

Original Research Article

Evaluation of the Topical Antiseptic Use of the EPX® Biomolecule in Periapical Surgical Treatments

Nahir Alejandro Naranjo-Cíntora^{1*}, Norma Patricia Figueroa-Fernández², Mara Gómez-Flores³, Marco Arturo Moreno-Solorio⁴, Roberto Luis Ibarra-Wiley⁵, Maikel Hermida-Rojas⁶

¹Master's Degree in Endodontics, Full-time Professor, School of Dentistry, Mexicali, Autonomous University of Baja California, Mexico

²Doctor in Health Sciences, Master's Degree in Public Health, Specialist in Oral and Maxillofacial Surgery, Full-time Professor, School of Dentistry, Mexicali, Autonomous University of Baja California, Mexico

³Doctor in Dental Sciences, Master's Degree in Educational Sciences, Specialist in Periodontics, Full-time Professor, School of Dentistry, Mexicali, Autonomous University of Baja California, Mexico

⁴Master's Degree in Dental Clinical Sciences, Full-time Professor, School of Dentistry, Mexicali, Autonomous University of Baja California, Mexico

⁵Doctor of Science in Chemical Engineering, Master's Degree in Industrial Administration, C. E. O. Medicaltech Laboratories S.A. de C.V

⁶Doctor in Medical, Dental and Health Sciences, Master's Degree in Oral Health, Specialist in Oral and Maxillofacial Surgery, Full-time Professor, School of Dentistry, Mexicali, Autonomous University of Baja California, Mexico

Article History**Received:** 19.08.2026**Accepted:** 10.10.2026**Published:** 15.10.2026**Journal homepage:**<https://www.easpublisher.com>**Quick Response Code**

Abstract: Periapical endodontic surgery involves surgical techniques to: remove a persistent periapical lesion, clean the apex of the tooth, and facilitate access to the apical end of the root canal, which will then be retrograde filled. Intraoperative antimicrobials are important in these procedures because they prevent and treat sepsis in the area. The EPX® Biomolecule contains chitosan fortified with silver and copper nanoparticles; it is non-toxic, biocompatible, and antiseptic. The safety and antimicrobial pharmacodynamics of this medication were evaluated in periapical surgery. An experimental study—a Phase I clinical trial—was conducted on a sample of 36 patients with a clinical and radiographic diagnosis of chronic periapical disease requiring surgical treatment, who were treated at the Mexicali School of Dentistry, Autonomous University of Baja California, Mexico, from January 2022 to December 2025. All were healthy patients who underwent periapical surgery with topical application of the EPX® Biomolecule, in the form of a surgical gel, with the patients' consent and under the multidisciplinary care of specialists in Oral and Maxillofacial Surgery and Endodontics. All patients had a favorable outcome, with signs and symptoms within normal parameters. Radiographic follow-up was favorable, with most patients showing signs of bone regeneration and no recurrent septic complications. No adverse reactions to the EPX® Biomolecule as an intraoperative gel were reported; doses were standardized in proportion to the size of the periapical lesion, and surgical wound healing was excellent in all patients, whether the procedure was simple or combined with bone grafting.

Keywords: Endodontics, Periapical Healing, Bone Healing, Periapical Surgery, Nanoparticles, Chitosan.

Copyright © 2026 The Author(s): This is an open-access article distributed under the terms of the Creative Commons Attribution **4.0 International License (CC BY-NC 4.0)** which permits unrestricted use, distribution, and reproduction in any medium for non-commercial use provided the original author and source are credited.

INTRODUCTION

Periapical surgery is an endodontic procedure indicated for treating persistent lesions of the periapical tissues when conventional treatment is insufficient, not feasible, or there is a specific surgical indication. It involves techniques such as flap access and osteotomy, curettage of the lesion, apicoectomy, and retrograde obturation, with the aim of removing pathological tissue,

controlling infection, establishing an adequate apical seal, and promoting the repair of periapical tissues [1-3].

Controlling microbial contamination during the procedure is essential for promoting healing. In this regard, intraoperative antiseptics can be used as adjuvants to reduce the microbial load in the surgical field. Chitosan, due to its biocompatibility, antimicrobial

*Corresponding Author: Nahir Alejandro Naranjo-Cíntora

Master's Degree in Endodontics, Full-time Professor, School of Dentistry, Mexicali, Autonomous University of Baja California, Mexico

activity, and ability to form matrices, is a biomaterial of interest for promoting local conditions conducive to tissue repair. The incorporation of nanoparticles and other bioactive components allows for the development of nanostructured formulations with potential applications in periapical surgery, designed to complement microbial control and promote healing of the treated tissues [4-6].

About a decade ago, MedicalTech Laboratorios S.A. de C.V., in collaboration with the Institute of Engineering at the Autonomous University of Baja California (UABC), developed a formulation based on chitosan and enriched with graphene nanoparticles, metallic components—including colloidal silver and copper—as well as essential oils. The combination of these components gave rise to a nanostructured biomaterial designed to provide antimicrobial properties and promote local conditions conducive to tissue repair processes. This formulation was registered as Biomolécula EPX®, and subsequently, various pharmaceutical formulations were developed for dental applications, including a surgical gel, a post-surgical gel, a mouthwash, and biodegradable strips for periodontal use. Given its characteristics and method of application, Biomolécula EPX® can be considered a nanostructured formulation and, based on its name and pharmaceutical development, a nanomedicine for topical application in the field of dentistry [7-9].

The potential antimicrobial properties of this formulation are of particular interest in periapical surgery, since controlling microbial contamination is one of the key factors in promoting the repair of periapical tissues. During these procedures, after surgical access, removal of pathological tissue, and resection of the apical end, the surgical site requires local conditions that promote repair and reduce the risk of microbial persistence or reintroduction. In this context, the local application of a nanostructured biomaterial with antiseptic properties could serve as an adjunctive strategy for microbial control of the surgical site, provided that its use is compatible with periapical tissues and does not interfere with physiological healing mechanisms [7-9].

The EPX® Biomolécula has been evaluated through *in vitro*, *in vivo*, and preclinical studies aimed at characterizing its biological properties, antimicrobial activity, and tolerability. These findings laid the groundwork for continuing its clinical evaluation using various pharmaceutical formulations for topical application. Based on this research program, specific projects were developed to evaluate its performance and safety in various dental procedures, including surgical applications. The clinical evaluation of the surgical gel formulation allowed for the study of its use as a local antiseptic adjuvant and the assessment of its performance during the repair processes of the treated tissues [7-9].

This clinical study was conducted as a multicenter trial, involving patients treated at the “Federico Rivera Luna” Oral Surgery Clinic and the University Polyclinic of dental specialties, both part of the Mexicali School of Dentistry at the Autonomous University of Baja California (UABC), Mexico. The inclusion of both centers provided different clinical settings for the standardized application of the protocol and the follow-up of patients undergoing surgical procedures. Both institutions have the necessary human and material resources, as well as professionals trained to perform oral surgery procedures and provide clinical follow-up for patients.

The overall objective of this study was to evaluate the topical antiseptic effect of the EPX® Biomolécula, in the form of a surgical intraoperative hydrogel, as an adjuvant in periapical surgical treatments. The specific objectives were to characterize patients undergoing periapical surgical treatment according to clinical and therapeutic variables; to evaluate the presence and progression of postoperative inflammation at 7, 14, and 21 days; to determine the degree of bone formation at 3, 6, and 12 months after surgery; and to identify the presence of any potential adverse reactions associated with the application of this nanostructured formulation.

METHODS

An experimental study—a Phase I clinical trial, without a control group (single-arm study)—was conducted to evaluate the topical antiseptic effect of the EPX® Biomolécula as an adjuvant to periapical surgery, through systematic monitoring of soft tissue healing and radiographic follow-up of hard tissues.

The study population consisted of 77 patients requiring periapical surgery who sought care at the Endodontics and Oral Surgery departments of the “Federico Rivera Luna” Oral Surgery Clinic and the University Polyclinic, both part of the Mexicali School of Dentistry at the Autonomous University of Baja California, Mexico; during the period from January 2022 to December 2025.

The sample consisted of 36 patients (46.8%), who were selected through controlled, non-randomized sampling and divided into two groups: a group of 18 patients who received surgical treatment without bone grafting and another group of 18 patients who received a bone graft following periapical surgery.

Inclusion Criteria:

- Adult patients (18 years of age or older) requiring periapical surgical treatment who provided valid informed consent to participate in the study.
- Patients with no history of disease that would pose an uncontrolled surgical risk, no substance

abuse, and no allergies to medications and/or foods.

Exclusion Criteria:

- Patients who did not meet any of the inclusion criteria.
- Patients with a history of previous periapical treatments.

Discharge Criteria:

- Patients who, after undergoing surgery, did not attend their scheduled postoperative follow-up appointments.

The variables studied were:

- Clinical: Age (broken down by age group) and sex (biological condition at birth)
- Therapeutic: Apical curettage alone and apical curettage with apicoectomy.
- Transoperative or intraoperative: With or without bone grafting.
- Clinical signs of healing: Re-epithelialization, hemostasis, and inflammation.
- Radiographic signs of bone regeneration: Growth and integration.

A Clinical Trial Protocol was developed and approved by the Ethics and Research and Graduate Studies Evaluation Committee in January 2022, with registration number FOM/UABC/CEEIP/2022-020-01-01, whose objective was to measure key parameters such as re-epithelialization, hemostasis, reduction of inflammation, and bone regeneration, as well as to evaluate potential adverse effects. The study complied with the bioethical principles of autonomy, beneficence, non-maleficence, and justice, and was supported by the signing of a valid informed consent form prior to surgical treatment.

Techniques and Procedures for Gathering Information:

The primary criterion for all patients participating in the study was to undergo some form of periapical surgical treatment, during which the EPX® biomolecule was applied as a surgical gel for 3 minutes and then rinsed off with normal saline (sodium chloride 0.9%).

During surgery, there were only two significant therapeutic differences:

- Group of patients without periapical bone grafting: The surgical procedure was performed, and the site was closed immediately following the application of the EPX® Biomolecule.
- Group of patients without periapical bone grafting: The surgical procedure was performed with the temporary application of the EPX® Biomolecule; once removed, a natural

hydroxyapatite graft (500–1000 µm particles) from the Bioceramics® brand was placed, along with a resorbable collagen membrane from the OsseoSeal® brand, followed by wound closure.

Subsequently, clinical follow-up was conducted with photographic documentation at three postoperative time points: 7 days, 14 days, and 28 days. During these follow-up visits, the Early Wound Healing Score (Early Wound Healing Score, EHS), published in 2018 and evaluated in 2019 by Marini L *et al.*, which consists of three fundamental parameters: clinical signs of re-epithelialization (CSR), clinical signs of hemostasis (CSH), and clinical signs of inflammation (CSI) [10, 11].

Clinical Signs of Re-epithelialization (CSR): Measures the progress of new epithelium formation at the wound site and uses the following scoring system:

- 0 points: visible gap between the incision margins.
- 3 points: contact between the incision margins.
- 6 points: fused incision margins.

Clinical Signs of Hemostasis (CSH): Determines the quality of hemostasis in the surgical area; its scoring scale includes:

- 0 points: bleeding at the incision margins.
- 1 point: presence of fibrin at the incision margins.
- 2 points: absence of fibrin at the incision margins.

Clinical Signs of Inflammation (CSI): Assesses the presence of signs of inflammation as an indicator of wound healing and uses the following scores:

- 0 points: redness involving more than 50% of the incision's length and/or pronounced swelling.
- 1 point: redness involving less than 50% of the incision's length.
- 2 points: absence of redness along the entire length of the incision.

Early Healing Scale (EHS): A total score is obtained by summing the three parameters mentioned above.

- 0 to 5 points: favorable healing has not been achieved
- 6 to 10: the healing process has been favorable

The Periapical Index (PAI), developed by Ørstavik in 1986, was the standard radiographic tool used to classify the condition of periapical tissues and measure bone healing or regeneration following root canal treatment or periapical surgery [12].

PAI Scoring Scale: The index was based on an ordinal scale from 1 to 5, comparing periapical radiographs with histological reference standards.

- PAI 1: Normal periapical structure (no abnormalities; periodontal ligament space and lamina dura intact).
- PAI 2: Marginal changes in bone structure (slightly widened periodontal ligament, discontinuous lamina dura).
- PAI 3: Apical periodontitis with early signs of bone mineral changes (widened ligament at the foramen and loss of continuity of the bone margin).
- PAI 4: Apical periodontitis with a well-defined lesion (bulb-shaped lesion and clear disappearance of the bone margin).
- PAI 5: Severe apical periodontitis with signs of exacerbation (large diffuse lesion and advanced bone destruction).

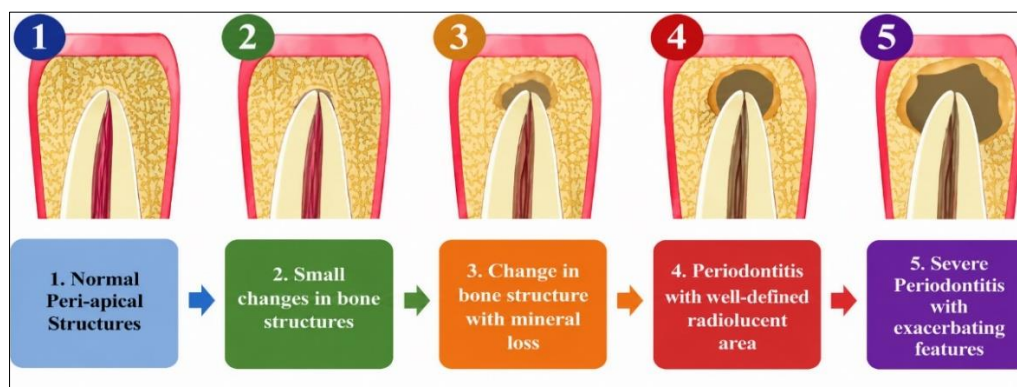


Image by: Salem, B., McKenna, G., & Quilligan, G. (2022). Impact of systemic disease on non-surgical endodontic treatment outcomes. *Dental Update*, 49(1), 69–73. <https://doi.org/10.12968/denu.2022.49.1.69>

Clinical Interpretation of Healing:

The progressive decrease in the PAI was measured to determine the success of bone regeneration and periradicular tissue healing. The first radiographic signs of bone repair were evaluated at 3 months, 6 months, and 12 months as standardized time points for regeneration.

- PAI values of 1 and 2 were considered clinically normal.
- PAI value of 3 was interpreted as a lesion in resolution.
- PAI values of 4 and 5 suggest failure or persistence of the inflammatory lesion.

Data Processing and Analysis Techniques

All information from the records and forms was entered into a database created using Microsoft Excel 2016. First, descriptive biostatistical methods were

applied—frequencies and percentages—and then inferential biostatistics were used to calculate the chi-square (χ^2) test, with $p < 0.05$ and without Yates' correction, as well as to measure the strength or intensity of the association between two categorical or nominal variables using Cramér's V.

RESULTS

Figure 1 shows the distribution of patients by age group and sex. The number of men and women was similar, as intentional sampling was used to ensure some similarities between the study groups; however, the age variable was more heterogeneous throughout the study. Seventy-two point two percent of the patients were over 30 years of age, and the most representative age group was 40 to 49 years, accounting for 30.6% of the patients.

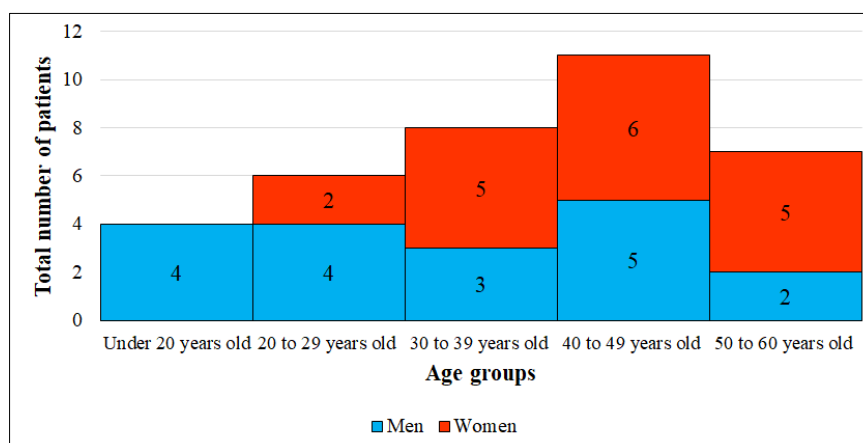


Figure 1: Distribution of patients according to age groups and sex. (n=36)
Source: The study's own database.

Figure 2. shows that, of the 36 patients included in the study, 72.2% (26 patients) underwent apicoectomy with apical debridement, while 27.8% (10 patients) received only apical debridement or curettage. Regarding the use of bone grafting, the overall distribution was balanced, with 18 patients (50%) treated with a graft and 18 (50%) without a graft as part of the experimental strategy. It is worth noting that the use of

bone grafting was proportionally higher in apicoectomy with debridement procedures, where it was used in 15 of 26 cases (57.7%), compared to 3 of 10 cases (30%) of isolated apical debridement. These results suggest a greater use of regenerative techniques associated with more extensive surgical procedures, likely related to the need to promote bone defect repair following the procedure.

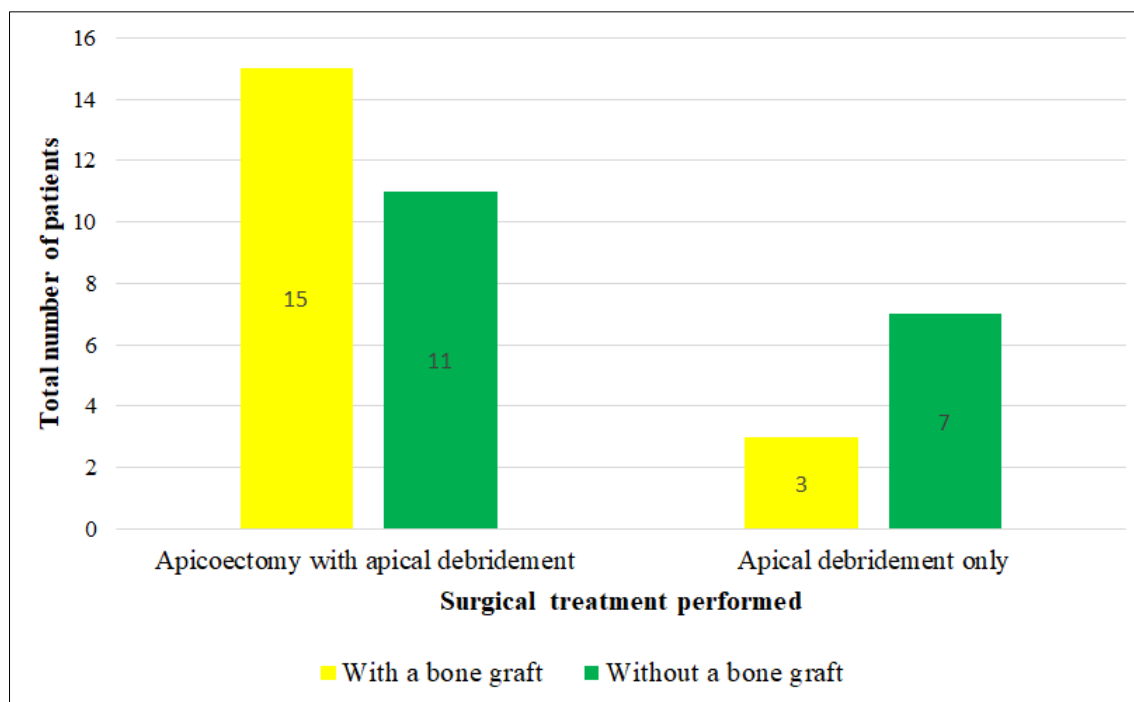


Figure 2: Types of surgical procedures performed and total number of patients who underwent bone grafting. (n=36)
Source: The study's own database.

The results in Figure 3 show a favorable trend in postoperative wound healing, as assessed using the Early Wound Healing Assessment Scale, with a gradual increase in the number of patients who achieved a favorable score during follow-up. At 7 days, a favorable score was observed in 4 patients who received a bone graft and 10 who did not; at 14 days, this number increased to 11 and 15 patients, respectively; at 21 days, to 16 and 18 patients; and at 28 days, all patients in both groups (18 with graft and 18 without graft) had a favorable score. This trend indicates a progressive improvement in healing conditions during the first four weeks following surgery, with an apparently earlier improvement in the group without a graft; however, by day 28, both groups showed complete favorable healing, so these descriptive results do not allow for the establishment of statistically significant differences or the attribution of causality to the use of bone grafting.

In the assessment of healing quality, better clinical outcomes were observed during the first week in patients who did not receive a bone graft, and a statistically significant association $\chi^2(1) = 4.88$ was found between the use of a graft and early healing quality ($p = 0.027$). Therefore, at a significance level of 0.05, the null hypothesis of independence was rejected, indicating that the two variables are related. The magnitude of this association, estimated using Cramér's V ($V = 0.373$), was moderate. This pattern could be explained by the initial inflammatory response associated with additional surgical manipulation and with the integration process of the graft material, which may generate a more intense tissue response during the early stages of healing. However, this difference was observed primarily in the early phase of the process; therefore, it should not be interpreted as evidence that the graft is detrimental to long-term healing, but rather as a possible transient inflammatory response associated with its placement.

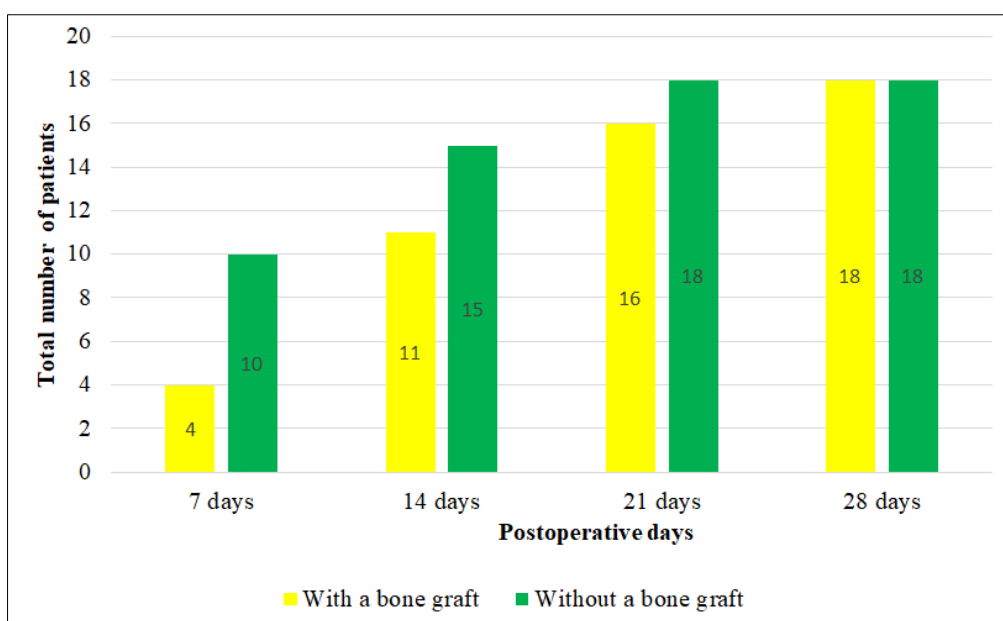
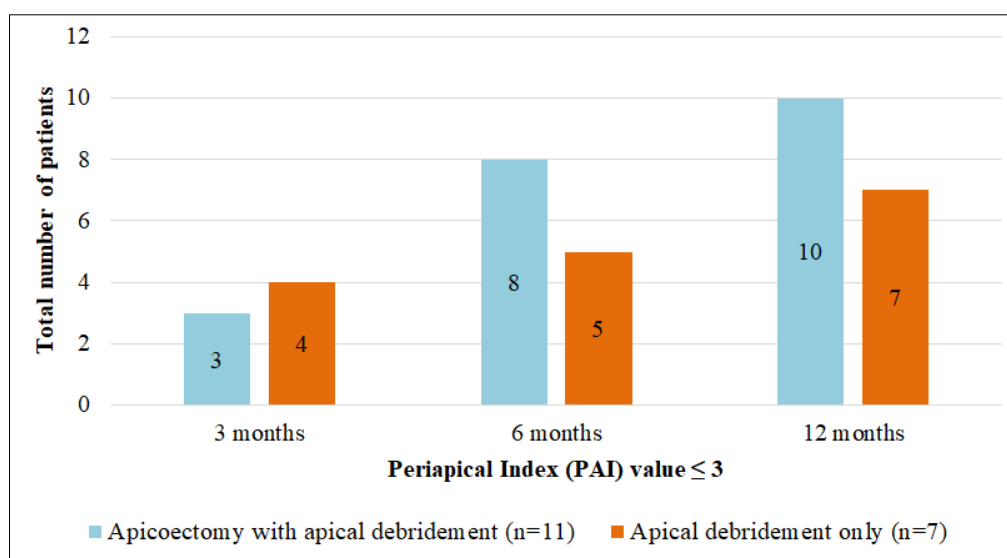


Figure 3: Presence of a favorable score on the Early Wound Healing Assessment Scale based on postoperative course. (n=36)
Source: The study's own database.



Graph 4: Changes in Periapical Index (PAI) values over time in patients who underwent surgery without bone grafting. (n=18)
Source: The study's own database.

Figure 4 shows the results of the favorable outcome, as measured by Periapical Index (PAI ≤ 3) values, during follow-up of patients who underwent periapical surgery without bone grafting ($n = 18$). At 3 months, 3 patients who underwent apicoectomy with debridement and 4 who underwent isolated apical debridement had PAI values ≤ 3 ; this proportion increased to 8 and 5 patients, respectively, at 6 months, and reached 10 and 7 patients at 12 months. Overall, the number of patients with a PAI ≤ 3 rose from 7 (38.9%) at 3 months to 17 (94.4%) at 12 months, suggesting a strong trend toward favorable periapical healing during the follow-up period. Although the proportion of favorable cases was progressively higher in both procedures, these results are descriptive and do not allow

for the identification of differences between the surgical techniques without inferential statistical analysis.

DISCUSSION

The results of this study show a favorable clinical outcome following periapical surgery, both in terms of soft-tissue healing and radiographic periapical repair. The Early Wound Healing Score (EHS) showed progressive improvement during the first four weeks, with favorable results observed in all patients by day 28. Furthermore, in patients without bone grafting, the proportion of cases with a PAI ≤ 3 increased from 38.9% at 3 months to 72.2% at 6 months and 94.4% at 12 months. These findings are consistent with those reported by Torra-Money [1] and Landázuri Rosero [2]. Regarding the favorable outcomes that can be achieved

through periapical surgery, success depends on various factors related to the lesion, the surgical technique, and local conditions.

The use of the EPX[®] Biomolecule is of interest due to its potential role as a local antiseptic adjuvant. Chitosan exhibits antimicrobial properties, and its characteristics can be modified depending on the formulation and its physicochemical conditions, as noted by Jøraholmen [6]. Similarly, Torres-Rosas [4], observed antibacterial and anti-inflammatory activity in a chitosan-based formulation, while Soto Barreras [13], demonstrated that chitosan nanoparticles can enhance the antibacterial activity of other agents in applications related to periapical regeneration. These findings are consistent with the rationale for using EPX[®] as an adjuvant to control microbial contamination; however, they do not allow us to directly attribute a specific antimicrobial effect to the formulation under study.

The incorporation of nanostructured silver and copper components is an additional point of interest due to their potential antimicrobial activity. In this regard, the topical application of EPX[®] Biomolecule could help create favorable local conditions for repair; however, the activity of these components depends on factors such as concentration, availability, release, and interaction with tissues. Therefore, although the observed clinical outcome was favorable, it is not possible to demonstrate a causal relationship between silver and copper nanoparticles and periapical antisepsis, since no direct microbiological evaluation was performed in this study. This consideration is important to avoid overestimating the results and underscores the need to incorporate microbiological variables in future research.

The findings related to wound healing are consistent with those of de Jesús [14], and Espinoza [15], who studied the use of chitosan in oral tissue repair. Similarly, Martínez-Morales [7], reported favorable results regarding the efficacy and safety of EPX[®] when used as a mouthwash, while Moreno-Solorio [9], specifically evaluated soft tissue healing following periodontal surgery assisted by this biomolecule. The consistency between this literature and our results reinforces the potential of EPX[®] as an adjunct biomaterial; however, differences in routes of administration, procedures, and study populations prevent us from establishing direct equivalence between the results.

The use of the Early Wound Healing Score provides a relevant methodological tool, as it allows for the systematic assessment of soft tissue healing. Our results are consistent with the approach taken by Marini [10], who developed this scale to evaluate early wound healing, and with Marini [11], who demonstrated its intra- and inter-examiner reliability. Likewise, Yuan [16], noted that healing following periodontal procedures is multifactorial. Consequently, the favorable outcome

observed in our study should be interpreted as the result of the interaction between the surgical technique, local conditions, the patient's response, and the adjunctive measures employed, rather than being attributed exclusively to EPX[®] Biomolecule.

With regard to bone grafting, its use was more common in apicoectomy procedures with debridement (57.7%) than in cases treated solely with apical debridement (30%). This distribution may be related to the extent or characteristics of the bone defect and to the need to employ additional regenerative strategies. The results are consistent with those reported by Torra-Money [1], who noted that regenerative techniques can be particularly useful in certain periapical defects, although their benefit is not uniform. Furthermore, the fact that 17 of 18 patients without grafting achieved a $PAI \leq 3$ at 12 months indicates that grafting is not necessarily indispensable in all cases. In agreement with Gallardo-Gutiérrez [12], assessment using radiographic indices allows for the documentation of lesion progression; however, a $PAI \leq 3$ should be interpreted as favorable radiographic periapical repair and not as direct histological evidence of bone regeneration.

Overall, the results are consistent with the literature regarding the potential of chitosan as an antimicrobial biomaterial that promotes tissue repair, as well as regarding the role of bone grafting as an adjunctive treatment in certain cases of periapical surgery [17-20]. The multicenter study of the EPX[®] Biomolecule—as a nanostructured formulation and topically applied nanomedicine—provides initial clinical evidence regarding its tolerability and behavior during healing and periapical follow-up. However, the absence of a control group and of direct microbiological evaluation limits the ability to establish a specific effect of EPX[®] Biomolecule, silver, or copper. Therefore, comparative studies with larger sample sizes, microbiological evaluation, and inferential statistical analyses are required to more accurately determine its efficacy and safety as an antiseptic adjunct in periapical surgery [13-15]

CONCLUSION

The results of this study show a favorable immediate clinical course in all patients, with postoperative signs and symptoms within expected parameters. Surgical wound healing was excellent in all cases, even in those in which the EPX[®] Biomolecule, in the form of an intraoperative gel, was used in combination with granular hydroxyapatite as a xenograft. Radiographic follow-up showed a favorable course in most patients, with findings consistent with progressive bone repair and regeneration and no evidence of recurrent septic complications during the follow-up period.

No adverse reactions associated with the use of the EPX[®] Biomolecule as an intraoperative gel were

reported. The dose used was standardized according to the size of the periapical lesion, allowing for localized application tailored to the characteristics of the surgical defect. Taken together, these findings support the tolerability and potential of the EPX® Biomolecule as an antiseptic and tissue-repairing adjuvant in periapical surgery; however, comparative studies with inferential statistical analysis are needed to confirm its efficacy and more precisely establish its contribution to treatment success.

Conflict of Interest:

Roberto Luis Ibarra Wiley declares his affiliation with MedicalTech Laboratorios S.A. de C.V., the company responsible for the development, manufacture, supply, financing, and intellectual property rights of the EPX® Biomolecule. The other authors declare that they have no conflicts of interest and that they participated in the research as part of their academic, clinical, and research activities at UABC.

REFERENCES

- Cardaropoli, D. (2023). *Cirugía periodontal plástica y regenerativa* (1st ed.). Editorial Edra.
- Myneni, S., & Bassir, S. H. (2023). Clinical practice guideline for treatment of periodontitis. In M. G. Newman, P. R. Klokkevold, S. Elangovan, Y. Kapila, F. A. Carranza, & H. H. Takei (Eds.), *Newman and Carranza's clinical periodontology and implantology* (14th ed., pp. 564–567). Elsevier.
- Baht, S. (2022). Antimicrobials in periodontics. In S. Smith & K. Almas (Eds.), *Essential periodontics* (pp. 245–253). John Wiley & Sons.
- Martínez-Morales, C., Gómez-Flores, M., Hermida-Rojas, M., Ibarra-Wiley, R., & Moreno-Solorio, M. A. (2024). Efficacy and safety of EPX® Biomolecule mouthwash for treating chronic gingivitis. *EAS Journal of Dentistry and Oral Medicine*, 6(6), 96–102. <https://doi.org/10.36349/easjdom.2024.v06i06.001>
- Amaya, A., & Gómez, M. (2023). Evaluación clínica periodontal después de la instrumentación mecánica subgingival coadyuvada con una laminilla de quitosán. *Revista Tamé*, 11(33), 1356–1360. https://www.uan.edu.mx/d/a/publicaciones/revista_tame/numero_33/Tame33-02.pdf
- Marini, L., Rojas, M. A., Sahrman, P., Aghazada, R., Pilloni, A. (2018). Early wound healing score: A system to evaluate the early healing of periodontal soft tissue wounds. *Journal of Periodontal & Implant Science*, 48(5), 274–283. <https://doi.org/10.5051/jpis.2018.48.5.274>
- Marini, L., Sahrman, P., Rojas, M. A., Cavalcanti, C., Pompa, G., Papi, P., & Pilloni, A. (2019). Early wound healing score (EHS): An intra- and inter-examiner reliability study. *Dentistry Journal*, 7(3), 86. <https://doi.org/10.3390/dj7030086>
- Dolińska, E., Pietruska, M., Milewski, R., & Sculean, A. (2025). Early healing after regenerative periodontal surgery with or without antibiotics. *Dental and Medical Problems*, 62(4), 601–608. <https://doi.org/10.17219/dmp/175893>
- Hasan, F., Tandon, A., AlQallaf, H., John, V., Sinha, M., & Gibson, M. P. (2025). Inflammatory association between periodontal disease and systemic health. *Inflammation*, 48(6), 3763–3775. <https://doi.org/10.1007/s10753-025-02317-1>
- Natarajan, P., Madanian, S., & Marshall, S. (2025). Investigating the link between oral health conditions and systemic diseases: A cross-sectional analysis. *Scientific Reports*, 15, 10476. <https://doi.org/10.1038/s41598-025-92523-6>
- Herrera, D., Sanz, M., Kebschull, M., Jepsen, S., Sculean, A., Berglundh, T., Papapanou, P. N., Chapple, I., & Tonetti, M. S.; EFP Workshop Participants and Methodological Consultant. (2022). Treatment of stage IV periodontitis: The EFP S3 level clinical practice guideline. *Journal of Clinical Periodontology*, 49(Suppl. 24), 4–71. <https://doi.org/10.1111/jcpe.13639>
- Atia, G. A. N., Shalaby, H. K., Zehravi, M., Ghobashy, M. M., Attia, H. A. N., Ahmad, Z., et al. (2022). Drug-loaded chitosan scaffolds for periodontal tissue regeneration. *Polymers*, 14(15), 3192. <https://doi.org/10.3390/polym14153192>
- Torres-Rosas, R., Torres-Gómez, N., Moreno-Rodríguez, A., García-Contreras, R., & Argueta-Figueroa, L. (2020). Anti-inflammatory and antibacterial activity of the chitosan/chlorhexidine gel commercial preparation for postexodontia treatment: An in vitro study. *European Journal of Dentistry*, 14(3), 397–403. <https://doi.org/10.1055/s-0040-1714453>
- Zhou, X., Liu, C., Han, Y., Li, C., Liu, S., Li, X., et al. (2022). An antibacterial chitosan-based hydrogel as a potential degradable bio-scaffold for alveolar ridge preservation. *RSC Advances*, 12(50), 32219–32229. <https://doi.org/10.1039/D2RA05151F>
- Jørholm, M. W., Bhargava, A., Julin, K., Johannessen, M., & Škalko-Basnet, N. (2020). The antimicrobial properties of chitosan can be tailored by formulation. *Marine Drugs*, 18(2), 96. <https://doi.org/10.3390/md18020096>
- Yuan, H., Liu, Q., Tang, T., Qin, H., Zhao, L., Chen, W., et al. (2022). Assessment of early wound healing, pain intensity, quality of life and related influencing factors during periodontal surgery: A cross-sectional study. *BMC Oral Health*, 22, 596. <https://doi.org/10.1186/s12903-022-02630-3>
- Sethiya, K. R., & Dhadse, P. V. (2020). Healing after periodontal surgery: A review. *Journal of Evolution of Medical and Dental Sciences*, 9(49), 3753–3759. <https://doi.org/10.14260/jemds/2020/824>
- Soto, U., Torres, F., Martínez, R., Valencia, C., Martínez, P., & Loyola, J. (2016). Chitosan nanoparticles enhance the antibacterial activity of chlorhexidine in collagen membranes used for periapical guided tissue regeneration. *Materials*

- Science and Engineering: C*, 58(1), 1182–1187. <https://doi.org/10.1016/j.msec.2015.09.085>
19. de Jesus, G., Marques, L., Vale, N., & Mendes, R. A. (2023). The effects of chitosan on the healing process of oral mucosa: An observational cohort feasibility split-mouth study. *Nanomaterials*, 13(4), 706. <https://doi.org/10.3390/nano13040706>
20. Espinoza, L., Menchaca, J., & Jiménez, J. (2021). Evaluación del tiempo de cicatrización en mucosa oral por la influencia del quitosano. *Anuario IUM*, 2(2), 37–40. <http://anuarioinvestigacion.um.edu.mx/index.php/anuarioium/article/view/195>

Cite This Article: Naranjo-Cintora, N. A., Figueroa-Fernández, N. P., Gómez-Flores, M., Moreno-Solorio, M. A., Ibarra-Wiley, R. L., & Hermida-Rojas, M. (2026). Evaluation of the Topical Antiseptic Use of the EPX® Biomolecule in Periapical Surgical Treatments. *EAS J Dent Oral Med*, 8(5), 190-198. <https://doi.org/10.36349/easjdom.2026.v08i05.006>
