

The effects of zinc oxide non-eugenol and cellulose as periodontal dressings on open wounds after periodontal surgery

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ABSTRACT

Background: Periodontal surgery forms a part of periodontal treatment that can sometimes cause open wounds, such as gingivectomy and depigmentation. Unfortunately, the healing process of open wounds can be inhibited due to bacterial infections and systemic factors. Thus, after surgery, the open wounds need to be closed with periodontal dressing. **Purpose:** This study aims to reveal the differences between using zinc oxide non-eugenol and cellulose periodontal dressings on open wounds after periodontal surgery. **Methods:** Thirty-two samples were divided into two groups. Group I consisted of 16 samples where zinc oxide non-eugenol was applied as a periodontal dressing. Similarly, Group II consisted of 16 samples where cellulose was applied as a periodontal dressing. The dressings were applied to open wounds after periodontal surgery using the split-mouth technique. Hence, zinc oxide non-eugenol was applied on the right side and cellulose was applied on the left side of the mouth. The patients' healing index (HI) score was measured on day seven and their wound healing index (WHI) score was measured on days seven and twenty-one. **Results:** The day-seven HI score of the wounds applied with cellulose was higher than those applied with zinc oxide non-eugenol. Meanwhile, the WHI of the cellulose group was lower than that of the zinc oxide non-eugenol group, except on day twenty-one. Both the HI and WHI scores then were analysed using Mann Whitney. **Conclusion:** The application of cellulose is better than zinc oxide non-eugenol on the healing of open wounds after periodontal surgery.

Keywords: periodontal dressing; healing index; open wound; periodontal surgery; wound healing index

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INTRODUCTION

Periodontal treatment is generally divided into four phases: phase I (non-surgical), phase II (surgical), phase III (restoration) and phase IV (maintenance). In Phase II (surgical), some procedures are needed, such as incisions or cutting gingival tissue, to provide access and visual field as well as repair anatomic and morphological damage. However, they still can cause plaque accumulation and pocket formation. Also, some of the procedures of periodontal surgery, as part of periodontal treatment in Phase II, can cause open wounds such as gingivectomy and depigmentation.¹

When a wound occurs, the body will naturally protect and prevent itself from infection; this is considered part of the

healing process.² There are four phases of the wound-healing process: haemostasis, inflammation, proliferation and remodelling.³ Unfortunately, the wound-healing process can be inhibited due to bacterial infections or systemic factors.⁴ Therefore, in periodontal surgical procedures, wound closure is required using periodontal dressing material.

A periodontal dressing is a physical barrier that protects wounds from compressive mastication and provides tissue with the opportunity to adapt to the wound-healing process.⁵ The periodontal dressing has no curative function, but it still can accelerate the healing process by protecting the wound while minimising the possibility of infection and postoperative bleeding.⁶

Thus, the use of periodontal dressing on the wound surface aims to provide comfort to the patient, protect the

wound, minimise the occurrence of infection and reduce postoperative bleeding.⁵ It also supports the healing process by preventing trauma caused by any contact between the wound, tongue and food during mastication. Zinc oxide non-eugenol is a material widely used for periodontal dressing in dentistry. It has an antibacterial reaction from metal oxide and fatty acids that can be used as a barrier to protect wounds.⁵

However, it has been reported lately that the weakness of zinc oxide non-eugenol is its higher toxicity to osteoblasts and fibroblasts. Through *in vitro* research, it was found that the rosin content in zinc oxide non-eugenol can trigger increased inflammatory reactions characterised by high polymorphonuclear neutrophilic leukocytes (PMN).⁶ It was also reported that zinc oxide non-eugenol can inhibit the wound-healing process, characterised by inflammation, until day seven after it has been applied.⁷

One of the periodontal dressing materials containing neither zinc oxide nor eugenol is cellulose, which can dissolve in 30 hours without leaving a residue. The content of cellulose does not interfere with the formation of fibroblasts so that the healing process occurs normally and does not trigger inflammation. Cellulose is not toxic to the cells that play a role in healing so the wound-healing process is not interrupted.

This study aims to reveal the differences between the use of zinc oxide non-eugenol and cellulose as a periodontal dressing on open wounds after periodontal surgery. Hence, the results of this study are expected to help dentists determine what periodontal dressing material to use after gingivectomy and gingival depigmentation.

MATERIALS AND METHODS

This study is quasi-experimental and involves two researchers. The research was conducted at the Periodontics Specialist Clinic at Prof. Soedomo Dental and Oral Hospital in Universitas Gadjah Mada, Yogyakarta. It was approved by the Research Ethics Commission of the Faculty of Dentistry, Universitas Gadjah Mada, No. 001389/KKEP/FKG-UGM/EC/2018.

Sixteen patients were involved in the study, consisting of fourteen people who experienced hyperpigmentation and two people with gingival enlargement in the anterior region of their lower jaw. The 16 subjects were divided into two groups. In Group I, open wounds were closed using zinc oxide non-eugenol Coe-PakTM (GC America, Illinois, USA), while those in Group II were closed using cellulose Reso-Pac[®] (Hager & Werken GmbH & Co. KG, Germany).

The selection of subjects was based on certain criteria such as suffering depigmentation or indications of gingivectomy, non-smokers, without systemic disease and willing to sign informed consent. Periodontal surgical treatment was performed by gingival depigmentation

or gingivectomy with a conventional technique using scalpels no. 11 and 14 (Swan Morton Limited, England). Open wounds were then irrigated with saline and distilled water and were dried using sterile gauze (PT. Ahmadharis, Indonesia). The wound areas were covered using a split-mouth technique. Thus, zinc oxide non-eugenol using Coe-PakTM was applied on the right side, while cellulose was applied on the left side using Reso-Pac[®].

Subsequently, during post-periodontal surgical treatment, the patients were instructed not to brush their teeth in the area of the surgery. Once the periodontal dressing was applied, patients had to rinse with clean water and then take 500 mg amoxicillin antibiotic (PT. Kalbe Farma Tbk, Bekasi, Indonesia), every eight hours for five days; they were advised to take 500 mg mefenamic acid analgesics (PT. Hexpharm Jaya, Bekasi, Indonesia) if they experienced pain. On the seventh day after post-periodontal surgery, the periodontal dressing using Coe-PakTM (GC America, Illinois, USA) was removed and oral hygiene control and wound-healing procedures were carried out once a week for four weeks.

The healing index (HI) and wound healing index (WHI) on days seven and twenty-one were examined and evaluated. HI was based on an index from Landry *et al.* describing post-surgical levels of clinical healing.² A score of 1 was very bad if there was more than 50% red-coloured gingival wounds, palpation bleeding, granulation tissue and no epithelialisation, with epithelial loss beyond the incisional limit. Score 2 was poor if there was more than 50% red gingiva, bleeding when palpated, granulation and open connective tissue because there was no epithelialisation. Score 3 was good if there was 25–50% red gingiva, no palpation bleeding, no granulation tissue and no open connective tissue. Score 4 was very good if there was less than 25% red gingiva, no palpation bleeding, no granulation tissue and no open connective tissue.

WHI was based on Sharon *et al.*'s index evaluating post-surgical wound healing with epithelialisation parameters through toluidine blue staining. First, the post depigmentation and gingivectomy wounds were smeared with toluidine blue before clinical photographs were taken using a Nikon D7100 digital camera (Nikon Corp Japan, Thailand). For WHI evaluation, a score of 1 meant perfect epithelialisation if staining with toluidine blue was negative. Score 2 was imperfect epithelialisation if the gingiva was bluish. Score 3 indicated an ulcer if the colour was yellowish or white. Score 4 indicated necrosis if the gingiva was blackish.

Next, data obtained from the HI and WHI observations was qualitative with ordinal scale. The HI and WHI data of both groups on the seventh and twenty-first days were statistically analysed with the non-parametric Mann Whitney test. All statistical analysis calculations were performed using SPSS version 22.0 (IBM, New York, USA) for Windows with an error rate of 5%.

RESULTS

Figure 1 shows the post-periodontal surgical open wound. Figure 2 shows the post-periodontal surgical wound after it was closed with periodontal dressing using the split-mouth technique.

HI observation was carried out on day seven to describe the level of clinical healing after periodontal surgery (Figure 3; Table 1). The data in Table 1 shows the results of HI assessment conducted on day seven. In group I (zinc oxide non-eugenol) 16 samples scored 2 (poor) and indicated as much as ≥ 50% reddish tissue colour and bleeding during palpation. Meanwhile, in group II (cellulose), two samples scored 2 (poor) and 14 samples scored 3 (good); they indicated as much as 25–50% reddish tissue colour and no bleeding during palpation.



Figure 1. The open wound after the surgical periodontal treatment of the mandibular ridge, considered as a depigmentation case.



Figure 2. The postoperative periodontal dressing application using the split-mouth technique, Coe-Pak™ (A) on the right side and Reso-Pac® (B) on the left side.



Figure 3. Clinical evaluation on the seventh day after the Coe-Pak™ was released and HI was observed.

Table 2 shows the difference in HI score on day seven between the zinc oxide non-eugenol and cellulose groups. Based on the results of the Mann Whitney non-parametric statistical tests, there was a significant difference ($p < 0.05$) between the non-eugenol zinc oxide and cellulose groups. On the other hand, WHI on days seven and twenty-one was observed by applying a toluidine blue liquid. The observation showed a bluish-purple colour, indicating inflammation. The clinical pictures can be seen in Figures 4 and 5.

Table 3 shows the WHI assessment results on day seven; in Group I, the zinc oxide non-eugenol group, 16 samples

Table 1 HI results on day seven

Periodontal dressing	HI on Day 7	
	Score 2	Score 3
Zinc oxide non-eugenol	16	-
Cellulose	2	14

Table 2. HI median score on day 7

Periodontal dressing	Median
Zinc oxide non-eugenol	Score 2 (2–2)
Cellulose	Score 3 (2–3)



Figure 4. Observation of the wound healing index (WHI) on day seven by applying a toluidine blue liquid indicated a positive result with a bluish-purple colour.



Figure 5. Observation of the wound healing index (WHI) on day 21 by applying a toluidine blue liquid indicated a negative result with no bluish-purple colour.

Table 3 WHI scores on the 7th and 21st days

Periodontal dressing	Day 7		Day 21	
	WHI score		WHI score	
	1	2	1	2
Zinc oxide non-eugenol	-	16	16	-
Cellulose	15	1	16	-

scored 2 (imperfect epithelialisation). Meanwhile, in Group II, the cellulose group, 15 samples scored 1 (perfect epithelialisation) and one sample scored 2 (imperfect epithelialisation). Based on WHI assessment results on day twenty-one, all 16 samples in both groups scored 1 (complete epithelialisation).

Table 4 shows a difference in WHI score on the seventh day between the zinc oxide non-eugenol and cellulose group, but there was no difference in WHI score on the twenty-first day. Based on the results of the Mann Whitney non-parametric statistical test on WHI scores, there was a significant difference ($p < 0.05$) between the zinc oxide non-eugenol and cellulose groups on day seven. Meanwhile, there was no significant difference ($p > 0.05$) between the zinc oxide non-eugenol and cellulose groups on day twenty-one.

DISCUSSION

HI's descriptive data showed a higher score in the cellulose group than in the zinc oxide non-eugenol group on day seven, therefore, there was a significant difference after data analysis was performed with the Mann Whitney test. In wounds closed with zinc oxide non-eugenol, prolonged inflammatory reactions can occur due to the side effects of rosin content.⁶ The acidic nature of rosin will stimulate polymorphonuclear (PMN) cells so that it triggers inflammation, which will inhibit the formation of fibroblasts resulting in an inhibited wound-healing process. Fibroblasts play a role in the early stages of wound healing to regenerate new tissue.⁷ This condition is characterised by bleeding when palpated on the seventh day on an open wound covered with zinc oxide non-eugenol.

According to Sachs *et al.*, when zinc oxide non-eugenol is applied, it has rigid physical properties and changes in dimensions can harbour food scraps and accumulate plaque.⁹ This can trigger the invasion of bacteria into the wound so that inflammation occurs as a form of self-defence so that the bacteria and endotoxin do not spread into other tissues. Inflammation can be caused by haemolysis in mucosal tissue due to the high toxicity of zinc oxide non-eugenol against osteoblasts and gingival fibroblasts.

Cellulose content is biocompatible with mucosal tissue so that it does not interfere with the healing process of open wounds after surgery. This is because cellulose does not affect tissue epithelialisation, angiogenesis and

Table 4. WHI median scores for each group on the 7th and 21st days

Periodontal dressing	Day 7 median score	Day 21 median score
Zinc oxide non-eugenol	Score 2 (2–2)	Score 1 (1–1)
Cellulose	Score 2 (1–2)	Score 1 (1–1)

vascularisation and does not trigger excessive inflammatory reactions in the wound healing process.¹⁰ Furthermore, cellulose only lasts for 30 hours before dissolving in saliva, so it does not disrupt the oxygen supply needed for angiogenesis and does not become a place for debris retention and plaque accumulation.¹¹

The descriptive data of WHI on day seven showed that the cellulose group had a higher WHI score than the zinc oxide non-eugenol group. In Group I, the zinc oxide non-eugenol produced a positive (+) bluish colour when stained using toluidine blue. This is due to inflammation in the open wound. During the inflammation process, mast cells containing granules will absorb the colour and turn purplish-blue when smeared with toluidine blue.¹² The combination of colophony and zinc found in zinc oxide non-eugenol also causes a cytotoxic effect on fibroblasts that have been investigated *in vitro*, thereby inhibiting the formation of new tissue in the wound-healing process.¹³

Open wounds that are closed with zinc oxide non-eugenol for seven days can experience a disruption to their oxygen supply. Oxygen plays an important role in the process of angiogenesis, the function of fibroblasts, the synthesis of collagen, the production of growth factors, the production of reactive oxygen species (ROS) and the prevention of anaerobic bacterial infections arising from plaque accumulation.¹⁴ The wound-healing stage on day seven is still in the process of epithelialisation, angiogenesis and matrix formation so the interruption of oxygen supply can inhibit the process.

In contrast, on day seven, group II indicated negative results (-) after staining with toluidine blue as there was no inflammation, so the colour was not absorbed into the wound area. Lee *et al.* state that cellulose content is not cytotoxic, so it does not cause lysis of cells. Wounds closed with cellulose do not interfere with microvascular oxygen supply.¹⁵ In the early stages of the wound-healing process, oxygen plays an important role in cell metabolism to produce adenosine triphosphate (ATP), prevent infection in the wound, stimulate angiogenesis, increase the differentiation of keratinocytes, migration and re-epithelialisation, as well as increase fibroblast cell proliferation and collagen synthesis.¹⁶

Observation of HI on day twenty-one showed no difference between the scores of the two treatment groups. The administration of toluidine blue in the post-operative periodontal wound areas indicated negative (-) scores because inflammation and the wound-healing process did

not occur on the twenty-first day and it had already reached the maturation and remodelling stages of collagen tissue and matrix deposition. Open wounds had been epithelialised completely and replaced with new tissue.¹⁷

Finally, the results of this study prove that the HI is higher in cellulose periodontal dressing than in zinc oxide non-eugenol periodontal dressing. However, the WHI is lower in cellulose periodontal dressing, except on day twenty-one. It can be concluded that the effects of cellulose periodontal dressing are better than those of zinc oxide non-eugenol dressing during the healing process of open wounds after periodontal surgery. This is in agreement with a previous study by Kadkhodazadeh *et al.*,⁶ who compared the effects of Reso-Pac[®] and Coe-Pack[™] *in vitro* although, unlike the previous study, this study focused on the effects of both dressing ingredients clinically. Consequently, the results of this study are expected to help dentists choose an appropriate dressing material for post-periodontal surgery treatment.

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