The Saudi Dental Journal (2009) **21**, 127–133

King Saud University

The Saudi Dental Journal

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ORIGINAL ARTICLE

The use of povidone–iodine and hydrogen peroxide mixture as an adjunct to non-surgical treatment of slight to moderate chronic periodontitis

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Received 2 November 2008; revised 17 November 2008; accepted 22 March 2009
Available online 29 October 2009

KEYWORDS

Povidone–iodine;
Hydrogen peroxide;
Periodontitis

Abstract *Objective:* The aim of this study was to evaluate the clinical effects of the adjunctive use of povidone–iodine with or without hydrogen peroxide as coolant and disinfectant during ultrasonic scaling and root planing in the treatment of chronic periodontitis.

Materials and methods: Sixteen patients initially participated in the study. Thirteen patients (8 males and 5 females) completed the 3-month follow-up period. Their mean (±SD) age was 42.92 ± 7.55 years. In each experimental subject, the mouth was split into four quadrants. A randomly selected quadrant was chosen to receive one of the three treatment group modalities which were: Group 1 – ultrasonic scaling and root planing plus irrigation with 1% povidone–iodine and 3.0% hydrogen peroxide mixture; Group 2 – ultrasonic scaling and root planing plus irrigation with 1% povidone–iodine; Group 3 – ultrasonic scaling and root planing plus irrigation with normal saline. The fourth quadrant served as a control group.

Results: At the 3-month evaluation, there was no significant difference between the three treatment groups in terms of probing depth reduction, clinical attachment gain, gingival recession increase, reduction in the bleeding upon probing or plaque score reduction ($P > 0.05$). However,

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doi:10.1016/j.sdentj.2009.10.004

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the three treatment groups had statistically significant higher mean reduction in the probing depth, gain in the clinical attachment level and reduction in the bleeding upon probing than the control group ($P < 0.05$).

Conclusion: There were no added benefits of using a mixture of povidone–iodine and hydrogen peroxide or povidone–iodine as disinfectants during ultrasonic scaling and root planing in the treatment of chronic periodontitis.

1. Introduction

Periodontal diseases are infections initiated by microorganisms colonizing the tooth surface at, or below, the gingival margin (Socransky and Haffajee, 2000). Chronic periodontitis is one of the most prevalent diseases (Albandar et al., 1999) throughout the world including Saudi Arabia. Sixty-eight percent of a Saudi population sample had more than 20% bone loss; of these, 28% had the localized and 40% had the generalized form (Al-Zahrani and Kayal, 2006).

Chronic periodontitis cases can be successfully managed by professional scaling and root planing in addition to an appropriate plaque control (Waerhaug, 1978). Ultrasonic devices have been shown to be effective in root planing, even in deep pockets (Badersten et al., 1981, 1984). However, the complete removal of plaque and calculus is difficult to achieve (Waerhaug, 1978). Insufficient removal of bacteria and its products might lead to the growth of the remaining microorganisms. This allows the re-colonization of the root surface by putative pathogenic bacteria.

Based on the microbial etiology of chronic periodontitis, local and systemic chemotherapeutic agents have been used to improve the effectiveness of scaling and root planing. Systemic antibiotics require repeated high doses to produce an effective concentration at the site of infection, i.e. periodontal pocket (Gordon et al., 1981). Furthermore, it has the potential to produce adverse systemic effects, and might lead to bacterial resistance. Locally delivered antibiotics are expensive and require considerable chair side time for their application (Rams and Slots, 2000).

Povidone–iodine (polyvinylpyrrolidone–iodine) is one of the most widely used antiseptic agents in the medical field. It is used as a disinfectant for skin, hands, and mucosal surfaces. It can also be used for wound treatment, rinsing body cavities, joints and for eye applications (Reimer et al., 2002). It is formed by a combination of water soluble polymer, povidone and iodine (Greenstein, 1999). This polymer prolongs the activity of iodine (Fleischer and Reimer, 1997). It was found to kill the microorganisms *in vitro* within 15 s (Higashitsutsumi et al., 1993). However, to be effective clinically, it requires 5 min of contact with the microorganisms (Slots, 2000). It has a wide antimicrobial activity against bacteria, fungi, mycobacteria and viruses (Schreier et al., 1997). It is safe and easy to use (Dajani et al., 1997), widely available and cost effective. Furthermore, it has minimal side effects and has no or minor potential to induce bacterial resistance (Lanker Klossner et al., 1997). Moreover, it was found that the effectiveness of povidone–iodine increased when combined with hydrogen peroxide (Maruniak et al., 1992).

This study aimed to evaluate first whether the usage of povidone–iodine as a coolant and disinfectant during ultrasonic scaling and root planing could improve the clinical outcome of the scaling and root planing in chronic periodontitis patients. Secondly, whether the addition of hydrogen peroxide to povidone–iodine could have added action.

2. Materials and methods

2.1. Design of the study

This is a single blind randomized clinical study, which compared three different treatment methods in periodontitis patients. The methods used are: (a) ultrasonic debridement with subgingival irrigation with a mixture of povidone–iodine and hydrogen peroxide, (b) povidone–iodine only, and (c) normal saline. For each patient, the mouth was divided into four quadrants. Each quadrant received one form of the three treatments modalities. The fourth quadrant served as negative control and was treated at the end of the study.

2.2. Subjects

Sixteen non-smoker subjects were recruited from the patients attending the dental clinics at the College of Dentistry, King Saud University, Riyadh, Saudi Arabia. An informed written consent was signed by each participant before the beginning of the study. Their age ranged between 30 and 55 years. All subjects had the presence of subgingival calculus and a minimum of 4 teeth in each quadrant with at least two sites with probing pocket depth $\geqslant 4$ mm and clinical attachment level $\geqslant 2$ mm. The third molars and central incisors were excluded from the study. The exclusion criteria were periodontal treatment within the previous 6 months or systemic antibiotic within the previous 3 months, patients with: thyroid gland disease, hypertension, known allergy to iodine, seafood and/or shellfish (Clark et al., 1989), aggressive periodontitis, pregnancy and/or lactating women.

2.3. Stent preparation

An individually customized acrylic stent was fabricated for all patients. Guiding steering grooves were identified on the stent to direct the probe during the measurement of the clinical parameter. The stent was also used as a fixed reference point for measuring the relative clinical attachment level.

2.4. Clinical parameters

The clinical parameters used to assess the presence of periodontitis were plaque index (Silness and Loe, 1964) at four surfaces per tooth (buccal, mesial, lingual, and distal) and bleeding upon probing (Polson and Caton, 1985) within 30 s. The probing pocket depth, gingival recession and the relative

clinical attachment level were recorded at six sites per tooth (mesiobuccal, midbuccal, distobuccal, distolingual, midlingual, and mesiolingual) using the Florida probe system adjusted at 0.25 N force (Lang et al., 1991). The third molars and the central incisors were excluded from the study. All measurements were taken at baseline, 6 weeks and 3 months following the completion of the treatment.

The mean plaque index, probing depth, gingival recession, and relative clinical attachment level, were calculated for each treatment method in every subject. The bleeding upon probing was calculated as a percentage of the total surfaces of the teeth.

2.5. Examiner calibration

The calibration was performed before the start of the study and included double measurements of the probing depth within the same day for 5 patients to ensure an accepted level of intra-examiner reproducibility.

2.6. Preparation of the solutions (test and control)

(Group 1) Mixture of 1% povidone–iodine[1] and 3.0% hydrogen peroxide.[2]
(Group 2) 1% povidone–iodine.
(Group 3) Normal saline (0.9% sodium chloride).

The solutions were prepared at the College of Pharmacy, King Saud University, Riyadh, Saudi Arabia and stored in coded dark bottles having the same color.

2.7. Treatment

Following the baseline examination, each patient received detailed information about his/her periodontal status, the etiology of the condition and the importance of the treatment. The participants' objectives and oral hygiene instruction started following the baseline measurements and continued throughout the study. All patients were subjected to the treatment utilizing the following protocol:

(Group 1) Quadrant A: Ultrasonic instrumentation using a Piezon master 400® plus subgingival irrigation with a mixture of 1% povidone–iodine and 3.0% hydrogen peroxide.
(Group 2) Quadrant B: Ultrasonic instrumentation plus subgingival irrigation with 1% povidone–iodine.
(Group 3) Quadrant C: Ultrasonic instrumentation plus subgingival irrigation with normal saline.
(Group 4) Quadrant D: No treatment.

The quadrants were distributed randomly to one of the assigned groups using the table of randomization. Each tooth was instrumented until the root surface felt smooth with the tip of a metallic probe. All treatment procedures were performed under local anesthesia. High volume evacuation and saliva ejector were used to remove any excess solution and its aerosol to minimize cross quadrant contamination. Following active treatment, patients were followed-up every 3 weeks for prophylaxis.

[1] Povidine®: SACO Medical, Riyadh, Saudi Arabia.
[2] Hay oxide®: Hayat Factory, Dammam, Saudi Arabia.

2.8. Statistical analysis

The descriptive statistical analysis of the changes in plaque index, bleeding upon probing, suppuration, gingival recession, probing pocket depth, and relative attachment levels were compared using a two way analysis of variance (ANOVA) of repeated measure designs with respect to the treatment methods and time factor. $P < 0.05$ was accepted as statistically significant at 95% confidence interval. Statistical analyses were done by using SPSS software version 10.0.

3. Results

3.1. Characteristics of the subjects

Out of 16 patients who initially enrolled in the study, 13 patients (8 males and 5 females) completed the 3-month follow-up period. The mean (±SD) age of the patients was 42.92 ± 7.55 years with a range of 30–54 years. They presented a total of 284 teeth. Of these, 69 (24.3%) teeth were treated with povidone–iodine plus hydrogen peroxide, 71 (25%) teeth with povidone–iodine only, 73 (25.7%) teeth with saline, and 71 (25%) teeth were in the control (untreated) group.

3.2. Examiner calibration

The double measurements of probing depth in five patients resulted in 90% agreement within 0.5 mm. The mean difference between the first and second measurements was <0.2 mm.

3.3. Plaque index (Table 1)

Groups 1–4 showed statistically significant reduction in the plaque score following the treatment ($P < 0.05$) with no statistically significant difference between the test and control groups at any visit ($P > 0.05$).

3.4. Bleeding upon probing (Table 2)

All groups showed statistically significant reduction in the bleeding upon probing at 6-week and 3-month visits but it was less pronounced in the control group ($P < 0.05$).

3.5. Probing depth (Table 3)

At the baseline examination, Group 3 which received saline irrigation had a higher mean value of probing depth when compared with the other groups. The three test groups 1–3 had statistically significant lower probing depth than the control group at both 6-week and 3-month visits ($P < 0.05$). However, there was no significant difference in the probing depth between them ($P > 0.05$). For the control group, the reduction in the probing depth was statistically significant at the 3-month visit only ($P < 0.05$).

3.6. Percentage of sites with probing depth ⩾3 mm and <6 mm (Table 4)

At baseline, there was no statistically significant difference in the percentage of sites with probing depth ⩾3 mm and

Table 1 Plaque index and mean (±SD).

	Group 1	Group 2	Group 3	Control group
Baseline	1.22 ± 0.78	1.00 ± 0.75	1.18 ± 0.82	1.09 ± 0.88
6-week	0.61 ± 0.68*	0.64 ± 0.71*	0.75 ± 0.72*	76 ± 0.83*
3-month	0.61 ± 0.67*	0.58 ± 0.62*	0.63 ± 0.64*	0.71 ± 0.71*

There is no statistical significant difference between the groups.
* ($P < 0.05$) statistically significant change from the baseline visit (intra-group).

Table 2 Percentage of sites with bleeding upon probing.

	Group 1 (%)	Group 2 (%)	Group 3 (%)	Control group (%)
Baseline	68.5	65.8	72.6	63.9
6-week	34.5*,†	27.9*,†	34.5*,†	53.8*
3-month	29.5*,$,†	31.5*,†	32.6*,†	51.6*

* ($P < 0.05$) statistically significant change from the baseline visit (intra-group).
$ ($P < 0.05$) statistically significant change from the 6-week visit (intra-group).
† ($P < 0.05$) statistically significant difference from the control group (inter-group).

<6 mm between the four groups ($P > 0.05$). At 6-week and 3-month visits there were statistically significant reductions in the percentage of sites with probing depth ⩾3 mm and <6 mm in the three test groups. However, there was no statistically significant change in the control group.

3.7. Gingival recession (Table 5)

There was no statistically significant difference in the gingival recession between the groups at the baseline examination ($P > 0.05$). At 6-week evaluation, Group 2 had statistically significant higher mean gingival recession when compared to the control group and Group 1. However, the three test groups had statistically significant higher mean gingival recession when compared to the control group at 3-month visit ($P < 0.05$).

3.8. Relative clinical attachment level (Table 6)

There was statistically significant gain of attachment in the three treatment groups at both 6-week and 3-month visits ($P < 0.05$). At 3-month visit there was statistically significant gain of attachment in the control group ($P < 0.05$).

4. Discussion

The present clinical study was designed to evaluate the clinical effects of the adjunctive use of povidone–iodine with, or without, hydrogen peroxide as coolants and disinfectants during ultrasonic scaling and root planing in the treatment of slight to moderate chronic periodontitis. In each subject, the mouth was split into four quadrants. Using the table of randomiza-

Table 3 Probing depth in mm and mean (±SD).

	Group 1	Group 2	Group 3	Control group
Baseline	2.86 ± 1.3	2.77 ± 1.24	3.07 ± 1.43	2.82 ± 1.43
6-week	2.22 ± 1.03*,†	2.17 ± 1.07*,†	2.27 ± 1.00*,†	2.69 ± 1.25
3-month	2.00 ± 0.88*,†	2.08 ± 0.98*,†	2.10 ± 0.93*,†	2.55 ± 1.23*

* ($P < 0.05$) statistically significant change from the baseline visit (intra-group).
† ($P < 0.05$) statistically significant difference from the control group (inter-group).

Table 4 Percentage of sites with probing depth ⩾3 mm and <6 mm.

	Group 1	Group 2	Group 3	Control group
Baseline	58.13 ± 49.72	50.80 ± 50.06	61.44 ± 48.73	51.26 ± 50.05
6-week	31.64 ± 46.56*,†	29.11 ± 45.48*,†	33.33 ± 47.19*,†	48.12 ± 50.02
3-month	21.74 ± 41.30*,†	26.53 ± 44.20*,†	25.57 ± 43.68*,†	45.07 ± 49.81

* ($P < 0.05$) statistically significant change from the baseline visit (intra-group).
† ($P < 0.05$) statistically significant difference from the control group (inter-group).

Table 5 Gingival recession in mm and mean (±SD).

	Group 1	Group 2	Group 3	Control group
Baseline	0.38 ± 0.82	0.43 ± 0.91	0.47 ± 0.95	0.47 ± 0.95
6-week	0.51 ± 0.94*	0.65 ± 1.02*,†	0.55 ± 0.98*	0.49 ± 1.01
3-month	0.65 ± 1.02*,†	0.64 ± 1.12*,†	0.57 ± 1.07*,†	0.41 ± 1.05

* ($P < 0.05$) statistically significant change from the baseline visit (intra-group).
† ($P < 0.05$) statistically significant difference from the control group (inter-group).

Table 6 Relative clinical attachment level in mm and mean (±SD).

	Group 1	Group 2	Group 3	Control group
Baseline	6.74 ± 1.56	6.70 ± 1.57	7.04 ± 1.61	6.79 ± 1.62
6-week	6.23 ± 1.40*,†	6.33 ± 1.46*,†	6.32 ± 1.34*,†	6.68 ± 1.56
3-month	6.15 ± 1.35*,†	6.22 ± 1.41*,†	6.17 ± 1.36*,†	6.46 ± 1.47*

* ($P < 0.05$) statistically significant change from the baseline visit (intra-group).
† ($P < 0.05$) statistically significant difference from the control group (inter-group).

tion, a selected quadrant was chosen to receive one of the three treatment modalities while the fourth quadrant served as a control.

The split-mouth design has the advantage of eliminating inter-subject variables. However, it carries the risk of transferring povidone–iodine with, or without, hydrogen peroxide from the assigned quadrants to the others. To minimize the risk, a high volume evacuation and saliva ejector were used to remove the excess solution and its aerosol. Furthermore, central incisors were not included in the study due to the possibility of transferring the antimicrobial agent across the midline. Another disadvantage of this design was the presence of untreated sites which might act as a reservoir for periodontal pathogens. This might affect underestimate the results, but not affect the comparison between treatment groups in as much as they will be affected equally.

The selection of the povidone–iodine as an adjunctive treatment during ultrasonic scaling and root planing was based on the microbial etiology of the periodontal diseases. Povidone–iodine is probably, the most commonly used antiseptic agent in medical practice, possessing an unblemished safety track record, broad spectrum antiseptic action and low cost (Reimer et al., 2002).

The addition of hydrogen peroxide was found to increase the effectiveness of povidone–iodine as an antimicrobial agent (Maruniak et al., 1992). Several studies (Maruniak et al., 1992; Gocke et al., 1985; Berkelman et al., 1982; Lacey, 1979) have shown that 1% or less concentration of povidone–iodine was effective as an antimicrobial agent and able to kill *Porphyromonas gingivalis*. The same effect was found with a 0.3% hydrogen peroxide (Maruniak et al., 1992).

Several studies (Rosling et al., 1986; Hung and Douglass, 2002) have shown that improvement of clinical periodontal parameters following scaling and root planing continues for a year but most of the effects occurred in the first 3 months. Hence, it was decided that a three month period was sufficient to evaluate the expected treatment outcomes in this study. Furthermore, ethical considerations did not allow the controlled sites to remain untreated for an extended time.

The results of this study demonstrated that using povidone–iodine with, or without, hydrogen peroxide as an adjunctive treatment to ultrasonic scaling and root planing had no positive clinical effects. These findings are in agreement with the results reported by Zanatta et al. (2006), Koshy et al. (2005), Hoang et al. (2003), and Del Peloso Ribeiro et al. (2006).

On the other hand, the results of this study contradicted those reported by Rosling et al. (2001) and Forabosco et al. (1996). Rosling et al. (2001) evaluated the periodontal scaling and root planing with an ultrasonic device "Odontoson®" plus 0.1% povidone–iodine irrigation and compared it to scaling and root planing with the same device, but with tap water irrigation. In the third month, they demonstrated that the reduction in probing depth for the povidone–iodine group was 1.1 mm compared to 0.8 mm for the tap water group and this difference was statistically significant. The difference in the gain of clinical attachment was 0.2 mm in favor of the povidone–iodine group. Several factors could explain the differences between this study and Rosling et al. (2001) study. First, in the present study, the Florida probe system, which is an electronic probe with a standardized constant force of 0.25 N, was used. The Florida probe system measures the probing depth with an accuracy of 0.2 mm. Samuel et al. (1997) demonstrated that the Florida probe system offered an increased accuracy over the conventional manual probe, and that the maximum probing error has been shown to be only 0.3 mm (Yang et al., 1992). However, in Rosling et al. (2001) study a conventional manual probe was used to measure the probing depth with all the measurement rounded to the nearest 1 mm. The precision of the manual probe to measure less than a 0.5 mm difference is highly questionable. Secondly, the present study compared the effectiveness of povidone–iodine with, or without, hydrogen peroxide to the normal saline, while, Rosling et al. (2001) compared the effectiveness of povidone–iodine with tap water irrigation. Thirdly, Rosling et al. (2001) did not only administer povidone–iodine to periodontal pockets, but to the entire oral cavity for 1 h with an excess amount of 0.1% povidone–iodine.

Forabosco et al. (1996) compared in eight subjects the outcome of: (i) modified Widman flap with conventional root planing and (ii) non-surgical root planing with Odontoson® using 0.5% Betadine®. The patients were examined after 12 months. They concluded that Odontoson® plus 0.5% Bet-

adine® achieved a statistically comparable outcome to that of surgical treatment, even in the pockets initially up to 7 mm in depth. However, it is unknown whether the addition of Betadine® irrigation had a positive impact on the results, or not.

Two reasons could explain the inability of the adjunctive use of povidone–iodine to augment the clinical effects of the ultrasonic scaling and root planing in this study: first, povidone–iodine is a non-sustained local antimicrobial agent. Second, the number of deep sites (> 6 mm) in this study were low. Rosling et al. (2001) showed that the effect of povidone–iodine was more pronounced in the initially deep pockets.

In this study, there was about a 1 mm reduction in the probing depth in Group 1, Group 2, and Group 3 at the end of the study. The reductions in the probing depth reported by the studies that used the povidone–iodine as an adjunct to the scaling and root planing were 1.1 mm (Rosling et al., 2001), 1.8 mm (Hoang et al., 2003), 1.73 mm (Koshy et al., 2005), and 2.53 mm (Zanatta et al., 2006), respectively. Our results are similar to the results of the Rosling et al. (2001) study, but different than those reported by Zanatta et al. (2006), Koshy et al. (2005), and Hoang et al. (2003). Group 1, Group 2, and Group 3 showed significant gain of clinical attachment at both 6-week and 3-month visits ranging from 0.5 to 0.9 mm. This gain of attachment was somewhat higher than the Rosling et al. (2001) study, but less than those reported by Koshy et al. (2005) and Zanatta et al. (2006). The mean initial probing depth was 2.88 mm in this study, 3.8 mm in Rosling et al. (2001), 5.6 mm in Zanatta et al. (2006), and 4.0 mm in Koshy et al. (2005). The differences in the initial probing depth are the possible explanations for the variations in the pocket depth reduction. Lindhe et al. (1984) have shown that deeper pockets demonstrated more reduction in the probing depth and more gain of attachment after periodontal therapy.

A meta-analysis report by Hung and Douglass in 2002 showed that the mean probing depth reductions following periodontal therapy were 1 mm for medium initial probing depths, and 2 mm for deep initial probing depths (Hung and Douglass, 2002). In addition, they reported a 0.5 mm gain of attachment for medium initial probing depths, and slightly more than 1 mm for deep initial probing depths. Another possible explanation was the presence of a quadrant in each patient that received no treatment, which could have served as a bacterial reservoir for colonization of freshly instrumented pockets.

The untreated quadrants in this study have shown a statistically significant reduction in the probing depth from 2.82 mm at the baseline to 2.55 mm at the 3-month visit. The reduction in the probing depth might be related to the penetration of the solutions into the untreated sites or improvement of oral hygiene. There was only 0.2 mm gain of clinical attachment level of the untreated sites. Hence, it is more likely that the shrinkage of the inflamed gingiva, due to effective plaque control, was responsible for the reduction in the probing depth.

Periodontal therapy results in shrinkage of the inflamed marginal soft tissue leading to gingival recession. The mean gingival recession at the baseline visit of this study ranged from 0.38 to 0.47 mm. At the end of the study, Group 1, Group 2, and Group 3 showed a statistically significant increase in the mean value of the gingival recession.

Clinical studies (Badersten et al., 1984; Lindhe et al., 1984) including the present study, confirmed that scaling and root planing, in combination with good supragingival plaque control, resulted in a marked resolution of the clinical signs of periodontal disease. The standard periodontal therapy includes the removal of plaque, calculus and cementum contaminated by endotoxins. Smart et al. (1990) have shown that endotoxins can be removed with only 15 light strokes per root surface. Extensive removal of cementum during scaling and root planing seems to be unwarranted. Our results demonstrated that the reduction in the pocket depth and the gain of clinical attachment took place regardless of whether the teeth had been treated with a povidone–iodine plus hydrogen peroxide mixture, povidone–iodine only or saline as a coolant during ultrasonic instrumentation. Furthermore, Zanatta et al. (2006) demonstrated that ultrasonic scaling and root planing for 45 min achieved similar results of four sessions quadrant-wise scaling and root planing. Thus, ultrasonic scaling and root planing can be considered as an accepted modality in mechanical periodontal therapy.

5. Conclusions

Within the limitations of the present study, it might be concluded that:

- A single episode of scaling and root planing using an ultrasonic scaler combined with supragingival plaque control resulted in a marked resolution of the clinical signs of periodontal disease.
- Povidone–iodine with or without hydrogen peroxide did not enhance the effectiveness of non-surgical treatment of slight to moderate chronic periodontitis.

The addition of hydrogen peroxide did not improve the effectiveness of povidone–iodine as an adjunctive to non-surgical treatment of slight to moderate chronic periodontitis.

Acknowledgment

This study was supported by College of Dentistry Research Center, Riyadh Saudi Arabia under Grant Number F1133. The authors do not have any financial interest in any products used in this study.

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