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Clinical effects of an essential oil solution used as a coolant during ultrasonic root debridement

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Cosyn J, Miremadi SR, Sabzevar MM, De Bruyn H. Clinical effects of an essential oil solution used as a coolant during ultrasonic root debridement.

Abstract: *Aim:* The use of chlorhexidine and povidone iodine solutions applied as a coolant during ultrasonic root debridement for the treatment of chronic periodontitis has been described. Hitherto, this application has not yet been extensively investigated for essential oil solutions. The goal was to clinically explore this and to compare to water irrigation. *Materials and methods:* Thirty-five chronic periodontitis patients participated in a single-blind randomized controlled clinical study. Patients were randomly allocated to the control group (n = 18) or test group (n = 17) receiving oral hygiene instructions and ultrasonic root debridement using water as a coolant, respectively, a pure essential oil solution. Oral hygiene was reinforced if necessary at each occasion, and clinical parameters were collected at baseline and after 1 and 3 months. *Results:* Significant pocket reduction (control, 1.02 mm; test, 0.89 mm) and clinical attachment gain (control and test, 0.48 mm) were shown in both groups. However, there were no significant differences between the groups at any point in time for any of the parameters. *Conclusion:* Essential oil solutions do not offer a clinical benefit over water when used as a coolant during ultrasonic root debridement for the treatment of chronic periodontitis.

Key words: chronic periodontitis; dental scaling; essential oils; ultrasonic

Introduction

Chronic periodontitis is a common infectious disease characterized by progressive attachment loss and alveolar bone resorption eventually resulting in tooth loss. The ultimate goal of periodontal therapy is to prevent this endpoint. At least when a strict supportive care programme is implemented following active therapy, subsequent tooth loss is limited to a mean of about 0.1 per patient per year (1, 2). In contrast, three to six times as many teeth may be lost if the disease is left untreated (3, 4).

Recent insights have shown that besides supportive care, the active treatment phase is of pivotal importance to limit disease progression and tooth loss in the end. In a large retrospective cohort study documenting on average 11 years of follow-up, deep residual pockets of at least 6 mm following active therapy were significantly associated with ongoing deterioration and tooth loss on a site, tooth and patient level (5). These findings essentially promote a pocket elimination strategy in the active treatment phase.

Even though scaling and root planing combined with oral hygiene reinforcement are effective (6, 7), periodontal surgery may be required in

many cases to accomplish pocket reduction beyond 6 mm at all sites. The outcome of non-surgical therapy may be particularly hampered at deep sites and molars with furcation involvement as a result of incomplete access (8). To optimize the results of non-surgical therapy mainly at these weakly responding sites hereby possibly reducing surgical treatment needs, chemo-mechanical concepts have been developed. These include the use of systemic antibiotics and locally applied antimicrobial agents as adjuncts to mechanical debridement. For obvious reasons of bacterial resistance, systemic or even local antibiotic therapy may not be justified for the treatment of chronic periodontitis, at least not on a routine basis (9). The subgingival administration of antiseptic solutions containing chlorhexidine or povidone iodine by means of a syringe following root debridement has been described and found fairly inadequate (10, 11). Similarly, chlorhexidine gels showed poor additional value (12). Modest beneficial effects may be expected following the application of a supersaturated chlorhexidine varnish (13, 14) and chlorhexidine chip (15–17). Other investigators studied the use of antiseptic solutions as a coolant during ultrasonic root debridement (18–25). This delivery route seems appealing as the contact time of the antiseptic with the subgingival environment is increased. Moreover, the administration of the active agent occurs in conjunction with mechanical root debridement, which is interesting from a perspective of time management. The objective of the present study was to explore the clinical effects of ultrasonic root debridement for the treatment of chronic periodontitis using an essential oil solution as a coolant and to compare with water in a single-blind randomized controlled clinical study. The hypothesis was that the use of an essential oil solution would result in a superior clinical outcome.

Study population and methodology

Experimental design

Thirty-five patients aged 30–70 years were recruited from new referrals to the Dental Clinic of the Free University of Brussels (VUB) for the treatment of chronic periodontitis.

The inclusion criteria were as follows:

1 Presence of 20 teeth or more (wisdom teeth not considered).
2 At least one pocket per quadrant with a probing pocket depth (PPD) of 6 mm or deeper showing bleeding on probing (BoP) and radiographic evidence of extended bone loss (≥ one-third of the root length).

The exclusion criteria were as follows:

1 Systemic diseases.
2 Antibiotic therapy 4 months prior to the study.
3 Removable partial denture(s).
4 Orthodontic therapy.

Antibiotic therapy and the use of antiseptic mouthwashes during the trial resulted in premature termination. Sites neighbouring recent extraction sockets were systematically excluded in all analyses, as were teeth showing endodontic–periodontal lesions.

After an initial screening visit for recruitment, baseline measurements were recorded. Thereupon, patients were randomly allocated to the control group or the test group (control group, 18 patients; test group, 17 patients). This was carried out by means of a computer-generated randomization scheme. All patients signed an informed consent statement. The demographic details of the volunteers are shown in Table 1, indicating mean age and distribution of gender and smokers were similar in both groups. Subjects were considered smokers if they smoked at least 10 cigarettes a day. Both groups were also relatively comparable with respect to the degree of periodontal destruction at baseline. The study protocol was approved by the Ethical Committee of the University Hospital in Brussels (UZ Brussel).

Treatment

Subjects of the control group received ultrasonic root debridement (EMS® Piezon Master 600; EMS, Nyon, Switzerland) using water as a coolant. Hand instruments were never used. Treatment was performed by an experienced clinician in two sessions of 90 min with 1 week between appointments. To synchronize the study, the upper right and lower right quadrant were treated in the first session and the remaining quadrants in the second session. The treated quadrants were polished using a low-abrasive paste (Nupro® Fine polishing paste, Ash; Division of Dentsply International Inc., York, UK), and oral hygiene instructions were given. This included manual brushing and interdental plaque control by using interdental brushes or tooth picks. All patients were provided with the same toothpaste (Elmex®; GABA BV, Almere, the Netherlands) and toothbrush (Lactona™; Voprak Lactona BV, Bergen op Zoom, the Netherlands). Oral hygiene was reviewed and, if necessary, re-instructed at the second treatment session and after 1 month.

Subjects of the test group received the same treatment; however, an essential oil solution (Listerine® Cool mint

Table 1. **Descriptive statistics on demographic details and periodontal destruction at baseline**

Treatment strategy	Number of subjects	Men	Women	Age (years)*	Number of smokers	Initial full-mouth PPD (mm)*	Initial full-mouth CAL (mm)*	% sites with 4- to 5-mm pockets*	% sites with ≥6-mm pockets*
Control group	18	10	8	44 (13)	3	3.84 (0.59)	4.34 (0.65)	45 (21)	26 (15)
Test group	17	9	8	50 (13)	4	3.69 (0.48)	4.40 (0.71)	50 (18)	22 (10)

*Mean (SD).
PPD, probing pocket depth; CAL, clinical attachment level.

Antiseptic Mouthwash; Johnson & Johnson, New Brunswick, NJ, USA) was used as a coolant during ultrasonic root debridement. This commercially available solution contains four essential oils as active agents: menthol (0.042%), thymol (0.064%), methyl salicylate (0.060%) and eucalyptol (0.092%). Essential oils are aromatic oily liquids of herbal sources and are industrially obtained using steam distillation. Ethanol is present in concentrations above 20% and serves to dissolve the active ingredients. The solution was not diluted.

To ensure blinding, one investigator treated all patients, whereas another collected the data at baseline, 1 and 3 months.

Adverse effects were recorded at each occasion.

Examination criteria

The following response parameters were recorded in a sequential order by the same calibrated investigator (JC) at baseline (prior to therapy), 1 and 3 months:

1 Location of the gingival margin in relation to the cemento-enamel junction was measured to the nearest millimetre using a manual probe (CP 15 UNC; Hu-Friedy®, Chicago, IL, USA). Recession was given a positive value, whereas pseudo-pockets were given a negative value.
2 Sulcus bleeding index (SBI) (26) was measured at six sites (mesial, central, distal; buccally as well as orally) at the Ramfjord teeth (or neighbouring teeth in case of absence). The scores ranged from 0 to 5.
3 Probing pocket depth (PPD) was measured to the nearest millimetre at six sites per tooth (mesial, central, distal; buccally as well as orally) using a manual probe (CP 15 UNC; Hu-Friedy®).
4 Bleeding on probing (BoP) was evaluated 15 s following pocket probing. A dichotomous score was given.
5 Plaque index (PI) (27) was measured at six sites (mesial, central, distal; buccally as well as orally) at the Ramfjord teeth (or neighbouring teeth in case of absence). The scores ranged from 0 to 5.
6 Clinical attachment level (CAL) was calculated for each site as the sum of the PPD and the gingival recession or overgrowth.

All recordings were made without access to previous measurements in order to avoid measurement bias.

Calibration session

The clinician who performed all clinical recordings was calibrated prior to the start of the study. Four patients suffering from chronic periodontitis were enrolled for this purpose. Duplicate measurements (n = 462) for PI, PPD and CAL were collected with an interval of 30 min between the first and the second recording.

Sample size calculation

Calculations were based on data of a randomized controlled study comparing different types of initial periodontal therapy in chronic periodontitis patients (28). A difference in PPD of 0.5 mm between the groups was considered as clinically relevant. Based on standard deviations of 0.55 mm for both groups, an alpha error level of 5% and statistical power of 80%, a sample size of 15 patients per group was calculated. To compensate for dropouts, we included 35 patients. Eighteen were allocated to the control group and 17 to the test group.

Statistical analysis

Data analysis was performed with the patient as the experimental unit, calculating mean values and standard deviations for all parameters per subject and per time point. The Shapiro–Wilk test was used to assess the distribution of the interval-scaled data (BoP, PPD, CAL). If a normal distribution was found, changes over time within each group (within-group comparison) and the impact of the treatment strategy (between-group comparison) were examined by means of repeated measures ANOVA. Treatment strategy, time and their interaction were modelled as fixed factors and the patient as a random factor. If the data failed to approximate a normal distribution, the Friedman test was used to seek for within-group differences. *Post hoc* tests included Wilcoxon signed ranks tests adjusted for multiple comparisons. Between-group comparisons were performed using the Mann–Whitney test. Ordinal-scaled data (SBI, PI) were also analysed using these nonparametric tests. The level of significance was set at 5%.

Results

Thirty-five patients entered the study and 29 fully complied until the end. At 1-month follow-up, the clinical status could not be evaluated in five patients (three in the control group, two in the test group). At 3-month follow-up, six patients had dropped out (three in each group). Premature terminations were attributed to the use of systemic antibiotics and lack of compliance.

Intra-examiner repeatability was good to excellent for PI (85% identical agreement; Wilcoxon signed ranks test: $P > 0.05$; Spearman's correlation: $r = 0.88$; $P < 0.001$), PPD (91% identical agreement; paired t-test: $P > 0.05$; Pearson's correlation: $r = 0.94$; $P < 0.001$) and CAL (87% identical agreement; paired t-test: $P > 0.05$; Pearson's correlation: $r = 0.90$; $P < 0.001$).

Gingival index, plaque index and bleeding on probing

The changes over time in SBI, PI and BoP are sorted per treatment strategy and shown in Table 2. SBI significantly decreased in both groups at 1 and 3-month follow-up in comparison with baseline ($P \leq 0.002$). There were no significant differences between the groups at any point in time.

Similar observations were seen for PI with significant reductions in both groups following therapy ($P \leq 0.010$). There were no significant differences among the groups.

Bleeding on probing dropped by approximately 50% at 1 and 3-month follow-up in both groups ($P < 0.001$). There were

Table 2. **Changes in periodontal parameters [mean (SD)]**

Periodontal parameter	Treatment strategy	Baseline	Month 1	Month 3
Gingival index (SBI)	Control group	0.76 (0.43)	0.22 (0.11)*	0.21 (0.18)*
	Test group	0.77 (0.43)	0.14 (0.08)*	0.16 (0.12)*
Plaque index (PI)	Control group	2.08 (0.72)	1.29 (0.58)*	1.23 (0.43)*
	Test group	2.04 (0.55)	1.12 (0.51)*	1.26 (0.32)*
Full-mouth BoP (%)	Control group	60 (19)	28 (12)*	28 (10)*
	Test group	56 (21)	25 (9)*	23 (8)*
Full-mouth PPD (mm)	Control group	3.84 (0.59)	2.88 (0.40)*	2.82 (0.35)*
	Test group	3.69 (0.48)	2.84 (0.52)*	2.80 (0.34)*
Full-mouth CAL (mm)	Control group	4.34 (0.65)	3.78 (0.56)*	3.86 (0.75)*
	Test group	4.40 (0.71)	4.03 (1.02)*	3.92 (0.88)*

*Significant within-group difference in comparison with baseline.
BoP, bleeding on probing; PPD, probing pocket depth; CAL, clinical attachment level; SBI, sulcus bleeding index.

no significant differences between the control group and the test group at any time point.

Probing pocket depth

Both treatment strategies showed significant reductions in full-mouth PPD at both re-assessments when compared to baseline: 1.02 mm for the control group ($P < 0.001$) and 0.89 mm for the test group ($P = 0.001$) at month 3. The reductions in PPD were not significantly different between the groups nor at 1-month follow-up, neither at 3-month follow-up ($P \geq 0.783$) (Table 2).

The changes in mean PPD per stratum (shallow, medium deep and deep) are depicted in Fig. 1. The largest reductions at study termination were obtained for initially deep pockets in both groups: 2.70 mm ($P = 0.001$) in the control group and 2.49 mm ($P = 0.001$) in the test group. For initially medium deep pockets, mean reductions of 1.27 mm ($P = 0.001$) rand 1.33 mm ($P = 0.001$) were found at 3-month follow-up. Initially shallow pockets also significantly reduced in depth, pointing to 0.26 mm ($P = 0.005$) in the control group and 0.19 mm ($P = 0.007$) in the test group at study termination. There were no significant differences among the groups at any point in time.

A boxplot illustrates the proportion of sites with a pocket reduction of at least 2 mm between baseline and 3-month follow-up (Fig. 2). There was no significant difference between the control group and the test group ($P = 0.445$).

Clinical attachment level

Full-mouth CAL decreased significantly in both groups as a result of therapy, pointing to a mean gain of 0.48 mm in the control group ($P = 0.003$) and the test group ($P = 0.001$) at study termination (Table 2).

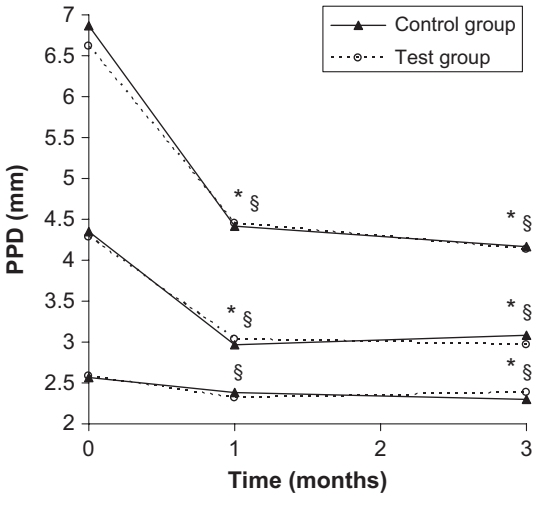

Fig. 1. Mean probing pocket depth (PPD) over time sorted per initial PPD stratum (shallow, medium deep and deep) and treatment strategy (control group and test group). *Significant difference within the control group when compared to baseline. §Significant difference within the test group when compared to baseline.

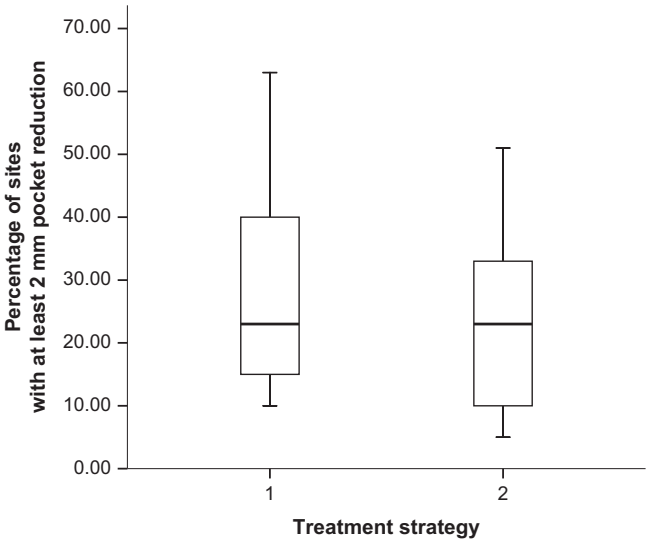

Fig. 2. Boxplot comparing the proportion of sites with at least 2-mm pocket reduction between baseline and 3 months of follow-up between the control group (1) and the test group (2).

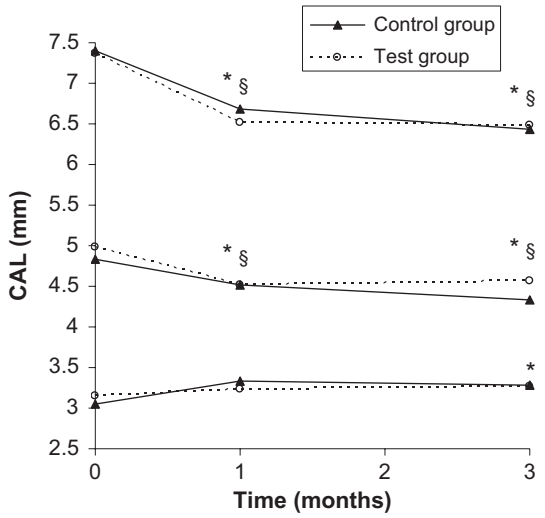

Fig. 3. Mean clinical attachment level over time sorted per initial probing pocket depth stratum (shallow, medium deep and deep) and treatment strategy (control group and test group). *Significant difference within the control group when compared to baseline. §Significant difference within the test group when compared to baseline.

Figure 3 shows the changes in CAL per stratum (shallow, medium deep and deep). The largest clinical attachment gains were found for initially deep pockets in both groups at 3-month follow-up: 0.97 mm ($P = 0.001$) in the control group and 0.87 mm ($P = 0.001$) in the test group. For initially medium deep pockets, the corresponding data were 0.51 mm ($P = 0.002$) and 0.43 mm ($P = 0.002$). Initially shallow pockets in the control group showed significant clinical attachment loss by 0.23 mm ($P = 0.016$) at 3-month follow-up. There were no significant differences among the groups at any point in time.

Adverse effects

Adverse effects included pain and tooth hypersensitivity in both groups. Recurrent oral ulcerations (ROU) were an infrequent complication (two patients in the control group, one in the test group).

Discussion

The purpose of this randomized controlled clinical study was to evaluate the additional value of an essential oil solution when used as a coolant during ultrasonic root debridement in chronic periodontitis patients. Given the results of the clinical parameters included, the research hypothesis could not be confirmed in that no clear benefit of such regimen could be shown when proper mechanical debridement was performed. The observation that the average pocket reduction for sites that had been subjected to the control strategy is in agreement with numerous reports in the literature (6, 7, 29) and may indeed substantiate the quality of the mechanical treatment in these patients. Another interesting finding in relation to the control group was the minor yet significant loss of clinical attachment for shallow pockets at 3-month follow-up. This observation is also in accordance with earlier data from animal (30) and clinical studies (31).

The available literature concerning the subgingival administration of essential oils is controversial. To our knowledge, only two studies have been published comparing irrigation with an essential oil solution to irrigation with a control solution in periodontal pockets (24, 25). First one is a 24-week study in which subjects received non-surgical periodontal therapy (24). After approximately 1 month, residual pockets (≥5 mm) received ultrasonic instrumentation irrigated with essential oils or ultrasonic instrumentation irrigated with a placebo. The latter was repeated twice afterwards with a time interval of 1 week. The results did not demonstrate any significant differences between the test and control group in terms of plaque index, bleeding on probing, full-mouth PPD and full-mouth CAL. However, when considering only deep pockets (≥7 mm), clinical results favoured essential oil irrigation. When interpreting these results, it should be taken into account that patients had undergone non-surgical debridement only 1 month before the onset of the study. In this regard, the high average pocket reduction of 1.11 mm observed in the control group 4 weeks after re-treatment may essentially result from the preceding mechanical therapy. This is confirmed by a weak healing response following re-scaling as shown by ample studies (32–35). The second study is a 3-month trial comparing the possible adjunctive effects of irrigation with essential oils in scaling and root planing to chlorhexidine and distilled water (25). Patients specifically with class II furcation involvement were recruited to the study and underwent a session of full-mouth ultrasonic debridement using chlorhexidine, essential oils or water as irrigant. All treatments tended to be equally effective in terms of PPD and CAL reduction at both 1-month and 3-month evaluations. Howbeit, the essential oil group showed significant reduction in BoP scores compared to the other groups at 1 month. Our results seem to be in line with the findings of this trial.

Quirynen *et al.* (36) introduced the so-called one-stage full-mouth disinfection protocol for the treatment of chronic periodontitis. Two randomized controlled studies evaluated this protocol using an essential oil solution. In a preliminary report by Cavalca Cortelli *et al.* (37), essential oils demonstrated substantial clinical benefits over a placebo, pointing to an additional pocket reduction of 0.89 mm. Interestingly, no such differences could be shown in a 6-month study from the same group (38). The results of the present study may also contrast the initial findings published by Cavalca Cortelli *et al.* (37), even though we applied the essentials oils solution constantly during active treatment and not intermittently. Other differences between the studies relate to the mode of mechanical debridement (hand instruments versus ultrasonic debridement) and the time frame (24 h for mechanical debridement versus two sessions with an interval of 1 week). However, it remains a matter of debate whether these disparities could explain the difference in clinical results.

For one thing, studies have shown comparable treatment outcome following root debridement with ultrasonic devices and hand instruments (6, 35). In addition, a recent systematic review by Farman and Joshi (39) concluded that both traditional quadrant approach and full-mouth debridement could be equally effective. On the other hand, it is clear that a nearly 50% contribution to clinical effects by a locally applied chemical agent as demonstrated by preliminary data of Cavalca Cortelli *et al.* (40, 41) is impressive, particularly because reports on the original one-stage full-mouth disinfection protocol have shown a major impact of mechanical debridement, yet negligible to minor effects of chlorhexidine on clinical parameters. In addition, studies on the clinical effects of locally applied antiseptics in a more conventional staged approach of root debridement have indicated similar results, irrespective of their mode of delivery (10–13, 16–23).

Short-term studies have been published evaluating the effects of chlorhexidine solutions used as a coolant during ultrasonic root debridement in chronic and aggressive periodontitis patients (18–20, 23). Some indicated minor additional effects in terms of pocket reduction, yet with questionable clinical relevance (18, 20). In addition, no study showed extra clinical attachment gain as a result of constant chlorhexidine irrigation during scaling. Similar disappointing results have recently been reported when using povidone iodine as the active agent (21, 22). The results of our study and the study of Feng *et al.* (24), both using an essential oil solution, seem to be in line with the existing knowledge on these antiseptics in this field. Hence, it seems that the lack of effectiveness is not related to the antiseptic agent itself, yet merely to the extreme biochemical conditions reigning within the periodontal pocket. These may include a constant outflow of crevicular fluid compromising contact time (42–44), the presence of saliva and blood-inactivating chemical agents to some extent (45–47) and the release of protective vesicles by some periodontopathogens (48).

When screening the patients for undesirable side effects of the treatment, the most common complaints in both groups were pain and tooth hypersensitivity, which are mainly related to mechanical treatment (49). The use of essential oils and their alcoholic base did not seem to increase the prevalence of adverse reactions. Kerr *et al.* (50) did not find any differences in objective or subjective measures of mouth dryness between alcohol- and non-alcohol-containing mouthrinses. In the study of Cortelli *et al.*, the patients underwent pocket irrigation with essential oils and subsequently used these as a mouthrinse during a 2-month period. Notwithstanding that, the pH or flow of the saliva remained unaltered. Judging by the available evidence, the short-term use of essential oil mouthrinse is not associated with any severe adverse effects.

In conclusion, ultrasonic root debridement using essential oils resulted in considerable pocket reduction and clinical attachment gain. However, there were no significant differences when compared to water used as a coolant. Hence, essential oil solutions do not offer a clinical benefit over water when used as a coolant during ultrasonic root debridement for the treatment of chronic periodontitis.

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Conflict of interest and source of funding statement

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