Am J Transl Res 2024;16(8):4190-4199
www.ajtr.org /ISSN:1943-8141/AJTR0157089

Original Article

Efficacy and inflammatory responses of root canal therapy plus periodontal non-surgical treatment for periodontal-endodontic combined dental lesions

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Received April 8, 2024; Accepted July 11, 2024; Epub August 15, 2024; Published August 30, 2024

Abstract: Objective: To investigate the efficacy and inflammatory responses of treating periodontal-endodontic combined lesions (PECLs) with root canal therapy (RCT) alone versus RCT combined with periodontal non-surgical treatment (PNST). Methods: A total of 103 patients with PECLs admitted between January 2019 and January 2020 to Shenzhen Baoan Women's and Children's Hospital were divided into control (RCT alone, 50 cases) and combined (RCT + PNST, 53 cases) groups. Comparative analyses included efficacy assessment, probing depth (PD), bleeding index (BI), plaque index (PLI), gingival index (GI), serum levels of interleukin-1β (IL-1β), tumor necrosis factor-α (TNF-α), and high-sensitivity C-reactive protein (hs-CRP), pain severity during RCT, incidence of adverse reactions, post-treatment tooth conditions, and recurrence rates at 6 and 12 months. Univariate analysis identified factors associated with poor treatment outcome in PECL patients. Results: The combined group demonstrated a higher total effective rate (90.57%) compared to the control group (74.00%) ($P < 0.05$). Patients receiving combined therapy showed significantly lower PD, BI, PLI, GI, IL-1β, TNF-α, and hs-CRP levels, as well as reduced pain severity and lower recurrence rates at 6 and 12 months (all $P < 0.05$). The combined group also had a lower incidence of adverse (periodontal distending pain and local foreign body sensation) reactions (7.54%) compared to the control group (26.00%) ($P < 0.05$). After treatment, the incidence of periodontitis, percussion tenderness, and loosening of teeth in the combined group was lower than that of the control group, and the retention rate of affected teeth was significantly higher (all $P < 0.05$). Factors such as history of alcoholism, betel nut chewing, and treatment method (RCT) were significantly associated with poorer prognosis in PECL patients ($P < 0.05$). Conclusion: Combined RCT and PNST improves clinical efficacy, reduces pain severity and inflammation levels, decreases adverse reactions, and enhances tooth retention in PECL patients. This treatment approach should be considered the preferred option for managing PECLs.

Keywords: Root canal therapy, periodental non-surgical treatment, periodontal-endodontic combined lesions, inflammatory factors, tooth retention

Introduction

Periodontal-endodontic combined lesions (PECLs) represent complex pathology affecting both pulp and periodontal tissues within the same tooth, often resulting in varying degrees of pain [1, 2]. These lesions are characterized by prolonged onset, multifaceted etiology, extended progression, and generally poor treatment outcome with conventional symptomatic approaches [3-5]. Inflammatory responses play a pivotal role in the progression of PECLs and are significant contributing factors to the disease [6, 7]. Therefore, comparative research on treatment modalities holds substantial clinical implications for enhancing outcomes and quality of life for patients with PECLs.

Root canal therapy (RCT), or pulp therapy, is commonly employed to address pulp necrosis and root infections, making it a standard treatment for PECLs [8, 9]. However, initial symptomatic relief through RCT alone for patients with PECLs, who initially present with typical pulp symptoms such as severe oral pain, often neglects concurrent periodontal issues, possibly exacerbating periodontal disease in the long term [10]. This oversight can lead to suboptimal

https://doi.org/10.62347/QXSM2899

treatment outcomes [11]. Given that teeth affected by PECLs frequently harbor dental calculus and plaque, the integration of periodontal non-surgical treatment (PNST) such as scaling and curettage can synergistically enhance treatment efficacy [12-14]. Alternative treatments like bone transplantation and open flap debridement exist but are constrained by high cost and variable treatment outcome [5, 15].

Therefore, a comprehensive treatment approach combining RCT and PNST holds promise for effectively managing PECLs and mitigating disease progression in affected teeth. This study aims to contribute to the current body of research in this area.

Materials and methods

General information

This retrospective study was approved by the Ethics Committee of Shenzhen Baoan Women's and Children's Hospital. Clinical data from 103 patients diagnosed with periodontal-endodontic combined lesions (PECLs) and treated from January 2019 to January 2020 were collected and analyzed. Patients were divided into two groups: a control group (n = 50) treated with RCT and a combined group (n = 53) treated with RCT plus PNST.

Inclusion criteria: (1) diagnosis of PECLs [16]; (2) presence of clinical symptoms such as gnawing pain, spontaneous pain, and loose teeth; (3) completion of one-year follow-up; (4) absence of contraindications for surgery; (5) normal cognitive and mental status.

Exclusion criteria: (1) patients had received other treatments within three months prior to enrollment; (2) patients had cardio-cerebrovascular diseases or coagulation disorders; (3) patients had severe infections or organic diseases.

Treatment methods

Both groups underwent thorough removal of the infection source to preserve affected teeth whenever possible. X-ray examinations assessed pulp vitality, tooth mobility, and pocket depth.

In the control group, patients underwent routine RCT, including mechanical preparation of the root canal using nickel-titanium files and irrigation with sodium hypochlorite and sodium chloride solution. The root canal was dried and filled with AH-plus paste + hot gutta-percha. Post-filling checks ensured proper placement and tightness of the filling.

In the combined group, in addition to RCT procedures, patients received supragingival scaling, subgingival curettage, and antibiotic therapy. Supragingival scaling involved cleaning visible calculus, plaque, and pigments above the gingival margin using an ultrasonic instrument. Subgingival curettage disinfected the gums and removed tartar, followed by verification of thorough tartar removal using a pointed probe. Local anesthesia facilitated incision of the periodontal pocket, flap exposure of the affected area, and meticulous cleaning of granulation tissue and infected cementum. The root surface was leveled, and cementum was thoroughly scraped to remove pathogens. After gingival membrane restoration and pocket suturing, oral rinsing with normal saline and 24-hour cold compression were administered, followed by a 3-day course of anti-infection treatment.

Efficacy evaluation

Markedly effective: Clinical symptoms remarkably relieved; complete disappearance of periodontal pockets; absence of gingival inflammation and swelling; normal masticatory function; no tooth mobility; cessation of alveolar bone resorption. Effective: Clinical symptoms relieved; slight reduction in periodontal pocket depth; improved masticatory function; alleviated tooth mobility; minimal alveolar bone resorption. Ineffective: Clinical symptoms not relieved; deepening of periodontal pockets; no improvement or worsening of masticatory function; aggravated tooth mobility; accelerated alveolar bone resorption.

Outcome measures

Efficacy [17]: The total effective rate (TER), assessed at 6 months post-treatment, was calculated as the percentage of markedly effective and effective cases among all cases treated. Periodontal Assessment: Full-mouth periodontal probing measured probing depth (PD), bleeding index (BI), plaque index (PLI), and gingival index (GI) before and after treatment [18].

Serum Inflammatory Factors: Levels of interleukin-1β (IL-1β), tumor necrosis factor-α (TNF-α), and high-sensitivity C-reactive protein (hs-CRP) were measured before treatment and 4 weeks post-treatment using enzyme-linked immunosorbent assay (ELISA) kits (Shanghai Xuanya Biotech, XY0322A, XY0210A, XY1152A) [19]. Fasting venous blood (4 mL) was centrifuged (1500×g, 15 min, 4°C) to isolate serum for analysis.

Pain severity following Root Canal Therapy (RCT) was assessed using the Visual Analogue Scale (VAS) six weeks post-treatment [20]. Scores were categorized as follows: 0 for no pain, 1-3 points for mild pain, 4-6 points for moderate pain, and above 6 points for severe pain.

The occurrence of adverse reactions, including periodontal distending pain and local foreign body sensation, was documented and compared six months post-treatment [21].

Six months after treatment, the condition of affected teeth was evaluated, focusing on the incidence of periodontitis, percussion tenderness, loose teeth, and tooth retention [22].

Both groups underwent follow-up assessment through telephone interviews and pathological inquiries every six months for one year to determine recurrence rates at 6 and 12 months post-treatment [23].

Statistical analysis

Statistical analyses were performed using GraphPad Prism 6 and SPSS 25.0. Counted and measured data were presented as number of cases/percentage (n/%) and mean ± SEM, respectively. Inter-group comparisons of enumerated data used the chi-square test with continuity correction for theoretical frequencies < 5. For measured data, independent sample t-tests compared groups, while paired t-tests assessed intra-group changes pre- and post-treatment, with significance set at $P < 0.05$.

Results

Comparison of baseline data

Clinical data were collected from both groups of patients. The control group comprised 29 males and 21 females with an average age of (53.24 ± 13.49) years, while the combined group consisted of 28 males and 25 females with an average age of (52.66 ± 14.51) years. There were no significant differences between groups in terms of average age, age, gender distribution, onset types, affected tooth types, history of smoking, history of alcoholism, betel nut chewing, or residence ($P > 0.05$) (**Table 1**).

Comparison of efficacy

In the control group, treatment outcomes included 15 (30.00%) markedly effective, 22 (44.00%) effective, and 13 (26.00%) ineffective cases. In contrast, the combined group had 28 (52.83%) markedly effective, 20 (37.74%) effective, and 5 (9.43%) ineffective cases. The combined group demonstrated a higher total effective rate of 90.57%, significantly higher than the control group (74.00%, $P < 0.05$) (**Table 2**).

Comparison of PD, BI, PLI, and GI levels

Baseline levels of PD, BI, PLI, and GI were comparable between the two groups (all $P > 0.05$). Post-treatment, all four indices significantly decreased, with greater reductions observed in the combined group (all $P < 0.05$) (**Figure 1**).

Comparison of serum inflammatory factor levels

Pre-treatment levels of IL-1β, TNF-α, and hs-CRP did not differ significantly between the groups (all $P > 0.05$). Following treatment, all three indicators decreased significantly, with greater reductions observed in the combined group (all $P < 0.05$) (**Figure 2**).

Comparison of pain severity after treatment

After treatment, the combined group showed significantly higher proportions of patients reporting no pain and mild pain compared to the control group (both $P < 0.05$). There were no significant differences between groups in the occurrence of moderate or severe pain (both $P > 0.05$) (**Table 3**).

Comparison of incidence of adverse reactions

In the combined group, the incidences of periodontal distending pain and local foreign body sensation were 2 (3.77%) and 2 (3.77%), respectively. In contrast, the control group

Table 1. Comparison of baseline information [n (%), mean ± SD]

Factor	n	Control group (n = 50)	Combined group (n = 53)	χ^2/t	P
Average age (Years)	103	53.24 ± 13.49	52.66 ± 14.51	0.210	0.834
Age (Years)				0.294	0.588
< 50	51	20 (40.00)	24 (45.28)		
≥ 50	52	30 (60.00)	29 (54.72)		
Gender				0.706	0.401
Male	64	29 (58.00)	35 (66.04)		
Female	39	21 (42.00)	18 (33.96)		
Types of onset				0.990	0.610
Periodontal diseases secondary to primary pulp diseases	24	10 (20.00)	14 (26.42)		
Pulp diseases secondary to primary periodontal diseases	27	15 (30.00)	12 (22.64)		
Combined lesions	52	25 (50.00)	27 (50.94)		
Types of affected teeth				0.401	0.818
Molars	36	19 (38.00)	17 (32.08)		
Premolar teeth	37	17 (34.00)	20 (37.74)		
Anterior teeth	30	14 (28.00)	16 (30.18)		
History of smoking				0.403	0.526
Yes	65	30 (60.00)	35 (66.04)		
No	38	20 (40.00)	18 (33.96)		
History of alcoholism				0.803	0.370
Yes	53	28 (56.00)	25 (47.17)		
No	50	22 (44.00)	28 (52.83)		
Betel nut chewing				1.627	0.202
Yes	33	13 (26.00)	20 (37.74)		
No	70	37 (74.00)	33 (62.26)		
Place of residence				0.713	0.398
Countryside	41	22 (44.00)	19 (35.85)		
City	62	28 (56.00)	34 (64.15)		

Table 2. Comparison of efficacy

Groups	n	Markedly effective	Effective	Ineffective	TER (%)
Control group	50	15 (30.00)	22 (44.00)	13 (26.00)	37 (74.00)
Combined group	53	28 (52.83)	20 (37.74)	5 (9.43)	48 (90.57)
χ^2 value	-	-	-	-	4.896
P value	-	-	-	-	0.027

Note: TER, total effective rate.

reported 7 (14.00%) cases of periodontal distending pain and 6 (12.00%) cases of local foreign body sensation. The combined group demonstrated a significantly lower overall incidence of adverse reactions compared to the control group (7.54% vs 26.00%, P < 0.05) (**Table 4**).

Comparison of condition of the affected teeth after treatment

Following treatment, the combined group reported 2 (3.77%) cases of periodontitis, 1 (1.89%) case of percussion tenderness, 2 (3.77%) cases of loose teeth, and 50 (94.33%) cases of tooth retention. In contrast, the control group had 9 (18.00%) cases of periodontitis, 6 (12.00%) cases of percussion tenderness, 8 (16.00%) cases of loose teeth, and 38 (76.00%) cases of tooth retention. The combined group exhibited significantly fewer cases of periodontitis, percussion tenderness, and loose teeth, with a notably higher retention rate of affected teeth compared to the control group (94.33% vs. 76.00%, P < 0.05) (**Table 5**).

Comparison of recurrence rates

At 6 months post-treatment, recurrence rates were 1.89% in the combined group and 16.00% in the control group; at 12 months, rates were

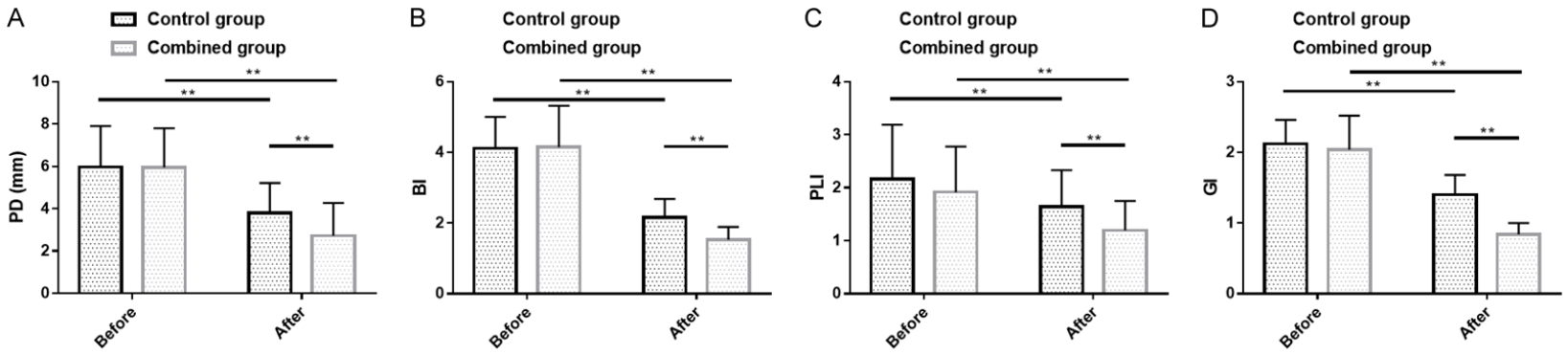

Figure 1. Comparison of PD, BI, PLI, and GI levels. In comparison to the control group, PD (A), BI (B), PLI (C), and GI (D) levels in the combined group decreased more significantly after treatment. Note: ** indicates $P < 0.01$. PD, probing depth; BI, bleeding index; PLI, plaque index; GI, gingival index.

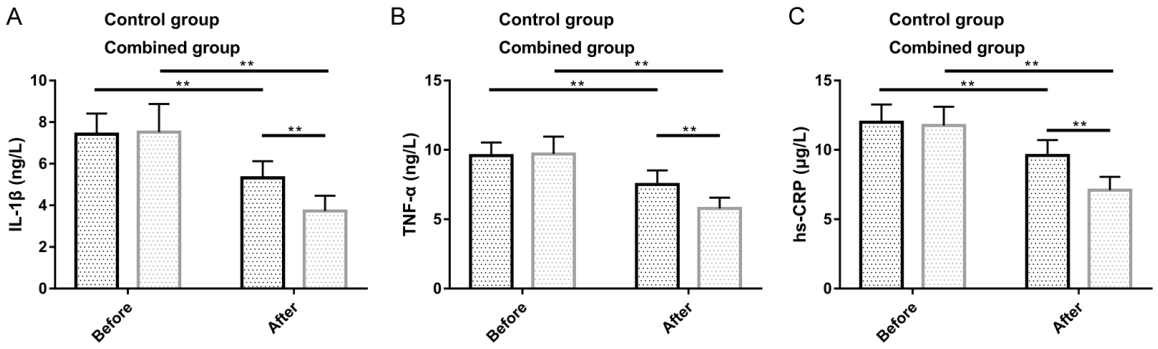

Figure 2. Comparison of serum inflammatory factor levels. More significant decreases in IL-1β (A), TNF-α (B), and hs-CRP (C) levels were observed in the combined group compared to the control group after treatment. Note: ** indicates P < 0.01. IL-1β, interleukin-1β; TNF-α, tumor necrosis factor-α; hs-CRP, high-sensitivity C-reactive protein.

Table 3. Comparison of pain severity after treatment [n (%)]

Category	Control group (n = 50)	Combined group (n = 53)	χ^2 value	*P* value
No pain	18 (36.00)	38 (71.70)	13.216	< 0.001
Mild pain	23 (46.00)	9 (16.98)	10.117	0.002
Moderate pain	6 (12.00)	6 (11.32)	0.012	0.915
Severe pain	3 (6.00)	0 (0.00)	3.275	0.070

Table 4. Comparison of incidence of adverse reactions

Category	Control group (n = 50)	Combined group (n = 53)	χ^2 value	*P* value
Periodontal distending pain	7 (14.00)	2 (3.77)	1.837	0.066
Local foreign body sensation	6 (12.00)	2 (3.77)	2.430	0.119
Total	13 (26.00)	4 (7.54)	6.357	0.012

Table 5. Comparison of affected teeth after treatment [n (%)]

Category	Control group (n = 50)	Combined group (n = 53)	χ^2 value	*P* value
Periodontitis	9 (18.00)	2 (3.77)	5.459	0.020
Percussion tenderness	6 (12.00)	1 (1.89)	4.154	0.042
Loose teeth	8 (16.00)	2 (3.77)	4.387	0.036
Tooth retention	38 (76.00)	50 (94.33)	6.955	0.008

Table 6. Comparison of recurrence rates [n (%)]

Time	Control group (n = 50)	Combined group (n = 53)	χ^2 value	*P* value
6 months	8 (16.00)	1 (1.89)	6.426	0.011
12 months	10 (20.00)	3 (5.66)	4.797	0.029

5.66% and 20.00%, respectively. Recurrence rates were significantly lower in the combined group compared to the control group (P < 0.05) (**Table 6**).

Univariate analysis of prognostic factors for PECL patients

Patients were categorized into good prognosis (n = 75) and poor prognosis (n = 28) groups based on treatment response, adverse effects, and relapse. Factors significantly influencing prognosis included history of alcoholism, betel nut chewing, and treatment methods (all P < 0.05). Age, gender, onset types, affected tooth types, history of smoking, and residence did not significantly affect prognosis (all P > 0.05) (**Table 7**).

Discussion

The etiology of PECLs is closely linked to bacterial infection in the oral cavity, with contributing factors such as periodontitis, tooth fracture and severe dental caries [5]. Infected dental pulp may lead to severe pain or, abscess formation, and in extreme cases, even systemic complications, highlighting the critical need for effective and timely treatment [24, 25]. In this study, the TER was remarkably higher in patients treated with RCT

Table 7. Univariate analysis of prognostic factors for patients with periodontal-endodontic combined lesions

Factor	n	Poor prognosis group (n = 28)	Good prognosis group (n = 75)	χ^2/t	P
Age (years)				0.146	0.702
< 50	51	13 (46.43)	38 (50.67)		
≥ 50	52	15 (53.57)	37 (49.33)		
Gender				0.076	0.783
Male	64	18 (64.29)	46 (61.33)		
Female	39	10 (35.71)	29 (38.67)		
Types of onsets				0.255	0.881
Periodontal diseases secondary to primary pulp diseases	24	7 (25.00)	17 (22.67)		
Pulp diseases secondary to primary periodontal diseases	27	8 (28.57)	19 (25.33)		
Combined lesions	52	13 (46.43)	39 (52.00)		
Types of affected teeth				1.021	0.600
Molars	36	8 (28.57)	28 (37.33)		
Premolar teeth	37	10 (35.71)	27 (36.00)		
Anterior teeth	30	10 (35.71)	20 (26.67)		
History of smoking				1.144	0.285
Yes	65	20 (71.43)	45 (60.00)		
No	38	8 (28.57)	30 (40.00)		
History of alcoholism				11.318	< 0.001
Yes	53	22 (78.57)	31 (41.33)		
No	50	6 (21.43)	44 (58.67)		
Betel nut chewing				14.522	< 0.001
Yes	33	17 (60.71)	16 (21.33)		
No	70	11 (39.29)	59 (78.67)		
Place of residence				0.704	0.402
Countryside	41	13 (46.43)	28 (37.33)		
City	62	15 (53.57)	47 (62.67)		
Treatment method				10.775	0.001
RCT	50	21 (75.00)	29 (38.67)		
RCT plus PNST	53	7 (25.00)	46 (61.33)		

Note: RCT, Root canal therapy; PNST, periodontal non-surgical treatment.

plus PNST compared to those receiving RCT alone, suggesting superior efficacy of the combined treatment for PECLs. In addition, the post-treatment PD, BI, PLI and GI levels were more alleviated in the combined group, demonstrating significant improvements over the control group. These findings suggest that combined treatment effectively enhances the periodontal micro-ecological environment compared to single RCT. Our results are consistent with findings from Monje et al. [26] where combining RCT with basic periodontal treatment in PECL patients significantly improved short-term clinical outcomes, particularly periodontal indicators.

Chronic inflammation plays a pivotal role in periodontal diseases, driven by bacterial infections within the dental pulp and its microenvironment [27]. Studies by Pandey et al. [28] have highlighted IL-1β as a major inflammatory mediator in progressive periodontitis, exacerbating periodontal tissue damage. Similarly, TNF-α and hs-CRP are implicated in the progression of periodontitis, with hs-CRP correlating closely with disease severity [29, 30].

In our study, inflammatory markers (IL-1β, TNF-α, and hs-CRP) showed favorable outcomes in the combined treatment group, indicating that RCT plus PNST effectively mitigates the inflammatory microenvironment of affected teeth. This aligns with observations by Manresa et al. [31], suggesting that combined therapy suppresses inflammatory responses, likely due to

enhanced bacterial clearance in the periodontal microenvironment through additional periodontal interventions [32, 33]. The study confirms the benefits of RCT plus PNST for patients with PECLs across various measures including efficacy, periodontal micro-ecological environment, inflammation, pain severity, adverse reactions, tooth condition, and recurrence. Comparing the combined treatment to RCT alone, a higher proportion of patients in the combined group reported no pain post-treatment, indicating significant pain relief. Despite advancements in dental disease management, toothache remains a significant detriment to patients' quality of life [34]. RCT plus PNST outperforms RCT alone by effectively clearing periodontal residues and dental plaque through procedures like supragingival scaling and curettage. This preventive approach helps mitigate the onset of periodontitis, thereby explaining the observed pain relief in patients [35]. Safety analysis revealed a notably lower incidence of adverse reactions in the combined group, better safety of RCT plus PNST over RCT alone.

Furthermore, assessment of affected teeth showed significantly fewer cases of periodontitis, percussion tenderness, and loose teeth in the combined group, coupled with a markedly higher tooth retention rate. These clinical improvements align with findings by Fang et al. [9], where combined therapy demonstrated higher tooth retention rates and fewer incidences of tooth loosening and periodontitis compared to conventional RCT.

Long-term follow-ups at 6 and 12 months post-treatment revealed substantially lower recurrence rates in the combined group, underscoring the enhanced treatment efficacy in improving long-term prognosis compared to single treatments. Univariate analysis identified a history of alcoholism, betel nut chewing, and RCT as significant factors influencing adverse prognoses in PECL patients.

While the study underscores the benefits of RCT plus PNST across multiple dimensions, improvements could include expanding the clinical sample size for enhanced result accuracy and further investigating risk factors affecting treatment efficacy in PECL patients.

In conclusion, RCT plus PNST emerges as a highly effective treatment option for PECL patients, offering significant improvements in periodontal health, inflammation reduction, pain management, adverse reaction mitigation, and long-term treatment outcome.

Disclosure of conflict of interest

None.

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