Influence of local anesthesia on the outcomes of non-surgical periodontal treatment

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Abstract

Background: There is limited evidence of the effects of local anesthesia (LA) on outcomes of non-surgical periodontal treatment (NSPT), in particular among the Chinese. This retrospective cohort study aimed to evaluate the effects of LA on short-term treatment outcomes of NSPT and to determine under what circumstances LA should be prescribed to improve these outcomes.

Methods: Data from periodontal examinations of 3980 patients were used. The data were from 3-month re-evaluation records of an electronic periodontal charting record system in the Department of Periodontology of Peking University School and Hospital of Stomatology from June 2008 to January 2015. Descriptive analyses included changes in probing depth (PD) and the Mazza bleeding index (BI). Two-level (patient and tooth) logistic regression models and three-level (patient, tooth, and site) linear regression models were constructed to analyze the influence of LA on PD for all teeth/sites and teeth/sites with an initial PD $\geq$ 5 mm. Decreases in PD and BI at sites under LA using the initial PD were also compared.

Results: A significantly higher mean decrease in PD after NSPT was found in the LA group than in the no local anesthesia (NLA) group (0.98 *vs.* 0.54 mm, $t = 24.12$, $P < 0.001$). A significantly higher probability of decreases was found in the LA group in BI (percentages of teeth with BI > 1 and BI > 2) for all teeth (16.7% *vs.* 13.8%, $t = 3.75$, $P < 0.001$; 34.7% *vs.* 28.1%, $t = 6.73$, $P < 0.001$) and PD for teeth with PD $\geq$ 5 mm (32.3% *vs.* 17.3%, $t = 28.48$, $P < 0.001$). The difference in PD between the LA and NLA groups increased as the initial PD increased. The difference between the two groups was 0.12 to 0.22 mm for sites with a baseline PD < 7 mm; however, it increased to 0.41 to 1.37 mm for sites with a baseline PD $\geq$ 7 mm.

Conclusions: LA improved the decrease in PD after NSPT. Root debridement at sites with initial PD $\geq$ 7 mm should be performed under routine LA.

Keywords: Local anesthesia; Periodontitis; Periodontal debridement

Introduction

Periodontal disease, one of the most common and chronic infectious oral diseases in the world, represents a major public health problem.[1] As periodontal disease is a plaque-induced infection,[2] thorough removal of the biofilm and calculus from contaminated root surfaces by non-surgical periodontal therapy (NSPT) is the basis of treatment.[3]

An electronic periodontal charting record system (EPCRS) has been used since 2007 to collect and store data in the Department of Periodontology, Peking University School and Hospital of Stomatology (PKUSS). A more favorable response to NSPT was found in patients who received treatment with local anesthesia (LA) than in those who did not.

Pain control is a safe and important measure of successful periodontal therapy, and patients who receive LA feel less discomfort or dental anxiety during NSPT as measured on visual analog scales and questionnaires.[4-13] However, there is limited evidence of the effects of LA on treatment outcomes of NSPT, in particular among the Chinese. We hypothesized that LA would affect NSPT outcomes. Initially, deep periodontal pockets benefit more from NSPT.[14] Moreover, higher perceived pain is found in

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deep pockets than shallow ones during periodontal probing and NSPT. However, it is still unknown whether the initial probing depth (PD) affects LA and NSPT outcomes.

Therefore, we verified the effects of LA on short-term treatment outcomes of NSPT using common clinical parameters such as changes in PD and the Mazza bleeding index (BI). A secondary objective was to determine the circumstances under which LA should be prescribed to improve treatment outcomes.

Methods

Ethical approval

This study was a retrospective study, and the data involved were no personal privacy. Only the data used for research purposes, such as the patient's gender, age, and clinical data, were retained, while other private information, such as the patient's name and contact information, were deleted. This study has been approved by the Ethics Committee of PKUSS (approval No. PKUSSIRB-201310066) before the study started, and there was no need to submit the patients' informed consent forms.

Patient selection and data extraction

Individuals were selected from among all patients who received NSPT and full-mouth periodontal charting at both initial and re-evaluation visits to the Department of Periodontology, PKUSS, from June 2008 to January 2015.

The inclusion criteria were being 18 to 80 years old and having an available re-evaluation record within 3 months of active periodontal therapy. The exclusion criteria were systemic disease (eg, acquired immunodeficiency syndrome, diabetes mellitus, nephrosis, hepatopathy, hypertension, neutropenia), pregnancy, periodontal surgery within the past 6 months, or systemic administration of antibiotics within 6 months.

The power value of this retrospective cohort study calculated by the simulation method of statistical efficiency was over 0.99, so test efficiency was good. The patient selection and screening process is shown in Figure 1.

Data for the included patients were extracted from the EPCRS database at the PKUSS Information Center.

The following parameters were extracted: baseline age, sex, LA used during NSPT, periodontal diagnosis (stage and grade of periodontitis) according to the classification proposed at the International Workshop for the Classification of Periodontal Diseases and Conditions in 2017,[15] smoking status (non-smoker *vs.* smoker), tooth type (non-molar *vs.* molar), BI score (0–5; the higher BI between the buccal and lingual surfaces of each tooth was recorded as the BI of the tooth),[16] initial PD, and decrease in PD at six sites.

Tooth- and site-level data from the third molars and teeth lost during NSPT were excluded.

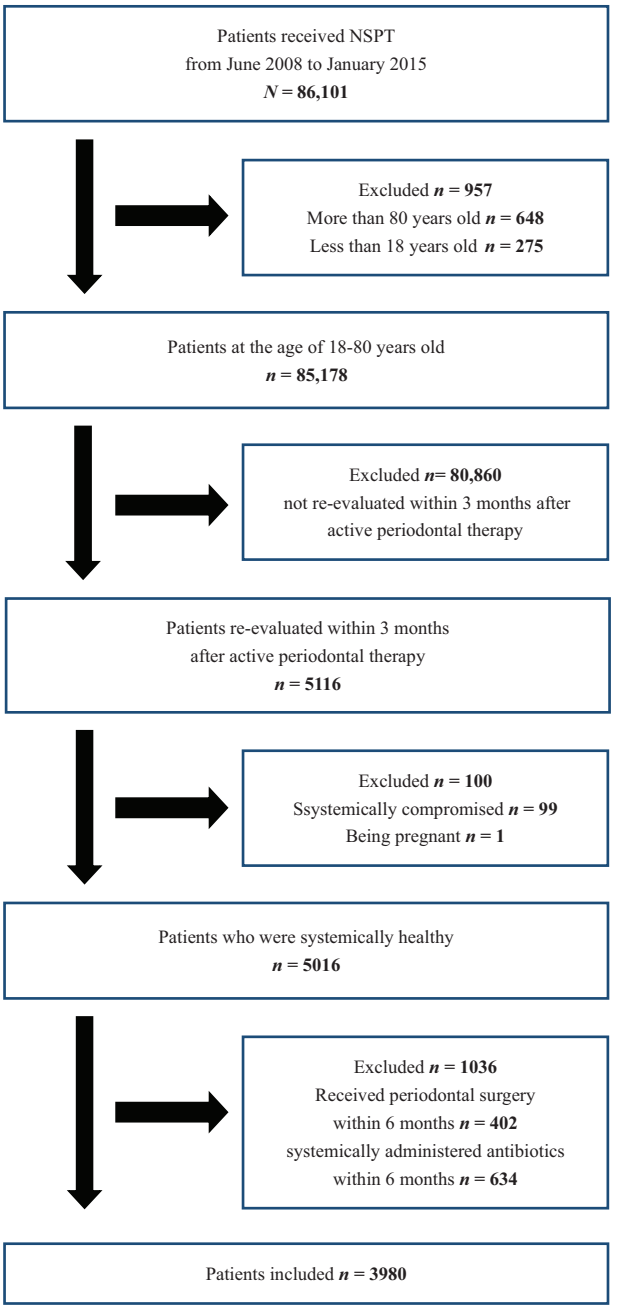

Figure 1: Flow chart for patient selection and screening of Chinese with periodontitis in the Department of Periodontology, Peking University School and Hospital of Stomatology (PKUSS) from June 2018 to January 2015.

Periodontal examinations and treatments

Periodontal examinations and treatments were performed by qualified clinical periodontists who had been systemically trained and calibrated in a pre-clinical program. Full-mouth periodontal examinations were performed at the initial visit. Oral hygiene instructions were given, and scaling and root planing (SRP) were performed with piezoelectric and hand instruments with or without lidocaine or articaine. A re-evaluation was performed 1 to 2 months after NSPT.

Statistical analyses

The data were analyzed with SPSS version 20 (IBM, Armonk, NY, USA). At the patient level, we used Chi-square tests to compare age, sex, and smoking status between patients who received LA and those who did not (no local anesthesia [NLA]). Means and standard deviations (SDs) for baseline PD, PD after treatment, and the decrease in PD were determined. Differences in initial decreases in PD after NSPT were compared between the two groups with Student's *t* test.

Means and SDs for the decreases in PD at the sites were computed. We compared differences in these decreases between the two groups during NSPT using Student's *t* test. We used two-way analyses of variance to test the effects of LA using the initial PD.

To evaluate the effects of LA on the decrease in PD after NSPT, we ran three-level (patient, tooth, and site) linear regression models with seven variables (use of LA, baseline age, sex, smoking status [patient level], BI and tooth type [tooth level], and baseline PD [site level]) for all sites and for sites with PD ≥ 5 mm. Similarly, we ran two-level (patient, tooth) logistic regression models with the same seven variables for all teeth and for teeth with PD ≥ 5 mm to evaluate the effects of LA on the change in BI after NSPT. Significance was tested by Chi-square analyses. $P < 0.05$ was considered significant.

Results

According to the inclusion and exclusion criteria, 3980 patients were included in the present study. The baseline characteristics of the participants grouped by whether local anesthesia was used (LA) or not (NLA) are presented in Table 1. More than 53% of the patients received NSPT under LA. The distributions of smoking status, stage, and grade of periodontitis in the two groups were significant. There were more smokers in the LA group than in the NLA group.

Changes in clinical parameters were more dramatic in the LA group than in the NLA group. The mean decrease in PD after NSPT was significantly higher in the LA group than the NLA group (0.98 *vs.* 0.54 mm, $t = 24.12$, $P < 0.001$). A higher mean decrease in the percentage of sites with PD ≥ 5 mm ([PD ≥ 5mm]%) after treatment was found in the LA group (32.3% *vs.* 17.3%, $t = 28.48$, $P < 0.001$). After we stratified the data by age, sex, and smoking status, we found that the LA group tended to benefit more from NSPT. However, the baseline PD and PD ≥ 5 mm (%) of the two groups differed significantly.

Significantly higher mean decreases in the percentages of teeth with BI > 1 and BI > 2 after treatment were observed in the LA group than the NLA group (16.7% *vs.* 13.8%, $t = 3.75$, $P < 0.001$; 34.7% *vs.* 28.1%, $t = 6.73$, $P < 0.001$). After stratifying the data as before, we found that the LA group tended to benefit more from NSPT. A higher mean decrease in percentage of teeth with BI > 1 was observed in the LA group for patients 40 to 60 years but not for patients 18 to 40 or >60 years. A higher mean decrease in percentage of teeth with BI > 2 was observed in the LA group for patients <60 years but not for patients >60 years. However, the baseline percentages of teeth with BI > 1 and BI > 2 values differed significantly between the two groups.

Given the limited ability of descriptive analyses to compare data with mismatched baseline values, we used multilevel analyses to evaluate the effects of LA on NSPT outcomes. The real effects of LA on changes in periodontal parameters were analyzed after the effects of age, sex, smoking status, tooth type, baseline BI, and baseline PD were adjusted. A total of 9565 teeth and 597,390 sites were included in the multilevel analyses. The three-level linear regression models showed a significantly higher decrease in PD in the LA group for all teeth and for teeth with PD ≥ 5 mm [Figure 2A].

Data from all sites were analyzed to evaluate whether baseline PD influenced the effects of LA on NSPT outcomes. The results showed significantly greater

Table 1: Characteristics of patients by local anesthesia during non-surgical periodontal therapy, *n* (%).

Variable	NLA ($n = 1849$)	LA ($n = 2131$)	χ^2	*P*
Gender			0.88	0.183
Male	1014 (54.8)	1137 (53.4)		
Female	835 (45.2)	994 (46.6)		
Smoking status			9.71	<0.001
Non-smoker	1566 (84.7)	1725 (81.0)		
Smoker	283 (15.3)	406 (19.1)		
Stage			148.98	<0.001
I	5 (0.3)	0 (0)		
II	117 (6.3)	48 (2.3)		
III	877 (47.4)	720 (33.8)		
IV	850 (46.0)	1363 (64.0)		
Grade			25.99	<0.001
B	558 (30.2)	491 (23.0)		
C	1291 (69.8)	1640 (77.0)		
Total	1849 (46.5)	2131 (53.5)	NA	NA

NLA: No local anesthesia; LA: Local anesthesia; NA: Not available.

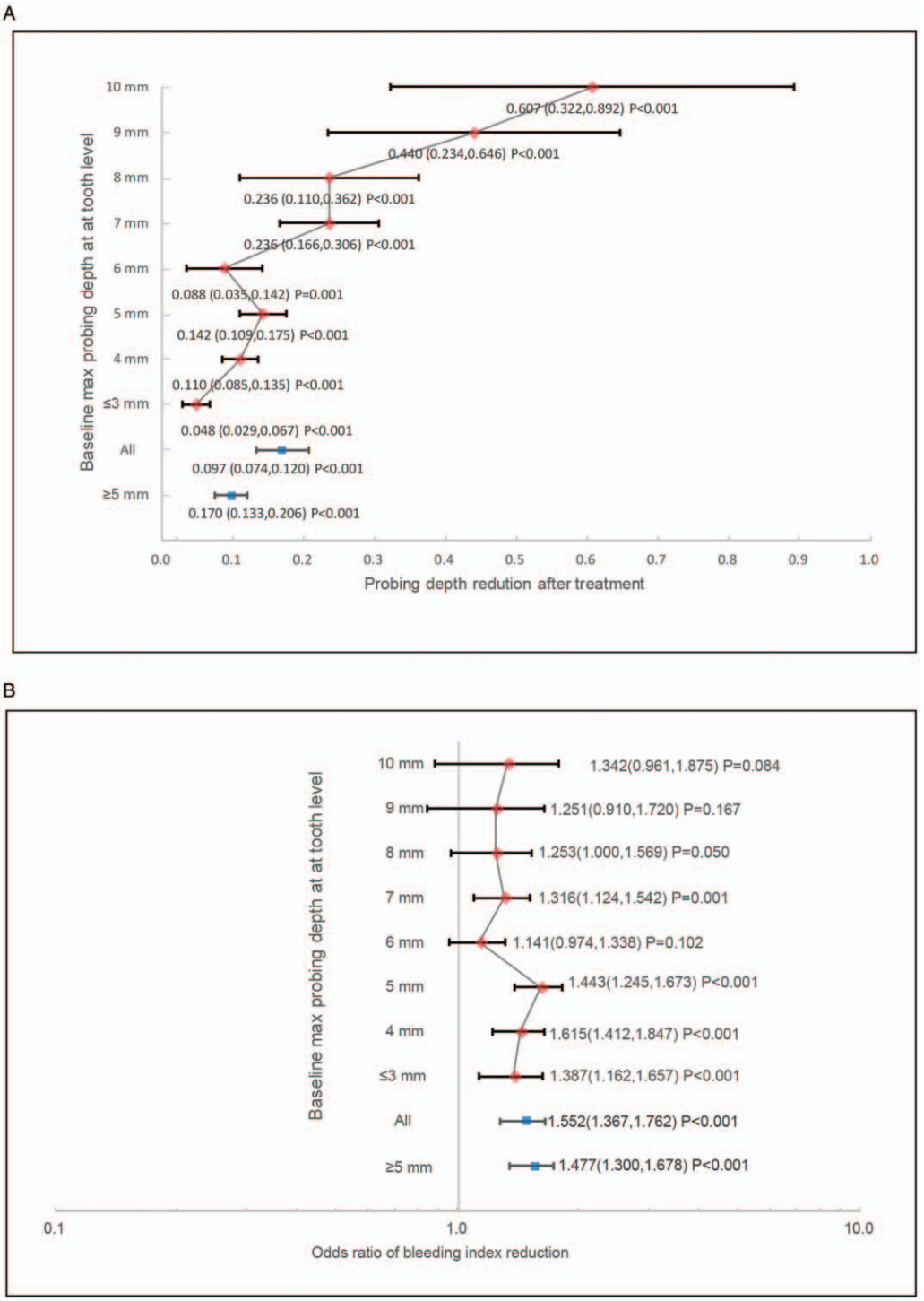

Figure 2: Differences (coefficients and 95% confidential intervals) in probing depth sites after NSPT between patients who did and did not receive anesthesia by multilevel linear regression with age, sex, smoking status, stage of periodontitis, and grade of periodontitis (patient level); bleeding index at baseline and molar *vs.* non-molar (tooth level); and probing depth at baseline (site level). Models were adjusted for all sites and for sites with probing depths at baseline ≥5 mm, which are marked in blue. The differences were also stratified by probing depth at baseline, which is shown in red (A). Differences in odds ratios and their 95% confidential intervals after NSPT between patients who did and did not receive local anesthesia by multilevel linear regression with age, sex, smoking status, stage of periodontitis, grade of periodontitis (patient level) and bleeding index at baseline, molar *vs.* non-molar, and mean probing depth at baseline (tooth level). Models were adjusted for all teeth and for teeth with a maximum probing depth at baseline ≥5 mm, which is marked in blue. The differences were also stratified by the maximum probing depth at baseline of the tooth, which is shown in red (B). NSPT: Non-surgical periodontal treatment.

decreases in PD at the LA sites after the data were stratified by baseline PD. The differences between the LA and the NLA groups for sites with various initial PD values are presented in Figure 2A. The difference increased as the initial PD increased. The difference between the two groups was 0.12 to 0.22 mm for sites with a baseline PD < 7 mm; however, it increased to 0.41 to 1.37 mm for sites with a baseline PD ≥ 7 mm [Figure 3A].

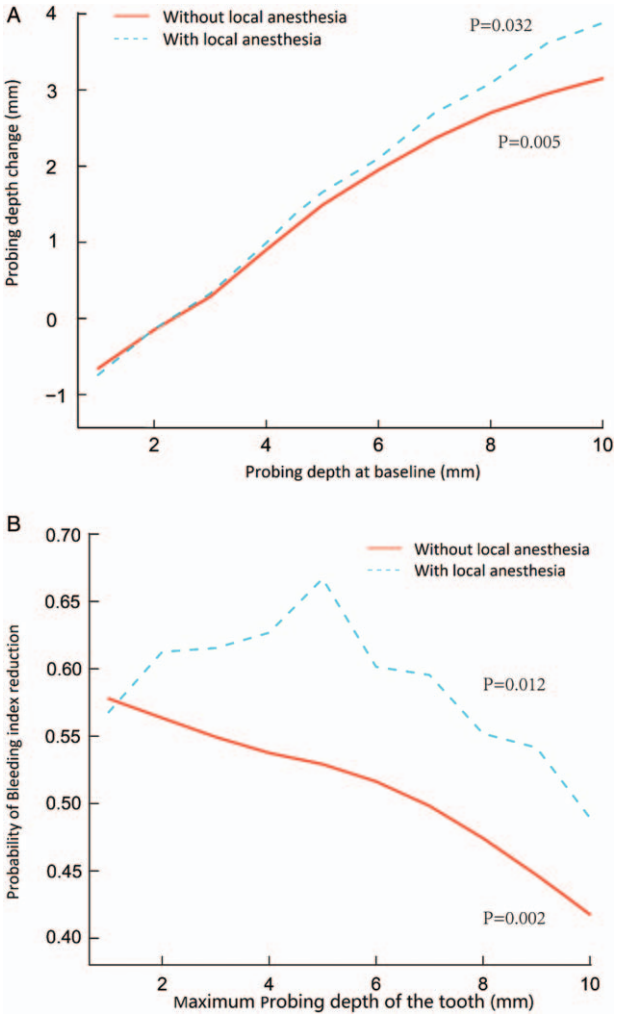

Figure 3: Smoothing plots of the relationship between probing depth at baseline and change in probing depth at the site level between patients who did (blue line) and did not (red line) receive local anesthesia. The fully adjusted model was adjusted for patient-level (age, sex, smoking status, stage of periodontitis, grade of periodontitis), tooth-level (bleeding index at baseline, molar *vs.* non-molar), and site-level (probing depth at baseline) parameters (A); Smoothing plots of the relationship between the change in maximum probing depth at baseline and the probability of a reduced bleeding index at the tooth level between patients who did (blue line) and did not (red line) receive local anesthesia. Plots were based on generalized additive models adjusted for age, sex, smoking status, stage of periodontitis, and grade of periodontitis (patient level) and bleeding index at baseline, molar *vs.* non-molar, and mean probing depth at baseline (tooth level) (B).

The three-level linear regression models showed a significantly greater decrease in odds ratio (OR) after NSPT in the LA group for all teeth and for teeth with PD ≥ 5 mm. The results showed significantly greater decreases in OR at LA sites with PD ≤ 5 mm and PD = 7 mm after the data were stratified by the maximum baseline PD of the tooth. However, differences between the two groups in the decrease in OR after NSPT at the other sites were not significant [Figure 2B].

Two-level linear regression models showed that the probability of a reduction in BI at the tooth level decreased with as the maximum PD at baseline increased in the NLA group. The probability of a reduction in BI increased as the initial PD increased for teeth with PD ≤ 5 mm in the LA group [Figure 3B].

Discussion

The results of the present study show that LA improved NSPT outcomes (reduced PD and BI) at the patient level. However, the results should be interpreted with caution owing to the uneven distribution of age, sex, and smoking status in the sample and the mismatch between baseline PD and BI. Multivariate analyses were used to adjust for other factors that affect NSPT. The multilevel analyses confirmed the benefit of LA for treatment outcomes after NSPT when other factors that might have affected NSPT outcomes were adjusted. A previous study demonstrated that more than 60% of patients might suffer from some degree of pain during periodontal scaling.[17] Perceived pain can hinder the use of ultrasonic or hand instruments in the bottoms of periodontal pockets where dental plaque and calculus collects. Several studies have compared the effects of different pain control regimens during NSPT on treatment outcomes.[4-8,10-12] However, data on whether LA affects NSPT outcomes are still limited. The results of this study demonstrate that LA improves treatment outcomes.

PD and BI are indices of periodontal inflammation. Improving PD and BI depends on removing initiating factors (ie, dental plaque); local stimulating factors, such as calculus and pigment; and systemic promoting factors, such as systemic diseases and hormones. LA effectively eliminates or reduces the pain of patients, which reduces anxiety during treatment and improves cooperation with doctors. Better cooperation is also conducive to a more thorough debridement of the deeper periodontal pockets, the root bifurcated area, and other areas that are difficult to operate on without LA. In addition, epinephrine (bluish blue) is added to local anesthetics used for oral treatment to increase their effects and duration. Epinephrine also has hemostatic effects in local anesthetics, which can help periodontists obtain a better operative field of vision.

The use of LA during mechanical SRP is considered routine in clinical practice and scientific research, as SRP is uncomfortable for most patients.[11,18-23] However, some patients choose to undergo procedures without LA because of a fear of injections or an aversion to post-operative numbness.[24] In a survey of students and staff at the University of Washington, more than 25% of adults expressed at least one clinically significant fear of injections.[10] In a multicenter study that evaluated patients' experiences with probing and NSPT, 33% of primary patients and 64% of recalled patients said that they would rather endure mild to moderate pain during treatment than receive an injection of a local anesthetic. In addition, cross-cultural differences may also affect attitudes toward LA. In a study performed in the United States to explore perceptions of pain from tooth drilling among individuals of different ethnicities, 90% of Chinese patients did not use anesthetic for treatment, which was much higher than Scandinavians (54%) and Anglo-Americans (7%).[25] In the present study, more than 46% of patients underwent NSPT without LA. The relatively low rate of LA may be associated with an increased tolerance for pain in the Chinese population or a fear of needles. The additional expense of LA may be

another reason why some patients refuse it. A misconception among some Chinese villagers is that LA is harmful to the central nervous system or memory, and this could lead to a lower use of LA during NSPT.

A secondary objective of this study was to identify the circumstances under which LA should be recommended for NSPT. The results of the present study demonstrate that the difference between the LA and NLA sites increased with an increase in baseline PD. An investigation of 638 patients undergoing periodontal maintenance demonstrated that increasing pocket depths accompanied higher perceived pain.[4] There could be several explanations for this observation. First, a larger area of the inflammatory pocket epithelium with erosion and ulcers in deeper periodontal pockets[26] may be more likely to be irritated by instruments. Second, deeper pockets with more severe inflammation may be less resistant to mechanical forces.[27-30] When subgingival debridement is performed in deeper pockets, instruments may extend to a more interior part of the junctional epithelium, and the patient may suffer more pain. Third, deeper pockets may have more exposed dentin, and the patient may be more likely to suffer from dentin hypersensitivity during debridement.

The results of the present study also demonstrated that deep pockets benefited more from LA. Thus, the recommendation is that LA be used in patients with generalized deep periodontal pockets to achieve comfortable and successful NSPT. When the initial PD < 7 mm, the benefit from LA on the NSPT outcomes was relatively small, despite being statistically significant. However, the difference between the LA and NLA groups was almost 0.5 mm when the initial PD reached 7 mm, which suggests that LA can affect NSPT outcomes for patients with deeper periodontal pockets and that LA should be routinely applied.

LA for NSPT is most commonly administered by injection. However, some patients may be reluctant to receive an injection of LA out of fear of the injection and/or postoperative numbness. In one study, more than one-fourth of patients surveyed expressed anxiety about injections, including pain and fear of bodily injury from the injection.[31] Moreover, 46% of patients who received primary NSPT expressed discomfort with post-treatment numbness due to the LA. Fortunately, some topical anesthetic agents are ideal alternatives to injections for patients who are anxious about injections or bothered by post-injection numbness. The effectiveness and efficacy of topical or intra-pocket anesthesia have been demonstrated in many studies.[4,6-8,10,12,32,33] In addition, a study that compared treatment outcomes after NSPT using a LA gel or injected LA found competitive outcomes for the two treatment modalities and the same beneficial results for PD and clinical attachment gain.[5]

Several potential limitations of the present study should be acknowledged. Heterogeneity in demographic characteristics and baseline PD between patients who did and did not receive LA may have distorted the results. Therefore, multilevel analyses were performed to adjust for potential confounding factors. The data in the present study showed that LA benefited NSPT outcomes. Furthermore, the large sample size and the number of factors considered may bolster the findings. In addition, selection bias and information bias are issues because of the retrospective nature of the study. Studies with more evidence, such as randomized controlled clinical trials, are needed to validate the findings. Finally, a reduction in PD, the major concern of the present study, is not the only measure of NSPT outcomes. The effects of LA on attachment loss, postoperative dentin hypersensitivity, and treatment time should be tested in future studies.

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Conflicts of interest

None.

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