsaw (KB/208/2017; KB/119/2021) and registered with ClinicalTrials.gov (NCT03354104; NCT05045586).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data are available upon reasonable request from the corresponding author. Access to the data is restricted at present due to administrative and technical issues related to repository registration.

Acknowledgments: Not applicable.

Conflicts of Interest: The authors declare no conflicts of interest.:

Abbreviations.

The following abbreviations are used in this manuscript:

EMD enamel matrix derivative,EDTA ethylenediaminetetraceticacid,HA hyaluronic acid,GM gingival margin,MTC marginal tissue contour,STT soft tissue texture,MGJ mucogingival junction alignment,GC gingival color,RES Root Coverage Esthetic Score,ARC average root coverage, CRC complete root coverage, GRred gingival recession reduction, RW gingival recession width,PPD probing pocket depth,CAL clinical attachment level,KTW keratinized tissue width,GT gingival thickness,GR gingival recession

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