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Clinical response stratification after scaling and root planning: creating an early monitoring model using indicators of periodontal risk

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Abstract

AIM. To develop an effective early-monitoring method grounded in periodontal risk factors and to categorize initial therapeutic responses to scaling as well as root planning (SRP).

MATERIALS AND METHODS. In a prospective cohort study, the plaque index, bleeding on probing, and probing pocket depth were measured at three different appointments: the first visit (baseline), the first follow-up visit (FU1), and the second follow-up visit (FU2). Mean reductions from pretreatment were calculated, and the patients were classified as Poor responders (<25% BoP reduction with little or no PPD decrease), Moderate (25 to 49% BoP reduction or <1 mm PPD reduction), or Rapid (more than 50% BoP reduction and less than 1 mm PPD reduction). Using non-parametric tests and Spearman correlations, the impacts of cigarette smoking and age were investigated.

RESULTS. SRP yielded clinically significant early enhancements in BoP and PPD at FU1, with further improvements noted at FU2. Smoking was associated with substantially diminished early BoP reductions and smaller PPD improvements. Age showed weak, non-significant correlations with early change. There were weak, non-significant relationships between age and early changes.

CONCLUSIONS. Risk-based assessment is made possible by early re-evaluation following SRP. Age by itself is not a short-term predictor, but smoking status is an actionable early risk sign. The suggested paradigm encourages smoking cessation counseling and supportive care intensity customization throughout the early maintenance stage.

Keywords: early monitoring model, indicators of periodontal risk, patient stratification, age, smoking

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Стратификация клинического ответа после удаления зубного камня и корневого планирования: создание модели раннего мониторинга с использованием индикаторов пародонтального риска

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Резюме

ЦЕЛЬ. Разработать эффективный метод раннего мониторинга, основанный на факторах пародонтального риска, и классифицировать начальные терапевтические ответы на удаление зубного камня и корневое планирование (SRP).

МАТЕРИАЛЫ И МЕТОДЫ. В проспективном когортном исследовании оценивались индекс зубного налета (PI), кровоточивость при зондировании (BoP) и глубина зондирования пародонтальных карманов

(PPD) на трех визитах: первый визит (исходные данные), первый повторный визит (FU1) и второй повторный визит (FU2). Вычислялись средние изменения относительно исходного уровня, а пациенты классифицировались как: Poor responders (<25% снижение BoP и минимальное или отсутствие уменьшения PPD), Moderate (25–49% снижение BoP или <1 мм снижение PPD) и Rapid (>50% снижение BoP и <1 мм снижение PPD). Для анализа влияния курения и возраста применялись непараметрические тесты и корреляции Спирмена.
РЕЗУЛЬТАТЫ. SRP обеспечило клинически значимое раннее улучшение BoP и PPD на FU1, с дальнейшими улучшениями на FU2. Курение было связано с существенно меньшим ранним снижением BoP и уменьшением PPD. Возраст показал слабую, статистически незначимую корреляцию с ранними изменениями.
ВЫВОДЫ. Раннее повторное обследование после SRP позволяет проводить оценку на основе риска. Возраст сам по себе не является предиктором краткосрочного ответа, тогда как статус курения служит важным ранним фактором риска. Предлагаемая модель способствует консультациям по отказу от курения и индивидуализации интенсивности поддерживающего лечения на ранней стадии.

Ключевые слова: модель раннего мониторинга, показатели пародонтального риска, стратификация пациентов, возраст, курение

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INTRODUCTION

The multifactorial, chronic inflammatory disease known as periodontitis progressively erodes the periodontal attachment system. It is managed in phases, starting with the foundation of Step 1–2 therapy, scaling, and root planning (SRP). To reduce inflammation and stop more tissue deterioration, SRP is intended to break up and eliminate subgingival biofilms and calculus [1]. The 2018 EFP/AAP classification and treatment guidelines strongly advise an early re-evaluation within 4–6 weeks of SRP to optimize long-term outcomes, modify care plans, and assess treatment response [2].

Although the advantages of SRP are predictable, patient reactions vary. According to Trombelli et al. [3], some people exhibit quick and significant improvements in important clinical indicators, such as the plaque index (PI), probing pocket depth (PPD), and bleeding on probing (BoP), while others show slower or less pronounced changes. This variation has significant therapeutic ramifications: early detection of individuals who may not respond well may direct more intensive therapy, the use of adjuvant therapies, or individualized supportive periodontal care.

Smoking continues to be the most reliable modifiable risk factor among recognized risk indicators associated with inferior results following non-surgical periodontal treatment. In contrast to non-smokers, the smokers usually exhibit less favorable healing, decreased pocket depth reduction, and poorer BoP resolution [4]. Age's function as a short-term predictor, however, is less evident. Studies show inconsistent evidence about whether chronological age significantly affects early healing following SRP, even if older people may present with altered immune responses and accumulated disease burden [5].

Investigating risk markers that stratify early treatment response is therapeutically useful considering this background. Clinicians may find it easier to customize recall intervals, identify patients in need of adjunctive treatments, and incorporate risk-based methods into supportive periodontal care if they develop a useful response categorization model (rapid, moderate, and poor responders) [6]. Furthermore, converting these results into a monitoring framework suitable for clinical settings may help close the gap between the data from studies and routine periodontal care.

Recent worldwide guidelines have highlighted the significance of early re-evaluation following non-surgical periodontal treatment. The S3 level of clinical practice recommendations for the treatment of stage (I-III) periodontitis from the European Federation of Periodontology (EFP) specifically recommend reassessment approximately 4-6 weeks following scaling and root planning to evaluate treatment response and guide additional interventions [6]. To maximize long-term results, this organized method emphasizes the necessity of classifying patients based on their early response and incorporating risk factors like smoking status.

In this study, the short-term therapeutic benefits of SRP were investigated by assessing shifts in plaque index (PI), probing pocket depth (PPD), and bleeding on probing (BOP). Additionally, patients were categorized into different responder groups. The study also investigated the impact of age and smoking as early indicators of treatment response as much as possible. Finally, it turned these results into a useful monitoring model to help promote personalized periodontal care.

MATERIALS AND METHODS

Study design and participants

Adult patients with periodontitis ($n = 160$) diagnosed using the 2018 EFP/AAP classification criteria with ages ranging from 20 to 70 years (mean 37.5 ± 11.3) were included in this prospective observational cohort

study [5; 7]. The study followed the Declaration of Helsinki issued by the International Medical Association in 2013 [8]. As part of standard Step 1–2 periodontal care, all the subjects were scheduled to get non-surgical periodontal treatment. PI, PPD, and BOP were recorded at three distinct times: baseline (before SRP), early re-evaluation at 4–6 weeks after SRP is the first follow-up visit [6], and prolonged reassessment within about 12 weeks following SRP [1; 3].

Informed consent was obtained, and ethical approval was obtained from the ethical committee of Baghdad University. The exclusion criteria included: (1) incomplete SRP treatment, (2) missing baseline or FU1 data for PPD or BoP, or (3) systemic or local problems that could impair a reliable evaluation of clinical parameters.

Clinical assessments

Using a UNC-15 periodontal probe (Premium Instruments, Germany), two certified periodontists conducted all clinical evaluations. Excellent intra- and inter-examiner reliability was demonstrated, as confirmed by repeated measurements on ten patients to verify calibration [9; 10].

The mean PPD (mm), full-mouth BoP (% of sites), and PI (%) were noted. SRP was provided in accordance with current guidelines. Individualized oral hygiene training was given to each patient. Changes from baseline in BoP, PPD, and PI during follow-ups one (FU1) and two (FU2) were the primary outcomes.

The stratification of responses

Participants were stratified into three response groups based on changes in BoP and PPD following the initial treatment (SRP) to account for variations in treatment results. This was achieved using methods from earlier research [11; 12]: rapid responders were defined as those with a PPD drop of ⩾1 mm and a BoP reduction of⩾50%. 25–49% BoP reduction or <1 mm PPD reduction are examples of moderate responders. Poor responders: less than 25% decrease in BoP with little to no change in PPD.

The EFP S3 guidelines' recommendations for tailored supportive treatment align with this three-tier structure, which is also consistent with previous research that categorizes patients into responders and non-responders based on changes in BoP and PPD [6].

Analytical statistics

IBM SPSS Statistics was used to analyze the data (version 26.0, IBM Corp., Armonk, NY, USA). Data distribution was tested using the Shapiro-Wilk test. Continuous variables were presented as means ± SD or medians with an interquartile range (IQR). Non-parametric techniques, such as the Mann- Whitney U test and the signed-rank test of Wilcoxon, were employed to assess differences in clinical variables between periods of time due to non-normal distribution. Using Spearman's rank correlation, relationships between age and clinical outcomes were investigated. To compare groups across age categories, the Kruskal-Walli's test was used. Pearson correlation coefficients and intraclass correlation coefficients (ICC) were used to assess reliability. Statistical significance was determined at $p < 0.05$.

RESULTS

The results of the study are presented in Tables 1–6 and Figures 1 and 2.

Table 1. Baseline clinical and demographic features of the research participants

Таблица 1. Исходные клинические и демографические характеристики участников исследования

	Age (years)	Smokers (%)	PI-baseline (%)	BoP-baseline (%)	PPD-baseline (mm)
Mean	37.52	33.33	0.85	0.60	5.25
SD	11.37	NA	0.13	0.15	0.69
Median	37.00	NA	0.88	0.60	5.00

Table 2. The variations in PI, PPD, and BoP following root planning and scaling at FU1 and FU2

Таблица 2. Изменения показателей PI, PPD и BoP после проведения удаления зубного камня и корневого планирования на этапах наблюдения FU1 и FU2

Outcome	Mean Change	SD	Median	IQR (25–75%)
PI change at FU1 (%)	80.15	6.00	80.35	77.91–84.00
PI change at FU2 (%)	86.55	5.95	87.37	82.61–90.86
BoP change at FU1 (%)	34.53	15.85	33.20	23.28–47.09
BoP change at FU2 (%)	77.55	13.48	82.57	72.09–86.33
PPD change at FU1 (mm)	0.49	0.57	0.00	0.00–1.00
PPD change at FU2 (mm)	1.72	0.70	2.00	1.00–2.00

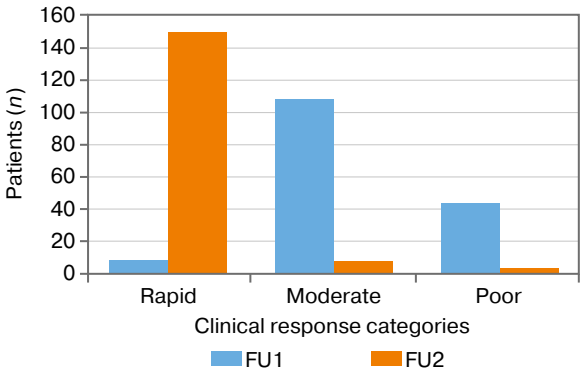

Fig. 1. Early (FU1) and delayed (FU2) re-evaluation of patients based on clinical response categories (Rapid, Moderate, Poor) after scaling and root planing (SRP)

Рис. 1. Ранняя (FU1) и отсроченная (FU2) повторная оценка пациентов в зависимости от клинических категорий ответа (быстрый, умеренный, слабый) после проведения удаления зубного камня и корневого планирования (SRP)

Table 3. Clinical response comparison between non-smokers and smokers after SRP

Таблица 3. Сравнение клинического ответа между некурящими и курящими пациентами после проведения удаления зубного камня и корневого планирования (SRP)

Outcome	Smokers Median (IQR)	Non-smokers Median (IQR)	*p*-value	Rank-biserial *r*
BoP reduction FU1 (%)	30.41 (19.57–38.84)	34.58 (24.56–49.60)	0.024	0.22
BoP reduction FU2 (%)	80.28 (72.88–85.07)	83.49 (70.71–86.97)	0.224	0.12
FU1 PPD decrease (mm)	0.00 (0.00–1.00)	0.00 (0.00–1.00)	1.000	0.00
FU1 PPD decrease (mm)	2.00 (1.00–2.00)	2.00 (1.00–2.00)	0.335	–0.09

Table 4. Age and clinical response correlation after SRP

Таблица 4. Корреляция между возрастом пациентов и клиническим ответом после проведения удаления зубного камня и корневого планирования (SRP)

Outcome	Spearman rho	*p*-value
BoP reduction FU1 (%)	–0.04	0.594
BoP reduction FU2 (%)	–0.03	0.668
PPD reduction FU1 (mm)	–0.00	0.981

Table 5. Kruskal-Wallis test to assess variations in the clinical response by age range

Таблица 5. Критерий Краскела–Уоллиса для оценки различий клинического ответа в зависимости от возрастных групп

Outcome	Kruskal–Wallis H	*p*-value
BoP reduction FU1 (%)	1.79	0.409
BoP reduction FU2 (%)	0.53	0.768
PPD reduction FU1 (mm)	1.31	0.519
PPD reduction FU2 (mm)	0.16	0.925

Table 6. Intra and inter-examiner reliability test for the repeated periodontal measurement

Таблица 6. Тест внутри- и межэкзаменаторской воспроизводимости при повторных пародонтологических измерениях

Variable	*r* (Pearson)	*p*-value	ICC (2,1)	ICC (3,1)
BOP (repeated measurements)	0.9876	1.65×1047	0.9875	0.9875
PPD (repeated measurements)	0.9907	3.41×1050	0.9894	0.9897
BOP (Examiner 1 vs 2)	0.9913	9.93×1053	0.9900	0.9910
PPD (Examiner 1 vs 2)	0.8979	1.30×1021	0.8955	0.8974

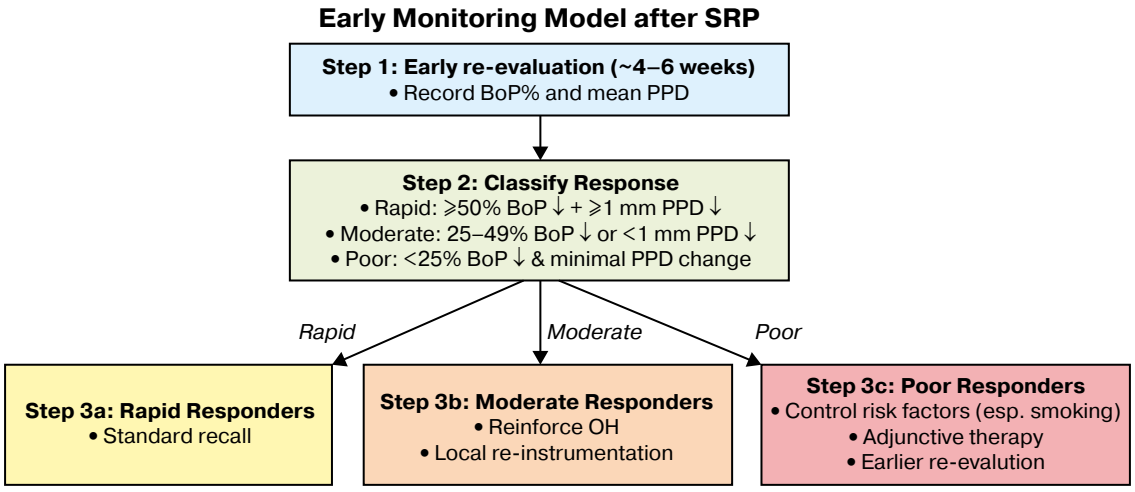

Fig. 2. Model for preliminary monitoring following scaling and root planning (SRP) developed using prior research on patient stratification following SRP and current EFP S3 guidelines

Source: [4; 6; 7]

Рис. 2. Модель предварительного мониторинга после проведения удаления зубного камня и корневого планирования (SRP), разработанная на основе ранее проведенных исследований по стратификации пациентов после SRP и действующих рекомендаций EFP S3

Источники: [4; 6; 7]

DISCUSSION

In this prospective cohort study, scaling and root planning's (SRP) rapid clinical outcomes were evaluated, and the influence of age and smoking as risk factors on early response was investigated. The results show that SRP is effective in lowering gingival inflammation, microbial plaque, and probing pocket depth (PPD), but they also show that patient reactions varied within the first 12 weeks.

At both FU1 and FU2, the plaque index (PI) showed significant decreases, demonstrating the quick efficacy of supra- and subgingival debridement in preventing the formation of biofilms. The idea that mechanical debridement is the mainstay of periodontal therapy is supported by these findings [1; 5]. BoP showed a slight improvement at FU1 but a significant decrease by FU2, which is consistent with earlier findings that gingival inflammation resolution takes longer than plaque clearance and necessitates soft tissue repair [3]. By FU1 (median = 0 mm), PPD changes were negligible; however, by FU2 (median = 2 mm), they became clinically significant, reflecting the biological process of periodontal pocket reduction and repair, which usually takes weeks to months [10].

Smoking was found to be a major risk factor that hindered the lowering of BoP at FU1 but not at FU2. According to Leite, Nascimento, and Scheutz [4], smoking appears to mainly postpone early inflammation resolution by reducing vascular responsiveness, vasoconstriction, and immune cell activity. Even though both smokers and non-smokers had significant improvements by FU2, smokers delayed early response highlights the significance of risk-factor management and smoking cessation programs. Smokers who get non-surgical or surgical periodontal therapy have also shown slower or less complete recovery, according to earlier clinical investigations [4; 13].

Age wasn't found to be a significant predictor of short-term results by either Kruskal-Wallis analysis or Spearman's correlation. The immediate tissue response to SRP is not affected by chronological age, at least not in this cohort's adult range. According to previous research, the early healing of periodontal disease is not significantly influenced by age [5]. These findings reflect this observation. Long-term research, however, has revealed that older individuals may have greater rates of tooth loss and recurrence, which may be due to aged host defense alterations and cumulative exposure to risk factors [2]. Age is therefore relevant for long-term risk assessment but should not be utilized as a short-term triage factor.

Based on early improvements in BoP and PPD, patients can be categorized as rapid, moderate, or poor responders, which offers helpful direction for tailored treatment. In general, rapid responders exhibit good healing and can proceed with routine care, but intermediate responders might profit from localized re-instrumentation and improved oral hygiene. Adjunctive medicines, increased risk control, and closer monitoring are necessary for poor responders, who are frequently associated with modifiable risk factors as smoking [4; 6; 7]. Clinicians can improve long-term periodontal outcomes and rapidly modify treatment techniques by identifying these trends early, as advised by the EFP S3 guidelines.

CONCLUSION

This study emphasizes the variability of early clinical responses while confirming the efficacy of the initial periodontal therapy: scaling and root planning in lowering plaque, gingival inflammation, and probing pocket depth. Although age did not affect short-term healing, it was discovered that smoking is a substantial modifiable risk indicator that delays the early reduction of BoP. Considering these results, we suggest a useful three-step monitoring paradigm that divides patients into rapid, moderate, and poor responders at 4–6 weeks and adjusts supportive care appropriately. This strategy further operationalizes the EFP S3-level clinical practice guideline, which suggests early re-evaluation to maximize treatment planning [6], into a framework that is ready for the clinic.

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AUTHOR'S CONTRIBUTION

The first author made the primary contribution to this publication, including the conception of the research idea, study design, data analysis, and drafting of the initial manuscript. The co-authors contributed to data collection, critically revised the manuscript for important intellectual content, and provided final approval of the version to be published.

ВКЛАД АВТОРОВ

Первый автор внес наибольший вклад в подготовку данной публикации, включая формирование исследовательской идеи, разработку дизайна исследования, анализ данных и подготовку первоначального варианта рукописи. Соавторы участвовали в сборе данных, критическом пересмотре статьи с учетом значимого интеллектуального содержания и дали окончательное одобрение версии рукописи для публикации.