KEY WORDS
Self-perception, Oral hygiene, Preventative dentistry, Dental plaque, Gingival bleeding

Cross-sectional survey

FACTORS ASSOCIATED WITH SELF-PERCEPTION OF GINGIVAL BLEEDING AND DENTAL PLAQUE: A CROSS-SECTIONAL EPIDEMIOLOGICAL STUDY

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PURPOSE. The aim of this cross-sectional study was to correlate patients' perception of gingival bleeding and dental plaque with the Full Mouth Bleeding Score (FMBS) and the Full Mouth Plaque Score (FMPS), as recorded by an expert examiner. A second aim was to investigate the factors that influenced the perception of the presence of gingival bleeding and dental plaque at different sites in the mouth.

MATERIALS AND METHODS. The patients filled out a questionnaire investigating sociodemographic variables and behavioural factors such as the individuals' perception of their oral health (including a visual analogue scale on the perception of own gingival bleeding [VAS-B]) and oral hygiene habits (including a visual analogue scale regarding the effectiveness of own oral hygiene manoeuvres in removing dental plaque [VAS-OH]). An operator, with the aid of a mirror, recorded the sites that, according to the patients' perception, had plaque or bleeding. Then, an expert examiner, blinded to the patient's perception, recorded the FMBS and FMPS. Descriptive statistics, correlation analyses and multilevel logistic models were employed.

RESULTS. One hundred subjects were enrolled in this study. Mean VAS-B was 2.4±2.3, and mean VAS-OH was 6.6±1.7, while FMBS and FMPS were respectively 6.1±1.7 and 43.3±12.5. The correlation coefficient between VAS-B and FMBS was 0.51 (95%CI from 0.35 to 0.64, P <0.0001), and between VAS-OH and FMPS it was -0.25 (95%CI from -0.42 to -0.05, P = 0.0134). Only 7.6% of the bleeding on probing sites were recognized as bleeding sites by patients. Bleeding perception was higher in smokers (odds ratio = 3.67, 95%CI from 1.14 to 11.80, P=0.0292), and at the upper teeth (OR = 2.33, 95%CI from 1.16 to 4.68, P = 0.0170) and front teeth (incisors *vs.* premolars OR = 10.0, 95%CI 3.33 to 25.0, P <0.0001). Only 21.5% of plaque sites were recognized as such by patients. Plaque perception was higher at the molars (molars *vs.* incisors OR = 22.4, 95%CI from 15.8 to 31.7, P <0.0001) and at lingual sites (OR = 2.60, 95%CI from 2.09 to 3.23, P <0.0001).

CONCLUSIONS. A fair correlation was observed between bleeding perception and FMBS. However, there was a discrepancy between the perception of the bleeding sites and the sites that actually bled on probing: the anterior or upper teeth were perceived as bleeding more, while much less bleeding was perceived at the lower and posterior teeth. A weak negative correlation was observed between patients' oral hygiene self-report scores and the observed presence of dental plaque; patients perceived low bacterial plaque at premolars and incisors, as compared to molars.

CONFLICT OF INTEREST STATEMENT. The authors declare that they have completely self-funded the study, and that there are no conflicts of interest.

INTRODUCTION

The quality of home oral hygiene and patient compliance with an individualized dental and periodontal care programme is fundamental to the prevention and treatment of oral diseases, and for promoting long-term success thereof[1,2].

The presence of gingival bleeding upon mechanical stimulation of the gingival sulcus is universally accepted as a diagnostic parameter for clinically evaluating gingival inflammation[3]. Since the 1965 pioneer study by Loe et al., a significant positive relationship between the severity of gingival inflammation and the amount of supragingival plaque has been repeatedly shown in the literature[4,5]. Variability in bleeding-on-probing (BoP), however, has been reported both among and within individuals, and cannot be merely explained by quantitative or qualitative differences in plaque accumulation[6,7].

Several studies have investigated the objective factors associated with the presence of plaque and/or bleeding at dental or implant sites[8-10]. However, current conceptual models of oral health and the tools to measure them focus on a perspective that incorporates qualitative measures and the patients' "point of view"[11]. In this context, some studies have investigated the perception of oral health and gingival bleeding from the perspective of patients[12-18]. Other studies have attempted to correlate self-assessment models, such as questionnaires, with clinical examination[19-23]. Nonetheless, few studies have compared self-reported gingival bleeding or dental plaque with clinical values[24-31].

Although self-assessment is a low-cost approach to assessing the oral health of an individual, it is strongly influenced by personal beliefs and often differs from clinical findings. Despite these issues, however, it would still be useful to determine whether, and to what extent, patient-related parameters (social, behavioural, perception of the problem) are correlated to clinical measurements of the state of oral health.

To date, no studies have evaluated the correlation, if any, between patients' perception of plaque and gingival bleeding at intraoral sites with that observed upon physical examination by an experienced clinician, taking into account associated factors. Hence, the aim of this cross-sectional epidemiological study was to determine any relationship between patients' perception of dental plaque and gingival bleeding with the clinical variables recorded by an expert examiner. Furthermore, a second aim was to investigate the factors that may influence the perception of the presence of plaque and bleeding among patients.

MATERIALS AND METHODS

Study design

This study is a cross-sectional epidemiological study investigating patients' perception of the presence of gingival bleeding and dental plaque at their gingivae and teeth. It is reported in line with the STROBE statement for epidemiological studies[32].

Setting and participants

The investigation was carried out from July to October 2013. During this period, 100 subjects requesting professional oral hygiene were consecutively recruited for the study at a private practice in Campi Bisenzio, Florence, Italy.

The inclusion criteria used for participant selection were:

- Age older than 18 years;
- Presence of at least 20 teeth or dental implants.

The following were excluded as participants:

- Subjects with manual inability to perform dental care;

- Patients with neurological disorders;
- Pregnant women.

The presence of neither dental caries nor periodontal disease precluded participation. Both patients previously treated by the practice and new patients attending for the first time were included in the study. Informed written consent was obtained from all participants.

Variables

Outcome measures were self-perception of presence of gingival bleeding and dental plaque at their own teeth and gingivae. Explicative variables were patient-related, namely gender, age (years), smoking habits (yes or no), tooth brushing frequency per day, and flossing (or other interproximal aids) frequency per day, and site-related, specifically type of tooth (incisors, premolars, molars), side (right *vs.* left), arch (upper *vs.* lower), and surface (interproximal sites *vs.* other, lingual *vs.* buccal).

Data sources and measurements

In the practice waiting room, each participant filled out a questionnaire investigating their demographic variables, dental hygiene habits, and the perception of gingival bleeding and dental plaque in their mouth. The questionnaire also featured two visual analogue scales: one, termed VAS-B, to report their perception of their own gingival bleeding (from 0 = no bleeding to 10 = massive spontaneous bleeding), and one, termed VAS-OH, to report their perception of their own efficacy at dental plaque removal (from 0 = very ineffective to 10 = very effective). The questionnaire was administered twice before starting the study, two weeks apart, to a sample of 20 non-participants, to check its validity and degree of understanding (test–retest procedure).

Then, one of two operators (JP, DL) checked and discussed the questionnaire responses with the patient chairside. If the patient had indicated the presence of dental plaque and/or gingival bleeding in their mouth on the questionnaire, they were given a mirror and asked to point out the afflicted sites. At the same sitting, an examiner (MG) blinded to the patient's responses assessed for bleeding-on-probing (BoP) and dental plaque. BoP was measured at six sites per tooth (buccal, lingual, mesial buccal, mesial lingual, distal buccal, and distal lingual) in a dichotomous manner[33] using a PCP-UNC 15 periodontal probe. Full mouth bleeding score (FMBS) was calculated as the percentage of the sites with BoP. Plaque index was also measured dichotomously[34] at the same six sites per tooth following the application of a staining solution for dental plaque (GC Tri Plaque ID Gel, Tokyo, Japan). Full mouth plaque score (FMPS) was calculated as the percentage sites exhibiting bacterial plaque. Before commencing the study, the examiner undertook plaque calibration assessment on 10 patients, and the intra-rater agreement was good (the intraclass correlation coefficient on plaque assessment was 0.86).

Sample size

Considering α = 0.05, a power of 90%, a perception of bleeding of the molar teeth of 15%, and considering clinically significant an odds ratio of 3 between the perception of bleeding of the incisors compared to the molars, 94 subjects were required[35]. It was decided to enrol 100 patients.

Statistical methods

The intraclass correlation coefficient (ICC) was used for test-retest analysis of the questionnaire. Means and standard deviations were calculated for quantitative variables, while frequency and percentage for qualitative variables.

One multilevel logistic restricted iterative generalized least square (RIGLS) model was applied to all sites to determine the variables associated with the presence or absence of gingival bleeding at the sites investigated. A two-level model was used, with patient and site as levels. The outcome variable was the presence of gingival bleeding. At the patient level, the predictor variables were as follows: gender, age (years), smoking habits (yes or no), tooth brushing frequency per day and flossing frequency per day, while at the site level they were: type (incisors, premolars, molars), side (right *vs*. left), maxillary or mandibular arch, interproximal sites *vs*. other, lingual *vs*. buccal surfaces. A similar multilevel logistic model was applied using the presence of dental plaque as the outcome variable.

Pearson's correlation coefficient was calculated to estimate the association between VAS-B and FMBS (perceived *vs*. observed gingival bleeding), and VAS-OH and FMPS (perceived *vs*. observed plaque removal efficacy). A logistic model was also used to evaluate the patients' perception of gingival bleeding, i.e., whether the patient had correctly identified BoP sites as bleeding. In this model the outcome variable was the correct perception of the presence of gingival bleeding. A two-level model was used, with patient and site as levels. The explicative variables were the same as those considered in the previous models.

A similar multilevel logistic model was applied using the correct perception of the presence of dental plaque as outcome variable, i.e., whether the patient had correctly identified plaque sites as having plaque.

The significance level was set at 0.05. The statistics software used was JMP v. 13 (SAS Institute Inc, Cary, NC, USA) and MLWin v. 3.05 (Centre of Multilevel Modelling, University of Bristol, UK).

RESULTS

Participants

One hundred consecutive patients were invited to participate in this epidemiological study. All patients agreed and signed the informed consent form. Data from all participants were recorded and analysed.

Descriptive data

The mean patient age was 44.1 (14.0) years (from 18 to 77 years), 68 (68%) were females, and 29 (29%) were smokers. The participants brushed their teeth 2.3±0.6 times/day, and flossed their teeth 0.8±0.6 times/day. VAS-B was 2.4±2.3 and VAS-OH 6.6±1.7. FMBS was 6.1±5.0 and FMPS 43.3±12.5.

A total of 16770 sites were examined on 2795 teeth. The total number of BoP sites was 1013 (6.0%), of which 77 (7.6%) were recognized by the participants as bleeding sites. The total number of sites with plaque was 7257 (43.3%), of which 1560 (21.5%) were recognized by the patients as having plaque.

Outcome data/main results

Correlations between VAS and clinical registrations

A fair correlation was observed between bleeding perception and FMBS. The correlation coefficient between VAS-B and FMBS was 0.51 (95%CI from 0.35 to 0.64, P <0.0001). A weak negative correlation was observed between the score that patients gave themselves on the effectiveness of their oral hygiene manoeuvres and the presence of dental plaque. The correlation coefficient between VAS-OH and FMPS was -0.25 (95%CI from -0.42 to -0.05, P = 0.0134).

Factors associated with presence of BoP and plaque

A multilevel logistic model was applied to determine the variables associated with the presence of BoP at all sites. Odds ratios of the factors associated with the presence of bleeding are reported in **TABLE 1**. BoP was more common at mandibular versus maxillary sites (P <0.0001), molar versus incisor sites (P <0.0001), premolar *versus* incisor sites (P <0.0001), and non-interproximal (P <0.0001) and lingual sites (P <0.0001).

A multilevel logistic model was also applied to verify the variables associated with the presence of plaque at all sites. Odds ratios of the factors associated with the presence of plaque are reported in **TABLE 2**. Plaque was more common at mandibular *versus* maxillary sites (P

TABLE 1 RESULTS OF THE MULTILEVEL LOGISTIC REGRESSION ANALYSIS OF PRESENCE OF BLEEDING ON PROBING

	Odds ratio	95%CI	P-value
Gender (male)	1.03	0.99; 1.07	0.1557
Age (years)	1.00	0.98; 1.02	0.6892
Brushing	0.82	0.57; 1.18	0.2775
Flossing	0.89	0.58; 1.37	0.5978
Smoker	0.68	0.41; 1.13	0.1331
Maxillary *vs.* Mandibular	0.69	0.59; 0.79	<0.0001
Right *vs.* Left	0.91	0.79; 1.06	0.2188
Premolar *vs.* Incisor	1.63	1.33; 2.00	<0.0001
Molar *vs.* Incisor	4.20	3.51; 5.01	<0.0001
Interproximal *vs.* Non-interproximal	0.75	0.65; 0.86	<0.0001
Lingual *vs.* Buccal	2.50	2.15; 2.90	<0.0001

TABLE 2 RESULTS OF THE MULTILEVEL LOGISTIC REGRESSION ANALYSIS ON PRESENCE OF DENTAL PLAQUE

	Odds ratio	95%CI	P-value
Gender (male)	1.04	0.76; 1.42	0.8050
Age (years)	1.00	0.99; 1.02	0.5050
Brushing	0.84	0.67; 1.06	0.1370
Flossing	0.86	0.66; 1.13	0.2903
Smoker	1.13	0.82; 1.55	0.4561
Maxillary *vs.* Mandibular	0.23	0.21; 0.26	<0.0001
Right *vs.* Left	1.31	1.19; 1.45	<0.0001
Premolar *vs.* Incisor	0.84	0.74; 0.95	0.0045
Molar *vs.* Incisor	1.91	1.70; 2.15	<0.0001
Interproximal *vs.* Non-interproximal	2.82	2.61; 3.05	<0.0001
Lingual *vs.* Buccal	1.25	1.16; 1.34	<0.0001

<0.0001), molar *versus* incisor sites (P <0.0001), incisor *versus* premolar sites (P = 0.0045), and interproximal (P <0.0001) and lingual sites (P <0.0001).

Factors associated with self-perception of bleeding and plaque

Multilevel logistic regression was applied to the patients' perception of bleeding, with reference to the sites that actually displayed bleeding. Odds ratios of the factors associated with the perception of bleeding are reported in **TABLE 3**. In particular, bleeding perception was higher in smokers (odds ratio = 3.67, 95%CI from 1.14 to 11.80, P = 0.0292), at maxillary teeth (OR = 2.33, 95%CI from 1.16 to 4.68, P = 0.0170) and at the front teeth (incisors *vs.* premolars OR = 10.0, 95%CI 3.33 to 25.0, P <0.0001, incisors *vs.* molars OR = 3.03, 95%CI 2.13 to 4.17, P <0.0001). However, there was a discrepancy between the perception of bleeding sites and the sites that actually bled on probing. Specifically, the anterior and upper teeth were perceived as bleeding more than they did, while much less bleeding was perceived at the lower and posterior teeth.

Multilevel logistic regression was used to correlate the patients' perception of plaque with reference to the sites that actually had plaque. Odds ratios of the factors associated with the perception of plaque are reported in **TABLE 4**. Plaque perception was higher at molars *vs.* incisors (OR = 22.38, 95%CI 15.82 to 31.66, P <0.0001) and at incisors *vs.* premolars (OR = 2.86, 95%CI 1.85 to 4.35, P <0.0001) and at lingual sites (OR = 2.60, 95%CI 2.09 to 3.23, P <0.0001). However, the data revealed that there was a poor perception of the presence of bacterial plaque at premolars and incisors (as compared to molars).

Other analyses

The intra-rater agreement yielded an intraclass correlation coefficient (ICC) of 0.72 (95% confidence interval from 0.42 to 0.88), considered as good, for the self-assessment of both bleeding (VAS-B) and oral hygiene (VAS-OH). For tooth-brushing frequency the ICC was 0.91 (95%CI from 0.78 to 0.96) and for flossing frequency the ICC was 0.78 (95%CI from 0.53 to 0.91).

TABLE 3 RESULTS OF THE MULTILEVEL LOGISTIC REGRESSION ANALYSIS OF BLEEDING PERCEPTION

	Odds ratio	95%CI	P-value
Gender (male)	0.71	0.20; 2.44	0.5825
Age (years)	0.99	0.95; 1.04	0.6956
Brushing	1.18	0.49; 2.83	0.7114
Flossing	1.20	0.43; 3.37	0.7246
Smoker	3.67	1.14; 11.80	0.0292
Maxillary *vs.* Mandibular	2.33	1.16; 4.68	0.0170
Right *vs.* Left	0.54	0.28; 1.03	0.0629
Premolar *vs.* Incisor	0.10	0.04; 0.30	<0.0001
Molar *vs.* Incisor	0.33	0.24; 0.47	0.0027
Interproximal *vs.* Non-interproximal	1.21	0.63; 2.96	0.5665
Lingual *vs.* Buccal	1.25	0.62; 2.52	0.5315

TABLE 4 RESULTS OF THE MULTILEVEL LOGISTIC REGRESSION ANALYSIS OF PLAQUE PERCEPTION

	Odds ratio	95%CI	P-value
Gender (male)	0.56	0.21; 1.52	0.2558
Age (years)	0.96	0.93; 1.00	0.0581
Brushing	1.88	0.91; 3.89	0.0895
Flossing	0.81	0.34; 1.90	0.6251
Smoker	0.85	0.31; 2.32	0.7562
Maxillary *vs.* Mandibular	0.85	0.60; 1.21	0.3684
Right *vs.* Left	0.82	0.60; 1.12	0.2159
Premolar *vs.* Incisor	0.35	0.23; 0.54	<0.0001
Molar *vs.* Incisor	22.38	15.82; 31.66	<0.0001
Interproximal *vs.* Non-interproximal	1.10	0.87; 1.38	0.4356
Lingual *vs.* Buccal	2.60	2.09; 3.23	<0.0001

DISCUSSION

Understanding how the perception of health and oral hygiene influences the efficacy of home hygiene manoeuvres could be useful for the prevention of periodontal disease through targeted approaches[36,37]. Hence, this study aimed to investigate how patients rate their degree of home oral hygiene, and whether they can in fact recognize a state of gingival inflammation.

There were no statistically significant correlations between the presence of bleeding and any of the main variables considered (gender, age, smoking habit, brushing frequency and interdental cleaning frequency). However, sites at the lower teeth, non-interproximal areas and the lingual side demonstrated more bleeding on probing. Molars and premolars displayed significantly more bleeding on probing than the incisors.

There was a correlation between self-perception of periodontal tissue bleeding and FMBS. However, the presence of bleeding was underestimated, with only 7.6% of bleeding-on-probing sites being perceived as bleeding sites by the patients. This result is in line with those reported by Tervonen and Knuttila (1988) and Kallio et al. (1994), who observed that perception of gingival bleeding is generally poor, and that the majority of patients did not recognize it[24,38].

There was a large discrepancy between the perception of bleeding sites and sites that bled on probing. This discrepancy seems to depend largely on visibility, and leads patients to indicate the most visible sites as bleeding. Indeed, among the sites that actually bled on probing, the molars and premolars were less likely to be perceived as such than the incisors, and the lower teeth sites than the upper sites.

Periodontal diseases are usually not painful, and bleeding from an inflamed site seems to be the first symptom of these conditions and also the most reliable indicator of disease[39]. Therefore, patients should be educated and informed of the clinical significance of gingival bleeding, not only if found during the physical examination, but also if perceived or observed by patients. The issue may also be used to improve motivation and compliance in oral hygiene.

The main variables considered (gender, age, smoking habit, brushing frequency and interdental cleaning frequency) displayed a not statistically significant association with the presence of plaque. Mandibular teeth, right teeth, interproximal sites and lingual surfaces more often

had dental plaque; incisors displayed significantly more plaque than premolars, and molars significantly more plaque than incisors.

Several other studies have shown that self-esteem and confidence in one's abilities (self-efficacy) are predictors of better oral health[12,40,41], and we found a weak negative correlation between self-perceived efficacy of home dental hygiene and FMPS. Specifically, only 21.5% of the plaque sites were perceived as such by the patients. Among the sites that actually had plaque, it was less likely to be perceived at the premolars than at the incisors, and at the incisors than at the molars. In addition, plaque was less often perceived on buccal surfaces than on lingual surfaces. This indicates that patients tend to underestimate the presence of bacterial plaque at sites deemed easier to clean, like premolar or buccal sites.

The results of the test–retest analysis validated the questionnaire items, which were considered reliable and repeatable.

The limitations of the present study mainly concern the sample selection. Specifically, participants were generally motivated patients with a periodontal maintenance plan. Hence, the results require confirmation in samples of different populations to be generalizable.

CONCLUSIONS

A fair correlation was observed between bleeding perception and FMBS. However, there was a discrepancy between the perception of the bleeding sites and the sites that actually bled on probing: the anterior or upper teeth were perceived as bleeding more, while much less bleeding was perceived at the lower and posterior teeth.

A weak negative correlation was observed between patients' oral hygiene self-report scores and the observed presence of dental plaque; patients perceived low bacterial plaque at premolars and incisors, as compared to molars.

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