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Original Article

Clinical evaluation of combined surgical/restorative treatment of gingival recession-type defects using different restorative materials: A randomized clinical trial

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Abstract *Background/purpose:* An ideal therapeutic procedure for the treatment of gingival recession associated with an NCCL has presented a challenge to clinicians. Various dental materials and surgical approaches have been used to manage gingival recessions associated with NCCLs for the most predictable combined surgical/restorative treatment. The objective of this study was to evaluate the treatment of gingival recessions associated with non-carious cervical lesions (NCCL) using a modified coronally advanced flap (MCAF) in combination with a connective tissue graft (CTG) on restored root surfaces.
Materials and methods: Twenty-three systemically healthy subjects, who were positive for the presence of three cervical lesions associated with gingival recessions in three different adjacent teeth, were enrolled in the study. The NCCL were each restored prior to surgery by using one of three different materials: nanofilled composite resin (NCR), resin-modified glass ionomer cement (RMGI) or giomer. The gingival recession defects were treated by CTG.
Results: Inter-group differences were not statistically significant for probing depth (PD), relative recession height (rRH), relative clinical attachment level (rCAL), keratinized tissue width (KTW) or keratinized tissue thickness (KTT) ($p > 0.05$) among the groups at any time. The mean percentage of defect coverage was 71.18 ± 23.16% for NCR + CTG group; 71.33 ± 22.33% for RMGI + CTG group; and 64.23 ± 20.33% for giomer + CTG group at 1 year postoperatively ($p > 0.05$).

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Conclusion: The combined surgical/restorative treatments provided successful clinical results. Giomer + CTG may be less effective compared to other groups for treatment of gingival recession associated with NCCL.

Introduction

The gingival recessions have been successfully treated by several periodontal plastic surgery procedures. The main indications for the treatment of gingival recessions are aesthetic concern, root hypersensitivity, prevention or management of root caries and cervical abrasion, enhancement of restorative outcomes and facilitation of plaque control efforts.[1] Coronally advanced flap (CAF) is an effective periodontal plastic surgical procedure for the treatment of gingival recessions.[2] The CAF with a connective tissue graft (CAF + CTG) technique is reported as the gold standard and does enhance the probability of achieving complete root coverage.[3]

The development of non-carious cervical lesions (NCCL) may occur on exposed root surfaces due to various mechanisms such as corrosion, stress forces, and friction.[4] Main concerns related to the association between gingival recessions and root abrasion are aesthetic concerns, dentin hypersensitivity, root caries/demineralization and bacterial plaque accumulation, which are the main indications for the treatment.[5] Because of the multiple factors involved, such as disappearance of the cemento-enamel junction (CEJ) and the depth and the width of the cervical lesions, treatment of gingival recession associated with an NCCL could not be easy and predictable. Therefore, to solve all these problems, a combined surgical/restorative therapy was proposed for treatment of these combined defects.[6]

Combined surgical/restorative approaches were observed as safe, predictable and effective than the surgical procedures alone.[6–11] A randomized-controlled clinical trial was reported that the combined surgical/restorative approach could provide soft tissue coverage without damage to periodontal tissues in the treatment of gingival recessions associated with NCCL.[6]

Various dental materials and surgical approaches have been used to manage gingival recessions associated with NCCLs for the most predictable combined surgical/restorative treatment.[6,12] Restorative materials must be biocompatible to minimize their adverse effects on periodontal tissues induced by direct contact.[13] Resin composites or resin modified glass ionomer cements have been commonly used to restore NCCLs.[14] Resin-ionomer materials have many properties such as biocompatibility with soft and hard tissues and displaying high marginal adaptation and minimal surface roughness as well as allowing them to be used successfully in the subgingival region.[10,15–17] Composite resin materials have many advantages including aesthetics and surface characteristics in terms of finishing and polishing.[18] It has been reported that well-adapted and finished composite resins seem have no adverse effects on the periodontal margin.[17,19,20] It has also been reported that the ageing of the composite resin restorations may produce gingival inflammation in subgingival areas.[19,20] Fluoride-releasing resin materials with pre-reacted glass (PRG), called giomer, has been suggested to have good color matching, biocompatibility, smooth surface finish, fluoride release and fluoride recharge potential.[21,22] It was reported in a randomized-controlled clinical trial that the use of CTG for treatment of root surfaces restored with giomer was effective over the 6-month period without any noxious effect on periodontal tissues.[23]

Therefore, the aim of this study was to evaluate clinically the treatment of gingival recession associated with NCCL in nanofilled resin composite (NRC) or resin modified glass ionomer cement (RMGI) or giomer plus CTG in the first year following surgery.

Materials and methods

Study population and design

The patients of this prospective randomized clinical trial study protocol were selected from individuals referred to the Department of Periodontology, at the Faculty of Dentistry, Gazi University, for dentin hypersensitivity and aesthetic complaints between October 2013 and January 2015. The study protocol was approved by the Ethics Committee of the Faculty of Medicine, Gazi University, Ankara, Turkey in accordance with the Helsinki Declaration of 1975, as revised in 2000 (Protocol ID: 25901600–7587). The trial is registered at ClinicalTrials.gov NCT02788266. The patients were informed about the protocol of the study and gave their written consent to the described procedures.

The patients were selected according to the following criteria:

- Positive for the presence of three cervical lesions associated with multiple gingival recessions in three different adjacent teeth excluding molars,
- Miller Class I gingival recession defect ($\geq$2 and $\leq$ 5 mm) associated with buccal NCCL Class B + step,[24]
- NCCL depth 1–2 mm,
- Non-smoker,
- Systemically healthy,
- Probing depth (PD)$\leq$3 mm,
- Presence of $\geq$1 mm highly keratinized tissue apical to the root exposure, and presence of $\geq$0.8 mm-thick gingival tissue.

The criteria for exclusion were as follows:

- Patients who had systemic problems that would contra-indicate for periodontal surgery,
- Taking medications known to interfere with periodontal tissue health or healing,
- Presence of non-vital teeth, caries or restorations on cervical areas, severe occlusal interferences and previous surgery in the area.

Different restorative materials were placed in the same subjects who have multiple gingival recessions associated with NCCLs in three adjacent teeth. The difference of restorative materials constituted treatment groups. NCCLs were randomly allocated to 3 treatment groups using a computer-generated randomisation scheme: NCR + CTG group: the combined defects were treated by CTG plus NCR to restore the entire NCCL; RMGI + CTG group: the combined defects were treated by CTG plus RMGI to restore the entire NCCL; giomer + CTG group: the combined defects were treated by CTG plus giomer to restore the entire NCCL. The use of opaque, numbered envelopes that contained the assigned intervention concealed the allocation. The examiner of the clinical registrations were blinded, and the surgeon was blinded to the restorative material used in the groups.

Twenty-three non-smoking subjects, 10 males and 13 females, aged between 28 and 59 years (mean 45 ± 9.5 years), participated in this study. All patients were included in a pretreatment program to eliminate the possible etiologic factors related to non-carious cervical lesions and gingival recession. Professional oral hygiene procedures were performed for each patient with the initial therapy included dental scaling, polishing, and occlusal adjustment as indicated at least 1 month prior to the surgery. All patients were instructed to use a non-traumatic brushing technique (roll technique) with a soft toothbrush. Patients were re-valuated at least 8 weeks after initial therapy and full-mouth plaque score <10% and full mouth bleeding score <15% were scheduled for surgical procedure. The CONSORT flow chart of the study is presented in Fig. 1.

Primary and secondary outcome variables

The primary outcome variable was the assessment of the percentage of combined defect coverage (CDC). The secondary outcome variables included the assessment of probing depth (PD), relative recession height (rRH), relative clinical attachment level (rCAL), keratinized tissue width (KTW), and keratinized tissue thickness (KTT).

Clinical assessments

An individual acrylic stent was used as a reference point for clinical parameters to reduce the errors associated with probe placement since the CEJ was not clearly visible in all groups.

The following clinical parameters were assessed immediately before surgery (baseline), after 3 and 6 months and 1 year using a manual periodontal probe (Williams periodontal probe, Hu-Friedy, Chicago, IL, USA) (Fig. 2):

- presence (1) or absence (0) of supragingival plaque (PI),[25]
- presence (1) or absence (0) of bleeding on probing (BOP)[25] were recorded at the mid-buccal aspect of the teeth,
- probing depth (PD) measured as the distance from the gingival margin to the bottom of the probeable pocket,
- relative recession height (rRH) measured as distance from the most apical point of gingival margin to the incisional border of the tooth,
- keratinized tissue width (KTW) measured from most apical point of the gingival margin to the mucogingival junction,
- relative clinical attachment level (rCAL) defined as (PD + rRH),
- keratinized tissue thickness (KTT) was evaluated using #15 endodontic reamer attached to a rubber stopper inserted perpendicularly to the mid-point location between the gingival margin and mucogingival junction into the gingival tissue 2 mm below the gingival margin under local anesthesia and then the penetration depth was measured to the nearest 0.1 mm using a digital caliper (Stainless Steel Digital Caliper 75 mm, Shan, China),
- combined defect height (CDH) measured as the distance from the coronal margin of the non-carious cervical lesion to the most apical point of gingival margin.

The parameters about characteristics of NCCL were also assessed at baseline:

- Non-carious cervical lesion height (CLH) measured as the distance from the coronal to apical margins of the non-carious cervical lesion,
- Non-carious cervical lesion width (CLW) measured as the distance from the mesial and the distal margins, at the level of the incisional border of the non-carious cervical lesion.

The assessed clinical parameters were used to obtain recession reduction (RR): calculated as preoperative rRH - postoperative rRH for all experimental groups; percentage of combined defect coverage (CDC): calculated as ([preoperative CDH - postoperative CDH]/preoperative CDH) x 100 for all groups.

All clinical measurements were recorded by a calibrated, single masked examiner (M.O.). The examiner did not perform the surgeries and was unaware of the treatment assignment. A calibration exercise was performed to determine the acceptable intra-examiner reproducibility. The calibration was achieved by examination of fifteen defects in five patients two times in a period of 72 h. Calibration was accepted, if measurements of recession (PD, rCAL, rRH, KTW and KTT) at baseline and at 72 h were similar to the 0.5 mm at the 90% level.[26]

Evaluation of dentin sensitivity and aesthetics

Each patient was given a questionnaire which included dichotomous questions, and evaluation of the intensity of the given event was marked on a 10-cm visual analog scale (VAS).[27]

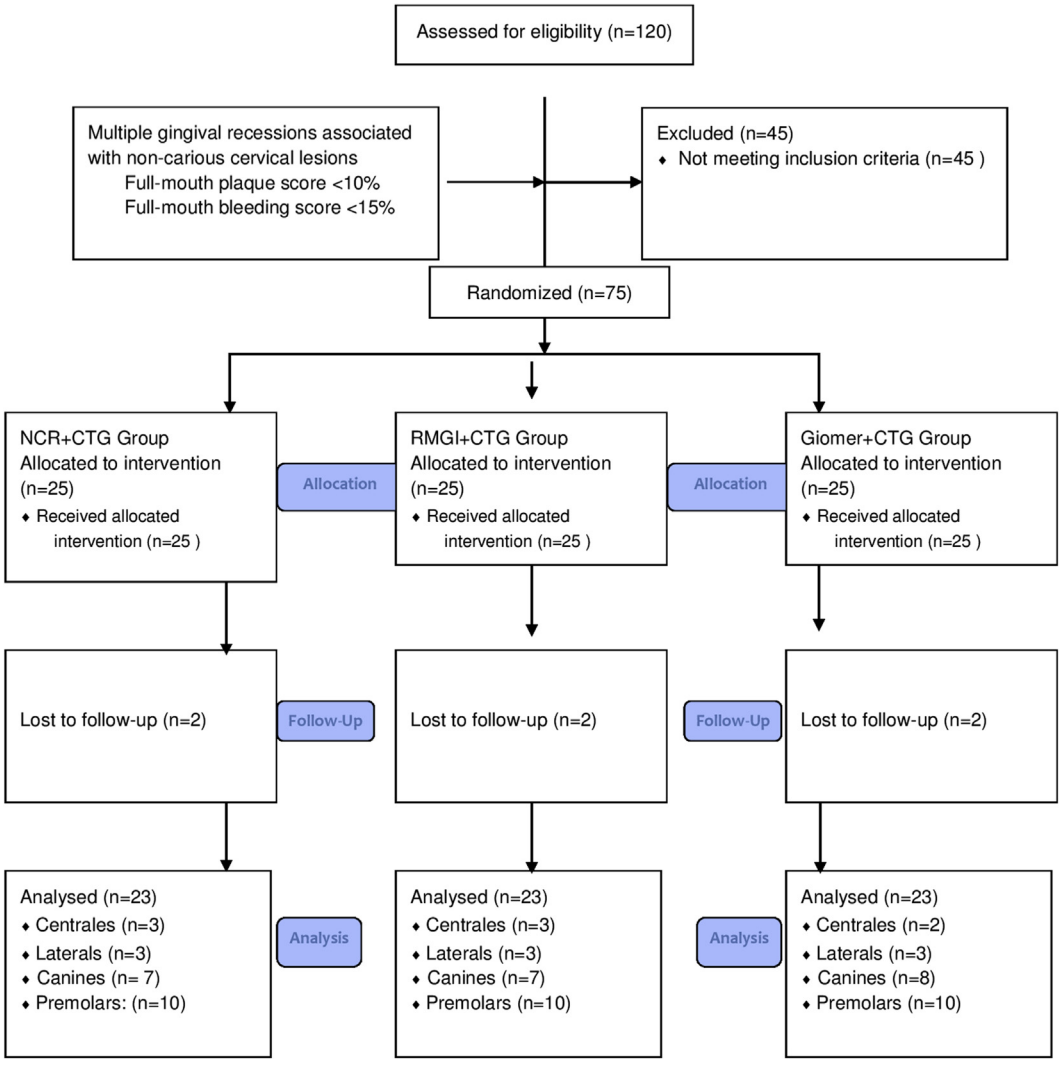

Figure 1 Flowchart of the study.

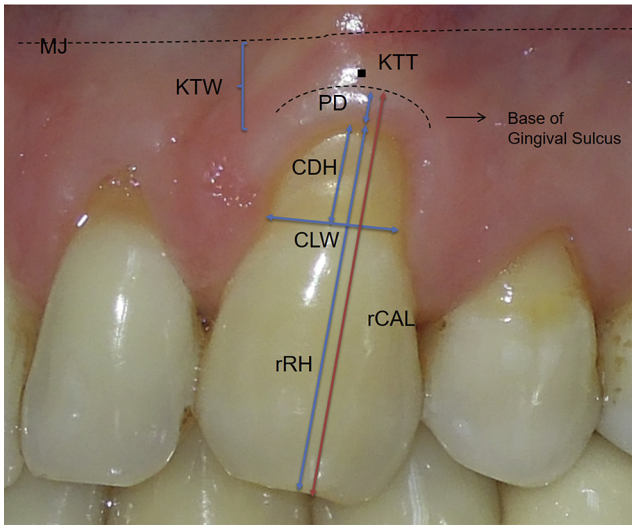

Figure 2 Clinical measurements before treatment. The dotted line at the top is presented as mucogingival junction (MJ) and the bottom line is presented as base of gingival sulcus.

Dentin sensitivity was evaluated at baseline and 1 year follow-up visit based on a VAS (VAS-S). Patients were asked to select among 10 scores (0 indicating no sensitivity or pain, 5 indicating moderate sensitivity or pain, and 10 indicating maximum sensitivity or pain). The patients were asked to rate their sensitivity when a jet of air was directed to the root surface. The jet of air (60 psi at 22 °C) was delivered by a dental syringe for 1 s, with the syringe held perpendicularly 2—3 mm from the root surface. After stimulation, the patient scored their sensitivity on the VAS.[28] The air pressure, temperature, and distance between the tooth surface and the tip of the air syringe was kept constant for all cases.

Patient satisfaction with aesthetic aspects was evaluated at baseline and a 1-year follow-up visit based on a VAS (VAS-E). Patients were asked to choose from 10 scores (0 indicating very bad, 5 indicating average and 10 indicating excellent) in terms of overall satisfaction, colour match and the amount of root coverage.[27]

Restorative procedures

All restorative procedures were performed by the same expert restorative dentist (H.O.) In the NCR group, cavities were filled with a nanofilled-composite (FiltekTM Supreme Plus-3M ESPE, St. Paul, MN, USA). A two-step etch-and-rinse adhesive (Adper Single Bond Plus SB, 3 M ESPE, St. Paul, MN, USA) was applied to the NCCLs, and light cured for a minimum of 20 s. In the RMGI group, cavities were filled with Fuji Ionomer Type II LC, GC Corporation, Tokyo, Japan. Firstly, GC Dentin Conditioner was applied to the NCCLs and light cured for 20 s. Encapsulated Fuji II LC was mixed as per the manufacturer's instructions, placed into the NCCLs and then again light cured for 20 s. In the giomer group, cavities were filled with Beautifil, Shofu Inc., Kyoto Japan. A two-step self-etching procedure, consisting of self-etching primer and fluoride-releasing bonding agent (FL-Bond), was used for the NCCLs and light cured for 20 s. Beautifil, which is supplied in syringe form, was flowed into the NCCLs and then light cured for 20 s. All restorations were performed as per the manufacturer's instructions. After polymerization, finishing was made with aluminum oxide disks of decreasing abrasiveness (Sof-Lex XT, 3 M ESPE, St.Paul.MN, USA).

Surgical procedures

Two weeks after the restorative appointment, the patients underwent surgical procedures. All surgeries were performed by the same periodontist (S.C.I.). Following local anesthesia, all recessions in each patient were treated with modification of the coronally advanced flap technique.[29] The flap design is an envelope type without vertical releasing incisions. An intrasulcular incision was made with a micro blade on the buccal aspect of the involved tooth. Beveled oblique incisions in the interproximal areas were outlined connecting the intrasulcular incisions. The oblique incisions started at the central tooth of the adjacent multiple defects toward the deepest recession of adjacent teeth. A split-full-split thickness flap was elevated to expose at least 3 mm of the marginal bone apical to the dehiscence area (Fig. 3C). The restoration margin was then established using a diamond bur. The exposed root surface apical to the restoration was planed with curettes. The anatomic interdental papillae were de-epithelialized to create a connective tissue bed.

CTG was obtained with a single incision technique.[30] CTG was harvested from the palate between the distal aspect of the lateral incisors and the mesial region of the second molar. A split-thickness dissection was made parallel to the long axis of the teeth, leaving the graft attached to the underlying bone. Then the graft was harvested by a sharp dissection and elevated from the underlying bone with a periosteal elevator. Grafts were positioned to cover the exposed roots and then sutured using 5—0 resorbable coated polyglactin suture (Dogsan Surgical Sutures, Trabzon, Turkey) to interdental papillae (Fig. 3D). The flaps were positioned coronally, completely covering the combined defects. Vertical double-crossed

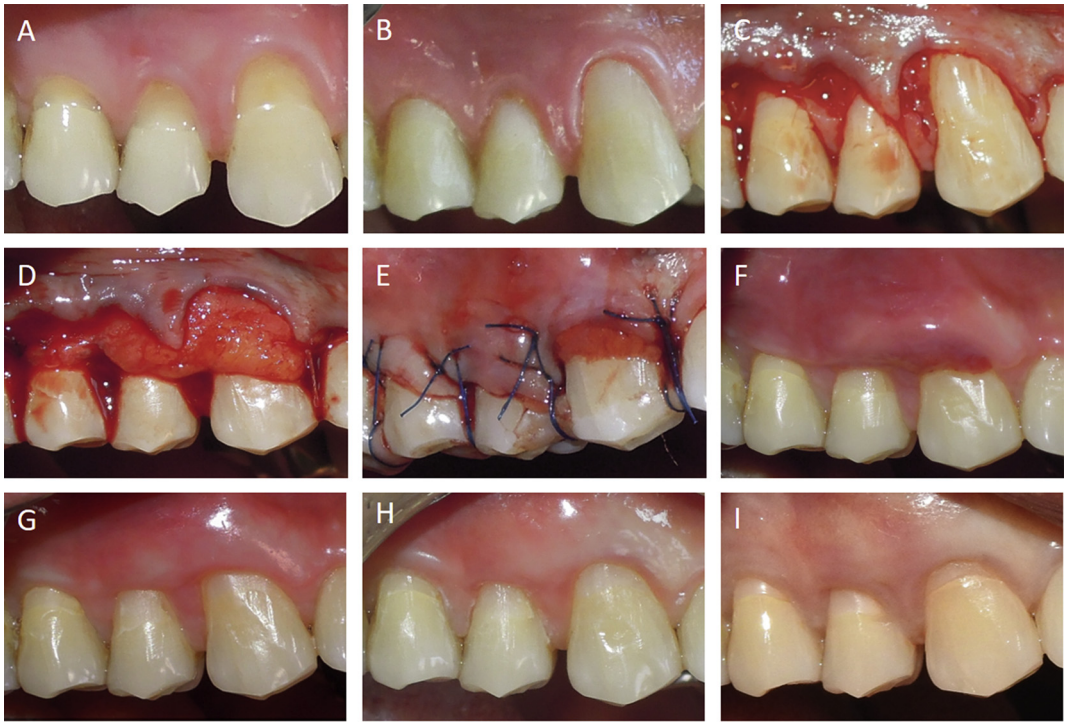

Figure 3 Preoperative and postoperative clinical views of the gingival recessions associated with NCCLs. (A) Preoperative view, (B) The exposed roots with NCCLs were treated with the restorative materials. (Tooth 13 was restored with NCR, tooth 14 was restored with RMGI and tooth 15 was restored with giomer), (C) Surgical incisions performed and the flap was elevated, (D) SCTG was placed on the recipient site, (E) Vertical double-crossed sutures were used to stabilize the flap, (F) 1-month post-operatively, (G) 3-months post-operatively, (H) 6-months post-operatively, (I) 1-year post-operatively.

sutures[31] were used to stabilize the flap (Fig. 3E). No periodontal dressing was used.

Postoperative care

The patients were prescribed oral analgesics (Naproxen sodium 550 mg, Apranax Forte 550 mg; Abdi Ibrahim, Turkey). Patients were instructed not to brush their teeth in the treated area until after suture removal, which was in 2 weeks, but to rinse their mouth with 0.12% chlorhexidine digluconate solution (Kloroben Oral Rinse % 0,12; Drogsan, Turkey) twice a day for 1 min for 4 weeks. At suture removal 2 weeks after surgery, all patients were checked and instructed to use mechanical tooth cleaning in the operative areas using a post-surgical soft toothbrush and a roll technique for a month. The patients were recalled for supragingival plaque removal and oral hygiene reinforcement once a week during the first month, twice per month until the third month, and once a month until the end of the study.

Sample size calculation and statistical analysis

The sample size calculation was performed to detect a minimum clinically significant difference in root coverage of 1 mm with a standart deviation of 0.5 mm and a power of 80%.[27,32] This would require 21 subjects in each group with $\alpha = 0.05$. To allow for possible dropouts, 23 patients were finally recruited.

Statistical analysis was performed using statistical software (PASW Statistics 20.0; SPSS, Inc., Chicago, IL, USA). Quantitative data of the recession sites were recorded as mean ± SD of mid-surface measurements. The percentage of combined defect coverage were calculated using the following formula: [(preoperative CDH −postoperative CDH)/preoperative CDH] x 100. For each continuous variable, normality was checked by Shapiro−Wilk tests and by histograms. Kruskal−Wallis test was used to evaluate the intra-group differences followed by a post hoc non-parametric test. The significance of differences over time in each group for each parameter was sought using Friedman's Two-Way Anova. The correlation between the parameters was evaluated by the Spearman's rho test. Differences were considered statistically significant when the p-value was <0.05.

Results

Twenty-three patients (13 women, 10 men) with a total of 69 Miller class I recessions were treated: thirteen maxillary incisors, fifteen maxillary canines, twenty-one maxillary premolars, four mandibular incisors, seven mandibular canines and nine mandibular premolars. Healing was uneventful in all patients and none was excluded from the study.

No statistical difference was observed between groups for rRH, PD, CLH, KTH and KTT ($p > 0.05$) (Table 1). Intra-group comparisons revealed statistically significant differences at 1 year compared to baseline for all parameters except for PD values in NCR + CTG and RMGI + CTG groups ($p < 0.05$) (Table 1).

All groups presented statistically significant reductions in the rRH ($p < 0.05$). The rRH values were 9.39 ± 0.48 mm for NCR + CTG group; 9.41 ± 0.39 mm for RMGI + CTG group; and 9.54 ± 0.33 mm for giomer + CTG group at 1 year. This difference between groups was not statistically significant ($p > 0.05$) for this parameter. The percentage of CDC were 71.18 ± 23.16% for NCR + CTG group; 71.33 ± 22.33% for RMGI + CTG group; and 64.23 ± 20.33% for giomer + CTG group at 1 year. The difference between groups was not statistically significant ($p > 0.05$) (Table 1).

No statistical difference was observed in PD for NCR + CTG and RMGI + CTG groups at any time ($p > 0.05$). There was statistically significant difference at 1 year compared to the baseline for giomer + CTG group ($p < 0.05$). However, the difference among all groups at 1 year was not statistically significant ($p > 0.05$) (Table 1). All groups showed statistically significant changes in 3 and 6 months and 1 year compared to the baseline for rCAL ($p < 0.05$). The rCAL values were 10.83 ± 0.85 mm for NCR + CTG group, 10.59 ± 0.62 mm for RMGI + CTG group, and 10.76 ± 0.6 mm for giomer + CTG group at 1 year.

All groups presented statistically significant increases in the KTH and KTT from the baseline until the 1-year follow-up ($p < 0.05$). The KTH was 3.78 ± 1.15 mm for NCR + CTG group, 3.83 ± 1.1 mm for RMGI + CTG group and 3.61 ± 1.18 mm for giomer + CTG group, while the KTT was 1.63 ± 0.36 mm for NCR + CTG group, 1.68 ± 0.33 mm for RMGI + CTG group, and 1.69 ± 0.32 mm for giomer + CTG group at 1 year (Table 1).

There were no statistically significant VAS-S and VAS-E measurement differences between the treatment groups at any time points ($p > 0.05$) (Table 2).

There was a positive correlation between CLH and RR at 1 year in NCR + CTG and giomer + CTG groups. CLH was statistically associated with CAL gain at 1 year in giomer group ($p < 0.05$). CLW were statistically associated with RR and PD at 1 year in giomer + CTG group ($p < 0.05$). However, these associations were weak for both RR and PD at 1 year (Table 3).

Discussion

The combined (surgical/restorative) approach, which has many advantages in terms of dentin hypersensitivity reduction and aesthetics, produced significant gains in clinical attachment level and gingival recession reduction.[6−11,33] However, there is a need for clinical trials discovering the most predictable dental materials and surgical approaches for treatment of this condition.[9] Recent clinical trials and case reports show that CTG combined with cervical restorations yield successful and predictable results in the treatment of gingival recessions associated with NCCLs.[9,33] The clinical outcome of these studies revealed that surgical procedures alone could not suffice to reduce dentin hypersensitivity and to provide better aesthetic results.[33] For those reasons, in the present study a control group of CTG alone was not included. The aim of this study was to reveal the most satisfactory type of restorative material in the combined surgical/restorative treatment.

Table 1 Clinical parameters (mean ± SD) for baseline, 3-month, 6-month and 1-year intergroup and intragroup comparisons.

	Baseline	3 Months	6 Months	1 Year	p
PD					
NCR group	1.13 ± 0.34	1.26 ± 0.45	1.3 ± 0.47	1.43 ± 0.66	0.081
RMGI group	1.13 ± 0.46	1.13 ± 0.34	1.09 ± 0.29	1.17 ± 0.39	0.723
Giomer group	1.04 ± 0.21	1.22 ± 0.52	1.22 ± 0.42	1.3 ± 0.47	**0.023***
p	0.592	0.538	0.187	0.34	
rCAL					
NCR group	12.5 ± 0.88	10.64 ± 0.65	10.79 ± 0.66	10.83 ± 0.85	**0.001***
RMGI group	12.48 ± 0.89	10.63 ± 0.63	10.54 ± 0.56	10.59 ± 0.62	**0.001***
Giomer group	12.35 ± 0.71	10.7 ± 0.66	10.79 ± 0.74	10.76 ± 0.6	**0.001***
p	0.891	0.915	0.341	0.518	
rRH					
NCR group	11.37 ± 0.73	9.38 ± 0.45	9.4 ± 0.45	9.39 ± 0.48	**0.001***
RMGI group	11.35 ± 0.73	9.5 ± 0.43	9.46 ± 0.42	9.41 ± 0.39	**0.001***
Giomer group	11.26 ± 0.62	9.55 ± 0.39	9.53 ± 0.37	9.54 ± 0.33	**0.001***
p	0.915	0.256	0.419	0.264	
CLH					
NCR group	3.07 ± 1.13	1.03 ± 0.86	1.03 ± 0.81	1.04 ± 0.89	**0.001***
RMGI group	2.89 ± 1.2	1.04 ± 1.08	0.96 ± 1.09	1 ± 1.04	**0.001***
Giomer group	2.83 ± 0.97	1.1 ± 0.87	1.1 ± 0.86	1.11 ± 0.81	**0.001***
p	0.743	0.862	0.603	0.691	
KTH					
NCR group	3.17 ± 1.15	4.02 ± 1.25	3.76 ± 1.02	3.78 ± 1.15	**0.001***
RMGI group	3.3 ± 0.99	3.87 ± 0.98	3.8 ± 1.07	3.83 ± 1.1	**0.001***
Giomer group	3.04 ± 0.99	3.96 ± 1.16	3.72 ± 1.16	3.61 ± 1.18	**0.001***
p	0.664	0.956	0.899	0.694	
KTT					
NCR group	0.89 ± 0.12	1.82 ± 0.4	1.7 ± 0.38	1.63 ± 0.36	**0.001***
RMGI group	0.89 ± 0.12	1.82 ± 0.41	1.69 ± 0.35	1.68 ± 0.33	**0.001***
Giomer group	0.88 ± 0.1	1.84 ± 0.38	1.71 ± 0.33	1.69 ± 0.32	**0.001***
p	0.998	0.747	0.783	0.598	
CDC (%)					
NCR group		71.31 ± 21.73	69.86 ± 20.82	71.18 ± 23.16	0.846
RMGI group		68.85 ± 21.19	71.93 ± 21.78	71.33 ± 22.33	0.102
Giomer group		66.62 ± 22.89	65.79 ± 22.09	64.23 ± 20.33	0.867
p	—	0.823	0.53	0.435	

*, Statistically significant at $p < 0.05$ determined by Friedman's Two-Way ANOVA test; PD, probing depth; rCAL, relative clinical attachment level; rRH, relative recession height, CLH, non carious cervical lesions height; KTH, keratinized tissue height; KTT, keratinized tissue thickness; CDC, combined defect coverage.

Table 2 Distribution of VAS-aesthetic (VAS-E) and VAS-sensitivity (VAS-S) at baseline and 1 year post-operatively.

	NCR group		RMGI group		Giomer group		p
	Baseline	1 year	Baseline	1 year	Baseline	1 year	
VAS-E	3.02 ± 1.24	8.93 ± 1.11*	3.65 ± 1.33	8.52 ± 1.65*	3.36 ± 1.28	8.57 ± 1.53*	0.71
VAS-S	6.42 ± 1.96	0.73 ± 1.38*	6.28 ± 2.11	0.95 ± 1.63*	6.19 ± 2.16	1.26 ± 1.76*	0.573

*, Significantly different compared to baseline ($p < 0.05$) determined by Friedman's Two-Way ANOVA test; p, intergroup comparison of the change determined by Kruskal Wallis H test; VAS-E, Visual Analogue Scale-Aesthetic; VAS-S, Visual Analogue Scale-Sensitivity.

In the present study, the percentage of CDC were 71.18 ± 23.16% for NCR + CTG group; 71.33 ± 22.33% for RMGI + CTG group; and 64.23 ± 20.33% for giomer + CTG group at 1 year after the surgery. Inter-group differences were not statistically significant for the CDC values ($p > 0.05$). In the literature, there is limited number of study evaluating the combined defect coverage in the treatment of gingival recessions associated with NCCLs. NCR + CTG and RMGI + CTG showed similar CDC values in the present study. This result is in accordance with the previous study, which reported that use of CAF for treatment of combined defects restored with resin modified glass ionomer cement (RMGI) and microfilled composite resin (MRC) showed similar CDC values

Table 3 Correlations between characteristics of the non carious cervical lesions and periodontal clinical parameters.

		CLH			CLW		
		NCR group	RMGI group	Giomer group	NCR group	RMGI group	Giomer group
CAL gain	r	0.214	0.247	0.501	−0.088	0.379	0.104
	p	0.327	0.256	**0.015***	0.688	0.075	0.638
PD	r	0.15	−0.095	0.228	0.071	−0.062	0.423
	p	0.495	0.667	0.294	0.747	0.78	**0.045***
RR	r	0.483	0.088	0.57	0.205	0.144	0.418
	p	**0.02***	0.691	**0.004****	0.349	0.513	**0.047***
CDC	r	−0.359	−0.02	−0.129	−0.34	−0.102	−0.118
	p	0.092	0.928	0.557	0.112	0.642	0.591

*$p < 0.05$, statistically significant correlations; **$p < 0.01$ statistically significant correlations; CLH, non carious cervical lesions height; CLW, non carious cervical lesions width; CAL gain, clinical attachment level; PD, probing depth; RR, recession reduction; CDC, combined defect coverage.

(71.99 ± 18.69% for CAF + RMGI, 74.18 ± 15.02% for CAF + MRC).[6] On the other hand, Santamaria et al.[9] reported that using the CTG in combination with CAF in the treatment of gingival recessions associated with NCCLs revealed better result in terms of CDC compared to using CAF alone. In their study, CDC were 74.88 ± 8.66% for CTG alone and 70.76 ± 9.81% for CTG + RMGI.[9] In another study by Santamaria et al.[11] CTG alone and CTG + NCR were compared for treatment of single maxillary combined defects and they found CDC values 82.16 ± 16.1% and 73.84 ± 19.2%, respectively.

All restorations had their apical border in the subgingival area due to root coverage procedures. Despite this undesirable situation, restorations did not show any negative effects to the adjacent gingival tissues. These findings are consistent with the outcomes of previous studies.[6–11,20] Van Dijken and Sjöstrom[19] reported that an increase in gingival crevicular fluid was observed around resin-modified glass ionomer cements, compomers and resin composite compared to unrestored sites. However, no statistically significant difference was found between restored and non-restored sites, and also between the restorations in the gingival index and plaque index scores.[19] These findings are compatible with the results of present study that there were no statistically significant differences among the groups in the PI and BOP scores at 1 year after the surgery according to the baseline in the present study. These results probably occurred as a result of a high standard of oral hygiene maintained by the subjects and also a proper finishing and contouring of the restorative materials.

All groups showed an increase in the PD values after the treatments. The PD values were not statistically significant for NCR + CTG and RMGI + CTG groups between the baseline and 1 year following the surgery ($p > 0.05$). However, there was a statistically significant difference in the giomer + CTG group between the baseline and 1 year after the surgery ($p < 0.05$). Inter-group differences were not statistically significant for the PD values ($p > 0.05$) but it is possible to say that the values of the RMGI + CTG group were lower than those of the other groups at 1 year after surgery. This finding can confirm the study by Camp et al.[34] reporting that fibroblast attachment to resin-modified glass ionomer cement was higher compared to other restorative materials. However, Pourabbas et al.[23] reported that there was not any statistically significant difference between giomer and resin ionomer with respect to fibroblast attachment to restorative materials. On the other hand, there was a significant decrease in CAL for all groups at the end of the study. These results were similar to previously reported studies.[6–9]

The success of these treatments depends not only the clinical parameters but also patient satisfaction with the solution of their complaints. The VAS analysis was used to measure the patient satisfaction with dentin hypersensitivity and aesthetics. The VAS-S scores at the baseline and 1 year after treatment were statistically significant in all groups ($p < 0.05$). The results revealed that the combined surgical/restorative treatment procedures can highly reduce dentin hypersensitivity. There was not any statistically significant difference of among VAS-S scores of the treatment groups at any time ($p > 0.05$). Aesthetic assessment is very important and subjective in root-coverage procedures. There was a significant increase in the VAS-E scores for all groups ($p < 0.05$). These findings can be interpreted to suggest that combined surgical/restorative treatment procedures have been proposed for the concomitant reestablishment of the patients' 'pink' and 'white' aesthetics.[35] Inter-group differences were not statistically significant for the VAS-E scores ($p > 0.05$) but it would be fair to say that the scores of the NCR + CTG was higher than the other groups at 1 year after the surgery. This situation can be considered that resin composite materials are show better wear resistance and aesthetics than the other restorative materials.

Previous studies suggest that the characteristics of the cervical lesion can be associated with the success of the gingival recession treatment. A correlation was found between CLH and RR in this study. According to this result, a higher mucosal coverage can be achieved for larger cervical lesions. This finding is consistent with the outcomes found by Santamaria et al.'s study.[36] Another interesting observation is the correlation found between CLW and PD at year 1 in giomer + CTG group. It was found that the width of cervical lesion was in positive correlation with PD. This finding may confirm that a statistically significant difference in the study was observed only in giomer + CTG group between baseline and 1 year after the surgery in the present study.

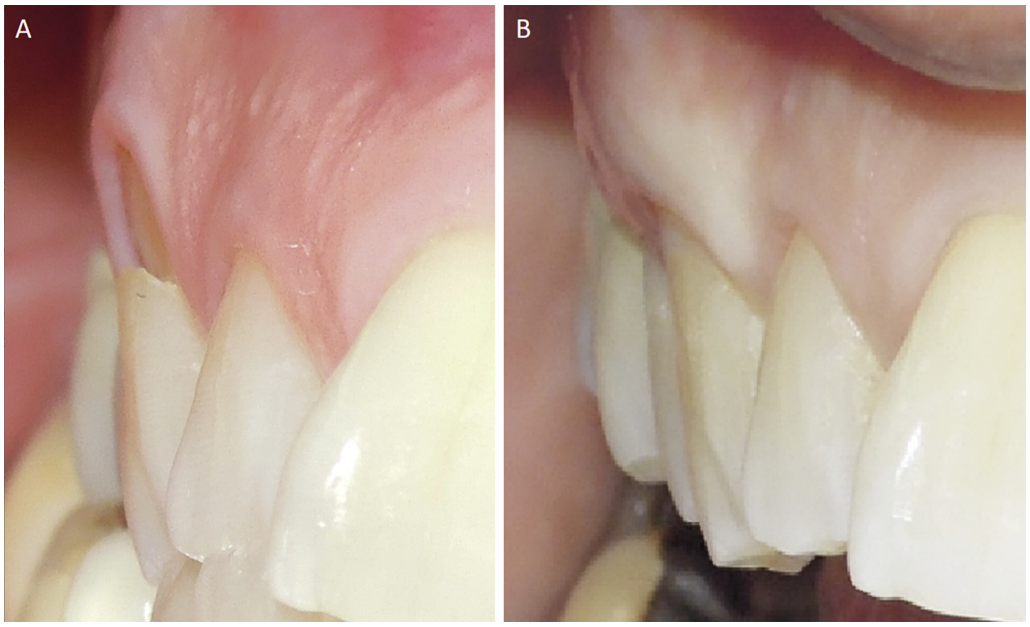

Figure 4 Preoperative and postoperative lateral views. (A) Preoperative view, (B) 1-year post-operatively.

In the literature, the most satisfactory type of restorative material (in terms of aesthetics, resistance and long-term mechanical stability) in the combined surgical/restorative treatment procedures, are still not completely elucidated and do require further studies. Within the limitations, it can be concluded that the combined surgical/restorative treatments provided successful clinical results and a good emergence profile (Figs. 3 and 4). The restorations did not show any negative effects to the adjacent gingival tissues throughout the period of 1 year from the surgical treatment. NCR and RMGI showed similar clinical results as a restorative material for combined surgical/restorative treatment. The results of using nanocomposites for restoring cervical defects of teeth before root coverage procedures were very promising in terms of both clinical and patient-centered parameters. Giomer may be less effective compared to other groups for treatment of gingival recession associated with NCCL. However, longitudinal studies are necessary to evaluate the stability of the results and establish the long-term success of the combined treatments.

Conflicts of interest

The authors reported no conflicts of interest related to this study.

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