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Tiny Titans: Silver Nanoparticles Incorporated with Coe-Pak: A Clinical Study

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Abstract

Introduction: Coe-Pak is the most commonly used periodontal dressing in clinical practice. Silver nanoparticles is shown to have antibacterial properties and provide faster and effective tissue repair. To the best of our knowledge currently no periodontal dressing incorporating silver nanoparticles is available.

Objectives: To compare and evaluate post-surgical wound healing using Coe-Pak and Coe-Pak with silver nanoparticles respectively in chronic periodontitis patients.

Methodology: 20 systemically healthy patients requiring periodontal flap surgery were randomly divided into test (Coe-Pak with silver nanoparticles) and control (Coe-Pak alone) group. Post-surgical pain and wound healing were evaluated using visual analogue scale (on 3rd and 7th day), wound healing index on 7th day and modified gingival index at baseline and 7th day respectively.

Results: Study revealed statistically significant outcomes, indicating that Coe-Pak with silver nanoparticles shows effective post-surgical wound

healing after periodontal flap surgery in chronic periodontitis patients.

Conclusion: Coe-Pak with silver nanoparticles exhibits a potential role in effectively controlling post-surgical infections and allows better wound healing.

Keyword: Coe-Pak, silver nanoparticles, periodontal dressing, wound healing.

Introduction

Chronic periodontitis is an inflammatory disease that results in significant destruction of the soft tissues and, eventually, the supporting bone structures around the teeth[1]. While mechanical plaque control methods can help maintain acceptable oral hygiene, they often fall short in effectively reducing inflammation and fully eliminating plaque. As a result, there is growing interest in incorporating antimicrobial agents as adjuncts to conventional therapy[2]. The primary microbial pathogens associated with periodontitis include Aggregatibacter actinomycetemcomitans, Prevotella intermedia, Porphyromonas gingivalis, Tannerella forsythia, Fusobacterium nucleatum, and Treponema denticola[2].

Periodontal dressing was first introduced by Ward in 1923, recommended its use following periodontal surgery[3]. At present, periodontal dressings are extensively used for various purposes; however, their use following periodontal surgery is a matter of debate[4]. Several advantages have been described for periodontal dressings recommending their application following periodontal surgery including wound protection from mechanical trauma, wound stabilization[5,6], patient comfort, favourable adaptation to the underlying tissue, prevention of post-surgical bleeding or infection, decreased tooth hypersensitivity, clot protection from the loads applied during mastication and speech, prevention of gingival separation from the root[7], prevent coronal displacement of an apically repositioned flap and to offer additional support for free gingival grafts during the healing phase [8]. In general, periodontal dressings are divided into 3 groups: (a)Dressings containing zinc oxide eugenol (Ward's Wondr Pak). (b)Dressings containing zinc oxide without eugenol (Periocare, Coe-Pak, Vac-Pac, Septo-Pac). (c)Dressings without zinc oxide and eugenol (cellulose-based dressings i.e. Mucotect and Reso-Pac) and light-cured resin-based dressings (i.e. Barricaid).

Coe-Pak is a widely utilized periodontal dressing in clinical practice. It comprises a two-paste system that includes base paste (zinc oxide, added oils, gums & lorothidol) and catalyst paste (unsaturated fatty acids & chlorothymol)[9]. The dressing is prepared by dispensing equal amounts of the two pastes and mixing them with a spatula until a thick, uniform consistency is achieved. The setting time can be modified by placing the material in cold water to slow down or in hot water to speed up the setting process. It offers protection and promotes healing, is easy to shape, eugenol-free, and compatible with both resin materials and soft tissues[10].

Silver (Ag) ions possess strong antibacterial properties and have been utilized in medical treatments for many years. Their low toxicity, excellent biocompatibility with human cells, and the continuous release of mobile silver ions contribute to a sustained and effective bactericidal effect[11]. Silver nanoparticles (AgNPs) measuring less than 100 nm and exhibiting a uniform spherical shape possess strong and broad-spectrum antimicrobial properties [12]. The antibacterial mechanisms of silver nanoparticles (AgNPs) include, but are not limited to, the release of silver ions that can disrupt cell walls and membranes, denature ribosomes, interfere with ATP production, and hinder DNA replication[13,14]. Beyond the common roles of antibacterial, antifungal, and drug carriers, AgNPs have been observed to enhance human

periodontal ligament fibroblasts (HPDLFs) osteogenic differentiation in a dose-responsive way at the concentration range of 25–100 μM[15].

Silver nanoparticles is shown to have antibacterial properties and provide faster and effective tissue repair. Hence, the aim of this study is to assess the post-surgical wound healing of silver nano particles with coe pak compared to coe pak alone.

Materials and methods: This randomized controlled clinical trial included 20 patients aged between 18 and 40 years, who reported to the Outpatient Department of Periodontology at Swargiya Dadasaheb Kalmegh Smruti Dental College and Hospital, Nagpur, India. The total sample of 20 patients was divided randomly into two groups. The study was conducted after obtaining written informed consent from all participants.

Eligible subjects were those undergoing periodontal flap surgeries and crown lengthening procedures. A detailed medical history, clinical examination, and complete hemogram were obtained for each patient. Inclusion criteria comprised systemically healthy males and females aged 18–40 years. Exclusion criteria included smokers, pregnant and lactating women, patients with periodontal disease, and individuals with systemic conditions known to affect healing and coagulation, such as diabetes, autoimmune diseases, and leukemia.

Participants were randomly allocated into two groups:

- **Test Group (Group I):** Patients who underwent periodontal surgery with suturing of the surgical site, followed by the application of a periodontal dressing made of Coe-Pak modified with silver nanoparticles.
- **Control Group (Group II):** Patients who underwent periodontal surgery with suturing of the surgical site, followed by the application of standard Coe-Pak periodontal dressing (without silver nanoparticles).

Following the surgical procedure, an equal amount of the Coe-Pak base and catalyst paste was used to cover teeth on both the buccal and lingual aspects. For the test group, 2 mg of silver nanoparticles was incorporated into the Coe-Pak dressing by mixing it with the base and catalyst paste on a glass slab during manipulation.

Parameters such as post-operative pain score (VAS) was assessed at 3rd day and 7th day post-surgery, modified gingival Index and wound healing index were assessed at baseline and 7th day post-surgery.

Statistical Analysis: The study results were reported using descriptive statistical methods (mean ± standard deviation). The test used to compare patients' preferences in different degrees of pain, repair, and stages of periodontitis was Chi-square test. Statistical analysis was performed using SPSS 18, and the statistical significance was set at $P < 0.05$. Repeated measurements test was used to compare the severity of pain at different time intervals.

Pocket probing depth > 5mm

Sutures placed after flap surgery

Silver nanoparticles + Coe-Pak

Coe-Pak with silver nano-particles placed

Coe-Pak removal after 7 days

After suture removal

Figure 1: Silver-nano particles + Coe-Pak placement after Periodontal flap surgery and Coe-Pak removal after 7 days

Result

The present study included 11 females and 09 males with a mean age of 29.15 ± 4.53 years. There were statistically significant differences in clinical parameters (VAS, WHI, MGI) between the two groups. All the 20 patients reported on both the 3rd and 7th day post-operative after each surgery for pain parameter and on baseline and 7th day for WHI and GBI.

Pain assessment (Table 1) presents the evaluation of pain severity in the studied patients based on the VAS in the study groups on days 3 and 7 after surgery. In the control group, the pain parameter on the 7th day after the surgery was significantly lower than the 3rd day by 0.8 units (P = 0.003). In the intervention group, the pain parameter on the 7th day after the intervention was significantly reduced by 0.5 units compared to the 3rd day (P = 0.001). In addition, the severity of pain in the studied patients was significantly lower in the intervention group than in the control group on the 3rd (P = 0.001) and 7th (P = 0.001) days after the intervention.

Wound Healing Index (Table 2) presents the evaluation of wound healing status in the studied patients based on the WHI in the study groups on baseline and 7th day after surgery. In the control group, the WHI value on the 7th day increased significantly by 1.2 units compared to the baseline after surgery (P = 0.001). In the intervention group, the WHI value increased significantly by 1.0 units on the 7th day after the intervention (P = 0.001). In addition, WHI values were significantly higher in the intervention group than in the control group on the baseline (P = 0.001) and 7th (P = 0.001) days after the surgery.

Modified Gingival Index (Table 3) presents the evaluation of gingival status in the studied patients based on the MGI in the study groups on baseline and 7th day after surgery. In the control group, the WHI value on the 7th day decreased significantly by 0.53 units compared to the baseline after surgery (P = 0.001). In the test group, the MGI value decreased significantly by 0.60 units on 7th day after the intervention (P = 0.001). In addition, MGI values were significantly higher in the intervention group than in the control group on the baseline (P = 0.001) and 7th (P = 0.001) days after the surgery.

Table 1: VAS (Visual Analogue Scale)

Group	Days post-operative	Mean ± standard deviation
Test group	3rd day	1.5±3.45
	7th day	0.9±0.65
Control group	3rd day	2.2±2.45
	7th day	1.4±0.35

Table 2: (WHI) Wound Healing Index

Group	Days post-operative	Mean + standard deviation
Test group	Baseline	2.8±1.2
	7th day	3.8±1.0
Control group	Baseline	2.6±1.1
	7th day	3.2±0.9

Table 3: (MGI) Modified Gingival Index

Group	Days post-operative	Mean + standard deviation
Test group	Baseline	1.7±0.7
	7th day	1.1±0.3
Control group	Baseline	1.8±0.6
	7th day	1.3±0.4

Discussion

Periodontal dressings are intended to protect the wound after periodontal surgery to prevent any delay in the process of wound healing. The present study included 20 subjects with age group of 18-40 years. This study identifies that the AgNPs incorporated in Coe-Pak significantly accelerates the wound healing and other parameters.

A study on Alginate-Based Materials Loaded with Nanoparticles in Wound Healing done by Froelich A, et al. (2023) concluded that integrating a hydrogel matrix with silver nanoparticles (AgNPs) offers considerable benefits for both promoting wound healing and providing antibacterial effects. While the physical, chemical, and biological characteristics of these engineered matrices and AgNPs have been well-researched and various applications have been identified, there are still important areas to explore—particularly the behavior of AgNPs at the cellular level in humans, as well as their local versus systemic toxicity.[16].

Kadkhodazadeh M. et al. (2017) reported that Reso-Pac, a cellulose-based periodontal dressing, demonstrates greater biocompatibility with human gingival fibroblast cells compared to Coe-Pak. In contrast, Coe-Pak exhibits notable cytotoxic effects on both human gingival fibroblasts and osteoblast-like cells, particularly after three days of application. Despite their intended benefits, certain periodontal dressings may hinder gingival wound healing post-surgery due to the release of harmful substances[17].

Singh M. et al. (2022) concluded that the strategic application and versatility of silver nanoparticles have introduced a new era of highly effective, multi-functional treatment options in the medical field. However, to fully harness their potential in tissue regeneration, further preclinical research is necessary. Additionally, producing

high-purity nanoparticles remains a significant challenge, as large-scale synthesis and purification of nanoparticles and associated polymers are often complex and inefficient. This underscores the ongoing need for the development of more advanced synthetic and analytical methods to facilitate the clinical translation of nanotechnology-based therapies[18].

Nasiri K et al. (2023) highlighted that metal nanoparticles are among the most promising antibacterial agents, owing to their high surface area-to-volume ratio, extended shelf life, and good biocompatibility. Their nanoscale size enables them to penetrate the biofilm matrix and establish direct contact with bacterial cells, thereby effectively disrupting and inhibiting biofilm formation.[19].

In a study by Moghare Abed et al (2011)[20] similar pain was noted in patients with and without periodontal dressings after surgery, while in the study by Jones et al (1979)[21] more pain was reported in patients following the use of periodontal dressings.

Liao et al. (2010) reported that titanium implant surfaces coated with silver nanoparticles exhibited significantly enhanced antibacterial and anti-adhesive properties against Aggregatibacter actinomycetemcomitans and Porphyromonas gingivalis [22].

In the current era of growing interest in nanotechnology, silver nanoparticles have emerged as promising agents for accelerating wound healing. In addition to their therapeutic role in combating infections, silver nanoparticles are considered non-toxic at appropriate concentrations, exhibit minimal to no side effects, and can be applied without the need for complex procedures or specialized equipment. Their ease of use, combined with high patient tolerance and acceptance, makes them an effective and practical option in clinical care[23].

Conclusion

Based on the result it can be concluded that incorporating silver nanoparticles into Coe-Pak significantly enhances its effectiveness as a periodontal dressing. Alongside its protective barrier function, the added antimicrobial properties help prevent infections, reduce inflammation, and promote faster healing. This dual-action approach supports cleaner, safer, and more predictable recovery, making it a promising advancement in post-surgical oral care.

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