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Pocket Closure in Non-Surgical Periodontal Treatment	Cerrahi Olmayan Periodontal Tedavide Cep Kapanması

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ABSTRACT

Objectives: This study assesses the efficacy of pocket closure (PC) following non-surgical periodontal treatment (NSPT) in patients diagnosed with stage III grade C Periodontitis, examining various tooth types and probing depth (PD) ranges.

Materials and Methods: 12 non-smoker, systemically healthy patients underwent NSPT and were reassessed after three months. Clinical parameters, including PD, bleeding on probing, and PC, were evaluated. Statistical analyses were conducted to assess changes in clinical measurements and PC rates among tooth types (incisors and canines, premolars, and molars) and PD ranges (1-3 mm, 4-6 mm, >6 mm). Statistical significance was set at $\alpha=0.05$.

Results: Following NSPT, significant reductions in PD were observed (1.29 ± 0.41 mm, $p<0.05$), particularly in PD >6 mm (2.63 ± 0.76 mm, $p<0.05$). PC rates varied among tooth types, with molars exhibiting lower rates compared to incisors and premolars ($p<0.05$). The percentage of PC was 74.07 ± 18.90 for incisors and canines, 74.21 ± 16.97 for premolars, and 57.52 ± 12.48 for molars. For incisors and canines, the percentage of PC was significantly higher for PD of 4-6 mm compared to PD>6 mm (77.74 ± 21.03 vs. 46.91 ± 25.02, $p<0.05$). Similar trends were observed in premolars and molars ($p<0.05$).

Conclusion: NSPT effectively improves periodontal health indicators, but achieving complete closure of deep pockets remains challenging, particularly in molars. Tailored treatment approaches based on site-specific factors including tooth type and PD ranges, are crucial for optimizing treatment outcomes in stage III grade C periodontitis.

Keywords: *Periodontitis; Periodontal pocket; Root scaling.*

ÖZET

Amaç: Bu çalışma, evre III derece C periodontitis teşhisi konmuş hastalarda cerrahi olmayan periodontal tedavi (COPT) sonrası farklı diş tiplerinde ve sondalama derinliği (SD) aralıklarında cep kapanma (CK) değerlerini incelemeyi amaçlamıştır.

Gereç ve Yöntemler: 12 sigara içmeyen, sistemik olarak sağlıklı hastaya COPT uygulanmış ve üç ay sonra yeniden değerlendirilmiştir. SD, sondalamada kanama ve CK gibi klinik parametreler hesaplanmıştır. Farklı diş tiplerinde (kesici ve kanin dişler, premolarlar ve molarlar) ve SD aralıklarında (1-3 mm, 4-6 mm, >6 mm) CK yüzdelerini ve SD verilerini karşılaştırmak için uygun istatistiksel analizler gerçekleştirilmiştir. İstatistiksel anlamlılık değeri 0,05 olarak belirlenmiştir.

Bulgular: COPT'den sonra, SD'de anlamlı azalma gözlenmiştir (1,29±0,41 mm, p<0,05). Bu azalma özellikle >6 mm ceplerde daha fazla bulunmuştur (2,63±0,76 mm, p<0,05). CK oranları diş tipleri arasında değişiklik göstermiş olup, molarların; anterior dişlere ve premolarlara göre daha düşük orana sahip olduğu saptanmıştır (p<0,05). CK yüzdesi, kesici ve kanin dişler için 74,07±18,90, premolarlar için 74,21±16,97 ve molarlar için 57,52±12,48 olarak belirlenmiştir. Kesici ve kanin dişlerde, 4-6 mm SD'de CK yüzdesi, >6 mm SD'deki CK yüzdesine göre anlamlı yüksektir (77,74±21,03 vs, 46,91±25,02, p<0,05). Benzer eğilim premolar ve molar dişlerde de gözlenmiştir (p<0,05).

Sonuç: COPT, periodontal sağlık göstergelerini etkili bir şekilde iyileştirmesiyle birlikte derin periodontal ceplere sahip dişlerde, özellikle molar, cep kapanma başarısının düşük olduğu tespit edilmiştir. Diş tipi ve SD aralıkları gibi bölgesel faktörlere göre özelleştirilmiş tedavi yaklaşımları, evre III derece C periodontitiste tedavi sonuçlarını optimize etmek için önemli olacağı düşünülmektedir.

Anahtar Kelimeler: *Periodontit; Periodontal cep; Kök yüzeyi diştaşı temizliği*

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Introduction

Periodontitis refers to a chronic inflammatory condition affecting the periodontium. It involves the progressive destruction of the periodontal ligament, alveolar bone, and gingival tissues, often leading to tooth loss if left untreated.[1] A classification system for periodontal diseases introduced in 2017 aimed to categorize periodontal disease based on a multidimensional staging and grading approach.[2] Staging is determined by the severity and complexity of the disease, while grading is intended to evaluate the likelihood of the disease progressing more rapidly than usual or responding less predictably to therapy. The primary goals of periodontal therapy are to maintain tooth integrity and prevent progression of the disease.[3] The treatment involves mechanical removal of subgingival biofilm and establishment of a microflora consistent with periodontal health.[4] The clinical guidelines, published by the European Federation of Periodontology in 2020, recommend a stepwise approach for treating patients with stage III periodontitis.[5] The First step of treatment targets supragingival biofilm and risk factors control, while the second step involves subgingival instrumentation to address subgingival biofilm and calculus.[5]

While mechanical plaque removal serves as the cornerstone of periodontal treatment, the choice between ultrasonic and manual subgingival scaling techniques is a subject of ongoing debate. Zhang et al. suggest that manual subgingival scaling may be more effective than ultrasonic scaling, particularly in cases with initial probing pocket depths ranging from 4-6 mm.[6] On the other hand, ultrasonic devices remove less root structure and inflict less trauma on soft tissues.[7] In the clinical setting, it's common to employ a mix of instruments during treatment. The conventional approach to the second step in periodontal treatment involves subgingival instrumentation conducted on a jaw quadrant or sextant basis, with a series of weekly appointments.[8] Shorter treatment regimens, such as full-mouth procedures, offer practical benefits by requiring fewer appointments, less commuting, and less chair time.[9] Hence, treatment delivery options may be determined by patient preferences, chair time tolerance, or the necessity for repeated oral hygiene instruction sessions.[10]

In the management of periodontitis, successful treatment outcomes are crucially evaluated through clinical parameters such as probing depth (PD) and bleeding on probing (BOP). Based on a study, a significant rate of residual PD≥6 mm post-initial periodontal treatment signifies the patient's susceptibility to further attachment loss.[11] Notably, achieving a shallow PD without BOP signifies the efficacy of active periodontal therapy, while deeper PD coupled with BOP post-treatment is indicative of a heightened risk for disease progression and tooth loss.[12] The effectiveness of periodontitis treatment fluctuates among patients and can differ within the same patient across different teeth or areas. Pocket closure (PC) is an essential outcome in successful non-surgical periodontal treatment (NSPT), signifying the reduction of PD's to 4 mm or less post-treatment in areas initially presenting with moderate to deep pockets, without signs of inflammation.[13] Tomasi et al. stated that PC was found to be dependent on factors like initial PD, tooth type, and smoking status while remaining independent of plaque index, age, gender, and treatment type.[14]

In the existing literature, there is insufficient research investigating the factors impacting PC following NSPT in individuals diagnosed with stage III grade C periodontitis.[15] This study aims to analyze PC outcomes in patients with stage III grade C periodontitis, examining variations across different tooth types and PD ranges.

Materials and Methods

The study received approval from the Clinical Research Ethics Committee of Marmara University's School of Medicine (ID: 09.2022.384) and adhered to the principles of good clinical practice as well as the guidelines outlined in the Declaration of Helsinki. Informing our sample size determination, we conducted a power analysis (G*Power software, version 7.3.1) aiming for a statistical power of 90% at a significance level of 0.05 and considering an effect size of 1.16.

Referring to prior research, we elected to utilize a sample size of 10 to detect clinically significant differences in mean PD.[16]

The study included 12 patients diagnosed with stage III grade C periodontitis, who required periodontal therapies at the Department of Periodontology, Faculty of Dentistry, Marmara University, Istanbul, Türkiye. Participants who met the following inclusion criteria were eligible to take part: (a) aged

between 18 and 65 years; (b) systemically healthy with no history of smoking; and (c) possessing a minimum of 20 teeth, excluding third molars. Subjects were disqualified if they: (a) were pregnant or breastfeeding; (b) had a diagnosed systemic disease; (c) had been prescribed any pharmacological treatment within 3 months prior to enrollment; (d) were currently undergoing orthodontic treatment; and (e) had undergone periodontal treatment within the previous 6 months.

The diagnosis of periodontitis was conducted based on the staging and grading system.[2] For stage III, clinical attachment loss (CAL) ≥5 mm was considered, with attention given to ensuring that the number of teeth extracted due to periodontal reasons was ≤4. PD is equal to or more than 6 mm in at least one tooth. The pattern of bone destruction was predominantly vertical. The bone loss/age ratio was considered for grade C, with the tooth exhibiting the highest degree of bone resorption selected. Those with a ratio ≥1 were included in the study.

The examiner underwent prior calibration to ensure the reproducibility of site-level PD in a separate cohort of 10 individuals (intraclass correlation coefficient = 0.87 to 0.90), distinct from those included in this study. A single calibrated examiner (BK) measured six sites for BOP, PD, and CAL values using a periodontal probe (NorthCarolina15, Hu-Friedy) on each tooth. PC was defined per site according to periodontal health classification as a PD of 4 mm in the absence of BOP or PD ≤3 mm.[17] All measurements were repeated at three months after NSPT.

Prior to NSPT (T_0), patients received comprehensive education regarding the causes, development, risk factors, and management of periodontitis. It was advised to brush twice a day using the modified Bass technique and to use dental floss or interdental brushes once a day. Additionally, patients were asked to bring their toothbrush and interdental cleaning device each session to demonstrate their oral hygiene practices. After that, professional mechanical plaque removal and subgingival instrumentation were done using a piezoelectric scaler (Woodpecker® UDS-A Cavitron, Guilin Woodpecker Medical Instrument) and Gracey curettes (EverEdge® Gracey, Hu-Friedy). NSPT was completed under local anesthesia by dividing into quadrants for four sessions in 2 weeks. The patients were reevaluated three months after NSPT (T_1).

A significance level of α = 0.05 was chosen for all tests, with analyses conducted using SPSS statistical software. Teeth were categorized into three groups based on PD range (1-3 mm, 4-6 mm, >6 mm) and tooth type (incisors and canines, premolars, molars) initially, and these measurements were repeated 3 months after NSPT. Continuous variables are presented as mean ± standard deviation and median, while categorical variables are presented as numbers along with mean percentage ± SD and median. The Wilcoxon signed-rank test was employed to compare dependent continuous variables. Categorical data were evaluated using either the Mann-Whitney U test or the Kruskal-Wallis test.

Results

The study was concluded with a total of 12 patients. In the patient cohort, five females and seven males, with an average age of 42.30 years (Table 1). A comprehensive assessment was conducted on a total of 313 teeth and 1878 regions (Table 1).

Table 1. Demographic parameters and baseline probing depths by tooth type and pocket depth ranges

Variable		Mean ± SD [Median] (N)
Age (years)		42.30 ± 6.37 [42]
Sex (Female-Male)		5-7
Number of Teeth		26.08 ± 0.90 [26] (313)
Number of Region		156.50 ± 5.40 [156] (1878)
CAL (mm)		4.30 ± 0.82 [4.37]
BOP (%)		59.04 ± 16.99 [62.23]
PD site at different pocket depth ranges	PD 1-3 mm	72.85 ± 20.64 [74] (874)
	PD 4-6 mm	70.75 ± 14.45 [70] (849)
	PD > 6 mm	12.92 ± 7.81 [11] (155)
PD 1-3 mm site at baseline	Incisors and canines	37.08 ± 12.49 [36] (445)
	Premolars	20.61 ± 7.08 [19] (247)
	Molars	15.16 ± 4.34 [16] (182)
PD 4-6 mm site at baseline	Incisors and canines	30.67 ± 10.97 [31] (368)
	Premolars	20.91 ± 4.96 [21] (251)
	Molars	19.16 ± 3.21 [19] (230)
PD > 6 mm site at baseline	Incisors and canines	4.17 ± 2.79 [4] (50)
	Premolars	2.91 ± 4.20 [3] (35)
	Molars	5.83 ± 3.29 [6] (70)

SD, standard deviation; N, number; PD, probing depth; CAL, clinical attachment level; BOP, bleeding on probing; NSPT, non-surgical periodontal treatment.

Of these, 155 were >6 mm, 849 were between 4-6 mm, and 874 were ≤3 mm. Within the pockets measuring >6 mm, there were 70 molars, 35 premolars, and 50 incisors and canines. In the examination of shallow pockets (1-3 mm), 445 were identified in incisors and canines, 247 in premolars, and 182 in molars. Mean CAL, PD, and BOP values were 4.30 ± 0.82, 3.97 ± 0.45, and 59.04 ± 16.99, respectively (Table 1).

Throughout the trial period, every patient modified their oral hygiene practices and adhered to the suggested routines. After three months, the reassessment indicated that NSPT resulted in an average reduction of 1.29 ± 0.41 mm in PD (Table 2), (p=0.002). No significant difference was observed after treatment in areas with PD of 1-3 mm (Table 2), (p=0.193). A mean decrease of 1.59 ± 0.29 mm was detected in PD regions of 4-6 mm 3 months after treatment (Table 2), (p=0.002). For initially PD >6 mm, a mean reduction of 2.63 ± 0.76 mm was observed (Table 2), (p=0.002). The PD reduction in deep pockets was significantly higher than the mean PD reduction (p<0.001).

Table 2. Probing depth changes following NSPT

PD range	Timeline	Mean ± SD [Median]
PD (All)	Baseline (T_0)	3.97±0.45 [3.89]
	After NSPT (T_1)	2.67±0.21 [2.66]
	PD reduction	1.29±0.41 [1.45]
	P^{T0-T1}	**0.002**
PD 1-3 mm	Baseline (T_0)	2.49±0.11 [2.50]
	After NSPT (T_1)	2.47±0.11 [2.47]
	PD reduction	0.01±0.05 [0.03]
	P^{T0-T1}	0.193

PD 4-6 mm	Baseline (T_0)	4.74 ± 0.20 [4.79]
	After NSPT (T_1)	3.15 ± 0.25 [3.16]
	PD reduction	1.59 ± 0.29^{b} [1.55]
	P^{T0-T1}	**0.002**
PD > 6 mm	Baseline (T_0)	7.53 ± 0.31 [7.57]
	After NSPT (T_1)	4.89 ± 0.71 [4.81]
	PD reduction	$2.63\pm0.76^{a,b}$ [2.67]
	P^{T0-T1}	**0.002**

SD, standard deviation; PD, probing depth; NSPT, non-surgical periodontal treatment, bold indicates statistically significant values. [a] compared to PD (all); [b] compared to 1-3mm; ($p<0.05$).

The percentage of PC was calculated based on pocket depth ranges (4-6 mm or >6 mm). Pockets classified as moderate to deep exhibited a PC rate of 60.50%. In pockets classified as moderate, this proportion has risen to an average of 65.37%; however, in deep pockets, it stands at an average of 33.13% (Figure 1) ($p<0.001$).
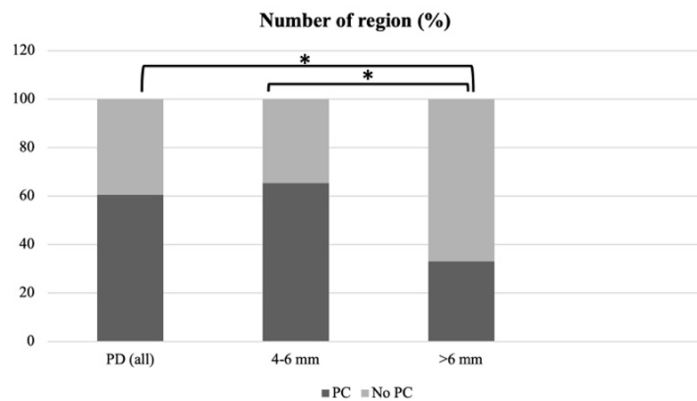

Figure 1. Pocket closure (PC) 3 months after treatment according to their probing depth (PD). * p<0.05.

The percentages of PC were calculated based on the tooth type: incisors and canines, premolars, and molars. Additionally, the percentages of PC at moderate and deep probing depths were determined for each tooth type. PC was observed less frequently in molar teeth compared to anterior and premolar teeth ($p<0.001$).

The percentage of PC was 74.07 ± 18.90 for incisors and canines, 74.21 ± 16.97 for premolars, and 57.52 ± 12.48 for molars (Figure 2) ($p<0.05$).

For incisors and canines, the percentage of PC was 77.74 ± 21.03 for PD of 4-6 mm and 46.91 ± 25.02 for PD >6 mm (Figure 2) ($p=0.014$). For premolars, the PC percentages were as follows: for PD of 4-6 mm, with a percentage of 75.38 ± 17.00, and for PD >6 mm with a percentage of 51.66 ± 16.49 (Figure 2) ($p=0.027$). In molars, the percentage of PC was $67.14\% \pm 12.64$ for PD of 4-6 mm, and 25.08 ± 12.49 for PD >6 mm, indicating a significantly lower PC rate in deeper pockets (Figure 2) ($p=0.003$).
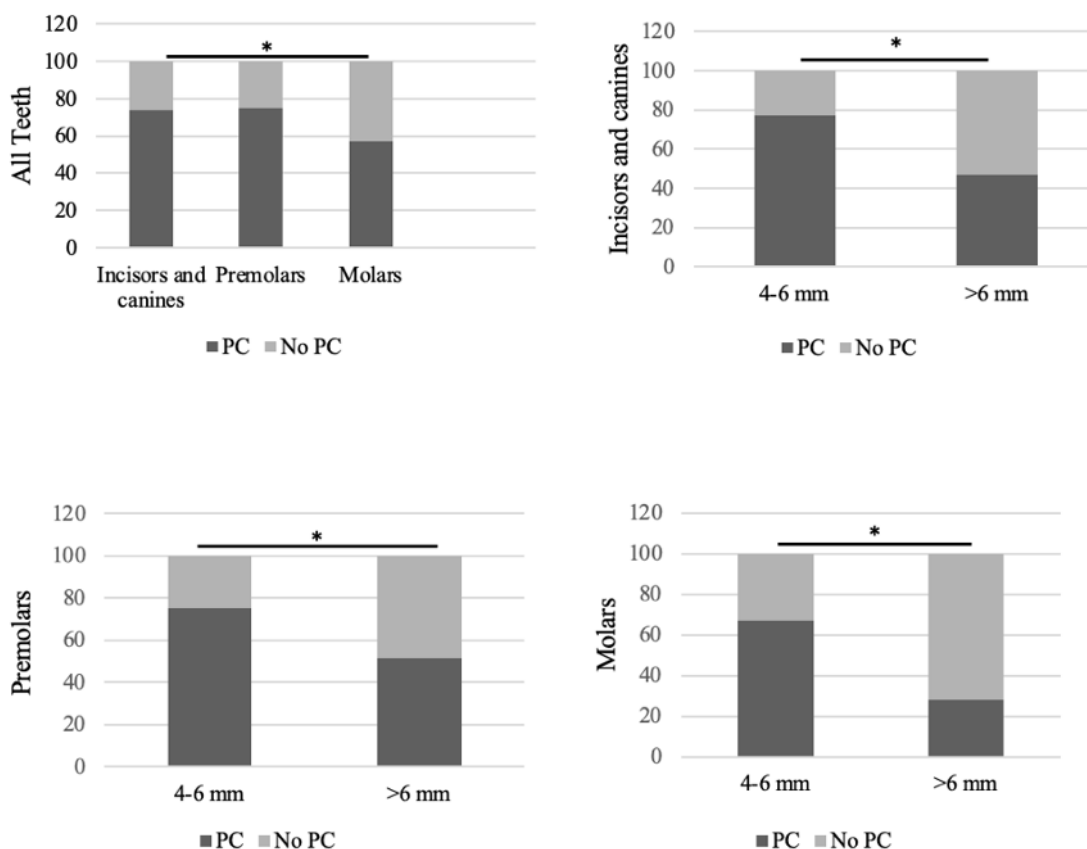
Number of region (%)

Figure 2. Pocket closure (PC) 3 months after treatment according to tooth type. * p< 0.05

Discussion

Periodontal therapy is essential for managing periodontitis, aiming to halt disease progression and restore periodontal health. This trial investigated the outcomes of NSPT in patients diagnosed with stage III grade C periodontitis, focusing on PC across different tooth types and PD ranges.

In our study, reassessment periods were scheduled at three months following NSPT to ensure that measurements were taken at a time when the most significant changes in PD reduction and clinical attachment gain typically occur. This timing aligns with findings from previous research indicating that while healing and maturation of the periodontium may take 9-12 months following NSPT, the most notable improvements usually manifest within 1-3 months after subgingival instrumentation.[18-20] Taking measurements prematurely could lead to a misinterpretation of the clinical response, as they may not fully capture the extent of improvement.
In our findings, the prevalence of pockets measuring 6

mm or deeper was notably higher in molars, whereas shallow pockets predominated in the anterior region, aligning with existing literature.[21] Emphasizing regular dental check-ups for monitoring and early detection of periodontal issues, particularly in molar regions, could be beneficial.

We observed a notable decrease in PD, signifying the effectiveness of periodontal therapy in reducing pocket depths, especially in deeper pockets (>6 mm), which are linked to an increased risk of disease progression and tooth loss. The decrease in probing depth after mechanical instrumentation arises from both the gain in clinical attachment and gingival recession.[3] In a meta-analysis examining the impact of NSPT on clinical measurements over a period of 1 to 24 months, Cobb et al.[18] calculated the reduction in pocket depths after NSPT as 0.03 mm in shallow pockets, 1.29 mm in pockets measuring 4-6 mm, and 2.16 mm in pockets of 7 mm or more. In accordance with these findings, the mean values in our study exhibit a slight elevation. This discrepancy may be

attributed to variances in severity of periodontitis and durations of follow-up. Apatzidou and Kinane[22] reported a reduction in probing depths of 1.7 mm after 13 weeks following quadrant-based root planning. This observed reduction slightly exceeds the reported findings, potentially attributed to the higher initial probing depths in their study, which measured 4.4 mm.

In terms of the post-NSPT PC rate, existing evidence remains limited, and there is considerable variability in how PC is defined across studies. In our study, we defined PC as a PD of ≤3 or 4 mm in the absence of BOP.[17] In a recent meta-analysis by Suvan et al.[10], the overall proportion of PC was reported as 74% at 6 to 8 months, defining PC similarly to us as residual PD ≤ 4 mm with no bleeding after probing. Citterio et al.[13] reported a PC rate of 63.9% (PD ≤ 4 mm), while Werner et al.[23] observed a PC rate of nearly 50% (PD of ≤3 or 4 mm in the absence of BOP). However, it's important to note that these studies encompassed all stages and grades of periodontitis patients. In addition, these studies included more heterogeneous patient populations, including individuals with varying factors such as smoking habits and systemic diseases. In a particular study involving only individuals with stage III or IV grade C periodontitis, the prevalence of PC (PD ≤4 mm and no BOP) was 58.4%. This prevalence was also found to have a significant correlation with smoking habits at the patient level.

The efficacy of NSPT in individuals with periodontitis was affected by the type of tooth.[14, 24] Furthermore, significant differences in PC rates were observed among different tooth types, with molars showing the lowest PC rates compared to incisors, canines and premolars. This finding suggests that multi-rooted teeth may present greater challenges in achieving optimal treatment outcomes, potentially due to anatomical differences like concavities on the root surfaces, cervical enamel projections, furcation involvements and developmental grooves.[25] These challenges pose difficulties in adequately accessing and treating deep pockets, particularly in posterior regions.

The findings emphasize the importance of tailored treatment approaches based on individual patient characteristics, including tooth type and PD ranges. Clinicians should consider the inherent challenges associated with treating deeper pockets and adjust

treatment strategies accordingly, such as more frequent follow-up appointments or additional interventions to enhance PC. Moreover, the lower PC rates observed in molars underscore the need for thorough instrumentation and meticulous plaque control in posterior regions to improve treatment outcomes.

Several limitations should be acknowledged, including having only stage III grade C periodontitis patients, the relatively small sample size and the exclusion of smokers and patients with systemic diseases, which may limit the generalizability of the findings. Future research with larger and more diverse patient populations is warranted to further explore the factors influencing PC following NSPT, including the impact of systemic conditions and lifestyle factors such as smoking. Additionally, longitudinal studies examining the long-term stability of treatment outcomes beyond the 3-month follow-up period would provide valuable insights into the sustainability of periodontal therapy effects. The effect of periodontal phenotype, which is one of the factors affecting treatment outcome, on pocket closure can be planned in further studies.[26]

Conclusion

In summary, PC is a crucial aspect to consider when evaluating the success of NSPT. While NSPT demonstrates efficacy in improving periodontal health parameters, achieving PC in deep pockets, especially in the posterior area, remains a difficult task. Hence, additional interventions such as surgical procedures may be necessary following NSPT, especially in these challenging areas. This study underscores the importance of tailoring periodontal treatments to meet the specific needs of each site, considering factors such as tooth type and initial pocket depth.

Conflicts of Interest

The authors declare no conflicts of interest.

Authors' Contribution

Concept/Idea: B.K., H.O.O Design: B.K., H.O.O Supervision/Consultation: B.K., H.O.O Analysis and/or Interpretation: B.K., H.O.O Literature Search: B.K., H.O.O Manuscript Writing: B.K., H.O.O. Critical Review: H.O.O

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