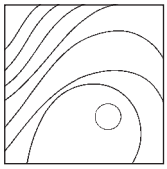
The Influence of Gingival Phenotype on the Outcomes of Coronally Advanced Flap: A Prospective Multicenter Study



Giulio Rasperini, DDS[1]
Michele Codari[1]*/Lorenzo Paroni*[2]
Serhat Aslan[3]*/Enrico Limiroli*[1]
Carols Solis-Moreno[4]*/Katarzyna Suckiel-Papiór*[5]
Lorenzo Tavelli[6]*/Raffaele Acunzo*[1]

[Au: Please provide degrees (DDS, PhD, etc) for all authors.]

The goal of this study was to evaluate the influence of gingival phenotype (GPh) on the clinical outcomes of coronally advanced flap (CAF). In a prospective study, 24 gingival recessions (recession type RT1 class or Miller Classes I and II) in 21 patients received CAF alone. Patients were classified as having thin, medium, thick, or very thick GPh using a color-coded probe. At 6 months, the lowest mean root coverage (mRC; 60.4% ± 28.8%) and complete root coverage (CRC; 25%) were found in patients with thin GPh compared to patients with medium (mRC: 86.4% ± 17.6%; CRC: 60%), thick (mRC: 93.3% ± 14.9%; CRC 83.3%), and very thick (mRC: 86.7% ± 26.7%; CRC: 80%) GPh. Regression analysis showed a statisticaslly significant difference (P < .05) between thin and thick/very thick GPh in the likelihood of achieving CRC. Higher RES values were observed in patients with thick and very thick GPh (8.2 ± 1.5 and 8.4 ± 1.4, respectively), while thin GPh was related to the lowest RES score (6.3 ± 2.2). CAF performed in patients with thick or very thick GPh results in superior clinical and esthetic outcomes than thin and medium phenotype. In particular, thin phenotype was associated with the lowest mRC, CRC, and root coverage esthetic scores. Int J Periodontics Restorative Dent 2020;40:e27–e34. doi: 10.11607/prd.4272

[1]Department of Biomedical, Surgical and Dental Sciences, University of Milan, Foundation IRCCS Ca' Granda Polyclinic, Milan, Italy.
[2]Istituto Stomatologico Italiano, Milan, Italy.
[3]Private Practice, Izmir, Turkey.
[4]Master of Periodontology and Implant Dentistry, Faculty of Dentistry, University of Granada, Granada, Spain.
[5]Private Practice, Wrocław, Poland.
[6]Department of Periodontics & Oral Medicine, University of Michigan School of Dentistry, Ann Arbor, Michigan, USA.

Correspondence to: Dr Giulio Rasperini, Department of Biomedical, Surgical and Dental Sciences, Foundation IRCCS Ca' Granda Polyclinic, Via della Commenda 12, 20122 Milan, Italy.
Email: giulio.rasperini@unimi.it

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Gingival recession (GR) is a common finding among adults, regardless of oral hygiene level.[1] When GR is associated with esthetic impairment, dentin hypersensitivity, root abrasion, or root caries, surgical treatment is indicated.[1] Among the techniques proposed for treating GR, coronally advanced flap (CAF) is probably one of the most investigated.[2] CAF has also been extensively performed alone or in combination with graft materials, including autologous connective tissue graft (CTG), acellular dermal matrix, collagen matrix, and biologics, such as enamel matrix derivatives, platelet-rich plasma, and platelet-rich fibrin.[3] Several clinical trials demonstrated that the addition of grafts may provide superior outcomes than CAF alone.[4] In particular, CAF + CTG seems to be the technique of choice in improving clinical and esthetic conditions.[3,5,6] Nevertheless, according to Chambrone and Pini Prato, flap preparation and management may be more crucial to surgical succes than adding a graft.[2] Similarly, other clinicians recommended a selective use of CTG that is based on gingival thickness and keratinized tissue width (KTW).[7,8]

Gingival phenotype (GPh) has been suggested as a determining factor that dictates whether the addition of a soft tissue graft is needed when CAF is performed.[2] Indeed,

in the presence of gingiva that is thicker than 1.2 mm, it has been demonstrated that the chances of obtaining complete root coverage (CRC) **[Au: Correct?]** with CAF alone are higher[9] and therefore, in such conditions, adding a graft in sites that already have a thick GPh may be viewed as "overtreatment."[2] Avoiding soft tissue graft when it is not needed reduces patient morbidity and the risk of postoperative complications, which are frequently related to the palatal donor site.[10,11] However, no studies have comprehensively investigated the effect of GPh on CAF outcomes. Therefore, the aim of this study is to evaluate the clinical efficacy and the esthetic outcomes of GRs treated with CAF in patients with thin, medium, thick, or very thick GPh.

Materials and Methods

This study was designed as a multicenter, multinational, prospective case series. Patients were consecutively selected from the Department of Periodontics at University of Milan in Milan, Italy (center 1); from a private practice in Izmir, Turkey (center 2); from a private practice in Grenada, Spain (center 3); and from a private practice in Wrocław, Poland (center 4) according to the following inclusion criteria: *(1)* 18 years of age or older; *(2)* no reported systemic diseases; *(3)* healthy periodontium or demonstrating stable periodontal health; *(4)* full-mouth plaque score (FMPS) and full-mouth bleeding score (FMBS) < 20%; *(5)* one or more GRs with no interproximal attachment loss (recession type RT1 or Miller Classes I and II)[1]; *(6)* visible cementoenamel junction (CEJ); and *(7)* KTW ≥ 2 mm. The criteria for exclusion were: *(1)* smoking patients; *(2)* pregnancy; *(3)* patients taking medications or receiving treatment that could negatively affect the healing of periodontal tissues (eg, steroids); *(4)* patients who previously received periodontal plastic surgery for the treatment of GRs; *(5)* inadequate endodontic treatment or tooth mobility at site of surgery; *(6)* GRs with interproximal attachment loss (recession types RT2 and RT3)[1]; and *(7)* GRs on molar teeth. After a thorough explanation of the study protocol and the related risks and benefits, patients signed informed consent forms. The study protocol was in accordance with the Declaration of Helsinki of 1965, revised in Tokyo in 2004. Surgeries were performed by one experienced periodontist in each center (G.R. in center 1; S.A. in center 2; C. S. in center 3; and K.S. in center 4). Training and calibration meetings were held to discuss the protocol design and objectives of the study.

Clinical Measurements

The following measurements were recorded to the nearest millimeter using the UNC periodontal probe (Hu-Friedy) at baseline and 6 months:

- Recession depth **[Au: Correct?]** (REC): distance from the free gingival margin to the CEJ at the midfacial aspect of the tooth
- Probing depth **[Au: Correct?]** (PD): measured at the midfacial site
- Clinical attachment level (CAL): calculated in the midfacial site as REC + PD
- KTW: distance from the free gingival margin to the mucogingival junction at the midfacial point.

GPh was evaluated at baseline and at 6 months using Colourvue probes (Hu-Friedy) (Fig 1). The Colorvue Phenotype system was explained in a previous article.[12] Esthetic evaluation was performed at 6 months using the root coverage esthetic score (RES). This score system evaluated five parameters at the 6-month follow-up: level of the gingival margin (GM), marginal tissue contour (MTC), soft tissue texture (STT), mucogingival line alignment (MGJ), and gingival color (GC).[13]

Presurgical Treatment

Each study participant received full-mouth supragingival scaling, polishing, and oral hygiene instruction at least 1 month before the scheduled surgery. The patients were instructed on optimal toothbrushing technique, dental floss, and/or interdental cleaning.

Surgical Procedures

Before starting the surgery, the portion of the root surfaces corresponding to the buccal attachment loss (GR + PD) were mechanically

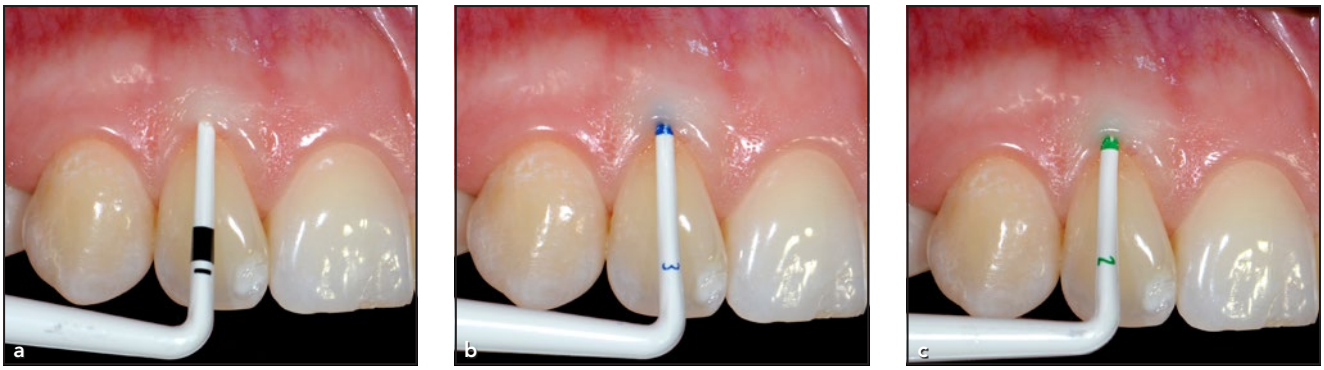

Fig 1 (a) *Gingival phenotype assessment in a maxillary lateral incisor prior to the root coverage procedure. The visibility of the* (b) *blue color through the gingival margin, while the* (c) *white and the green color are not clearly visible, indicates that the tooth has a thick gingival phenotype.*

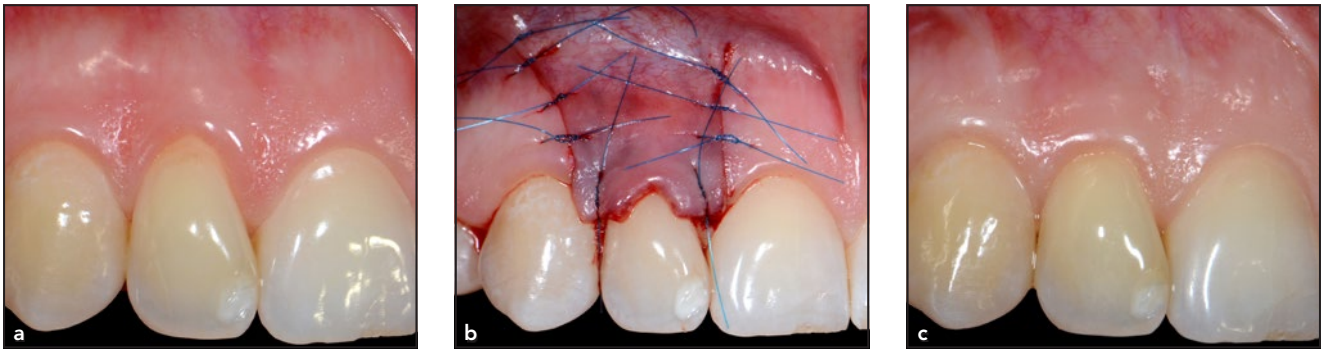

Fig 2 *Isolated gingival recession on a maxillary right lateral incisor with thick gingival phenotype treated with a coronally advanced flap.* (a) *Baseline.* (b) *A coronally advanced flap with two vertical releasing incisions was performed and sutured tension-free 2 mm coronally to the cementoenamel junction using a combination of sling and simple interrupted sutures.* (c) *Results at 6 months showing complete root coverage.*

instrumented using Gracey curettes (Hu-Friedy). Then, 24% ethylenediaminetetraacetic acid gel was applied on the root surfaces for 2 minutes to eliminate the smear layer and to improve the adhesion of the blood clot to the root.[14] The CAF for localized gingival recession was designed as described by de Sanctis and Zucchelli.[15] Briefly, two horizontal beveled incisions (approximately 3 mm) mesial and distal to the recession were performed beginning apically from the tip of the anatomical papillae equal to the depth of REC plus 1 mm. Two beveled, oblique, slightly divergent incisions were placed starting at the end of the two horizontal incisions extending 2 to 3 mm into the alveolar mucosa. A trapezoidal flap was then elevated using the conventional split-full-split approach.[7] Elevation was achieved by using a small periosteum elevator until 3 to 4 mm of bone, apical to the bone dehiscence, was exposed. To eliminate all muscle insertions, split-thickness elevation was used before turning parallel to the bone plate, then parallel to the external mucosal surface. **[Au: Change okay?]** The tension-free flap was then sutured 1.5 to 2 mm coronal to the CEJ with single or double sling sutures[16] (Figs 2 and 3).

Postsurgical Instructions

Each patient was given 600 mg of ibuprofen immediately before surgery and was then instructed to take another dose of 600 mg after 6 hours. Further doses were taken only if needed. It was recommended to intermittently apply an ice bag on the operated area for the first 2 hours. Patients were instructed to rinse twice daily with 0.2% chlorhexidine and to avoid any mechanical trauma, toothbrushing, and excessive muscle traction in the surgical area for 4 weeks. No interdental cleaning was allowed in the first 4 weeks. Sutures were removed after

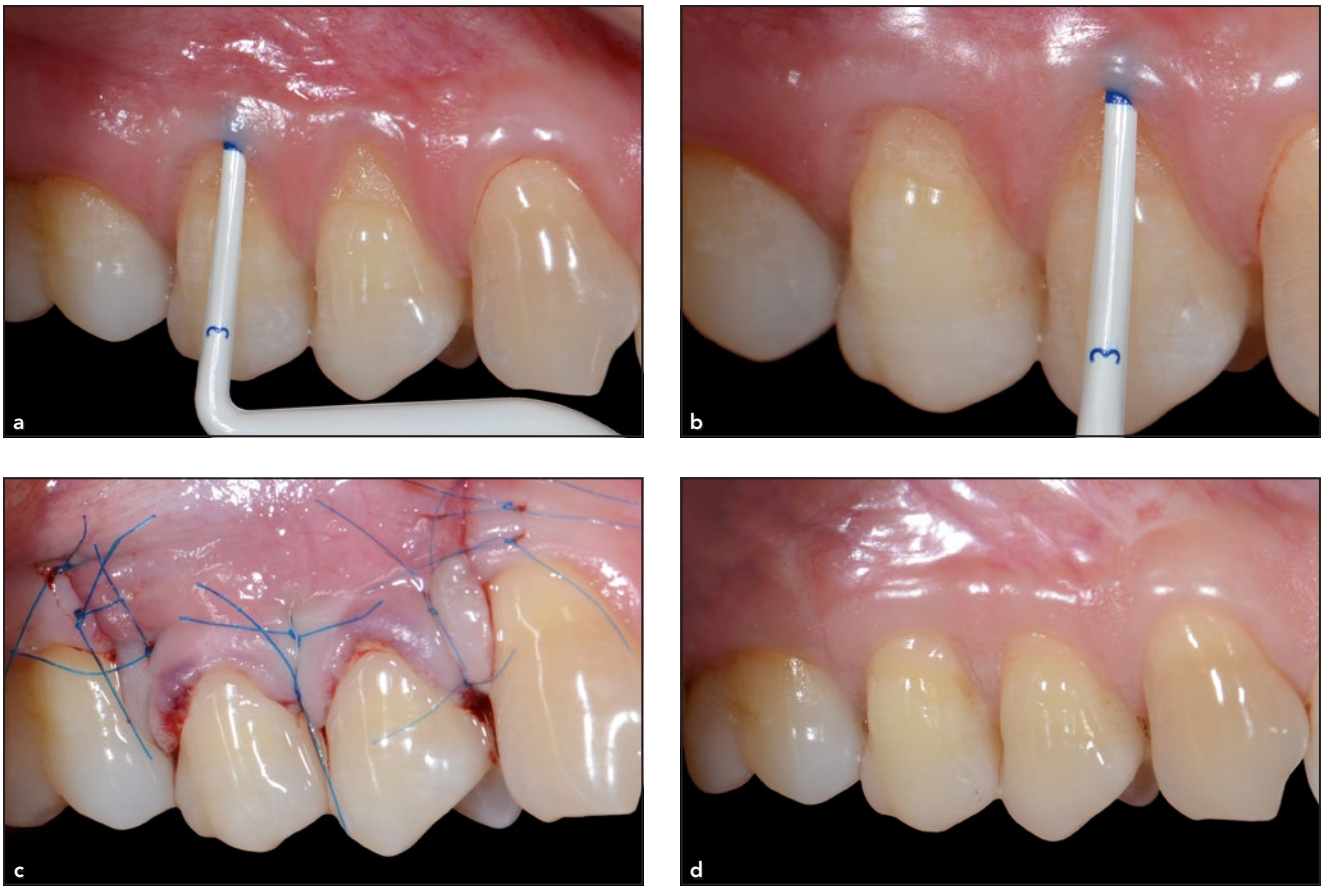

Fig 3 *Multiple adjacent gingival recessions on maxillary right premolars.* (a, b) *The visibility of the blue color through the soft tissue (while the white and the green colors were not visible) indicates that both sites have a thick gingival phenotype.* (c) *Postoperative view of the advanced flap, sutured 2 mm coronally to the cementoenamel junction using a combination of sling and simple interrupted sutures.* (d) *Results at 6 months showing complete root coverage.*

14 days, and patients were instructed to resume mechanical brushing using a postsurgical toothbrush (for the first 3 months). Patients were then recalled for 1-, 3-, and 6-month follow-ups for prophylaxis and reinforcement of brushing instruction.

Data Analysis

Data were expressed as mean ± standard deviation obtained from 24 GRs in 21 patients. All patients enrolled in the present study completed the 6-month study protocol. Comparison between baseline and 6-month REC values were performed using paired Student *t* test ($\alpha = .05$). The primary outcome variables were REC and RES scores (GM, MTC, STT, MGJ, and GC).

Results

Baseline Characteristics

Twenty-four GRs were treated in 21 patients (7 men, 14 women). Patient characteristics at baseline are depicted in Table 1. The mean age of patients was 38.4 ± 9.7 years (range: 18 to 52 years). The treated sites consisted of 12 maxillary canines, 8 maxillary premolars, 3 maxillary incisors, and 1 mandibular canine. Baseline FMPS and FMBS values were 14.3% ± 8 % and 7.4% ± 2.3%, respectively. Eight sites presented with thin GPh, while medium, thick, and very thick GPh were observed in five, seven, and four sites, respectively (Table 1). Baseline REC and KTW were 2.9 ± 1 mm and 3.1 ± 1.1 mm, respectively.

Table 1 Baseline Characteristics of Study Subjects

Patient no.	Gender	Age, y	GPh
1	M	37	Thin
2	F	41	Thin
3	F	49	Thin
4	F	20	Thin
5	F	37	Thin
6	F	42	Thin
7	M	51	Thin
8	F	35	Medium
9	F	44	Medium
10	F	47	Medium
11	F	44	Medium
12	F	30	Thick
13	F	50	Thick
14	M	34	Thick
15	F	37	Thick
16	M	38	Thick
17	F	18	Thick
18	M	52	Very thick
19	F	31	Very thick
20	M	43	Very thick
21	M	41	Very thick

M = male; F = female;
GPh = gingival phenotype.

Table 2 Recession Depth and KTW Changes Between Baseline and 6 Months

Tooth no. (FDI system)	REC, mm		KTW, mm		mRC at 6 mo, %	CRC, 6 mo	KTW change, mm
	Baseline	6 mo	Baseline	6 mo			
23	6	5	4	3	16.7	No	–1
43	3	1	1	0	66.7	No	–1
14	3	2	6	3	33.3	No	–3
24	3	2	4	3	33.3	No	–1
14	2	0	3	4	100	Yes	1
23	3	1	3	4	66.67	No	1
23	3	0	4	3	100	Yes	–1
13	3	1	4	3	66.67	No	–1
24	2	0	2	3	100	Yes	1
14	2	0.5	2	3	75	No	1
23	3.5	1.5	3.5	3	57.1	No	–0.5
13	2	0	3	3	100	Yes	0
22	2	0	4	3	100	Yes	–1
12	2	0	3	3	100	Yes	0
23	3	0	2	2	100	Yes	0
23	4	0	1.5	2	100	Yes	0.5
23	5	2	4	5	60	No	1
13	2	0	3	3	100	Yes	0
14	3	0	2	2	100	Yes	0
15	3	0	2	2	100	Yes	0
13	2	0	3	3	100	Yes	0
14	3	2	4	3	33.33	No	–1
12	2	0	3	2	100	Yes	–1
13	2	0	3	2	100	Yes	–1
Average	2.9 ± 1	0.8 ± 1.1	3.1 ± 1.1	2.8 ± 1	79.5 ± 27.1	58.3%	–0.3 ± 0.9

REC = recession depth; KTW = keratinized tissue width; mRC = mean root coverage;
CRC = complete root coverage. **[Au: FDI system correct?]**

Overall Clinical and Esthetic Outcomes at 6 Months

REC and KTW change over the follow-ups are presented in Table 2. At 6 months, average REC was 0.8 ± 1.1 mm while KTW averaged 2.8 ± 1 mm. The mean root coverage (mRC) was 79.5% ± 27.1%, and CRC was achieved in 58.3% of sites. Differences in REC at baseline and 6 months were clinically and statistically significant ($P < .01$). Esthetic evaluation was performed at 6 months using RES: Three GRs achieved the maximum score (RES = 10), and in 10 out of 24 sites, an RES ≥ 9 was observed. The mean RES was 7.5 ± 2. Table 3 reports the GM, MTC, STT, MGJ, and GC for each site treated.

Clinical and Esthetic Outcomes at 6 Months Based on Patients' Gingival Phenotype

Patients with thin GPh showed the lowest mRC (60.3% ± 28.8%), while mRC values of 86.4% ± 17.6%, 93.3% ± 15.1%, and 83.3% ± 33.3% were found in patients with medium, thick, and very thick GPh, respectively. However, these differences were not statistically significant

Table 3 Root Coverage Esthetic Score at 6 Months

Tooth no. (FDI system)	GPh	RES parameters, points					Total score, points
		GM	MTC	STT	MGJ	GC	
23	Thin	0	0	0	1	1	2
43	Thin	3	1	1	0	1	6
14	Thin	3	1	0	0	1	5
24	Thin	3	1	1	0	1	6
14	Thin	6	1	0	0	1	8
23	Thin	3	1	1	1	1	7
23	Thin	6	1	1	1	1	10
13	Thin	3	1	1	0	1	6
24	Medium	6	1	0	0	1	8
14	Medium	3	1	0	0	1	5
23	Medium	3	0	1	1	1	6
13	Medium	6	1	1	0	1	9
22	Medium	6	1	1	1	1	10
12	Thick	6	1	0	1	1	9
23	Thick	6	0	1	1	1	9
23	Thick	6	1	0	1	1	9
23	Thick	3	1	0	1	0	5
13	Thick	6	1	0	0	1	8
14	Thick	6	1	1	0	1	9
15	Thick	6	1	1	0	1	9
13	Very thick	6	1	0	0	1	8
14	Very thick	3	1	0	1	1	6
12	Very thick	6	1	1	0	1	9
25	Very thick	6	1	1	1	1	10

RES = root coverage esthetic score; GM = level of the gingival margin (0 = failure of root coverage; 3 = partial root coverage; 6 = complete root coverage); MTC = marginal tissue contour (0 = irregular gingival margin; 1 = proper marginal contour/scalloped gingival margin); STT = soft tissue texture (0 = scar formation and/or keloid-like appearance; 1 = absence of scar or keloid formation); MGJ = mucogingival line alignment (0 = MGJ not aligned with the MGJ of adjacent teeth; 1 = MGJ aligned with the MGJ of adjacent teeth); GC: gingival color (0 = color of tissue varies from gingival color at adjacent teeth; 1 = normal color and integration with the adjacent soft tissues). **[Au: FDI system correct?]**

($P > .05$). Similarly, medium, thick, and very thick GPh were associated with a CRC of 60%, 85.7%, and 75%, respectively, which was higher than the CRC observed in patients with thin GPh (25%). Regression analysis showed that the difference in the likelihood of achieving CRC between thin and thick/very thick GPh was significant ($P < .05$). The mean KTW change was –0.3 ± 0.9 mm, and patients with thin GPh showed lower KTW gain (–0.8 ± 1.2 mm) compared to patients with thick GPh (0.2 ± 0.4 mm); however, this was not statistically significant ($P > .05$). Higher RES values were observed in patients with thick and very thick GPh (8.3 ± 1.5 and 8.3 ± 1.7, respectively), while medium GPh showed a mean RES of 7.6 ± 1.9, and thin GPh was related to the lowest RES (6.3 ± 2.2). However, these differences were not statistically significant ($P > .05$). Results based on patients' GPh are reported in Table 4.

Discussion

Several factors affect the likelihood of achieving CRC, including tooth location, KTW, and GPh.[17,18] GPh is associated with gingival thickness and KTW, with thick GPh characterized by greater gingival thickness and KTW than thin GPh.[19–21] Assessing a patient's GPh before surgery can suggest whether a soft tissue graft is indicated or not.[2,7] When performing CAF + CTG in patients, regardless of their GPh, Kahn et al observed similar results in terms of mRC.[22] The present results showed that GPh is a key factor affecting the outcomes of CAF alone. Patients with thin GPh showed the lowest mRC (60.3%) compared to patients with medium, thick, or very thick GPh that exhibited similar outcomes (83.3% to 94.3% of mRC, on average). While the limited sample size in each group prevented the authors from detecting statistically significant differences in terms of mRC and RES, a significantly higher chance of achieving CRC was found in patients with thick or very thick GPh compared to thin GPh. Previous authors reported that CAF alone was able to achieve satisfying results in terms of mRC and CRC.[15,23,24] In addition, it was shown that gingival thickness > 1.2 mm at the level of the keratinized mucosa was a positive predictor of CRC.[9] Given the strong correlation between

Table 4 Clinical and Esthetic Outcomes Based on Patient Phenotype

GPh	Sites, n	Baseline REC, mm	6-mo mRC, %	6-mo CRC, %	Baseline KTW, mm	KTW change at 6 mo, mm	6-mo RES
Thin	8	3.3 ± 1.1	60.3 ± 28.8	25	3.6 ± 1.3	–0.8 ± 1.2	6.3 ± 2.2
Medium	5	2.3 ± 0.6	86.4 ± 17.6	60	2.9 ± 0.8	0.1 ± 0.8	7.6 ± 1.9
Thick	7	3 ± 1.2	94.3 ± 15.1	85.7	2.75 ± 0.8	0.2 ± 0.4	8.3 ± 1.5
Very thick	4	2.6 ± 0.5	83.3 ± 33.3	75	2.8 ± 0.7	–0.7 ± 0.5	8.3 ± 1.7

GPH = gingival phenotype; REC = recession depth; mRC = mean root coverage at 6 months; CRC = complete root coverage; KTW = keratinized tissue width; RES = root coverage esthetic score.
All values except CRC are presented as average ± standard deviation.

gingival thickness and GPh,[19,20] it can be concluded that the present results are in line with previous investigations demonstrating the key role of gingival thickness.[7,24] It is interesting to note that GPh does not affect the outcomes of CAF when CTG is used,[22,25] suggesting that this approach should be recommended only in the case of a thin GPh.[25] Advantages that have been attributed to CTG include its ability to improve stabilization of the flap to the root surface (and of the blood clot), increasing the marginal soft tissue thickness and KTW.[26] However, it was demonstrated that CAF + CTG provides superior outcomes than CAF alone only when gingival thickness is ≤ 0.8 mm,[7] leading Cairo et al to conclude that the addition of CTG is beneficial only in thin GPh, which is in agreeance with the current results.[7] In a histologic and histomorphometric evaluation, no differences in epithelial thickness were observed between thin and thick GPh, but thick GPh showed a significantly thicker connective tissue layer.[19] It may be reasonable to assume that the increased thickness of the connective tissue layer in thick GPh has the same function of a CTG, and therefore CTG should be recommended only when GPh is thin. Indeed, Stefanini et al recently proposed a selective use of CTG only for sites presenting with gingical thickness < 1 mm and KTW ≤ 1 mm.[8]

The present study also demonstrated that GPh can affect esthetic outcomes. Achieving CRC contributes to 60% of the final RES value; these findings can explain the lower RES results observed in patients with thin GPh. Overall, no differences were found between medium, thick, and very thick GPh, suggesting that these conditions present an adequate gingival thickness for root coverage procedure, not affecting the final outcomes. Different techniques of evaluating gingival thickness have been proposed, including transgingival probing, ultrasonic measurement, and probe visibility.[1] De Rouck et al distinguished thin, medium, and thick GPh by probing the buccal side of the sulcus and assessing the transparency of the gingiva.[27] Other authors who have used the same method tend to discriminate only thin and thick GPh.[28] The present group of authors introduced a color-coded probe that was found to be effective in differentiating GPh types and in demonstrating that mandibular incisors with thin GPh are more prone to GM instability following orthodontic treatment.[12]

Within the limitation of the present investigation, it should be mentioned that patient-reported outcomes were not evaluated and that the study design lacks a control group. In addition, the outcomes are based on a small sample size for each GPh; whether CAF in patients with thick or very thick GPh is related to superior clinical and esthetic outcomes than in patients with thin GPh has to be confirmed in future investigations. Further studies are needed to compare CAF + CTG vs CAF alone in patients with thick or very thick GPh.

Conclusions

Within its limitation, the present study demonstrated that GPh highly affects the outcomes of CAF, with thin gingival phenotype showing the lowest clinical and esthetic results. Clinicians should be aware that the addition of a soft tissue graft together with CAF may be indicated in the presence of gingival recessions with thin gingival phenotype.

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