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ORIGINAL ARTICLE

Investigation of the prevalence, clinical features, and risk factors of dentin hypersensitivity in a selected Brazilian population

Taís Scaramucci · Taciana Emília de Almeida Anfe · Stella da Silva Ferreira · Antônio Carlos Frias · Maria Angela Pita Sobral

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Abstract
Objectives To evaluate the prevalence, clinical features, and risk factors of dentin hypersensitivity (DH) in a Brazilian population.
Materials and methods 300 patients at the Dentistry Clinic of the University of São Paulo participated in this study. The subjects completed a questionnaire regarding their personal information, the presence of DH, and some of its risk factors. Following completion of the questionnaire, a clinical examination was undertaken. To confirm the presence of DH, the subjects were evaluated with the use of a probe and cold air from a triple syringe. Statistical analysis was performed with the chi-square test and odds ratio, with the critical level $p < 0.05$.
Results The prevalence of DH was 46 %. Females presented a higher prevalence than males ($p < 0.05$). The left posterior region was affected by DH the most (maxilla=41 % and mandible=36 %). Cold was reported as the most common pain-inducing stimulus (88 %). The pain was described as "discomfort" by 51 % of the subjects with DH. Toothbrushing four times a day ($p < 0.05$), toothbrushing with excessive force ($p < 0.05$), bruxism ($p < 0.05$), and gastroesophageal reflux ($p < 0.05$) were strongly correlated with DH.
Conclusions The prevalence of DH was particularly high. The risk factors for DH were gender (female), toothbrushing four times a day, toothbrushing with excessive force, bruxism, and gastroesophageal reflux.
Clinical relevance DH was a common finding in this population suggesting that preventive measures considering its risk factors must be implemented in order to reduce or control the symptoms.

Keywords Dentin hypersensitivity · Prevalence · Clinical features · Risk factors · Tooth wear · Non-carious cervical lesions

T. Scaramucci (✉) · T. E. de Almeida Anfe · S. da Silva Ferreira · M. A. P. Sobral
Department of Restorative Dentistry, School of Dentistry, University of São Paulo, Av. Prof. Lineu Prestes 2227, 05508-900 São Paulo, SP, Brazil
e-mail: tais_sca@hotmail.com

A. C. Frias
Department of Social Dentistry, School of Dentistry, University of São Paulo, São Paulo, Av. Prof. Lineu Prestes 2227, 05508-900 São Paulo, SP, Brazil

Introduction

A non-carious cervical lesion is the loss of tooth structure at the cement–enamel junction, not related to caries [1]. This event is of a multifactorial origin [2], where erosion, abrasion, and abfraction are known to play important roles [3]. Frequently, the non-carious cervical lesion is associated with DH, which is defined as a short, sharp pain that is originated from the exposed dentin in response to thermal, tactile, osmotic, chemical, or evaporative stimuli that cannot be attributed to any other form of dental disease or defect [4].

The epidemiological data about the prevalence of DH can vary widely according to the population and the design of the study [5]. In some studies, the prevalence of DH can be as high as 74 % [6]; however, in other investigations, it appears to be only about 4 % [7, 8]. The prevalence of DH may be influenced by the population's oral hygiene habits as well as the consumption of acidic foods and drinks [5]. In addition, it was observed that patients from a specific specialist practice, such as periodontology, tend to show a higher prevalence of DH (84 %) due to the greater risk of root exposure as a result of the loss of attachment and gingival recession [9]. In relation to the study design, some studies are based only on

a questionnaire [10–12], where subjects are asked to self-report the presence of DH. Usually, the prevalence found in these studies is high, as the 50–55 % reported by Gillam et al. [10] and Clayton et al. [11] and the 68.4 % reported by Bamise et al. [12]. Other studies evaluated the self-reported DH as well as the DH that is diagnosed with a clinical exam [5, 13–18]. The examination of the patients generally yields lower prevalence values (2.8–42.4 %). The overestimation of the magnitude of DH found in questionnaire-based investigations can be related to the patient's difficulty in determining the cause of the pain that they are experiencing. In some cases, they may mistakenly attribute their pain to DH when in fact it is caused by another dental disease, such as caries [5]. Moreover, according to Fischer et al. [13], epidemiological studies should also investigate the relation of DH with its possible causative factors, such as dental erosion, in order to suggest the appropriate preventive measures for that specific population.

To the author's knowledge, there are only a few reports about the prevalence of DH in Brazilian populations [13]. In the last few decades, a change in the habits of people worldwide has been observed with an increase in the consumption of acid drinks [19] and a greater concern about oral hygiene [20]. These changes might have an impact in the prevalence of DH [20] and supports the current need for more recent investigations. Thus, the aim of this study was to evaluate the prevalence, clinical features, and risk factors of DH in a Brazilian population. The study was carried out at the Restorative Dentistry Clinic of the School of Dentistry, University of São Paulo.

Materials and methods

Ethical aspects and sample selection

The study protocol was approved by the local Ethics Committee in Research (School of Dentistry, University of São Paulo, process no. 163/08). This investigation was a cross-section and single center study conducted at the Dental School Clinic of University of São Paulo. The aims of this investigation and all the procedures involved were explained to each subject, who had to sign a written informed consent prior to the study. To be included in the study, subjects had to be 18 years of age or older and in good health. The exclusion criteria were based on the studies of Clark and Troullous [21] and Gillam et al. [22], and included the presence of any chronically debilitating disease or any chronic disease related to daily pain episodes, such as arthritis; having periodontal surgery, or scaling and root planning procedures less than 6 months before the evaluation; non-collaborating patients; any disease requiring analgesic drugs, tranquilizers, or mood-altering medication; and the use of orthodontic appliances.

Sample size determination

The sample size determination was performed with the formula described in Naing and Rusli [23], considering a 95 % level of confidence and a precision of 5 %. For the calculation, it was considered the 17 % prevalence of DH obtained in the study of Fischer et al. [13], which was the only data found for Brazilian population at the time of the elaboration of the study design. According to the calculation, a sample size of 227 subjects would allow the determination of the population prevalence with a good precision.

Data collection and oral examination

Data collection and oral examinations were conducted by three investigators previously trained to diagnose DH (T.S., T.E.A.A., and S.S.F.). The consistency among the investigators was tested prior to the beginning of the study through the evaluation of a small percentage of subjects, which were re-evaluated in a second time by a different investigator. A standard κ test was performed to evaluate this data, obtaining κ values in the range of 0.713–0.806, which represents a substantial agreement.

A questionnaire regarding the personal information (name, age, and gender), the presence of DH, its related factors (type of sensitivity, trigger stimuli, degree of pain, location of the sensitive teeth, and treatment attempts), and its causative factors (frequency of toothbrushing, bristle hardness, use of excessive force during toothbrushing, daily consumption of acidic foods and drinks, presence of gastro-esophageal reflux, frequent vomiting, and bruxism) was read to the subjects and the answers were recorded. The questions about the characteristics of DH were asked only of the subjects who reported having DH.

All subjects were submitted to a clinical exam, which was performed on all teeth, except the third molars. In this exam, the number of teeth, the presence of dental caries, and restorations were also recorded. The teeth with any of the following conditions were not included in the evaluation of DH: caries, root-filled, crowns, and abutment for dentures and bridge work [15].

The patients who reported having DH were submitted to a specific DH evaluation, using tactile and cold-air stimulation. The tactile stimulus was performed with a probe, which was applied with slight pressure perpendicular to the cervical region (buccal and lingual) of all the teeth in a mesial-distal direction, in order to identify any sensitive area. If DH was detected, subjects had to rank their pain according to the following scale: 1—discomfort, 2—moderate pain, or 3—strong pain. Ten minutes after the tactile stimulus, the response of the subject to cold-air sensitivity was assessed using a dental air syringe applied perpendicular to the cervical region of the tooth, at a distance of approximately 1 cm

for a period of 3 s [16]. The surrounding teeth were isolated during testing using the investigator's fingers. Again, if DH was detected, patients were asked to rank their pain according to the previously described scale.

After the evaluation, the subjects with hypersensitive teeth received instructions from the investigators in order to minimize DH symptoms, such as substituting their regular dentifrices for sensitivity dentifrices. Furthermore, they received a clinical treatment for this condition using the product Sensi Kill (DFL, Rio de Janeiro, RJ, Brazil).

Statistical analysis

Frequency distribution and cross-tabulation tables were constructed using the Epinfo 7™ Software (Center for Disease Control and Prevention, Atlanta, GA, USA). Associations between discrete variables were tested by the odds ratio, considering a 95 % confidence interval, and by the chi-square test, with a p value of <0.05 as significant.

Results

Three hundred subjects were eligible to participate in this study. The age of subjects ranged from 18 to 77 years old, with a mean age (±SD) of 40.42 years (±13.75). Of the 300 subjects, 179 (60 %) were females and 121 (40 %) were males. The prevalence of DH was found to be 46 %, affecting almost half of the subjects (139). The left side of the mouth was most frequently affected by DH (maxilla=41 % and mandible=36 %). Cold was reported as the most common pain-inducing stimulus (88 %), followed by air (68 %), toothbrushing (42 %), sweets (34 %), and heat (25 %). Seventy-one subjects with DH (51 %) described their pain as just a discomfort, while 57 (41 %) stated that they experienced moderate pain. Only 10 subjects (7 %) described their pain as a strong. The 139 subjects with DH presented a total of 981 sensitive teeth, with an average of 7 sensitive teeth per subject. Four hundred twenty-eight of these teeth (44 %) were sensitive when stimulated with the probe and 859 (87 %) were sensitive due to the air from the syringe. Thirty-seven subjects with DH (27 %) had tried to treat this condition with the use of desensitizing toothpastes. Fourteen subjects (10 %) opted for another treatment alternative, such as fluoride, in-office products, and laser. The remaining 88 subjects with DH (63 %) had never tried any treatment for the condition.

Table 1 presents the DH distribution data according to gender and age. Of the 139 subjects with DH, 100 were women and 39 were men, giving a female to male ratio of 2.66 (p <0.01). No association could be observed between DH and any of the different age groups of the study. Regarding the frequency of toothbrushing (Fig. 1), 4 subjects with DH (3 %) reported to brush their teeth only 1 time/day, 40 subjects (29 %) brushed 2 times/day, 73 subjects (52 %) brushed 3 times/day, and 20 subjects (14 %) brushed 4 times/day. Two subjects with DH (2 %) could not estimate how many times they brush their teeth a day. The subjects who brush their teeth four times a day had a significantly greater risk of DH. Seventy-one patients with DH (51 %) stated that they use soft brushes for toothbrushing, 59 patients (42 %) use medium brushes, and only 8 subjects (6 %) reported the use of hard brushes. One patient did not know the type of brush that he/she uses. It was not possible to establish a relation between the hardness of different brush bristles and the presence of DH (Fig 2). Of the subjects diagnosed with DH, 74 (53 %) admitted to brushing their teeth applying excessive force, 56 (40 %) reported to have bruxism, 34 (24 %) stated that they were diagnosed with gastroesophageal reflux, and 5 (3 %) had frequent vomiting. Figures 2 and 3 show that brush-applying excessive force, bruxism, and gastroesophageal reflux were found to be risk factors for DH, while no relation was found between DH and frequent vomiting, and between DH and the consumption of acidic foods and drinks (Figs. 3 and 4).

Discussion

The prevalence of DH found in this study was 46 %, which is much higher than the 17 % diagnosed in 1992 by Fischer and

Table 1 DH and its relation with gender and age (n=300, where 139 subjects were diagnosed with DH)

Presence of DH	Gender		Age		
	female	male	18–30	31–60	>60
Yes	100 (56 %)	39 (32 %)	37 (41 %)	69 (51 %)	33 (43 %)
No	79 (44 %)	82 (68 %)	52 (58 %)	65 (49 %)	44 (57 %)
Total	179	121	89	134	77
Odds ratio	2.66		0.76	1.45	0.82
(CI)	(1.64–4.31)		(0.46–1.25)	(0.92–2.30)	(0.49–1.39)
X^2	15.28		0.89	2.23	0.33
p values	0.00009		0.34357	0.13527	0.56395

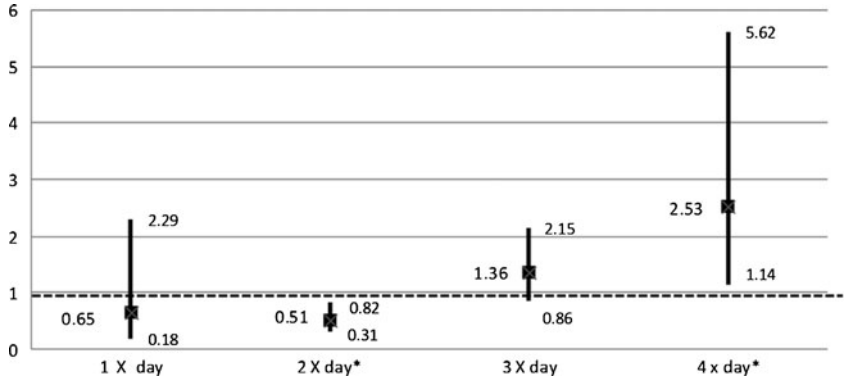

Fig. 1 Odds ratio with 95 % confidence intervals for DH and frequency of tooth brushing (per day). *Asterisk* (*) imply significant difference

colleagues [13] in an investigation also performed in Brazil. Although both studies concerned different Brazilian populations, one from a Dental School and the other from a Marine Dental Clinic, it is undeniable that nowadays, individuals are retaining their natural dentition for a longer period of time in their mouths in comparison to past years and, as consequence, the deleterious effects of tooth wear are becoming more evident. Thus, this increase in the prevalence of DH may be a reflection of this fact. Similar to our results, Liu et al. [14] and Taani and Awartani [15, 24] also found a high prevalence of DH (ranging from 32 to 53 %) in a population from a hospital and from a general practice, respectively. Both investigations were also comprised of a questionnaire and a clinical exam to confirm the presence of DH.

In agreement with previous investigations [13, 16, 24], this study showed that women were more at risk for DH than men. This fact may be related to the observations that DH is strongly associated with gingival recession and low plaque scores and women tend to demonstrate better oral hygiene care than men [25, 26]. Thus, it may be suggested that the individual's oral hygiene habits, mainly toothbrushing, are important factors in the development of DH. Different from previous studies [8, 22] that found a peak in DH prevalence in certain age groups; in this investigation we were not able to observe any association between DH and age.

Regarding DH clinical features, it was observed that the left side of the mouth was most frequently affected by DH. Since it is known that right-handed subjects tend to brush more on the left side of the mouth [25], and assuming that most of the patients participating in this study were right-handed, it seems that toothbrushing abrasion may indeed be an important component in the development of DH [27]. Corroborating this concept, in the present study, it was found that subjects who brush their teeth four times a day, as well as subjects who apply excessive force during toothbrushing, may have more risk for DH. Also concerning toothbrushing, we could not find any association between the hardness of different brush bristles and DH. Although differences between the populations must not be disregarded, this result is in contrast with the study of Bamise et al. [12], in which DH

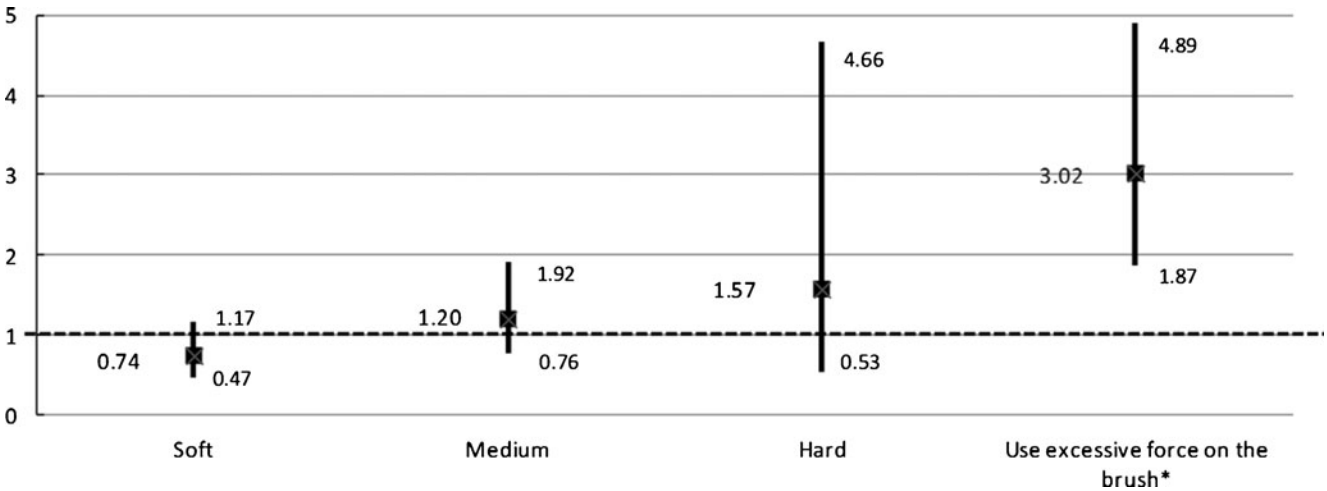

Fig. 2 Odds ratio with 95 % confidence intervals for DH and hardness of brush bristles and DH and brushing with excessive force. *Asterisk* (*) imply significant difference

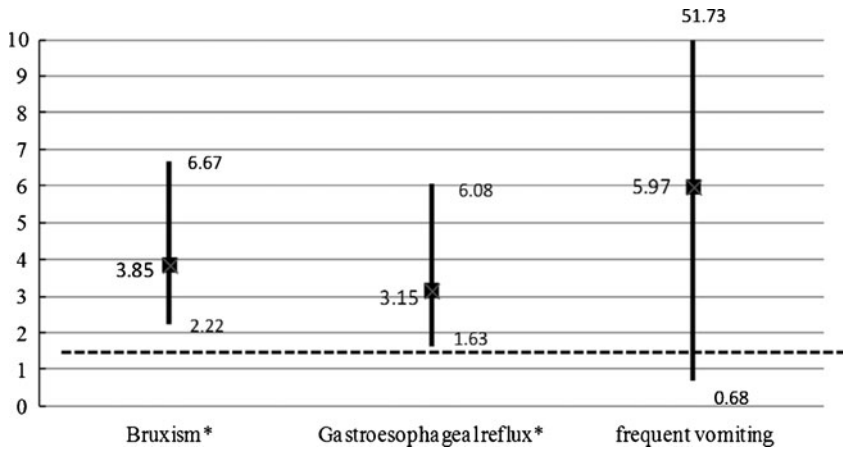

Fig. 3 Odds ratio with 95 % confidence intervals for DH with bruxism, gastroesophageal reflux, and frequent vomiting. *Asterisk* (*) imply significant difference

was strongly associated with subjects who used hard brush bristles for toothbrushing.

In agreement with most of the DH investigations [12, 13, 16, 22, 28], cold was reported as the most common pain-inducing stimulus. According to the hydrodynamic theory proposed by Brännström [29], the pain in DH occurs due to a stimulation of nociceptors located on the dentin–pulp interface, as a result of an inward or outward movement of the fluid within the dentinal tubules. This movement can be caused by tactile, thermal, or chemical stimuli applied to the exposed dentin surface. It is speculated that cold stimulus causes a rapid and intense fluid flow away from the pulp, which will result more often in pain sensation in comparison to other stimulus, such as heat [30]. Most subjects described their pain as just a mild discomfort, but moderate pain was also frequently reported. Although the subjects did not consider DH a strong pain sensation, 37 % of them felt extremely uncomfortable with this sensation and have already searched for treatment, mainly by the use of desensitizing toothpaste (27 %). Similar findings were also reported by Fischer et al. [13], who observed that 32 % of the patients with DH had tried desensitizing toothpastes as treatment. It should be pointed out that the pain evaluation in our study was performed with a simplified score system, based on a descriptive category scale, since the intention was only to give an overview of the degree of sensitivity in that population.

Despite not being an exact reproduction of daily life stimuli [14], in this investigation, the evaporative/cold stimulus showed to be a better method to detect hypersensitive teeth than the tactile stimulus, as a greater number of teeth were sensitive to the air from the syringe in comparison to the probe. This is in agreement with previous reports on the literature [13, 14] and according to Absi et al. [31], it may have occurred because usually, only a small area of the exposed dentin is sensitive, and if the probe did not touch this area, the subject will probably not respond.

Bruxism and gastroesophageal reflux were also strongly associated with DH. Ommerborn et al. [32] found a higher prevalence of non-carious cervical lesions in subjects with bruxism. Since non-carious cervical lesions are also frequently associated with DH, this could explain the greater risk for DH found in this study for subjects with bruxism. It has been well established that gastroesophageal reflux and frequent vomiting may cause dental erosion [33], due to the contact of the hydrochloric acid with the tooth structure. In addition, previous investigations have shown that erosive

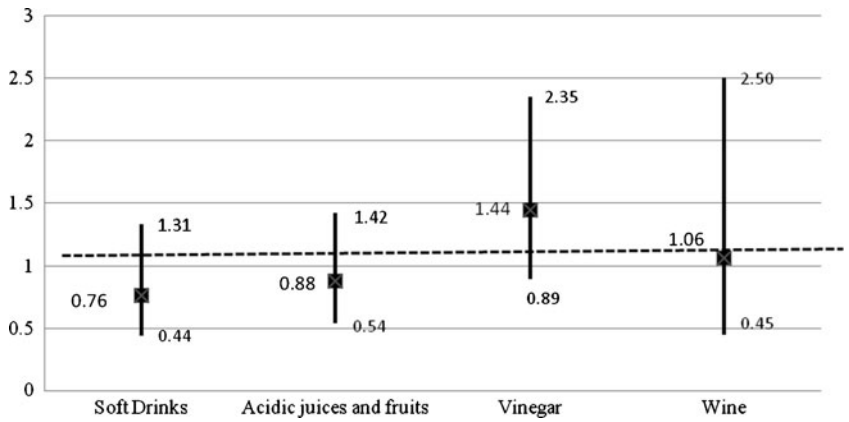

Fig. 4 Odds ratio with 95 % confidence intervals for DH with consumption of acidic foods and drinks. *Asterisk* (*) imply significant difference

acids can dissolve the smear layer and open dentin tubules, thus leading to DH [34, 35]. In this sense, it is not clear why we could not find a significant association between DH and the consumption of acidic foods and drinks and between DH and frequent vomiting. Nevertheless, it must be taken in account that erosion has a complex multifactorial etiology, therefore, other biological and behavioral parameters can play a role modifying the effect of acidic agents on the tooth [33], and this was not assessed in the present investigation. Perhaps it would be an interesting idea for future studies to collect more detailed data about these factors, such as the frequency of consumption of acidic foodstuff, which could help us to better explain the results.

In conclusion, the prevalence of DH found in this investigation was 46 %, suggesting that it is relatively common in this population. Gender (female), toothbrushing four times a day, toothbrushing using excessive force, bruxism, and gastroesophageal reflux were found to be important risk factors for DH. Different from other investigations, the hardness of the brush bristle and the consumption of acidic foods and drinks could not be associated to the presence of DH. Since the results concerning the prevalence and risk factors of DH in the literature are conflicting, further epidemiological investigations in this field are still needed in order to identify with accuracy the risk factors and implement the most suitable preventive measures.

Conflict of interest The authors declare that they have no conflict of interest.

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