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ORIGINAL ARTICLE

Patient-reported outcomes of palatal donor site healing using four different wound dressing modalities following free epithelialized mucosal grafts: A four-arm randomized controlled clinical trial

Hussein S. Basma[1] | **Muhammad H. A. Saleh**[2] | **Ramzi V. Abou-Arraj**[1] | **Matthew Imbrogno**[3] | **Andrea Ravida**[2] | **Hom-Lay Wang**[2] | **Peng Li**[4] | **Nicolaas Geurs**[1]

[1]Department of Periodontics, University of Alabama at Birmingham, Birmingham, Alabama, USA

[2]Department of Periodontics and Oral Medicine, University of Michigan School of Dentistry, Ann Arbor, Michigan, USA

[3]Department of Periodontics, University of Louisville School of Dentistry, Louisville, Kentucky, USA

[4]School of Nursing, University of Alabama at Birmingham, Birmingham, Alabama, USA

Correspondence
Hom-Lay Wang, Department of Periodontics and Oral Medicine, University of Michigan School of Dentistry, 1011 North University Avenue, Ann Arbor, MI 48109-1078, USA.
Email: homlay@umich.edu

Abstract

Background: The aim of this study was to compare the effects of four different commonly used wound dressings in improving patient reported outcomes (PROMS) after free epithelialized mucosal grafts (FEGs) harvesting.

Methods: Following 72 FEGs harvesting from 72 patients, patients were assigned into four groups. Control: collagen plug + sutures (CPS); test: collagen plug with cyano-acrylate (CPC), platelet rich fibrin (PRF) + sutures, or palatal stent only (PS). Patients were observed for 14 days, with evaluation of pain level utilizing the visual analog scale, number of analgesics consumed, need for additional analgesics, amount of swelling, amount of bleeding, activity tolerance, and willingness for retreatment.

Results: Compared to the control group all test groups indicated significant lower pain perception ($P < 0.0001$), lower analgesic consumption ($P < 0.0001$), and higher willingness for retreatment ($P < 0.0001$), while no statistically significant differences among test groups were observed. There were no statistically significant differences in amount of day-by-day swelling, bleeding, and activity tolerance among four groups. Compared to other groups, the PS had the lowest overall pain scores (over the 14-day period). Palatal thickness, graft length, graft width, and graft thickness did not appear to affect patient morbidity ($P > 0.05$).

Conclusions: All interventions significantly decreased pain perception compared to a hemostatic collagen sponge alone over the palatal donor site after FEG

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surgery. In the first few days after surgery, the use of a palatal stent seemed to be associated with less overall pain, pain pills consumed, and higher willingness of doing the same procedure again.

KEYWORDS
pain, palate, sutures, tissue adhesives, wound healing

1 | INTRODUCTION

Gingival grafting procedures have long been performed for the treatment of mucogingival deformities and gingival recession for root coverage and increase keratinized tissue (KT).[1] Maynard and Oschenbein postulated that an area should be treated if there is ≤1 mm KT present.[2] Lang and Löe found that gingival health can be maintained in areas with ≥ 2 mm of KT.[3] Generally, about 2 mm of KT and about 1 mm of attached gingiva are desirable around teeth to maintain periodontal health, even though a minimum amount of keratinized tissue is not needed to prevent attachment loss when optimal plaque control is present.[4]

A multitude of approaches have been developed to increase the width of KT and/or obtain root coverage.[1,5] The free epithelialized mucosal grafts (FEG) technique as initially described by Sullivan & Atkins in 1968 remains to be the gold standard for increasing the width of KT.[6] However, the main concern regarding FEGs for patients is typically donor site discomforts.[7] Patients receiving FEGs report more postoperative discomfort, bleeding, and swelling compared to those receiving connective tissue grafts, some of which can oftentimes be difficult to manage.[7] Assessment of patient's perception of the treatment received is key to minimizing patient's discomfort, even if such evaluation is somewhat subjective.[8]

Several approaches to lessen patients' postoperative discomfort have been reported.[9,10] Utilized techniques include using a palatal stent, collagen-gelatin scaffolds, resorbable gelatin sponge, oxidized cellulose, collagen membranes, medicinal plant extract, cyanoacrylate by itself or in addition to other dressing materials (e.g., Alvogyl, platelet concentrates and platelet rich fibrin [PRF]).[11] In a previous randomized clinical trial (RCT), we observed that adding an additional layer of cyanoacrylate over a hemostatic collagen sponge on the palatal wound following FEG was successful in minimizing patients' postoperative discomfort and the need for analgesics.[12] Another RCT has demonstrated that PRF bandages significantly reduced postoperative pain and discomfort and facilitated wound healing following FEG procedures compared to negative control.[13] Palatal stents are commonly used means to control post-operative bleeding and discomfort after FEG.[14] Although it stands out as the one that is least studied and highest variability of results.[15] Finally, it is not surprising that these studies used different approaches when assessing how effective each technique was in reducing patients' post-operative morbidity.

Therefore, the aim of the present study was to compare four common wound management approaches (collagen plugs with sutures [CPS], collagen plugs with cyanoacrylate [CPC], platelet-rich fibrin with sutures [PRF], and palatal stents [PS]) to alleviate patient discomfort as well as to achieve the best clinical outcomes.

2 | MATERIALS AND METHODS

2.1 | Ethical approval and registration

This experimental protocol was approved and obtained by the University of Alabama at Birmingham, AL, USA Health Science Institutional Review Board (300002777). This study was conducted in accordance with the Helsinki Declaration for the ethical principles for medical research involving human subjects, as revised in 2013. This randomized controlled trial has complied with the CONSORT guidelines (see Supporting Information Table S1 in online *Journal of Periodontology*).[16]

2.2 | Eligibility criteria and recruitment

This study was conducted at the University of the University of Alabama at Birmingham, AL, USA, between September 2020 and August 2021. Adult subjects who agreed to participate in this study were pre-screened. Each subject received sufficient information about the study design, risks, benefits, and timeline of the study. Patients were eligible if they fulfilled all the following criteria: (1) age ≥ 18 years; (2) systemically healthy; and (3) palatal tissue thickness > 2 mm evaluated with a University of North Carolina (UNC) periodontal probe for bone sounding, placed perpendicular to the hard palate before surgery. Patients were excluded if they were: (1) smokers; (2) with coagulation disorders (history of hemophilia, von Willebrand disease), or currently subject to anticoagulant

TABLE 1 Demographic data of the included patients in each group

Characteristics	Group, mean (SD) or *N* (%)				*P* values
	CPS (*n* = 18)	CPC (*n* = 18)	PRF (*n* = 18)	PS (*n* = 18)	
Age	57.6 (±18.4)	55.4 (±14.8)	64.2 (±9.9)	52.0 (±18.9)	0.1409
Sex					0.4988
Male	7 (38.9%)	8 (44.4%)	4 (22.2%)	8 (44.4%)	
Female	11 (61.1%)	10 (55.6%)	14 (77.8%)	10 (55.6%)	
Race					0.4569
Asian	0	0	0	2 (11.1%)	
African American	1 (5.6%)	2 (11.1%)	1 (5.6%)	1 (5.6%)	
Hispanic	1 (5.6%)	0	0	2 (11.1%)	
White	16 (88.9%)	16 (88.9%)	17 (94.4%)	13 (72.2%)	
Smoking					NA
No	18 (100%)	18 (100%)	18 (100%)	18 (100%)	
Yes	0	0	0	0	

therapy; (3) patients with altered healing patterns (i.e., type 2 diabetes mellitus).

2.3 | Experimental design

This study was designed as a clinical trial with a parallel design to assess the patient-reported outcome of four different types of wound dressing placed in the palatal donor site after FEG harvesting. The four groups were: collagen plug with sutures (CPS, control), collagen plug with cyano-acrylate (CPC, test), platelet rich fibrin (PRF, test), or palatal stent (PS, test).

2.4 | Sample size and characteristics

Sample size was based on a previous study,[17] in which the standard deviation of pain score was about 1.4 and the difference of pain scores between two procedures was about 2.3. Assuming similar SD and mean difference (i.e., Cohen's d = 1.6) in this study to be observed, 13 patients were deemed necessary in each group to achieve 80% power to detect such difference using two-sided, equal variance t-test at the significance level of 0.05. This number was increased to 18 patients to compensate for any possible dropouts during the follow-up period. Hence, a total of 72 patients were included in this study, 27 of which were male, and 45 were females. Demographic data of the study participants are shown in (Table 1).

2.5 | Surgical procedures

For the preparatory phase, prophylaxis and periodontal therapy, consisting of full mouth scaling using both hand and ultrasonic instruments, were performed. As for surgeries, they were all performed under local anesthesia (2% lidocaine with 1:100,000 epinephrine and 1:50,000 epinephrine) without sedation, and by the same operator (H.B.). For all groups, FEGs were done following the surgical technique described by Sullivan and collegues[6,18] with all grafts being placed on a periosteal bed. To standardize graft thickness harvested, an endodontic file was used was to gauge at the time of harvesting for a graft thickness of roughly 2 mm; and confirmed intra-surgically with a caliper. Measurements were done at the mesial, central, and distal parts of the designated area. These measurements were taken about 2–3 mm apical to the gingival margin of adjacent teeth (Figure 1). FEG thickness, length, width, and palatal thickness were recorded for each graft. The graft was then firmly adapted to the recipient area and stabilized with suspensory periosteal sutures using resorbable sutures. The same suture material was used for all procedures at both donor and recipient site in all groups.

2.6 | Compared interventions

After graft harvesting, the patient was randomly assigned into one of the four groups of treatment using a randomization software. Random allocation, patient enrolment, and assignment was done by different clinicians. Patients in the control group (CPS) had multiple collagen plugs* packed firmly in the wound site and resorbable sutures were used to stabilize it in place. With the cyanoacrylate† (CPC) group, after collagen plugs were used to seal the palatal wound in the same fashion described for the

* Cytoplast RTMPLUG, Collagen Matrix, Inc., Oakland, New Jersey
† PeriAcryl, Glustitch Inc., Delta, BC, Canada

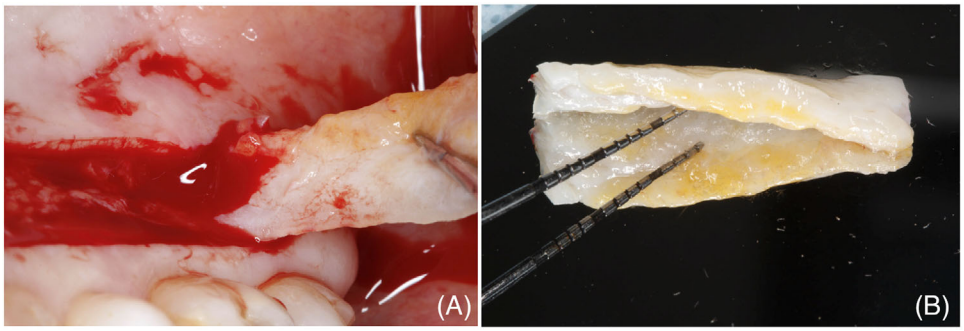

FIGURE 1 (**A**) Intra-surgical photo of graft harvesting. (**B**) Uniform graft width was always attempted while considering the thickness of the palatal tissue

control group, several drops of a high-viscosity cyanoacrylate were applied along the wound margins, and subsequently throughout the whole collagen sponge to have a uniform superficial layer of the acrylic adhesive. No sutures were placed for this group. Patients in the (PS) group had alginate impressions taken before starting the surgery and custom vacuum shells (clear splint 0.5 mm/125 mm round) were fabricated. The fit of the stents was checked before commencing the surgery. Chairside modifications were performed as necessary. Patients were instructed not to remove the stent for the first 3 days. Starting the 4th day patients were instructed to remove the stents and clean after every meal. For the PRF group, 10 mL of venous blood were drawn from the patient's antecubital vein to be collected in glass-coated plastic tubes free from anticoagulant agents. These tubes were then immediately centrifuged at 3000 rpm for 10 min (653 g relative centrifugal force (RCF max).[19] ‡ PRF coagulum was compressed to form a consistent "PRF membrane." PRF membranes were applied over the donor sites after harvesting the FEG and were secured in place with same suture material (Figure 2).

2.7 | Postsurgical care

Patients were seen 1 and 2 weeks following the surgical procedure. Patients were asked not to brush the palatal surface of the maxillary teeth until they were seen for the 2nd postoperative visit. Patients were instructed to take ibuprofen 800 mg right before the surgery. During the following days, no ibuprofen was prescribed unless clearly necessary. No antibiotics were prescribed. Only salt-water rinses were prescribed 2–4 times daily for 2 weeks. Patients were also reminded to describe only the pain perceived from the palate during the Visual Analog Scale (VAS) recording.

‡ Intra-Spin centrifuge [Intra-Lock], BioHorizons, Birmingham, Alabama

2.8 | Postsurgical assessment

Patients were followed for 14 days, with daily evaluation of pain level using the VAS. The need for additional analgesics and the total number of pills consumed was recorded daily. Total "pills consumed" was documented as the average number of ibuprofen 600 mg pills that were required to manage postoperative discomfort during the 14-day period following surgery. The amount of swelling, bleeding, and activity tolerance were all reported on a 0–10 scale. Patients were also asked how likely they would be willing go through another FEG procedure based on a 0–10 scale, with 0 being "absolutely not willing" and 10 being "I don't mind" to undergo the surgery again if an alternative was available. Pain score was patient reported and averaged for each of the four groups for each day of the 14 days following the procedure. Patients reported a number from 0 (none) to 10 (worst ever, unbearable pain) based on the magnitude of pain or discomfort they were experiencing. All other parameters were patient reported. Activity tolerance was measured on a scale from 0 to 10, with 0 being no limitation on activity to 10 (bedrest required).

2.9 | Statistical analysis

Patients' demographics and clinic characteristics at baseline were summarized with descriptive statistics such as mean, standard deviation (SD), frequency, and proportion where appropriate. The group comparisons at baseline were conducted with analysis of variance (ANOVA) or Fisher's exact test. Outcome variables – number of analgesics consumed and need for additional analgesics – were summarized as median and range in each group and the group comparisons were conducted with Kruskal-Wallis's test followed by post hoc Bonferroni-corrected Wilcoxon rank-sum tests. All the other outcome variables including pain score, swelling level, amount of bleeding, activity

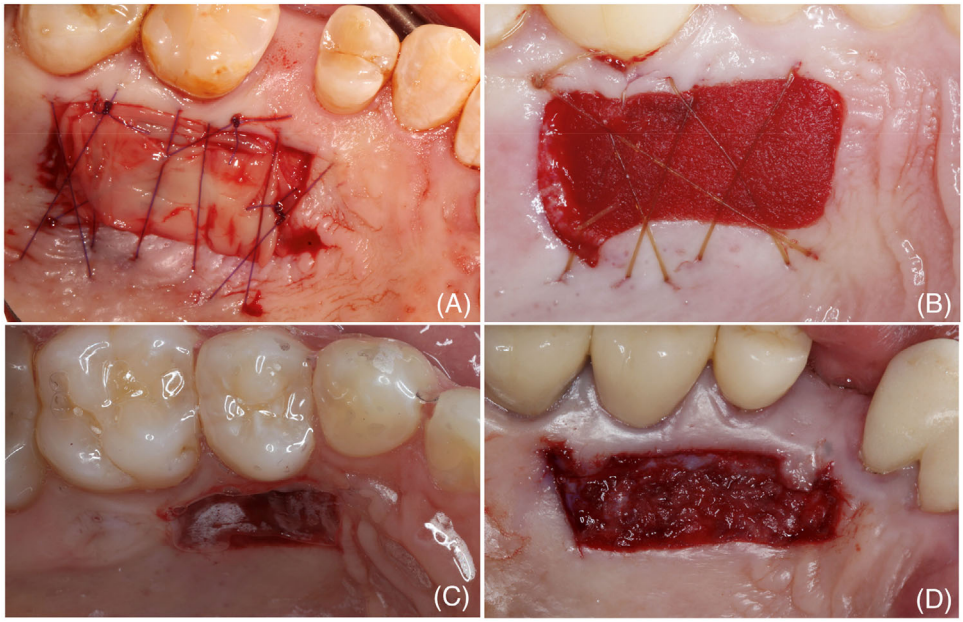

FIGURE 2 Donor site management in the four groups. (**A**) PRF group: platelet-rich fibrin membranes packed in the donor site and stabilized with sutures. (**B**) CPS group: Collagen sponge packed in the donor site and stabilized with resorbable sutures (control group). (**C**) PS group: Palatal stent delivered immediately after the surgery. No dressing was placed in the surgical site. (**D**) CPC group: Collagen sponge packed in the donor site and stabilized with cyanoacrylate. No sutures were used

tolerance, and the need for additional analgesics were summarized with mean ± SD, and analyzed using a general linear mixed regression model to account for the repeated measures. Similar general linear mixed regression models were also used to explore the associations between outcome variables and graft length, width, area, and thickness. All analysis was conducted using SAS 9.4 (Cary, NC, USA) under the significance level of 0.05.

3 | RESULTS

3.1 | Baseline data analysis

Each of the four groups included 18 patients, who all successfully continued the study from commencement until conclusion, making a 100% retention rate for the included 72 patients. No statistically significant group differences were observed regarding age, sex, and race. Smoking was one of the exclusion criteria of the present study. Demographic data for each group of the study participants is shown in (Table 1).

3.2 | Surgical data analysis

The thickness of the palatal graft harvested was 2.0 (±0.4) mm, 1.7 (±0.4) mm, 2.2 (±0.6) mm, and 2.4 (±1.1) mm for the CPS, CPC, PRF, and the PS groups, respectively. The difference in graft thickness was statistically significant ($P = 0.0472$). Specifically, the average graft thickness in CPC group was smaller than the average graft thickness in PS group (1.7 ± 0.4 vs. 2.4 ± 1.1; $P = 0.0279$). No statistically significant differences were found for either palatal thickness, graft length or graft width or graft area for any of the compared groups. Table 2 shows the dimensions of the harvested grafts within each group.

3.3 | Compared outcomes

For all test groups, there were significantly less analgesics consumed postoperatively ($P < 0.0001$) than in the control group (Table 3). These results were not statistically significant among the test groups themselves, but the palatal stent group took significantly less pain medication than the CPC group ($P = 0.0183$). Additionally, patients were significantly more willing for retreatment in all test groups ($P < 0.001$) compared to the control group, with the highest willingness in the palatal stent group (Table 3).

The linear mixed model suggested significant differences among groups regarding pain perception over time ($P < 0.0001$), with the average daily mean scores of 4.2 (±2.4), 2.2 (±2.5), 1.9 (±2.1), and 1.0 (±1.4) for CPS, CPC, PRF, and PS, respectively. Specifically, statistically significant differences in pain perception were found between test and control groups for the first 10 studied days ($P < 0.0001$). The VAS values were statistically significant between the collagen plug and collagen

TABLE 2 Graft dimensions compared among the four groups

Graft dimensions	Group, mean (SD)				*P* values
	CPS ($n = 18$)	CPC ($n = 18$)	PRF ($n = 18$)	PS ($n = 18$)	
Palate thickness (mm)	4.5 (1.2)	4.1 (0.9)	4.0 (1.1)	4.4 (1.4)	0.6236
Graft length (mm)	15.1 (5.3)	17.4 (6.7)	17.8 (5.7)	20.4 (5.3)	0.0629
Graft width (mm)	6.4 (1.2)	6.6 (1.2)	7.1 (1.4)	7.0 (1.4)	0.3292
Graft area (mm^2)	96.8 (37.8)	120.0 (58.0)	126.4 (44.6)	142.6 (45.6)	0.1789
Graft thickness (mm)	2.0 (0.4)	1.7 (0.4)	2.2 (0.6)	2.4 (1.1)	0.0472*

*Statistically significant ($p < 0.05$).

TABLE 3 Comparison of number of pills consumed and willingness to do the same surgery again

Characteristics	Group, median (range)				*P* values	Pairwise comparison Wilcoxon test					
	CPS (n = 18)	CPC (n = 18)	PRF (n = 18)	PS (n = 18)		CPS versus CPC	CPS versus PRF	CPS versus PS	CPC versus PRF	CPC versus PS	PRF versus PS
Pills consumed	21.5 (10-29)	15 (0-62)	11.5 (0-23)	7.5 (0-12)	<.0001	<.0001	<.0001	<.0001	0.5948	0.0183	0.1358
Will you do this surgery again?	3 (0-7)	6 (2-10)	6.5 (4-10)	8.5 (4-10)	<.0001	<.0001	0.0002	<.0001	0.4715	0.0192	0.1543

plug + cyanoacrylate groups for the first 4 days postoperatively and were statistically significant for the first 10 days when compared to the palatal stent group. The VAS values were only statistically significant for days 7 and 8 when comparing the collagen plug and platelet rich fibrin groups. After 10 days, the difference in VAS values diminished among groups (Figure 3).

Even though the control group indicated a little higher amount of swelling over time compared to the test groups, the differences were not statistically significant. The average daily mean scores were 2.2 (±2.4), 1.4 (±2.0), 1.3 (±1.9), and 1.3 (±2.0) for CPS, CPC, PRF, and PS, respectively.

At all observed days postoperatively, the bleeding amount was not significantly different between the test and control groups, with the average daily mean scores of 1.0 (±1.9), 0.9 (±1.9), 0.6 (±1.4), and 0.7 (±1.6) for CPS, CPC, PRF, and PS, respectively (Figure 3). The control group generally had more bleeding than the three test groups through the first 5 days; however, this was not statistically significant.

The Activity tolerance test is represented in Figure 3. The average daily mean scores were 2.4 (±2.4), 1.8 (±2.4), 1.5 (±2.1), and 1.3 (±1.8) for CPS, CPC, PRF, and PS, respectively. Compared to the test groups, the control group tended to have higher score particularly in the first 10 days, and PS had the lowest overall. However, there were no significant differences among groups over time.

The need for more painkiller scales were represented in Figure 3. The average daily mean scores were 2.1 (±2.5), 2.2 (±2.8), 2.0 (±2.6), and 1.5 (±1.8) for CPS, CPC, PRF, and PS, respectively. Compared to other groups, the PS group had the lowest overall score; however, there were no significant differences among groups over time.

There was a difference in graft thickness that was found to be statistically significant ($P = 0.0472$) among groups; in the exploratory analysis, palatal thickness, graft length, graft width, and graft thickness did not appear to affect patient morbidity ($P > 0.05$).

4 | DISCUSSION

The results of this study demonstrated that the use of cyanoacrylate in addition to a hemostatic collagen sponge, use of platelet rich fibrin, or a palatal stent, resulted in significantly decreased pain perception when compared to a hemostatic collagen sponge alone over the palatal donor site after FEG harvesting surgery ($P < 0.0001$). Using these interventions also resulted in better patient acceptance for retreatment and decreased consumption of analgesics compared to the control group ($P < 0.0001$).

Overall, the PS patients seemed to have less pain pills consumed and be more willing to perform the same surgery again. Other than less pain score for the PS compared to CPC on the 8th and 9th day, there was no difference in day-by-day pain scores when interventions were compared to each other. However, the PS group had statistically significant better postoperative pain perception compared to CPS through the first 10 days following surgery ($P < 0.0001$). A recent case series also reported the similar findings.[20] In another study,[14] periodontal dressing, Essix retainer, modified Essix retainer, and modified Hawley retainer groups were compared. They found that the periodontal dressing group on average had higher postoperative pain through the first week compared to all types of retainers.

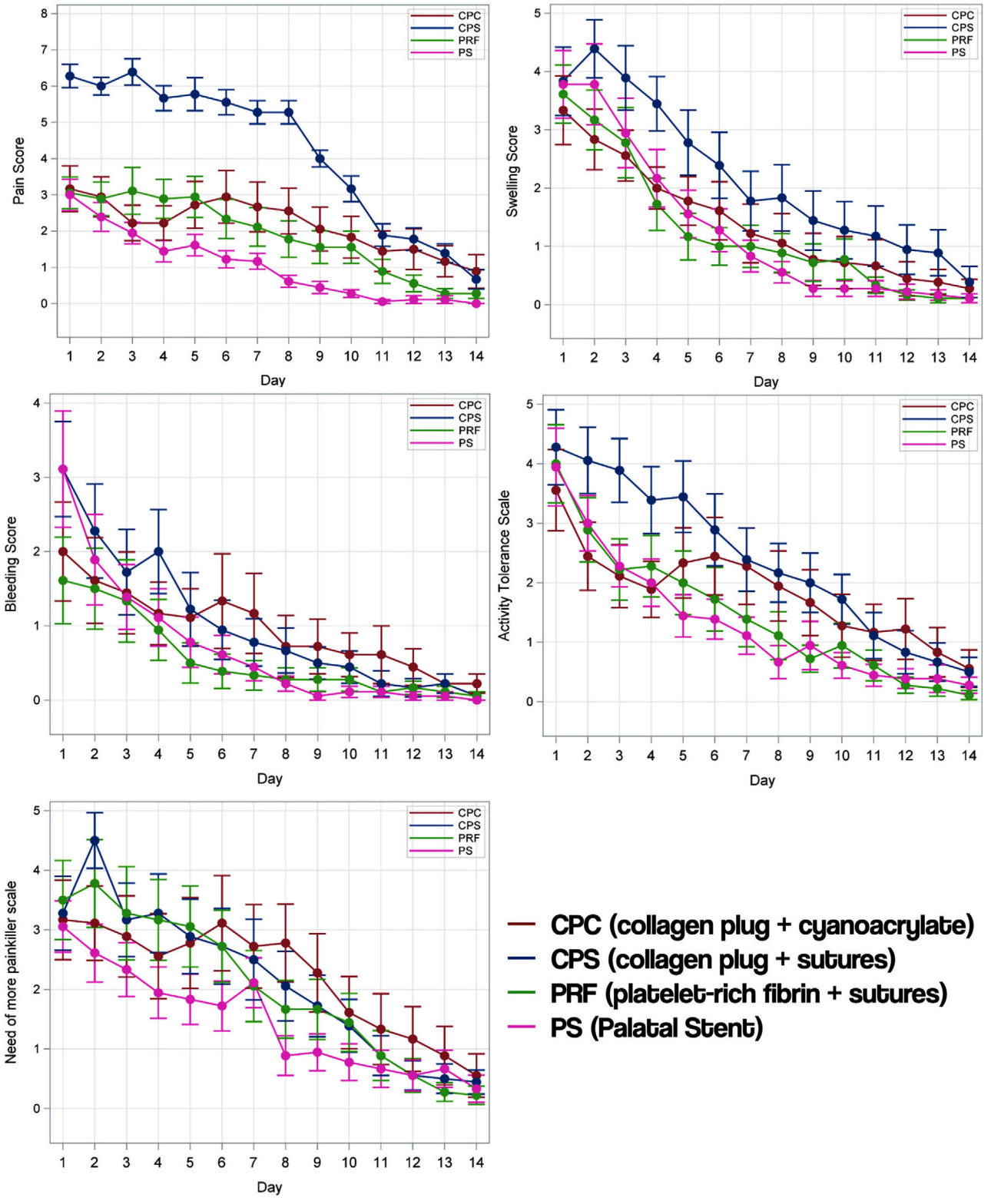

FIGURE 3 Statistical comparison of day-to-day pain, swelling, bleeding, activity tolerance, and need for more pain killer scores among the four groups

PRF is gaining more and more popularity in the dental and periodontal premises including root coverage procedures.[21,22] Other studies have demonstrated its ability to help lower patient morbidity from the palatal donor following FEG harvest.[13,17,23] In this study, the use of PRF was found to be beneficial in reducing the need for additional analgesics, pain, swelling, bleeding, and ability to perform activities compared to use of a collagen plugs alone ($P < 0.0001$). The most significant benefit of PRF was the reduction in bleeding on the first postoperative day. This could be due to the fact that PRF has shown to enhance the wound healing mechanisms of angiogenesis, immunity, and epithelial proliferation.[24] PRF also contains numerous growth factors such as transforming growth factor beta-1 (TGFβ-1), platelet derived growth factor (PDGF), and vascular endothelial growth factor (VEGF); furthermore, PRF is known for its ability to augment proliferation of fibroblasts, osteoblasts, adipocytes, and keratinocytestes.[25] Recently, another biologic, enamel matrix derivative, was applied to excisional palatal wounds and was not found to provide any clinical healing benefits.[26]

Cyanoacrylates, tissue adhesives, are commonly used as an alternative to sutures. They have both bacteriostatic and hemostatic properties, which prove useful for site management and hemostasis.[27] Application of cyanoacrylates have shown to be effective when treating extraction sockets, fixation of mandibular fractures, aiding in healing of intraoral wounds, fixation of FEGs, and helping periodontal flaps heal.[28] Compared to sutures, cyanoacrylates were found to have less inflammation and more a uniform spread of neutrophils, lymphocytes, histiocytes, and eosinophils.[29] One study found that cyanoacrylate is an effective alternative to sutures and helped maxillofacial incisions heal faster.[30] Cyanoacrylate has already proven beneficial to help palatal wounds heal when applied with gauze.[31] However, there was no statistical difference in postoperative pain whether cyanoacrylate tissue adhesive or sutures were used for the donor site of tissue graft (CTG) procedures.[32] The main benefit of cyanoacrylate was the time saved, which was around 5 min.[32] Interestingly, our results indicate otherwise. Patients in the CPC group compared to CPS had statistically significant less for needing analgesics, willingness to have another FEG surgery performed, and postoperative pain ($P < 0.0001$). CPC also had less postoperative swelling compared to CPS, and less bleeding through the first 5 postoperative days. Patients that were in the CPC group also performed the Activity Tolerance test better for the first 10 days compared to the control group.

The presented results suggest that the palatal thickness, graft length, graft width, and graft thickness have no effect on patient morbidity. A recent study comparing three groups depending on the length of the harvested graft ($\leq$10 mm, 10-20 mm, or 20 mm) and the thickness of the graft ($\leq$2 mm, or $>$ 2 mm) found no differences in the postoperative patients' morbidity between the examined groups.[33] This comes in agreement with earlier reports from other randomized clinical trials.[34]

The main limitation of this study, like other studies analyzing postoperative discomfort of the FEG donor site, is using patient reported outcomes. It is well documented that smoking and diabetes adversely affect patients' healing and overall success rate. Even excluding factors such as smoking and diabetes, not all patients heal the same. Some will experience more pain, swelling, and bleeding than others, which is related more to the patients' healing and experience rather than what technique that was used to help postoperatively.

A recent study explored for the first-time topical application of phenytoin as palatal wound treatment and suggested that phenytoin application on palatal wounds could result in improved clinical healing outcomes.[35] In addition to similar investigations, for future studies, a split mouth study design can be used to compare two techniques to try and improve patients' postoperative experience following a FEG if two quadrants need addressed. Also, daily postop visits can be performed so the clinician is objectively measuring all parameters, with the exception to pain, to decrease patient-reported variance.

5 | CONCLUSIONS

Within the limitations of this study, the following conclusions can be made:

1. Applying a layer of cyanoacrylate to a hemostatic collagen sponge, application of platelet rich fibrin, or use of a palatal stent is effective in reducing postoperative pain and analgesic consumption compared to use of a hemostatic collagen plug alone, but these differences seemed to diminish over after the 5th day.
2. Palatal stents seemed to have the lowest overall need for painkillers, lowest effect on activity, and the highest willingness for retreatment.

AUTHOR CONTRIBUTIONS

Hussein S. Basma and Ramzi V. Abou-Arraj contributed to the conception and design of the work. Hussein S. Basma, Peng Li, and Ramzi V. Abou-Arraj collected and analyzed the data; Muhammad H. A. Saleh and Matthew Imbrogno contributed to manuscript preparation; and Hom-Lay Wang and Nicolaas Geurs made critical changes and gave final approval to the manuscript. All authors gave their final approval and agreed to be accountable for all aspects of the work.

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CONFLICT OF INTEREST

The authors do not have any financial interests, either directly or indirectly, in the products or information listed in the paper.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon request.

ORCID

Hussein S. Basma https://orcid.org/0000-0003-0631-7220

Ramzi V. Abou-Arraj https://orcid.org/0000-0003-3552-6603

Hom-Lay Wang https://orcid.org/0000-0003-4238-1799

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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