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RANDOMIZED CLINICAL TRIAL

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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

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Abstract

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 CM 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 CM 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 CM and SCTG, of which the latter is more efficient as far as root coverage and aesthetic parameters are concerned.

KEYWORDS
collagen matrix, modified coronally advanced tunnel technique, multiple gingival recessions, subepithelial connective tissue graft

1 | INTRODUCTION

In recent years, surgical treatment of gingival recessions has become an important element not only of periodontal treatment but in broadly understood interdisciplinary treatment as well. An indication to use the procedure is the need to cover the exposed root surface and augment soft tissue volume. Long-term observations showed that tissue volume supports the stability of marginal gingiva and minimizes a recurrence risk (Bonacci, 2011; Zucchelli et al., 2014).

The treatment of gingival recessions encompasses a number of established surgical techniques, including various tunnel procedures which, due to the elimination of vertical cuts, ensure good vascularization, nourishment of the flap and faster healing in the

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early phase (Allen, 1994; Aroca, Barbieri, Clementini, Renouard, & Sanctis, 2018; Vincent-Bugnas, Borie, & Charbit, 2018; Zabalegui, Sicilia, Cambra, Gil, & Sanz, 1999). The effectiveness of this technique has been extensively discussed in the literature in recent years (Aroca et al., 2010, 2013; Graziani et al., 2014; Molnár et al., 2013; Yaman, Demirel, Aksu, & Basegmez, 2015). Majority of authors suggest routine use of SCTG, which remains a standard means of augmenting soft tissue to secure the best possible coverage of recessions and phenotype thickening (Zuhr, Bäumer, & Hürzeler, 2014). There are, however, some drawbacks of using autogenous grafts. Harvesting the graft creates yet another surgical site, and the amount of available tissue may be limited (Cairo, 2017; Vincent-Bugnas et al., 2018). The surgery itself takes longer time, makes the patient suffer additional pain and increases a risk of intra- and postsurgical complications, mainly bleeding from the donor site (Griffin, Cheung, Zavras, & Damoulis, 2006; Soileau & Brannon, 2006). It seemed obvious to begin search for new materials that would replace autogenous grafts. One of the newest types of such biomaterials is a xenogenic collagen matrix (CM), a three-dimensional membrane made of two functional structures: a dense layer of tightly packed collagen fibres on a thick porous scaffold. Such structure provides space for clot formation and ingrowth of adjacent tissue (Vignoletti et al., 2011). Clinical efficacy of CM has not yet been clearly confirmed, particularly for cases of gingival recession in the mandible.

Therefore, the aim of the study was to compare the outcomes of MCAT randomly combined with CM or SCTG in the treatment of Miller class I and II multiple gingival recessions in the mandible. The primary objective of the study was to asses GR reduction and soft tissue thickness gain after treatment (primary outcome). The secondary objective was to evaluate aesthetic parameters.

Clinical Relevance

Scientific rationale for the study: Post-surgical discomfort, due to graft harvesting from the palate, draws attention to the necessity of replacing subepithelial connective tissue graft (SCTG) by biomaterials, such as collagen matrix, in the treatment of multiple gingival recessions.
Principal findings: Both collagen matrix (CM) and SCTG were efficient when applied within modified coronally advanced tunnel technique in the treatment of mandibular recessions. SCTG, however, seems to produce a greater clinical attachment level gain, mean and complete root coverage as well as Root Coverage Esthetic Score.
Practical implications: The results indicate that subepithelial connective tissue graft is superior to collagen matrix in the treatment of gingival recessions in the mandible.

2 | MATERIALS AND METHODS

2.1 | Study design and population

The study was designed as a single-centre, randomized, split-mouth, assessor-blind trial and encompassed a group of 20 patients—13 women aged 20-56 and seven men aged 23-43—referred to the Department of Periodontal and Oral Mucosa Diseases, Medical University of Białystok between June 2015 and June 2016 (Figure 1). Financial limitations determined the size of the group. Eventually, a post hoc analysis of power of the test showed it to be 0.9529. Allocation of treatment sites to test and control sites was done by means of a computer-generated randomization table created by a biostatistician (R.M.). One examiner (A.S.) qualified patients into the study while the other (Ł.P.) registered them accordingly for randomized testing. The surgeon (M.P.) was told which procedure to perform at the specific site only after the patient had been given anaesthetic.

Each patient signed a consent form prior to entering the study. The study was compliant with Helsinki Declaration of 1975 as revised in 2000, reviewed and approved by the local ethics committee (R-I-002/222/2014).

Inclusion criteria were as follows: at least two single-rooted teeth with gingival recessions Miller class I and/or II ≥1 mm deep in two quadrants in mandible without loss of CAL on aspects other than the buccal; FMPS and FMBOP <20%; no active periodontal disease; over 18 years of age; detectable cemento-enamel junction (CEJ); and no caries lesions or restorations in the cervical area. Patients with general diseases which could affect healing process, smokers, as well as pregnant or breastfeeding women did not qualify for the study. The quantity and quality of soft tissue on teeth with gingival recessions (e. g., gingiva thickness, width of keratinized tissues) were not inclusion/exclusion criteria. At a scheduled prophylaxis appointment, the patients were instructed on how to use the roll technique in order to minimize mechanical trauma by vigorous tooth brushing.

2.2 | Clinical examination

The following clinical parameters were measured for each gingival recession defect:

1. Gingival recession height (GR)—at mid-buccal aspect of the tooth from the CEJ to the most apical extension of gingival margin;
2. Recession width (RW)—at CEJ level;
3. Probing depth (PD)—at mid-buccal aspect of the tooth from the gingival margin to the bottom of the sulcus;
4. Clinical attachment level (CAL)—at mid-buccal aspect of the tooth from the CEJ to the bottom of the sulcus;
5. Keratinized tissue (KT)—from the most apical point of gingival margin to the muco-gingival junction (MGJ);
6. Gingival thickness (GT)—at mid-buccal aspect of the tooth on a long axis, 3 mm apically from the gingival margin with use of K-file

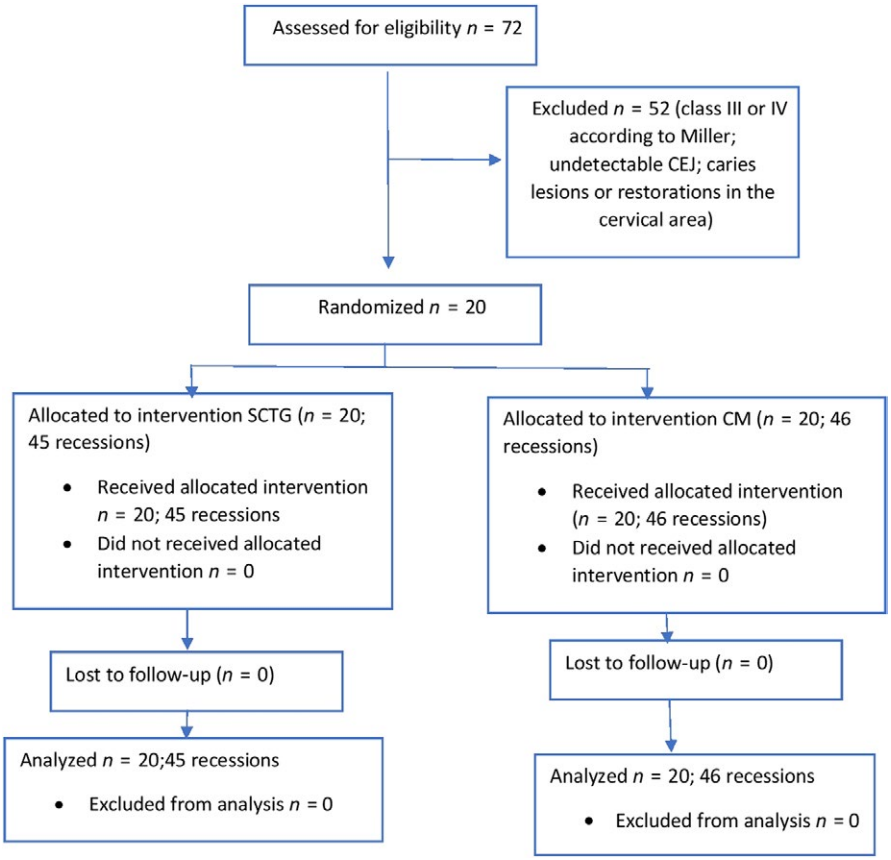

FIGURE 1 Consort flowchart of the study

25 ISO with a silicon marker driven perpendicularly to the gingival surface under local anaesthesia;

7. Full-mouth plaque score (FMPS)—at four aspects of tooth (O'Leary, Drake, & Naylor, 1972);
8. Full-mouth bleeding on probing (FMBOP)—at four points of tooth: mesio-vestibular (mv), mid-vestibular (v), disto-vestibular (dv), mid-lingual (l) (Ainamo & Bay, 1975).

All measurements were rounded to the nearest 0.5 mm. Two clinical examinations by the same examiner took place, one at baseline and the other 12 months later, with the use of periodontal probe (PCP UNC15, Hu-Friedy). The intra-examiner reproducibility for GR measurements was assessed, and the interclass correlation coefficient was 98%. Five patients, not included in the study, with at least two contralateral teeth with recessions, were used to calibrate the examiner (A.S.). The examiner evaluated four teeth of each patient on two separate occasions, 48 hr apart. Calibration was accepted if measurements at baseline and at 48 hr appointment were equal to the millimetre at >90% level.

To evaluate the effectiveness of the treatment, additional calculations were performed:

1. Recession reduction (GRred) = GR 0−GR 12
2. Mean root coverage (MRC) = GR 0−GR 12/GR 0 × 100%
3. KT gain = KT 12−KT 0
4. GT gain = GT 12−GT 0.

2.3 | Aesthetic evaluation

An independent examiner (J.P.) evaluated the aesthetic outcome according to the Root Coverage Esthetic Score (RES) (Cairo, Rotundo, Miller, & Pini Prato, 2009).

2.4 | Surgical procedure

The sole surgeon (M.P.) carried out all surgical interventions using the modified coronally advanced tunnel technique as described by Zuhr, Fickl, Wachtel, Bolz, and Hürzeler (2007) with collagen matrix on one side of the mandible (46 recessions—Test) or subepithelial connective tissue graft on the opposite side (45 recessions—Control). All adjacent gingival recessions on one side were treated within a single intervention, and both sides were covered during one appointment. The recipient site was prepared as a full thickness flap up to the muco-gingival junction (MGJ) and then as a split thickness flap above MGJ. Subsequently, subepithelial connective tissue graft was harvested from the palate as the epithelialized gingival graft. After its de-epithelialization, the graft was positioned at CEJ or 1 mm below the CEJ and stabilized with resorbable monofilament 6-0 sutures (Biosyn®, Covidien, Ireland) on one side. The thickness of the graft was less than 1 mm, and its width varied from 4 to 5 mm. Likewise, the preparation of recipient bed and collagen matrix (mucoderm®, botiss biomaterials, Germany) positioning was done on the opposite

side. Then, the SCTG and CM were covered with coronally advanced flap and secured with sling sutures using 6-0 non-resorbable monofilament suture (Ethilon®, Ethicon). Patients were instructed to rinse the mouth twice daily using 0.2% chlorhexidine solution, refrain from eating hard food and avoid vigorous tooth brushing at surgical area for 2 weeks. Painkillers were prescribed accordingly to patients' needs. The sutures were removed 2 weeks post-op. Check-up appointments were scheduled for 1, 2 and 4 weeks and then 3, 6 and 12 months after the surgery. Healing and possible complications (CM and SCTG exposure; graft, flap or papillae necrosis, inflammation as well as pain exacerbations) were monitored during the follow-up appointments. Additionally, at check-ups, the supragingival plaque was removed and photographs were taken, except week 1 appointment to avoid tissue trauma.

2.5 | Statistical analysis

In statistical analysis, normal distribution was verified by the Kolmogorov–Smirnov test combined with the Lillefors amendment and the Shapiro–Wilk test. No normal distribution of quantitative variables was found. The non-parametric Mann–Whitney U test was used to compare ordinal or quantitative variables without normal distribution. The Wilcoxon matched pairs test was used to compare dependent variables. A Spearman's rank order correlation coefficient was also determined to examine the relationship between post-op GT and GRred and between post-op GT and MRC. Additionally, a univariate linear regression analysis was done to estimate the relationship between post-op GT and GRred, and a univariate logistic model was calculated to estimate the relationship between post-op GT and CRC. The results were considered statistically significant at $p < 0.05$. The Statistica 12.0 package (StatSoft) was used for all calculations.

3 | RESULTS

All patients kept scheduled appointments and none abandoned the study. Two weeks post-op healing was uneventful both at the donor and recipient sites in majority of patients. Prolonged healing with signs of inflammation occurred only in two patients, but the cases did not require any additional intervention.

No statistically significant differences were found between the two sides in any clinical parameter evaluated at baseline examination. At the 12 months post-op examination, PD did not change significantly in regard to either technique. However, statistically significant CAL gain was observed—1.1 mm after applying CM and 1.54 mm after applying SCTG. Mean root coverage (MRC) on the CM side was 53.20%, whereas on the SCTG side 83.10%. Complete root coverage (CRC) was achieved in 9 out of 45 (20%) gingival defects treated with CM and 31 out of 46 (67%) treated with SCTG. Complete coverage of all gingival recessions on the side treated with CM was evident in two subjects (10%), whereas on the SCTG side in nine subjects (45%).

Statistically significant reduction in GR was achieved on both sides. It ranged from 1.95 ± 0.76 mm to 0.95 ± 0.79 mm on the CM side and from 1.94 ± 0.66 to 0.40 ± 0.69 mm on the SCTG side. Also, a statistically significant decrease in RW was noted, from 2.97 ± 0.75 to 2.08 ± 1.30 mm on the CM side and from 3.04 ± 0.73 to 0.89 ± 1.37 mm on the SCTG side. There were significant differences in all parameters (MRC, CRC, GR, RW) between the CM and the SCTG sides after treatment.

Post-treatment examination revealed significant increases of KT and GT on both sides: for KT, from 1.38 ± 0.68 to 1.91 ± 0.84 mm on the CM side and from 1.28 ± 0.72 to 4.06 ± 1.59 mm on the SCTG side; for GT, from 0.82 ± 0.30 to 1.10 ± 0.37 mm on the CM side and from 0.76 ± 0.31 to 1.86 ± 0.48 mm on the SCTG side. There were statistically significant differences in KT and GT gains between the two sides at 12-month examination. Table 1 presents all clinical parameters.

There was a statistically significant correlation between post-op GT and MRC ($p = 0.004$, R Spearman = 0.41), as well as between post-op GT and GRred ($p = 0.003$, R Spearman = 0.42) in the CM group.

The univariate linear regression model showed a significant impact of post-op GT on recession reduction in the CM group ($p = 0.045$, Coef. = 0.555), whereas the univariate logistic regression model showed no relationship between post-op GT and CRC in both groups.

The average RES after MCAT with CM was 7.11 ± 1.95 while after MCAT with SCTG 8.36 ± 1.78. There was a statistically significant difference in the RES (Root Coverage Esthetic Score) as well as in the three component parameters: gingival margin (GM), mucogingival junction alignment (MGJ) and gingival colour (GC) between the two procedures (Table 2). Figures 2 and 3 show images of outcome in two patients.

4 | DISCUSSION

The aim of the study was to compare the efficacy of multiple gingival recessions treatment on single-rooted mandibular teeth when MCAT technique is used in conjunction with CM or SCTG. The primary objective of the study was to evaluate a degree of GR reduction and soft tissue thickness gain. Both methods brought improvement of clinical parameters reflecting reduced recession and increased thickness of the gingiva and the amount of keratinized tissue. Statistical comparison of relevant parameters revealed significant differences in the outcome these two methods each bring. Figures illustrating reduced recession, gingival thickness and keratinized gingival height were greater when autogenous graft was used.

There is little data in the available literature that took a comparative approach to effectiveness of the discussed techniques. As far as we know, ours has been the second study that focuses on the two-way treatment outcome over 12-month observation, and the first one concerning recessions in the mandible. Our results are partly comparable to those attained in other randomized trials.

TABLE 1 Clinical parameters (mean and *SD*) at baseline and 12 months post-surgery

	Baseline	12 month	*p*
GR SCTG 46n	1.94 (0.66)	0.40 (0.69)	<0.001
GR CM 45n	1.95 (0.76)	0.95 (0.79)	<0.001
p	0.7004	<0.001	
MRC SCTG		83.10 (27.63)	
MRC CM		53.20 (32.17)	
p		<0.001	
GRred SCTG		1.54 (0.58)	
GRred CM		1.00 (0.69)	
p		<0.001	
RW SCTG	3.04 (0.73)	0.89 (1.37)	<0.001
RW CM	2.97 (0.75)	2.08 (1.30)	<0.001
p	0.4675	<0.001	
PD SCTG	1.57 (0.48)	1.58 (0.64)	0.9546
PD CM	1.47 (0.46)	1.37 (0.58)	0.3809
p	0.3135	0.0703	
CAL SCTG	3.52 (0.75)	1.98 (0.88)	<0.001
CAL CM	3.43 (0.93)	2.33 (0.89)	<0.001
p	0.3055	0.0545	
KT SCTG	1.28 (0.72)	4.06 (1.59)	<0.001
KT CM	1.38 (0.68)	1.91 (0.84)	<0.001
p	0.5909	<0.001	
KT gain SCTG		2.78 (1.53)	
KT gain CM		0.52 (0.65)	
p		<0.001	
GT SCTG	0.76 (0.31)	1.86 (0.48)	<0.001
GT CM	0.82 (0.30)	1.10 (0.37)	<0.001
p	0.2956	<0.001	
GT gain SCTG		1.10 (0.54)	
GT gain CM		0.27 (0.40)	
p		<0.001	
PI SCTG	0.02 (0.07)	0.05 (0.11)	0.2393
PI CM	0.03 (0.10)	0.04 (0.09)	0.8139
p	0.6992	0.7961	
BOP SCTG	0.04 (0.13)	0.07 (0.13)	0.3202
BOP CM	0.06 (0.14)	0.03 (0.08)	0.3636
p	0.5641	0.1145	
FMPS	7.26 (4.10)	5.53 (3.44)	0.2096
FMBOP	6.86 (3.88)	6.00 (3.77)	0.3837

Notes. MRC (mean root coverage) = (GR 0−GR 2)/GR 0 × 100%.
GRred (recession reduction) = GR 0−GR 12.
KT gain = KT 12−KT 0.
GT gain = GT 12−GT 0.

Aroca et al. (2013) compared the efficacy of MCAT + CM with MCAT + CTG in the treatment of Miller class I and II recessions located in the maxilla and mandible. In their study, with an observation period spanning 12 months, they attained 42% of CRC in the MCAT + CM group, while 85% in MCAT + CTG. The difference was statistically significant in favour of the group treated with CTG, as was MRC (71 ± 21% MCAT + CM; 90 ± 18% MCAT + CTG). In their study, there was also a significant decrease in gingival recession depth by 1.6 mm (from 1.8 ± 0.5 to 0.2 ± 0.3 mm) and width by 3.3 mm (from 3.8 ± 0.9 to 0.4 ± 1.0 mm), compared to the CM group, in which the depth of the recession decreased by 1.3 mm (from 1.9 ± 0.6 to 0.6 ± 0.5 mm) and width by 2.4 mm (from 3.8 ± 0.8 to 1.4 ± 1.2 mm). The only factors in favour of CM were a substantially shorter procedure time and lesser discomfort for patients (Aroca et al., 2013).

After a 6-month observation, Cieślik-Wegemund, Wierucka-Młynarczyk, Tanasiewicz, and Gilowski (2016) reported satisfactory average gingival recession coverage (ARC) delivered by both techniques (91% CM; 95% CTG) as well as reduction in gingival recession depth and width. The depth of gingival recession decreased by 2.6 mm (from 3.0 ± 0.8 to 0.4 ± 0.3 mm) in CM group and by 2.5 mm (from 2.7 ± 0.9 to 0.2 ± 0.4 mm) in CTG group. In turn, the width of gingival recession decreased by 2.9 mm (from 3.6 ± 0.9 mm to 0.7 ± 0.6 mm) in CM group and by 2.6 mm (from 3.1 ± 0.6 to 0.5 ± 0.9 mm) in CTG group. However, they showed that CM, in contrast to CTG, has limited potential to ensure a complete coverage of the recession (14.3% CM; 71.4% CTG) (Cieślik-Wegemund et al., 2016).

An analysis of data published as a case series evaluating the effectiveness of coverage of 42 Miller class I and II recessions after MCAT + CM in eight patients revealed that CRC was achieved in 30 recessions (71%) and in two patients (25%) while MRC reached the value 84 ± 15%. The average recession height significantly decreased by 1.7 mm (from 2.0 ± 0.5 to 0.3 ± 0.3 mm), and width by 2.4 mm (from 3.4 ± 0.8 to 1.0 ± 1.3 mm) (Molnár et al., 2013).

In our own research, we attained slightly less desirable results of the discussed parameters in comparison with those quoted above. These differences are probably due to the fact that our study concerned only treatment of gingival recessions in the mandible. Also Aroca et al. (2018) and Chambrone and Chambrone (2006) pointed to significantly unsatisfactory clinical results in the treatment of gingival recession located within the lower jaw.

Effective treatment of the recessions in the mandible appears more complex than in the maxilla due to a less favourable anatomy. What may affect the outcome is insufficient vascularization and dimensional stability of narrower lower papillae. Another factor could be difficult to coronally mobilize and stabilize tissue due to function of lip muscles and the minor vestibular depth (de Sanctis & Clementini, 2014; Aroca et al., 2018). Additionally, according to some authors, bilateral treatments may carry a greater risk of failure than unilateral ones (Clauser, Nieri, Franceschi, Pagliaro, & Pini-Prato, 2003). The awareness of these obstacles demands a very rational review of indications for surgery. It is important to carefully consider postoperative discomfort in the context of a potentially defective treatment effect. The anatomical obstructions also demand a great dose of practical experience in performing procedures which effects depend so much on the clinician's skills (Tonetti & Jepsen, 2014).

TABLE 2 Aesthetic evaluation after modified coronally advanced tunnel technique with collagen matrix (CM) or subepithelial connective tissue graft (SCTG)—mean (standard deviation)

	RES	GM	MTC	STT	MGJ	GC
CM	7.11 (1.95)	3.46 (2.01)	0.93 (0.25)	0.82 (0.38)	0.95 (0.20)	0.93 (0.25)
SCTG	8.36 (1.78)	5.15 (1.50)	0.91 (0.28)	0.76 (0.43)	0.76 (0.43)	0.76 (0.43)
p	0.001	<0.001	0.724	0.477	0.008	0.023

Note. GC: gingival colour; GM: gingival margin; MGJ: muco-gingival junction alignment; MTC: marginal tissue contour; RES: Root Coverage Esthetic Score; STT: soft tissue texture.

FIGURE 2 (a—h) Partial recession coverage after MCAT+CM on the right side and MCAT+SCTG on the left side in mandible (a) CM side at baseline—canine, first and second premolar with high recessions on the right side in mandible; (b) Intra-operative view with CM prepared for installation; (c) CM in place stabilized by 6-0 absorbable sling sutures; Flap reposition and stabilization by sling 6-0 non-absorbable sutures on every papilla (d) Postoperative (12 months) view of partial root coverage; (e) SCTG side at baseline (opposite side to presented in Figure 2a-d)—canine, first and second premolar with high recessions; (f) Intra-operative view with de-epithelialized SCTG harvested from palate (g) SCTG in place after flap reposition (h) Postoperative (12 months) view of partial root coverage

Considering the above, aesthetic indications, especially in the case of shallow gingival recessions in the mandible, are not of a primary concern. In our research, the minimal recession height was 1 mm (which gave a relatively low average value of less than 2 mm) that placed an aesthetic aspect out of discussion. On the other hand, all teeth had a well-preserved CEJ, which draws attention to the validity of surgical intervention to protect hard tooth tissues. When considering the methodology of the research, attention should be paid to the fact that a well-preserved CEJ can be an additional attribute allowing for more precise measurements (Zuhr, Bäumer et al., 2014; Zuhr, Rebele et al., 2013).

A subsequent primary objective of the presented study was to assess soft tissue thickness gain. After applying SCTG, the thickness of the gingiva increased by 1.1 mm, and after CM by 0.27 mm. Other authors achieved a lower GT gain—0.5 mm after using CTG, and comparable figures of 0.2 or 0.3 mm after CM (Aroca et al., 2013; Molnár et al., 2013). The width of the keratinized gingiva in our research increased by 2.78 and 0.52 mm, after SCTG and CM,

FIGURE 3 (a—h) Complete recession coverage after MCAT+SCTG on the right side and MCAT+CM on the left side in mandible (a) SCTG side at baseline—canine, first and second premolar with minor recessions on the right side in lower jaw; (b) Intra-operative view of SCTG before placement (c) SCTG covered by coronally advanced flap (d) Postoperative (12 months) view of complete root coverage; (e) CM side at baseline (opposite side to presented in Figure 3a-d—canine and first premolar with minor recessions on the left side in lower jaw; (f) Intra-operative view with CM prepare for installation (g) CM covered by coronally advanced flap (h) Postoperative (12 months) view of complete root coverage

respectively. According to other authors, KT width gain after application of CTG was also higher than after CM. Aroca et al. (2013) reported 0.7 and 0.3 mm KT width gain when CTG and CM were used. Cieślik-Wegemund et al. (2016) achieved a greater gain in this parameter—1 mm with CTG and 0.8 mm with CM. Molnár et al. (2013) in a case series study attained 0.5 mm of KT width gain after CM application. These results differ from ours, most probably due to factors like quantity and quality of tissue surrounding recessions, which can favourably or adversely affect treatment (Baldi et al., 1999; Berlucchi, Francetti, Del Fabbro, Basso, & Weinstein, 2005; Santamaria et al., 2010). Although in our study, the height of keratinized gingiva before treatment was distinctly lower as compared to the studies cited above, after augmentation, especially with the use of SCTG, the quality of tissue improved significantly. This may depend on a type of connective tissue graft used. In our study, subepithelial connective tissue graft was obtained after de-epithelialization of gingival graft (DGG), while other authors used a modified distal wedge technique or single-incision technique (Azzi, Etienne, & Carranza, 1998; Hürzeler & Weng, 1999). According to Zucchelli et al. (2010), a statistically greater increase in buccal soft tissue thickness may be achieved with DGG, owing to a better quality of connective tissue directly under the epithelium.

Another important factor that could affect the measurements of gingival thickness and consequently the KT gain score was the method of measurement. We used K-file 25 ISO with a silicon marker to measure GT. The point where the measurement was taken in relation to the free gingival margin was standardized by the radius of the silicone stopper. Taking GT measurements with an endodontic tool is a commonly used method. It is simple, inexpensive and does not need any additional equipment. However, it has certain disadvantages as tool requires anaesthesia and is error-prone, which can limit a study. There are other methods to assess soft tissue thickness such as ultrasonic examination or cone beam computed tomography (CBCT). Although relatively modern, they also carry some limitations,

namely high costs, problems taking reliable measurements of gingival thickness in different parts of the oral cavity (ultrasonic) and a necessity of radiating the patient (CBCT) (Müller, Barrieshi-Nusair, & Kononen, 2007; Ronay, Sahrmann, Bindl, Attin, & Schmidlin, 2011). In addition, the results of recently published studies indicate high compliance (agreement 86.1%) between measurements made with CT scans and transgingival assessment (Alves et al., 2018). The latest method of performing gingival measurements is to compare superimposed digital scans taken before and after treatment. Besides non-invasive character, this method is highly reproductible and accurate, allowing to avoid rounding error due to possibility to perform linear measurements to the nearest 0.01 mm (Lehmann et al., 2012; Schneider et al., 2013; Windisch et al., 2007). According to (Zuhr, Rebele et al., 2013) and Rebele, Zuhr, Schneider, Jung, and Hürzeler (2014), this method has however certain limitation in evaluation of gingival contour—gives possibility only of postoperative soft tissue thickness values.

The presented study has reviled that there was a relationship between post-op GT and GRred/MCR and that post-op GT had a significant impact on recession reduction only in the CM group. The absence of the above dependences in the SCTG group can be explained by a significantly greater increase in gingival thickness after the use of autogenous graft as compared to the collagen matrix. According to Rebele et al. (2014), there is a minimal thickness of the gingiva—1.44 mm, necessary to obtain CRC, and exceeding a certain soft tissue thickness is not worthwhile with regard to the efficacy of the treatment. In our study, after applying SCTG, the thickness of the marginal soft tissues did not exceed 1.5 mm only at 4 out of 46 teeth, while after applying CM—at 17 out of 45. The results also confirm the legitimacy of performing minimally invasive techniques of harvesting grafts from the palate as the thin grafts collected in this way are sufficient to obtain both, optimal gingival thickness and aesthetics (Zucchelli, Amore, Sforza, Montebugnoli, & de Sanctis, 2003).

The secondary objective of the study was to evaluate the aesthetic outcome of the two-way MCAT treatment incorporating CM or SCTG. A success in root coverage procedure rests on position of the gingival margin coronally in respect to CEJ in conjunction with minimal probing depth (Vignoletti et al., 2011). The Root Coverage Esthetic Score System proposed in 2009 by Cairo et al. (2009) has changed the way effectiveness of recession treatment is assessed. Apart from gingival margin position, other aspects such as soft tissue texture, marginal tissue contour, colour and muco-gingival junction alignment need to be included into assessment (Cairo et al., 2009, 2010). An independent examiner who analyzed photographs taken 1 year after the surgery found significant differences in gingiva appearance between sides. Total RES and GM were significantly higher on the SCTG side, while other aesthetic parameters, that is, MGJ and GC turned out to be higher on the CM side. It needs to be emphasized that a large proportion of RES score (60%) is based on root coverage assessment, that is why it turned out to be higher in the control group. The lower score of MGJ position comes from discrepancies between MGJ position in the operated site and adjacent teeth. SCTG application permanently increases volume of soft tissue in the augmented area, that is why MGJ remains more coronally in relation to neighbouring teeth. On the other hand, when CM gradually degrades, the position of MGJ returns to baseline. When CM is applied, the colour of the augmented gingiva matches better the colour of the surrounding soft tissue while in case of SCTG, the colour of the augmented gum is generally somewhat paler or whitish. This fact can be explained by a difference in tissue healing, especially when material for augmentation was exposed during healing process. According to Zucchelli et al. (2014), additional use of SCTG with CAF procedure is responsible for a less desirable colour match due to keloid formation if the graft has been exposed. The above argument cannot explain the results in our study though, where SCTG had not been exposed in any case. A paler gum shade can be linked to the thickness of the flap in the recipient site, which in many cases was extremely thin.

There are few publications in existing literature that explore efficacy of CM and CTG in combination with other surgical techniques. Tonetti et al. (2018) concluding a six-month follow-up after a coronally advanced flap showed that CAF + CM is less effective in treating multiple gingival recessions than CAF + CTG. The authors pointed to certain benefits for the patient resulting from CAF + CM combination, that is, the surgery takes shorter time, the patient experiences lesser pain, it takes shorter to recover. Although CAF cannot be directly compared to MCAT, it seems that clinical benefits of using CTG are greater than CM, regardless of which technique is used to prepare the recipient site. However, from the patient's point of view, CM is less of a burden, both during the surgery and postoperative period. That is why also patients in presented study, who complained of severe palatal pain, would rather chose CM procedure.

To sum up, the results of our own research it can be concluded that CM may be an alternative to SCTG, but only for a certain group of patients, including those who are overly scared of surgical procedures and those suffering from systemic diseases that cause prolonged bleeding or/and affect healing. The choice of material for gingival augmentation should also depend on the primary purpose of the procedure. If treatment is to cover an exposed part of the root, the choice of CM may be justified, with a possibility of attaining over 50% of mean root coverage. If, however, in addition to root coverage, it is important to improve the quality of the gingiva, SCTG should be considered a method of choice. Unlike CM, SCTG ensures a significant thickening of the gingiva and widening of keratinized tissues. Improvement in gingival quality is particularly important for people with a thin phenotype and in patients who are planning orthodontic treatment with arch expansion. In both cases, thicker gingiva is a factor that reduces the risk of developing gingival recessions as a result of involutional changes, trauma or vestibular orthodontic tooth movement (Joss-Vassalli, Grebenstein, Topouzelis, Sculean, & Katsaros, 2010; Zucchelli et al., 2010, 2014). However, due to a rather small number of participants, which is a limitation of the study, our results should be confirmed in a larger group of patients and extended observation time.

5 | CONCLUSIONS

Within the limits of the study, it can be concluded that the modified coronally advanced tunnel technique combined with either CM or SCTG enables reduction in gingival recessions. SCTG option seems to be more effective as far as root coverage and aesthetic parameters are concerned.

CONFLICT OF INTEREST

The authors have stated explicitly that there are no conflict of interests in connection with this article.

COMPLIANCE WITH ETHICAL STANDARDS

The study was compliant with Helsinki Declaration of 1975 as revised in 2000.

ETHICAL APPROVAL

Local ethics committee approved this study under R-I-002/222/2014.

INFORMED CONSENT

Each participant gave their informed consent.

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