

Comparative Evaluation Of Microbial Colony Counts On Sutures With Use Of Collagen Dressing (Fix Cote) And Non-Eugenol Periodontal Dressing (Coe-Pak): A Split-Mouth Randomized Controlled Study

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ABSTRACT

Background: Periodontal flap surgery is an established therapeutic approach for managing periodontitis by providing access for effective debridement and promoting periodontal healing. The success of the procedure depends not only on surgical technique but also on maintaining a stable wound environment and limiting postoperative microbial contamination. Silk sutures, although widely preferred because of their ease of handling and knot security, are susceptible to bacterial colonization due to their braided structure. Periodontal dressings are commonly applied to protect the surgical site during the initial healing phase. Collagen-based dressings possess biological properties that may enhance tissue repair while reducing microbial adherence when compared with conventional non-eugenol periodontal dressings. Therefore, this study evaluated and compared the microbial colony counts recovered from silk sutures placed beneath collagen dressing (Fix Cote) and Coe-Pak following periodontal flap surgery.

Methods: A randomized split-mouth clinical trial was conducted in ten systemically healthy patients diagnosed with Stage II or Stage III periodontitis requiring periodontal flap surgery in bilaterally comparable posterior sextants. After completion of flap surgery and placement of 3-0 black braided silk sutures, one surgical site received collagen dressing (Fix Cote) and the contralateral site received Coe-Pak according to a random allocation sequence. Sutures were removed on the seventh postoperative day, transferred into sterile tubes containing 1 mL of sterile peptone water, incubated, and processed microbiologically to determine colony counts of *Enterococcus faecalis*, *Escherichia coli*, *Streptococcus mutans*, and *Staphylococcus aureus*. Plaque Index and Debris Index were also recorded. Data were analyzed using the paired Student's *t*-test and Wilcoxon signed-rank test with the level of significance set at $P < 0.05$.

Results: Microbial colony counts for all four bacterial species were significantly lower in sites treated with collagen dressing than in those treated with Coe-Pak ($P < 0.05$). In contrast, no statistically significant differences were observed between the two groups with respect to Plaque Index and Debris Index scores.

Conclusion: Collagen dressing (Fix Cote) was associated with a significant reduction in postoperative microbial colonization of silk sutures compared with Coe-Pak. Although plaque and debris accumulation remained comparable between the treatment groups, the microbiological findings suggest that collagen dressing may offer advantages in maintaining a favorable environment for early periodontal wound healing.

Keywords: Collagen dressing; Colony-forming units; Microbial colonization; Periodontal flap surgery; Periodontal dressing; Silk sutures

How to cite this article: Agrawal H, Khare S, Agrawal R, Kumar R, Patel KK, Divya, Comparative Evaluation Of Microbial Colony Counts On Sutures With Use Of Collagen Dressing (Fix Cote) And Non-Eugenol Periodontal Dressing (Coe-Pak): A Split-Mouth Randomized Controlled Study, Int J Drug Deliv Technol. 2026;16(71s): 488-494. DOI: 10.25258/ijddt.16.71s.59

Source of support: Nil.

Conflict of interest: Nil.

INTRODUCTION

Periodontitis is a chronic inflammatory disease initiated by a dysbiotic dental biofilm that results in progressive destruction of the periodontal supporting tissues. The disease is characterized by clinical attachment loss, alveolar bone resorption, periodontal pocket formation, and, if untreated, eventual tooth loss. Surgical periodontal therapy is indicated in patients with persistent periodontal pockets after nonsurgical treatment, as it allows direct access for thorough root debridement and facilitates optimal healing of the periodontal tissues.¹

Successful healing after periodontal flap surgery depends on precise flap adaptation, wound stabilization, and effective control of bacterial contamination during the postoperative period. Sutures play a critical role in maintaining tissue approximation and stabilizing the surgical flap. Among the available suture materials, braided silk continues to be widely used in periodontal surgery because of its favorable handling characteristics and knot security. However, the multifilament structure of silk provides niches that facilitate bacterial adhesion and biofilm formation, making it more susceptible to microbial colonization than monofilament suture materials.^{2,3}

Periodontal dressings are frequently placed following flap surgery to protect the surgical wound from mechanical trauma, enhance patient comfort, and support wound stability during the initial stages of healing. Coe-Pak, a non-eugenol periodontal dressing, has been extensively used for this purpose because of its acceptable physical properties and biocompatibility. Nevertheless, it primarily serves as a mechanical barrier and does not actively contribute to the biological processes involved in tissue repair.^{3,4}

Collagen dressings have gained attention as biologically active wound management materials because of their excellent biocompatibility, hemostatic capacity, biodegradability, and ability to promote cellular migration and angiogenesis. By acting as a scaffold for tissue regeneration and maintaining an optimal wound environment, collagen may facilitate periodontal healing while simultaneously reducing postoperative microbial colonization.²

Previous studies have demonstrated that the type of periodontal dressing and the characteristics of suture materials can influence bacterial accumulation following periodontal surgery. Heaney et al. observed that different periodontal dressings altered the microbial profile of healing periodontal wounds.³ Shah et al. reported increased microbial colonization associated with periodontal packs when compared with undressed surgical sites.⁴ In addition, Parirokh et al. demonstrated greater plaque accumulation on braided silk sutures than on monofilament materials, whereas Nadafpour et al. confirmed that commonly used oral suture materials readily support bacterial colonization.^{5,6} More recently, Gupta et al. highlighted the importance of selecting periodontal dressings capable of minimizing postoperative microbial contamination while improving patient-related outcomes following periodontal flap surgery.⁷

Although collagen dressings have shown promising wound-healing properties, clinical evidence comparing their influence on microbial colonization of postoperative silk sutures with that of conventional non-eugenol periodontal dressings remains limited. Therefore, the present randomized split-mouth clinical trial was designed to compare microbial colony counts recovered from silk sutures placed beneath collagen dressing (Fix Cote) and Coe-Pak, together with plaque and debris accumulation during the early postoperative healing period.

Aim

To compare microbial colony counts recovered from postoperative silk sutures beneath collagen dressing (Fix Cote) and non-eugenol periodontal dressing (Coe-Pak) following periodontal flap surgery.

Objectives

- To compare colony counts of *Enterococcus faecalis*.
- To compare colony counts of *Escherichia coli*.
- To compare colony counts of *Streptococcus mutans*.
- To compare colony counts of *Staphylococcus aureus*.
- To compare Plaque Index scores.
- To compare Debris Index scores.

Null hypothesis: There is no significant difference in microbial colonization of postoperative silk sutures between collagen dressing (Fix Cote) and Coe-Pak.

Materials and Methods

Study design

The present investigation was designed as a randomized split-mouth clinical trial and was conducted in the Department of Periodontology, Sri Aurobindo College of Dentistry, Sri Aurobindo University, Indore, Madhya Pradesh, India. Ethical approval was obtained from the Institutional Ethics Committee before commencement of the study. The study adhered to the principles outlined in the Declaration of Helsinki (2013 revision). Prior to participation, all patients received detailed information regarding the study and provided written informed consent.

Study population

A total of 10 systemically healthy patients, aged between 30 and 55 years, diagnosed with Stage II or Stage III periodontitis according to the 2017 World Workshop Classification⁸, were recruited from the outpatient clinic. Patients requiring periodontal flap surgery in bilaterally comparable posterior sextants were considered eligible for inclusion.

Inclusion criteria

Participants were enrolled if they fulfilled the following criteria:

- Age between 30 and 55 years.
- Systemically healthy.
- Diagnosed with Stage II or Stage III periodontitis requiring periodontal flap surgery in bilaterally comparable posterior sextants.

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- Presence of a probing pocket depth (PPD) ≥ 5 mm following completion of Phase I periodontal therapy.
- Willingness to participate and provide written informed consent.

Exclusion criteria

Patients were excluded if they had any of the following:

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- Pregnancy or lactation.
- Systemic conditions known to interfere with periodontal wound healing.
- History of antibiotic, anti-inflammatory, or immunosuppressive therapy within the previous three months.
- Known hypersensitivity to collagen or periodontal dressing materials.
- Inadequate compliance with oral hygiene instructions.

Sample size

A total of 10 patients (20 surgical sites) were included in the study. Owing to the split-mouth design, each patient served as his or her own control, thereby minimizing inter-individual variability and improving the efficiency of treatment comparisons.

The sample size was calculated for a paired clinical study using the formula:

$$n = \frac{(Z_{\alpha/2} + Z_{\beta})^2 \sigma_d^2}{\Delta^2}$$

Assuming a mean paired difference of 1 log₁₀ CFU between the two periodontal dressings, a standard deviation of paired differences of 1 log₁₀ CFU, 95% confidence level, and 80% statistical power, the minimum required sample size was calculated as eight participants. Considering a possible attrition rate of approximately 20%, the final sample size was rounded to 10 participants.

Randomization

Following completion of flap surgery, the bilateral surgical sites were allocated to the treatment groups using a simple lottery method.

- Group A: Collagen dressing (Fix Cote)
- Group B: Non-eugenol periodontal dressing (Coe-Pak)

Allocation was performed immediately after surgery. To minimize operator-related bias, all surgical procedures were carried out by the same clinician.

Surgical procedure

All participants initially underwent Phase I periodontal therapy, including oral hygiene instructions, scaling, and root planing. Clinical re-evaluation was performed after four weeks.

After administration of local anesthesia, intracrevicular incisions were made and full-thickness mucoperiosteal flaps were reflected to expose the root surfaces. Thorough debridement and root planing were completed, followed by irrigation of the surgical field with sterile normal saline.

The flaps were repositioned and stabilized using 3-0 black braided silk sutures. According to the random allocation sequence, one surgical site received collagen dressing (Fix

Cote), while the contralateral site received Coe-Pak. Standard postoperative instructions and medications were provided uniformly to all participants.

Clinical assessment

The following clinical parameters were evaluated:

- **Plaque Index (PI)** according to Silness and L  e (1964)⁹.
- Debris Index (DI) of the Simplified Oral Hygiene Index according to Greene and Vermillion (1964)¹⁰.

Clinical measurements were recorded at baseline and again on the seventh postoperative day by the same calibrated examiner to ensure consistency.

Microbiological assessment

On the seventh postoperative day, the silk sutures were removed aseptically. Approximately 1 cm of each suture was transferred immediately into a sterile test tube containing 1 mL of sterile peptone water.

The collected samples were subsequently incubated under standardized laboratory conditions. Following incubation, microbiological processing was performed for the isolation and quantification of the following microorganisms:

- *Enterococcus faecalis*
- *Escherichia coli*
- *Streptococcus mutans*
- *Staphylococcus aureus*

The incubated samples were cultured on appropriate microbiological media, and the resulting bacterial growth was quantified as colony-forming units (CFU). All microbiological procedures were carried out in the Department of Microbiology using standardized aseptic techniques.

Outcome measures

Primary outcome

Comparison of microbial colony counts (CFU) recovered from postoperative silk sutures beneath collagen dressing (Fix Cote) and Coe-Pak.

Secondary outcomes

- Plaque Index (PI)
- Debris Index (DI)

Statistical analysis

The collected data were entered into Microsoft Excel and analyzed using IBM Statistical Package for the Social Sciences (SPSS) Statistics version 26.0 (IBM Corp., Armonk, NY, USA).

Continuous variables were summarized as mean $\pm$ standard deviation (SD), whereas microbiological findings were expressed as median (range).

Intergroup comparisons of Plaque Index and Debris Index scores were performed using the paired Student's *t*-test. Microbial colony counts were analyzed using the Wilcoxon signed-rank test because of the non-parametric distribution of the data. A two-sided *P* value of <0.05 was considered statistically significant.

RESULTS:

A total of 10 participants completed the study and were included in the final analysis. Demographic characteristics, clinical parameters, and microbiological outcomes were

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evaluated to compare the efficacy of collagen dressing (Fix Cote) and non-eugenol periodontal dressing (Coe-Pak) following periodontal flap surgery.

Table 1: Age distribution of study population

Variable	N	Minimum	Maximum	Mean	Std. Deviation
Age	10	28	46	37.80	6.106

Table 1 shows 10 participants aged between 28 and 46 years, with a mean age of 37.80 ± 6.11 years, indicating that the study population predominantly comprised middle-aged adults.

Table 2: Gender distribution of study population

Gender	Frequency	Percentage
Male	3	30.0
Female	7	70.0
Total	10	100.0

Table 2 and Graph 1 indicates that 7 (70%) were females participants and 3 (30%) were male participants, demonstrating a female predominance in the study population.

Graph 1: Gender distribution of study population

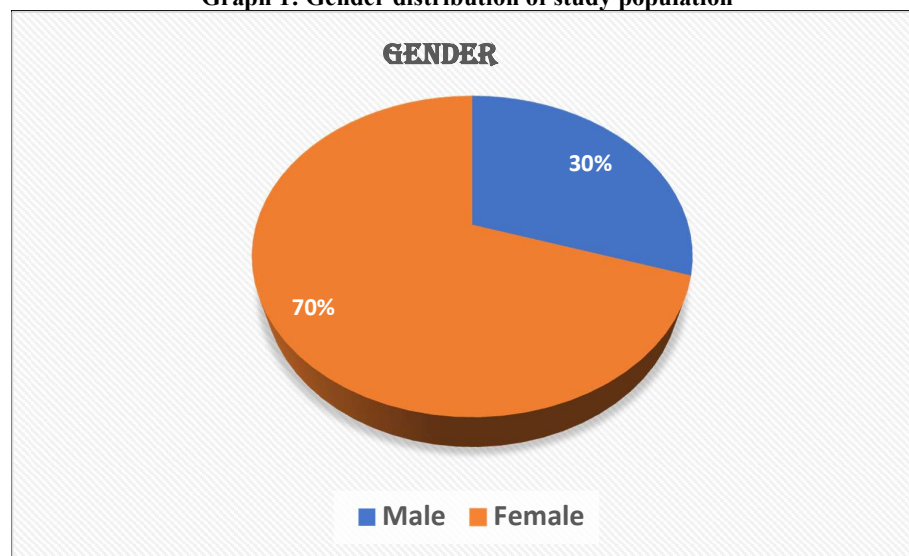


Table 3: Comparative evaluation of Plaque and debris score at various intervals

Variable	Intervals	Groups	Mean	Std. Deviation	Mean Difference	't' test	P value
Plaque Index	Baseline	Group A	2.5820	.33239	.10800	.785	.443 (NS)
		Group B	2.4740	.28072			
	7 th Day	Group A	1.1840	.15263	-.12400	-1.684	.109 (NS)
		Group B	1.3080	.17144			
Debris Index	Baseline	Group A	2.5070	.59935	.06000	.225	.825 (NS)
		Group B	2.4470	.59343			
	7 th Day	Group A	1.1680	.29482	-.17200	-1.492	.153 (NS)
		Group B	1.3400	.31875			

NS = Not Significant

Table 3 and Graph 2 shows Baseline plaque and debris scores were comparable between the collagen dressing (Fix

Cote) and Coe-Pak groups ($p > 0.05$). Both groups showed improvement by the seventh postoperative day. Although the collagen dressing group demonstrated slightly lower

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plaque and debris scores, the intergroup differences were not statistically significant ($p > 0.05$), indicating comparable plaque control with a trend favouring collagen dressing.

Graph 2: Comparative evaluation of Plaque and debris score at various intervals

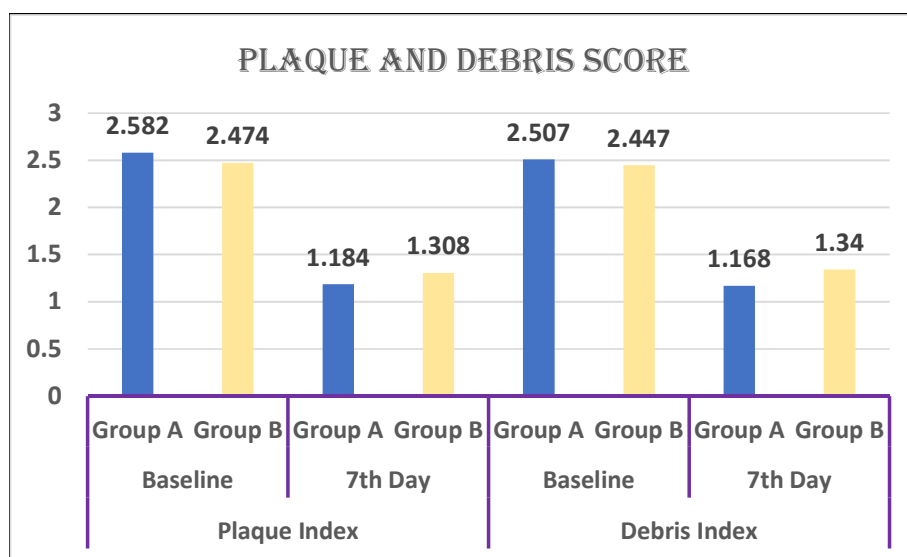


Table 4: Comparative evaluation of microbial colony count at the 7th postoperative day

Variable	Group A (Median [Range])	Group B (Median [Range])	Wilcoxon Signed-Rank Test (Z)	P value
Enterococcus faecalis	10 ² (10 ¹ –10 ³)	10 ³ (10 ² –10 ⁴)	–2.214	0.027*
Escherichia coli	10 ² (10 ¹ –10 ³)	10 ³ (10 ² –10 ⁴)	–2.146	0.032*
Streptococcus mutans	10 ² (10 ¹ –10 ²)	10 ³ (10 ² –10 ⁴)	–2.803	0.005*
Staphylococcus aureus	10 ³ (10 ² –10 ³)	10 ⁴ (10 ³ –10 ⁵)	–2.097	0.036*

NS = Not Significant; * = Significant

Table 4 shows the median microbial colony counts of *Enterococcus faecalis*, *Escherichia coli*, *Streptococcus mutans*, and *Staphylococcus aureus* were significantly lower in the collagen dressing (Fix Cote) group compared with the non-eugenol periodontal dressing (Coe-Pak) group on the seventh postoperative day. The differences were statistically significant for all four microorganisms ($p < 0.05$), suggesting superior antimicrobial efficacy of collagen dressing in reducing postoperative microbial colonization and promoting a favourable healing environment following periodontal flap surgery.

Overall interpretation:

A total of 10 participants completed the study and were included in the final analysis. The study population had a mean age of 37.80 ± 6.11 years, with a female predominance (70%). Baseline plaque and debris scores were comparable between the two treatment groups. Both periodontal dressings resulted in improved plaque and debris scores by the seventh postoperative day, with a non-significant trend favouring the collagen dressing.

Microbiological analysis demonstrated significantly lower colony-forming counts of *Enterococcus faecalis*, *Escherichia coli*, *Streptococcus mutans*, and *Staphylococcus aureus* in the collagen dressing group compared with the Coe-Pak group, indicating superior antimicrobial efficacy of collagen dressing during the early postoperative healing period.

DISCUSSION

Successful periodontal therapy depends not only on the elimination of periodontal infection but also on the establishment of an environment that promotes predictable wound healing following surgery. During the early postoperative period, bacterial colonization of the surgical site may interfere with tissue repair, making wound protection and plaque control important determinants of treatment outcome. Silk sutures continue to be widely used in periodontal surgery because of their favorable handling properties and knot security; however, their braided configuration provides a suitable surface for bacterial adherence and biofilm formation.^{1,5}

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The present randomized split-mouth clinical trial evaluated the influence of collagen dressing (Fix Cote) and non-eugenol periodontal dressing (Coe-Pak) on postoperative microbial colonization of silk sutures. The findings demonstrated that sutures covered with collagen dressing exhibited significantly lower colony counts of *Enterococcus faecalis*, *Escherichia coli*, *Streptococcus mutans*, and *Staphylococcus aureus* than those covered with Coe-Pak. Conversely, Plaque Index and Debris Index scores remained comparable between the two treatment groups throughout the observation period.

The lower microbial burden observed in the collagen dressing group may be attributed to the biological characteristics of collagen. Besides acting as a protective covering, collagen serves as a natural extracellular matrix that supports hemostasis, cellular migration, angiogenesis, and tissue regeneration. These properties help create a favorable environment for wound healing and may indirectly reduce bacterial colonization by promoting rapid tissue organization and stabilization.²

Our findings are in agreement with those reported by Gupta et al., who demonstrated that the choice of periodontal dressing can influence postoperative microbial levels following periodontal flap surgery. Although their study evaluated *Porphyromonas gingivalis*, whereas the present investigation assessed four different bacterial species, both studies indicate that biologically active dressings may contribute to improved microbiological outcomes during the healing phase.⁷

The observations of the present study are also consistent with the work of Heaney et al., who reported that different periodontal dressings altered the microbial composition of healing periodontal wounds. Their findings support the concept that dressing materials affect the postoperative wound environment and may influence the extent of bacterial colonization.³

Similarly, Shah et al. observed significantly higher microbial colony counts associated with conventional periodontal dressings compared with uncovered surgical sites. Although the comparison in the present study involved two different dressing materials rather than dressed and undressed wounds, both investigations demonstrate that the type of dressing used after surgery can influence postoperative microbial accumulation.⁴

The increased microbial counts observed in the Coe-Pak group may also be related to the characteristics of braided silk sutures. Parirokh et al. demonstrated, using scanning electron microscopy, that silk sutures accumulate considerably greater bacterial deposits than monofilament materials because microorganisms readily become trapped between the braided filaments. This finding provides a biological explanation for the substantial microbial colonization observed on postoperative silk sutures.⁵

Selection of the four bacterial species investigated in the present study was based on their clinical relevance in postoperative oral wound contamination. Nadafpour et al. reported that *Enterococcus faecalis*, *Escherichia coli*, *Streptococcus mutans*, and *Staphylococcus aureus* readily colonize oral suture materials, supporting their use as

representative microorganisms for evaluating postoperative bacterial adherence.⁶

Although collagen dressing significantly reduced microbial colony counts, no statistically significant differences were detected in Plaque Index or Debris Index between the two treatment groups. This finding suggests that the reduction in bacterial colonization cannot be explained solely by differences in plaque accumulation. Rather, the biological properties of collagen may have contributed to a wound environment less favorable for bacterial persistence while simultaneously supporting normal tissue repair.²

Strengths of the study

A major strength of the present investigation is its randomized split-mouth design, which minimized inter-individual variability by allowing each participant to serve as his or her own control. In addition, all surgical procedures were performed by a single operator using standardized techniques, thereby reducing procedural variability. Evaluation of four clinically relevant bacterial species further enhanced the comprehensiveness of the microbiological assessment.

Limitations

Certain limitations should be considered while interpreting the findings. The study included a relatively small sample size, and microbiological analysis was limited to culture-based techniques. Future studies employing molecular methods such as polymerase chain reaction or next-generation sequencing could provide a more detailed characterization of postoperative microbial changes. Furthermore, studies with larger sample sizes and longer follow-up periods are warranted to determine whether the reduction in microbial colonization observed with collagen dressing translates into superior long-term clinical outcomes.

Clinical significance

Within the limitations of the present study, collagen dressing (Fix Cote) was associated with significantly lower postoperative microbial colonization of silk sutures than Coe-Pak. These findings suggest that collagen dressing may provide a more favorable biological environment during the initial stages of periodontal wound healing and may serve as a useful alternative to conventional non-eugenol periodontal dressings following periodontal flap surgery.

CONCLUSION

Within the limitations of this randomized split-mouth clinical trial, the use of collagen dressing (Fix Cote) following periodontal flap surgery resulted in significantly lower microbial colonization of postoperative silk sutures than Coe-Pak. Statistically significant reductions were observed in the colony counts of *Enterococcus faecalis*, *Escherichia coli*, *Streptococcus mutans*, and *Staphylococcus aureus*. In contrast, Plaque Index and Debris Index scores did not differ significantly between the treatment groups.

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These findings indicate that collagen dressing may provide a more favorable biological environment during the initial phase of periodontal wound healing by limiting postoperative microbial colonization while maintaining clinical plaque and debris levels comparable with those of conventional non-eugenol periodontal dressing. Further studies involving larger sample sizes and longer follow-up periods are recommended to validate these observations and determine their long-term clinical implications.

FUNDING

No financial support was received for the conduct of this study or for the preparation of this manuscript.

CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest related to this study.

INFORMED CONSENT

Written informed consent was obtained from all participants before enrollment in the study.

DATA AVAILABILITY

The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request.

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