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ORIGINAL ARTICLE

Adrian Kasaj · Brita Willershausen · Mohamad Berakdar · Haki Tekyatan · Anton Sculean

Effect of an oily calcium hydroxide suspension on early wound healing after nonsurgical periodontal therapy

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Abstract The purpose of the present study was to evaluate clinically the effect of an oily calcium hydroxide suspension on early wound healing after nonsurgical periodontal therapy. A total of 19 patients with chronic periodontitis were enrolled in the study. Each subject had three sites in each of two contra-lateral jaw quadrants with a probing pocket depth (PPD) of ≥5 mm and bleeding on probing (BoP+). All teeth received scaling and root planing under local anesthesia followed by irrigation with sterile saline. An oily calcium hydroxide suspension (Osteoinductal) was applied subgingivally to the test sites at random. All sites were reexamined after 1, 2 [gingival index (GI) and BoP], and 3 weeks (GI, BoP, and PPD). Treatment success was defined as no signs of GI (GI=0), no BoP (BoP−), and pocket closure (PPD≤4 mm). At all three different points in time, there were improvements in both GI and BoP at the control and test sites, which were in favor of the test therapy ($p<0.05$). For PPD change, no differences were found between the test and the control sites. The results of the study suggest that the topical application of an oily calcium hydroxide suspension (Osteoinductal), after nonsurgical periodontal therapy, improves early periodontal wound healing.

A. Kasaj · B. Willershausen · M. Berakdar · H. Tekyatan
Department of Operative Dentistry,
Johannes Gutenberg University,
Mainz, Germany

A. Sculean
Department of Periodontology,
University Medical Center,
Nijmegen, The Netherlands

B. Willershausen (✉)
Department of Operative Dentistry,
Johannes Gutenberg University Mainz,
Augustusplatz 2,
55131 Mainz, Germany
e-mail: willersh@mail.uni-mainz.de
Tel.: +49-6131-177246
Fax: +49-6131-173406

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Introduction

The effectiveness of nonsurgical periodontal therapy in reducing gingival inflammation, decreasing probing depths and arresting progression of periodontal disease has been shown in numerous clinical studies [1, 9, 22, 26, 27]. Although nonsurgical periodontal therapy is successful in removing bacterial plaque and calculus from periodontal pockets, there are also significant limitations to its effectiveness. Because of limited access, deep molar furcation sites show an impaired healing response to nonsurgical therapy and a higher frequency of continuous probing attachment loss [12, 25]. At sites with a pocket depth ≥5 mm, efficacy of subgingival scaling and root planing is limited, and significant amounts of residual calculus can be observed [29, 34]. Claffey et al. [6] studied the probing attachment loss occuring as a result of trauma after subgingival instrumentation. Their results showed that immediately after subgingival instrumentation, 24% of sites showed an attachment loss of ≥1 mm due to an instrumentation trauma. Similar observations were made by Nylund and Egelberg [26] and by Claffey and Egelberg [5]. A histological examination by Biagini et al. [2] after nonsurgical periodontal therapy confirmed a trauma to the gingival epithelium and connective tissue due to subgingival instrumentation with hand curettes or ultrasonic scalers. Furthermore, the authors reported a decrease in the gingival crevicular fluid flow and in the number of inflammatory cells during the healing phase. The restoration and epithelization of the sulcus after subgingival instrumentation requires 2 to 7 days, whereas collagen fibers appear within 21 days [23]. Recently, the findings by Müller and Heinecke [24] demonstrated that in patients with chronic periodontitis the clinical short-term effect after the hygienic phase of therapy occurs regardless of the presence or absence of *Actinobacillus actinomycetemcomitans*.

Several treatment modalities, including bone grafts, application of growth factors and guided tissue regeneration, have been used to restore lost periodontal attachment in intrabony defects [16, 28]. Osteoinductal (Osteoinductal GmbH, Muenchen, Germany) constitutes a commercially available compound consisting mainly of calcium hydroxide and fatty acids esterfied with glycerol. Recent studies have shown that an oily calcium hydroxide suspension, applied to the root surface in conjunction with surgical periodontal therapy, may promote periodontal regeneration [31, 32]. Findings from histological studies in animals and humans showed that the use of an oily calcium hydroxide paste leads to an accelerated bone regeneration [15, 19]. As oily calcium hydroxide creates an alkaline (pH 8–9) environment in the wound site by releasing hydroxyl and calcium ions [21], this may also influence soft tissue healing. The purpose of the present study was to evaluate, by clinical means, the effect of an oily calcium hydroxide suspension on early wound healing of soft tissues after nonsurgical periodontal therapy.

Materials and methods

A total of 19 patients (seven females, 12 males), aged 29–68 years (mean age 43±6.5 years) with moderately advanced chronic periodontitis were included in this split-mouth, randomized, single-blinded, controlled clinical trial of 3-week duration. The study was in accordance with the Helsinki Declaration of 1975, as revised in 1983. Criteria for inclusion in the study were: (1) no systemic diseases that could influence the therapy, (2) presence of three tooth surfaces in each of two contralateral jaw quadrants with a probing pocket depth of ≥5 mm and bleeding on probing (BoP+), (3) one pair of sites with a probing pocket depth (PPD)≥6 mm, and (4) experimental teeth must have a vital pulp or be asymptomatic after root canal treatment. In addition, exclusion criteria were long-term medication, systemic antibiotic therapy within the last 6 months, systemic diseases, and disorders affecting wound healing. Pregnant women were also not eligible for inclusion in this study. All subjects were given oral and written information concerning the study and gave their written consent before the clinical examination. The baseline examination of the experimental (test or control) teeth (six teeth per patient) included assessment of PPD, BoP, gingival index (GI), and plaque index (PlI) [20]. All measurements were taken again 1, 2, and 3 weeks after treatment by the same blinded and previously calibrated investigator using the same periodontal probe (PCP 15, Hu-Friedy, USA). The measurements were performed at six sites around all experimental teeth: mesiobuccal, mid-buccal, distobuccal, mesiolingual, midlingual, and disto-lingual. Bleeding on probing was recorded as presence (+) or absence (−) within 15 s after pocket probing.

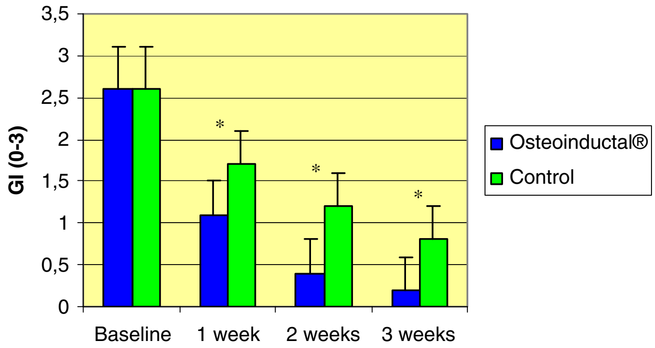

Fig. 2 Mean values (SD) for the gingival index scores at baseline and after 1, 2, and 3 weeks (n=19). *Statistically significant difference (p<0.001)

Intra-examiner reproducibility

Five patients, each showing 10 teeth (single and multi-rooted) with probing depths of >6 mm on at least one aspect of each tooth, were used to calibrate the examiner. The examiner evaluated the patients on two separate occasions, 48 h apart. Calibration was accepted if measurements at baseline and at 48 h were similar to the millimeter at >90% level. The examiner was not aware of the clinical procedure to be performed.

After the initial examination, the experimental teeth were subjected to a single session of scaling and root planing under local anesthesia (4% articaine with

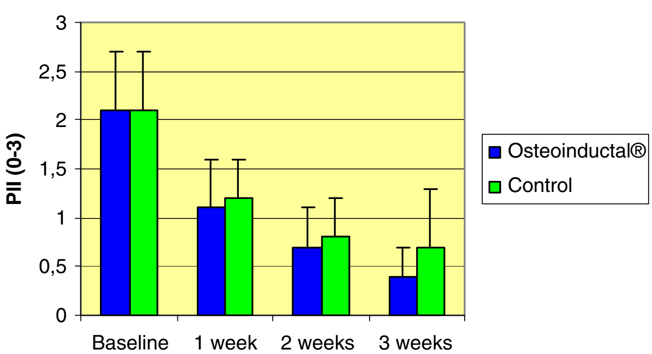

Fig. 1 Mean values (SD) for the plaque index scores at baseline and after 1, 2, and 3 weeks (n=19)

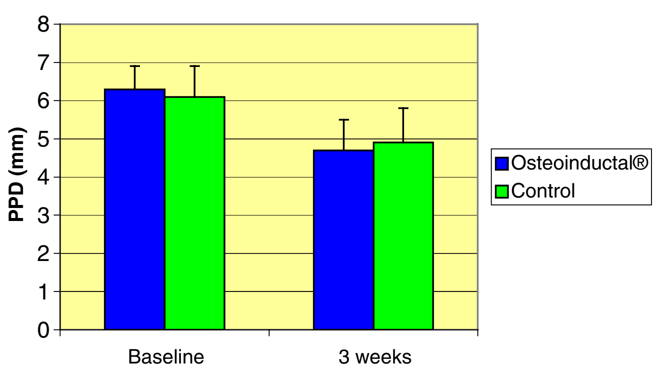

Fig. 3 Mean values (SD) for probing pocket depth at baseline and after 3 weeks (n=19)

Table 1 Proportion of sites (%) reaching the endpoint of treatment success GI=0 after 1, 2, and 3 weeks

	Osteoinductal (%)/*N* sites	Control (%)/*N* sites
Baseline	0/0	0/0
1 week	14/8*	7/4*
2 weeks	33/19*	17/10*
3 weeks	37/21*	24/14*

$^*p<0.001$

1/200,000 epinephrine, Aventis Ultracaine D-S) to remove pocket epithelium and granulation tissue. The test and control sites were then carefully irrigated with sterile saline until no bleeding from the pocket could be detected. After instrumentation and irrigation with saline, an oily calcium hydroxide suspension (Osteoinductal, Osteoinductal GmbH, Munich, Germany) was applied subgingivally to the test sites at random. The material is composed of calcium hydroxide, oleum pedum tauri, and vaselinum album. The oily calcium hydroxide suspension was delivered subgingivally by using a 30-gauge short needle, placed at the bottom of the pocket until the pocket was overfilled. All sites were reexamined after 1, 2, and 3 weeks. Patients were instructed to refrain from toothbrushing during the first 2 days after treatment and to use a 0.12% chlorhexidine rinse twice daily for 1 week. Treatment success was defined as no signs of GI (GI=0), absence of BoP (BoP−), and pocket closure (PPD≤4 mm). All statistical analyses were performed using SPSS (11.0 for Windows). For the clinical parameters PPD, GI, and PlI, data were expressed as mean values with standard deviation (SD). The clinical parameter BoP was recorded as dichotomous measures at the experimental and control sites. For the comparison of the test and control sites, the paired *t* test was used. *P*-values <0.05 were considered as statistically significant. The comparison between the frequencies of sites reaching the defined treatment success was performed by using the Fisher exact test.

Results

All 19 patients recruited for the study completed the trial, and the data were included in the statistical analysis. Each of the 19 patients contributed six sites to the study for a total of 114 periodontal sites. No statistically significant differences were observed at baseline between test and control sites for any of the measured parameters. The mean values for the plaque and gingival scores for the PPD showed an improvement in the test and the control sites over the 3-week period (Figs. 1, 2, and 3). The plaque scores showed reduced values after 1 week for both groups and remained at a low level for the entire 3 weeks. The mean baseline plaque score was 2.1±0.6 for the test sites and 2.1±0.6 for the control sites (Fig. 1). No statistically significant difference was found. At 3 weeks, the mean plaque score was 0.4±0.3 for the test sites and 0.7±0.6 for the control sites (Fig. 1). However, there was no statistical difference ($p>0.05$) when test and control sites were compared. At the 1-, 2-, and 3-week reevaluation, a statistically significant difference between test and control sites was found for the mean GI values ($p<0.001$). The mean GI score at baseline was 2.6±0.5 for the control sites and 2.6±0.5 for the test sites. After 1 week, the mean GI score was 1.1±0.4 for the test group vs 1.7±0.4 in the control group. After 2 weeks, the corresponding data were 0.4±0.4 vs 1.2±0.4, and after 3 weeks 0.2±0.3 vs 0.8±0.4 (Fig. 2). The mean PPD decreased from 6.3±0.6 mm at baseline to 4.7±0.9 mm after 3 weeks in the experimental sites and from 6.1±0.8 to 4.9±0.9 mm in the control sites (Fig. 3). The reduction of PPD for both sites was statistically significant; however, there were no significant differences between the sites ($p>0.05$). The primary endpoint GI=0 (Table 1) was reached after 1 week in 14% of the test sites and in 7% of the control sites. Two weeks after treatment, the corresponding data were 33.3 vs 17.5%, and after 3 weeks 36.6 vs 24.5%. At all three different points in time, the changes in GI were statistically significant and were in favor of the test therapy ($p<0.001$). Absence of bleeding after probing (Table 2) was reached after 1 week in 15.8% of the sites treated with Osteoinductal compared to 12.3% of the control sites. After 2 weeks, the corresponding figures were 35 vs 19.3%, and 36.8 vs 28% after 3 weeks. There was a statistically significant difference ($p<0.001$) with respect to BoP− between the test and the control sites at all three reexaminations. In terms of the endpoint PPD≤4 mm (Table 3), no differences were found between the test and the control sites at any time. After 3 weeks, the endpoint pocket closure was reached in 32% of sites treated with Osteoinductal compared to 31% of the control sites.

Table 2 Proportion of sites (%) reaching the endpoint of treatment success BoP− after 1, 2, and 3 weeks

	Osteoinductal (%)/*N* sites	Control (%)/*N* sites
Baseline	0/0	0/0
1 week	16/9*	12/6*
2 weeks	35/20*	13/7*
3 weeks	37/21*	28/16*

$^*p<0.001$

Table 3 Proportion of sites (%) reaching the endpoint of treatment success PPD ≤4 mm after 3 weeks

	Osteoinductal (%)/*N* sites	Control (%)/*N* sites
Baseline	0/0	0/0
3 weeks	32/18	31/17

Discussion

The results of the present study have shown that the topical subgingival application of an oily calcium hydroxide suspension (Osteoinductal) after nonsurgical periodontal therapy improved early periodontal wound healing. The application of Osteoinductal resulted in significantly greater improvement in gingival and bleeding indices in experimental vs control sites at the 1-, 2-, and 3-week examinations. In addition, no side effects like inflammation or pain were reported at sites subjected to Osteoinductal application. The changes in gingival and bleeding scores at both test and control sites due to the short-term effect of nonsurgical periodontal therapy are consistent with previously reported data [3, 22]. However, in the present study, changes in both GI and BoP after 1, 2, and 3 weeks were statistically significant and in favor of the test therapy. The long-acting antibacterial and antiinflammatory properties of calcium hydroxide were demonstrated in several experimental studies [7, 30, 33]. Bystrom et al. [4] demonstrated that calcium hydroxide effectively eliminated all microorganisms from root canals when the medication was maintained for 4 weeks. While aqueous solutions of calcium hydroxide cause a rapid increase of the pH up to 12–13 in living tissues, from the oily calcium hydroxide suspension, a stable, long-lasting pH gradient of 7–11 is formed within the tissue without causing irritation [8]. Thus, the oily suspension produces a long-term, mild alkaline environment because only the calcium hydroxide at the interface between the liquid/oily phase is released. As a result, a significant pain relief and suppression of inflammation can be observed [8]. Further studies described the antiinflammatory and analgetic properties when used in cases of wounded or surgically exposed bone surfaces [10, 11]. The pH plateau of 8–9 created by the oily calcium hydroxide suspension in the wound site seems to stimulate the local metabolism of gingival fibroblasts, while bacterial activity seems to be inhibited. However, the biological mechanism of oily calcium hydroxide in early soft tissue wound healing is not understood at present; the use of oily calcium hydroxide can therefore not be recommended for certain indications. For example, the study by Kohal et al. [17] indicates that the use of an oily calcium hydroxide suspension (Osteoinductal) can even have an adverse effect on wound healing and osseointegration of dental implants.

In a study by Gleissner et al. [13], an antiinflammatory effect on gingival tissues was shown and attributed to an oily component of a dentifrice. Kozlovsky et al. [18] found significant improvements in periodontal health, plaque accumulation, and microbial levels in patients using a two-phase oil–water mouthrinse. However, whether the beneficial effect of Osteoinductal, as seen in the present study, is due to its oily or calcium hydroxide component cannot be concluded at present.

The finding that no improvement in PPD reduction in sites treated with Osteoinductal compared to the control sites could be achieved in this study can be explained by the inability of adequate coating of the root surface due to a nonsurgical environment. Also, the Osteoinductal formulation used in the study is mainly indicated as an osteoinductive and osteostimulative wound cover for use in a surgical environment. Furthermore, a possible wash-out effect after subgingival application can be assumed.

The soft tissue wound healing after adjunctive use of an oily calcium hydroxide suspension can be compared with the improved wound healing of soft tissues after treatment with enamel matrix derivative (EMD). Wennstrom and Lindhe [35] demonstrated an improved periodontal wound healing in instrumented pocket sites after subgingival application of enamel matrix derivative. The authors observed significantly greater improvements in gingival and bleeding indices in sites treated with EMD than in those treated with the vehicle alone (control) at the 1- and 2-week reevaluation. In contrast, the results reported by Gutierrez et al. [14] showed no effectiveness of the adjunctive use of EMD after nonsurgical therapy at the 3-month follow-up. The authors concluded that the beneficial effects of EMD are only of a short-term nature.

In conclusion, results from the present study indicate that the adjunctive use of Osteoinductal improves early soft tissue wound healing after nonsurgical periodontal therapy. However, further studies are needed to investigate the mechanism behind the influence of oily calcium hydroxide suspensions on wound healing and the long-term effect on the healing of soft tissues after nonsurgical and surgical periodontal therapy.

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