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ORIGINAL ARTICLE

The use of medium bristle toothbrushes is associated with the incidence of gingival fissures

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Abstract

Objectives The objective of this study was to compare the incidence of gingival fissures (GF) associated with the use of soft and medium bristle toothbrushes over three months.

Material and methods A blind randomized crossover clinical trial was conducted with 20 high school students (14 females, 14–24 years old) using both toothbrushes type (soft and medium bristle) during 3 months each. Periodontal examinations and photographs of premolars and molars were recorded on days 0, 30, 60, and 90 of 1st phase. Following a 10-day washout period, the 2nd phase was carried out with the participants changing the assigned brush type. Toothbrushing perception was evaluated at the end of study through a questionnaire. A calibrated and blind examiner analyzed the photographs for GF presence. Differences in the GF incidence between toothbrushes type were analyzed by McNemar test, while factors associated with GF incidence were investigated by Poisson regression.

Results Sixty-five percent ($n=13$) of participants had at least one GF throughout the study, with 40% ($n=8$) of them while using medium brushes only ($p=0.039$). GF occurrence was significantly associated with medium brushes (IRR, 3.582; 95% CI 1.459–8.795; $p=0.005$). 58.8% of participants reported gingival soreness or bleeding with medium brushes.

Conclusions Both toothbrushes led to the GF occurrence. Nonetheless, medium bristles toothbrushes determined a 3.58 times greater risk of developing these lesions.

Clinical relevance

The use of medium bristle brush is associated with greater incidence of gingival fissures. The presence of gingival fissures should be considered by the clinician when evaluating the toothbrushing habits of patients.

Keywords Oral hygiene · Toothbrushing · Gingival fissures · Clinical trial

Introduction

Gingival recessions (GR), for the most part, are the result of the periodontitis progression. Consequently, GR increase in prevalence and severity with the progression of the disease over time [1, 2]. The second leading cause of GR, especially in periodontal healthy individuals, is associated with established traumatic oral hygiene habits [3–7]. Both toothbrushing and the use of instruments for interproximal cleaning have been related with GR [4, 8, 9]. Interestingly, epidemiological studies reported an increase in the prevalence of young individuals with GR present mainly on the buccal surfaces of teeth with gingival health [10–12].

Gingival abrasions (GA) and gingival fissures (GF) have been identified as precursor injuries to recessions, although there is still a need for better evidence [13, 14]. GF are

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defined as grooves or notches present at the gingival margin [15], and having traumatic brushing as one of the main causal factors [16]. In the pathogenesis of GF, the traumatic factor would initially act by disrupting the oral epithelium, leading to an inflammatory response of the underlying connective tissue, resulting in the loss of continuity and consequent formation of the fissure [17, 18]. The presence of GA and GF has been associated with the hardness of the brush bristles, the inadequate technique, the high frequency, and/or the time spent on brushing [5, 19–23].

It is evident from the results of these studies that the hardness of the brushes is an important factor in traumatic brushing. In this sense, it would be important to compare brushes with different degrees of hardness being used for 3 months, a period usually recommended for changing brushes [24, 25]. Therefore, the aim of this study was to compare the incidence of GF associated with the use of soft and medium brushes over 3 months.

Material and methods

Study design and ethical considerations

The study was a blind randomized crossover clinical trial of 6 months' duration. The randomization occurred at day 0, followed by the 1st phase (3 months), a washout period of 10 days, and finally the 2nd phase (3 months).

The Ethics Committee of the Federal University of Rio Grande do Sul approved the study protocol, and all participants or their parents signed a free and informed consent form. The study was registered at ClinicalTrials.gov (#NCT03367481), and this manuscript follows the CONSORT guidelines [26].

Sample

Students from the High School Colégio Tiradentes of the State Military Corporation (Porto Alegre, RS, Brazil) participated in the study, which was conducted between the months of April and December 2019.

Sample size: the calculation was based on the study of Greggianin et al. [23]. Considering a mean difference of 5.7% participants presenting GF between the experimental groups (medium brushes versus soft brushes), an variance of 8, an 80% power and an alpha error of 5%, it was established the need to include 18 individuals (G*Power 3.1 software). However, 20 participants were involved in the study, assuming an attrition rate of 10%.

Eligibility criteria: the study included individuals of both sexes, aged between 14 and 24 years, who had good systemic health, and a negative history of periodontitis (absence of loss of interproximal attachment ≥ 3 mm). The study did not include students who were smokers or pregnant, used orthodontic appliance, or presented abnormal arrangement of teeth or malocclusion, had dental implants, had caries lesions or restorations in the vestibular cervical region, and/or who needed antibiotic prophylaxis for dental examination.

Data collection

Examinations were performed in a dental office at Policlínica Bananeiras belonging to the State Military Corporation and located contiguous to Colégio Tiradentes.

Interview: at the baseline (day 0), an interview was conducted in which the participants answered a questionnaire about their oral hygiene habits related to the frequency, time and predominant brushing technique; type of brush used; use of interproximal cleaning devices; as well as which was the dominant hand in brushing; and smoking and onychophagy habits.

Periodontal examination: periodontal clinical examination was performed for all teeth present, except for the 3rd molars: plaque index (PlI) [27] and gingival index (IG) [28], in 3 buccal sites (mesio-buccal, buccal, disto-buccal); periodontal probing depth (PPD), bleeding on probing (BOP), and clinical attachment loss (CAL), at 6 sites/tooth. PPD and CAL were measured in millimeters and, when necessary, rounded up to the upper millimeter, using a Williams-type probe (Neumar Instrumentos Cirúrgicos, São Paulo, Brazil). An examiner (AVF), blinded to the type of brush used, performed all the periodontal exams of the study.

Calibration: prior to the beginning of the study, the examiner (AVF) was trained for assessments of PlI and GI and calibrated for the examinations of PPD and CAL. Reproducibility for PPD and CAL measurements was performed by repeated exams in 10 individuals with an interval of at least 1 h. The intra-class correlation coefficient reached values higher than 0.9 for both PPD and CAL.

Clinical photographs: GF were evaluated using clinical photographs [29]. In detail, after periodontal examinations, all teeth received, with the aid of a cotton swab, topical application of a disclosing plaque solution (2Tone®, Young Dental Manufacturing, Missouri, USA) for 1 min followed by washing with water spray. After isolation with cotton rolls and light drying to remove excess liquids, photographic records of the molar and premolar buccal areas of each quadrant were performed. The photographs were taken with an extra oral digital camera (Nikon D90, Nikon Corporation, Tokyo, Japan) with 105 mm objective lens with Twin flash mounted on a fixed device with a chin and forehead support. In this way, it was possible to maintain the same reference

point and a constant distance from the area in order to minimize image distortions. Pictures were repeated monthly. An examiner (DR), blinded to the type of brush used, made all the photographic records over the study period.

Analysis of gingival fissures: following the completion of the study, the photographs were analyzed for the presence of GF by the blinded and calibrated examiner (DR). The examinations of the photographs were performed with the aid of an image processing software (NK Remote 2.2.3., Breeze Systems Limited, Surrey, UK). The presence of GF was registered whenever a notch or groove, V-shaped lesion was detected, regardless of size, located in the gingival margin at the buccal aspects.

Calibration: the examiner (DR) was trained for photographic records and calibrated for the registration of the GF presence by analyzing 20 random images from the study database and repeating the analysis in an interval of one week. Kappa coefficient was 0.95.

Evaluation of the toothbrushes by participants: at the end of the study, participants were given a questionnaire on the perception of the use of the two brushes.

Experimental design

The study was carried out in two experimental phases of three months duration each, with a washout period of 10 days [23].

At baseline (day 0) periodontal examinations and photographs were performed, and the participants were randomly allocated (1:1 ratio) to one of the two experimental sequences (use of soft-medium brush; use of medium-soft brush) from a random table generated on the website www.random.org.br. A third researcher (PDMA), not involved with data collection, was responsible for the concealment of the distribution, kept the sequence in individual brown envelopes. PlI, GI, and photographs were repeated monthly over the study. On the 90th day, the brushes used were collected, and all individuals were allowed to return to their usual oral hygiene habits for 10 days. The second phase of the experiment reproduced exactly the initial procedures of the first phase, with the participants changing the assigned brush type. On the 190th day, the study was completed.

Daily oral hygiene procedures: the toothbrushes used were multi-tufted, flat head, and rounded bristles tips (Sorriso Original, Colgate-Palmolive®, São Paulo, SP, Brazil). Both types of bristles were made of Nylon 6.0, being different in two aspects: the soft brush had a higher mean number of bristles than the medium (55 vs. 36), whereas the medium presented a larger diameter than the soft one, 0.25 mm and 0.20 mm, respectively. Throughout the study, all participants used the same non-therapeutic MFP-toothpaste (Sorriso Dentes Brancos 90 g, Colgate-Palmolive®, São Paulo, SP, Brazil). Brushes and toothpastes, from the same batch, were purchased in the local market by the researchers. Participants were recommended to maintain their usual oral hygiene habits. All participants received written and verbal instructions about not sharing the toothbrush with family members, use only the toothbrush and toothpaste provided, and returning the toothbrush used at the end of each phase.

Stop rule: the participants were questioned monthly throughout the study on complaints and eventual adverse effects. In order to protect the participants, in the event of detecting GF $\geq$ 3 mm, the treatment would be interrupted, and the participants monitored until the lesion regressed.

Analysis of the data

The primary outcome of the study was GFs incidence over 3 months of use of soft and medium toothbrushes. Data analyses were conducted by using intention-to-treat strategy.

For descriptive analyses, means ($\pm$ standard deviation) or frequencies (percentages) were calculated for numeric and categorical variables, respectively. Also, PlI and GI were dichotomized, respectively, into visible plaque index (VPI) and gingival bleeding index (GBI) considering the scores 0 and 1 as absence and the scores 2 and 3 as presence.

McNemar test was used to identify differences on distribution of patients that presented at least one new GF during the 3 months of use of both toothbrushes as well as to compare the cumulative distribution of examining sessions where the patients presented at least one new GF when using the tested toothbrushes.

Poisson regression models, by generalized estimating equation, were conducted to investigate the association between the incidence of at least one new GF over time and the following independent variables: toothbrushing type, experimental examination, self-reported toothbrushing frequency and technique, VPI on buccal site, and mean CAL on buccal site. Those independent variables that presented p value < 0.250 at crude model were taken to multivariate model. No significant interactions were observed.

Additionally, the existence of carry-over effect was assessed comparing the incidence of GFs between 1st and 2nd phases of the study by Wald test and by the inclusion of the variable "sequence" at Regression model.

Lastly, the perception of the participants regarding the use of both types of toothbrushes was descriptively presented by frequencies and percentages.

All the analyses were performed at SPSS software, version 20.0 (SPSS Inc., Chicago, IL, EUA). The participant was the unit of analysis and the significance level was set at 5%.

Results

Twenty individuals were included in the study. However, two participants quit the study already at day 30 of the 1st phase. Additionally, at day 60 of the 2nd phase, another patient left the study. The reasons for these losses are presented in Fig. 1. Notwithstanding, considering the intention-to-treat strategy, data from all 20 participants were used in the study. No one patient was excluded from the study due GFs progression considering the stop rule pre-established.

Characteristics of the sample are presented at Table 1. The mean age was 18.9 ± 2.5 years. Fourteen participants were female. Regarding oral hygiene habits, most part of patients reported to brush their teeth 3 or more times/day ($n = 14$), during 2 or more minutes ($n = 12$), and by using horizontal technique ($n = 14$). Fifty-five percent of the individuals reported to use medium toothbrushes. Dental floss was the most used interdental cleaning method ($n = 13$). All participants were right-handed. Considering the periodontal parameters, the sample was composed by individuals presenting periodontal health, and no significant alterations on VPI and GBI mean percentages were observed overtime (data not shown).

At 1st phase baseline, 4 (22.2%) participants already presented GFs. Among them, 3 individuals reported to routinely use medium toothbrushes. At 2nd phase baseline, GFs were observed in 6 participants, where 4 of them reported to use medium toothbrushes, one did not remember, and another one reported to use soft toothbrushes. Also, among these 6 individuals, 2 of them already presented GF at 1st phase baseline. GFs observed in these situations were not accounted for the GFs incidence of the study.

Thirteen participants (65%) presented at least one new GF during the study (Table 2). Among them, 4 individuals (20%) presented GFs with the use of the two types of toothbrushes, 8 (40%) presented GFs only with the use of medium toothbrush, and one (5%) presented GF only with the use of soft toothbrush. This distribution was significantly different considering the types of brushes ($p = 0.039$).

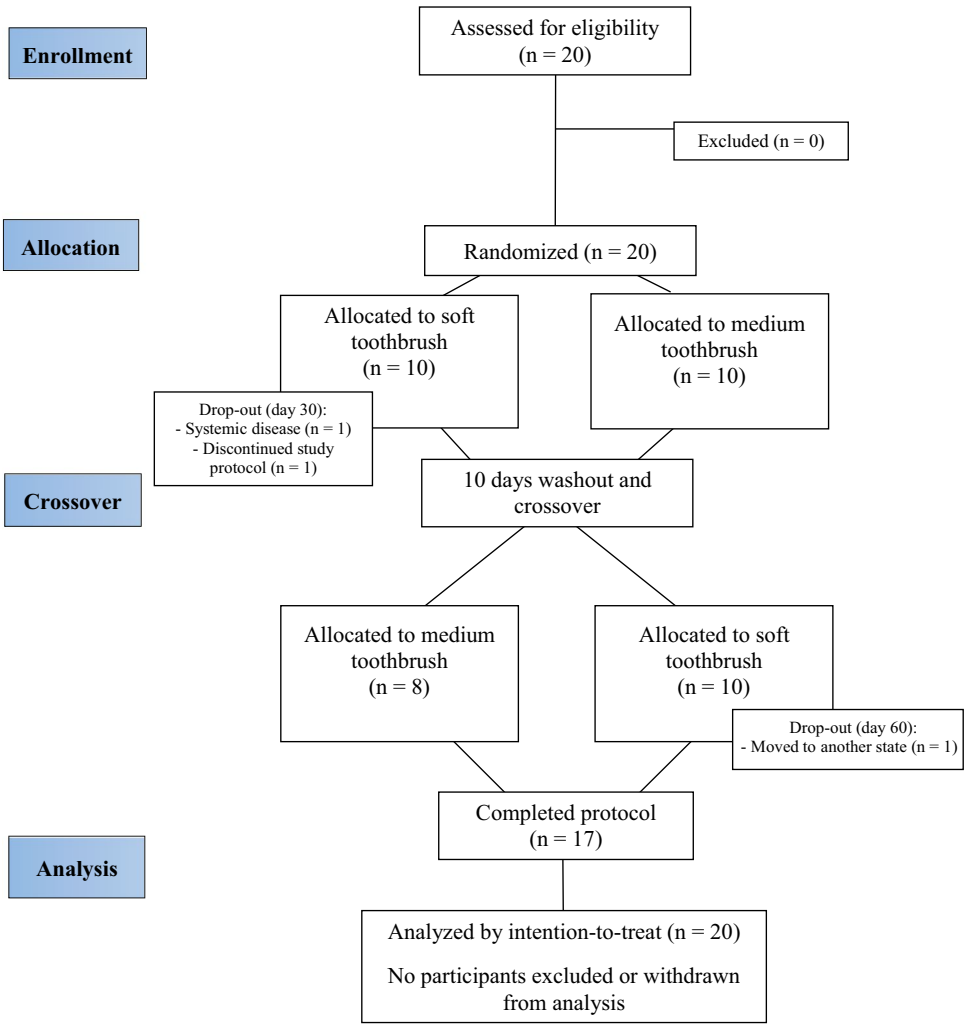

Fig. 1 Study flowchart

Table 1 Characteristics of the participants at baseline (day 0) of the study

Variables	Sample ($n=20$)
Agee (years) †	18.9 ± 2.5
Sex (female) *n* (%)	14 (70.0%)
Self-reported toothbrushing frequency *n* (%)	
Twice/day	6 (30.0%)
3 times/day	12 (60.0%)
> 3 times/day	2 (10.0%)
Self-reported toothbrushing time *n* (%)	
1 min	8 (40.0%)
2 min	2 (10.0%)
> 2 min	10 (50.0%)
Self-reported toothbrushing technique *n* (%)	
Vertical	2 (10.0%)
Circular	4 (20.0%)
Horizontal	14 (70.0%)
Type of toothbrush used *n* (%)	
Extra-soft	1 (5.0%)
Soft	8 (40.0%)
Medium	11 (55.0%)
Self-reported interdental cleaning *n* (%)	
Do not use	6 (30.0%)
Toothpick	1 (5.6%)
Dental floss	13 (65.0%)
Right-handed n (%)	20 (100%)
Visible plaque index (%) †‡	4.89 ± 3.63
Gingival bleeding index (%) †‡	6.40 ± 4.49
Periodontal probing depth (mm) †§	1.64 ± 0.27
Bleeding on probing (%) †§	6.09 ± 4.04
Clinical attachment loss (mm) †§	0.32 ± 0.12
Number of teeth † (range)	27.9 ± 0.49 (26–28)

† mean ± standard deviation; ‡ M-B-D sites/full-mouth; § 6 sites/full-mouth

GFs were not observed in 58.3% of the study examining sessions (35 from 60) (Table 2). Nevertheless, GFs were observed in 31.7% and 6.7% of the examinations related to use of medium and soft toothbrushes, respectively. This difference in the cumulative incidence of GFs in the examining sessions was statistically significant ($p=0.003$).

Figure 2A depicts the number of participants with at least one new GF at each experimental examination over 3 months considering the toothbrushes type. Already at day 30, GFs were observed in 3 vs. 5 participants, respectively, for soft and medium toothbrushes. This examination (day 30) was the peak of incidence for patients using soft toothbrushes, while the next examination (day 60) was the peak of incidence for medium toothbrushes, where 9 patients presented GFs.

Figure 2B illustrates the sum of new GFs at each experimental examination over 3 months of study considering the toothbrushes type. Although both types of brushes determined the appearance of GFs at day 30, the number of lesions was considerably higher when using medium brushes compared to soft brushes (9 vs. 3, respectively). Once again, this examination (day 30) represented the one with the highest cumulative number of new GFs when using soft brushes, whereas for the use of medium brushes, the peak was reached on day 60, when 12 new FGs were observed.

Results of regression analyses are presents at Table 3. According to the crude associations (model 1), the incidence of at least one new GF was significantly associated with medium toothbrushes (IRR, 3.500; $p=0.008$). Plaque accumulation at buccal site showed an association inside the p-value established to be taken to adjusted model (IRR, 2.273; $p=0.179$). All other variables (sex, experimental examination, self-reported toothbrush frequency and technique, and the mean attachment loss at buccal sites) were not significantly associated with the incidence of new lesions. In sequence, the multivariate analysis (model 2) showed no significant association between the incidence of new GFs

Table 2 Distribution of participants presenting at least one new gingival fissure over 3 months of use of soft and medium toothbrushes (A) and cumulative distribution of examining sessions on which the participants presented at least one new gingival fissure over the three months of use of soft and medium toothbrushes (B)

(A) GF incidence over 3 months ($n=20$)

		Medium toothbrush†		
	Participants with new GF	Absent	Present	*p* value*
Soft brush†	Absent	7 (35.0%)	8 (40.0%)	
	Present	1 (5.0%)	4 (20.0%)	0.039

(B) GF occurrence over all examining sessions ($n=60$)

		Medium toothbrush†		
	Examining sessions whit new GF	Absent	Present	*p* value*
Soft brush†	Absent	35 (58.3%)	19 (31.7%)	
	Present	4 (6.7%)	2 (3.3%)	0.003

* McNemar test; † number (percentage)

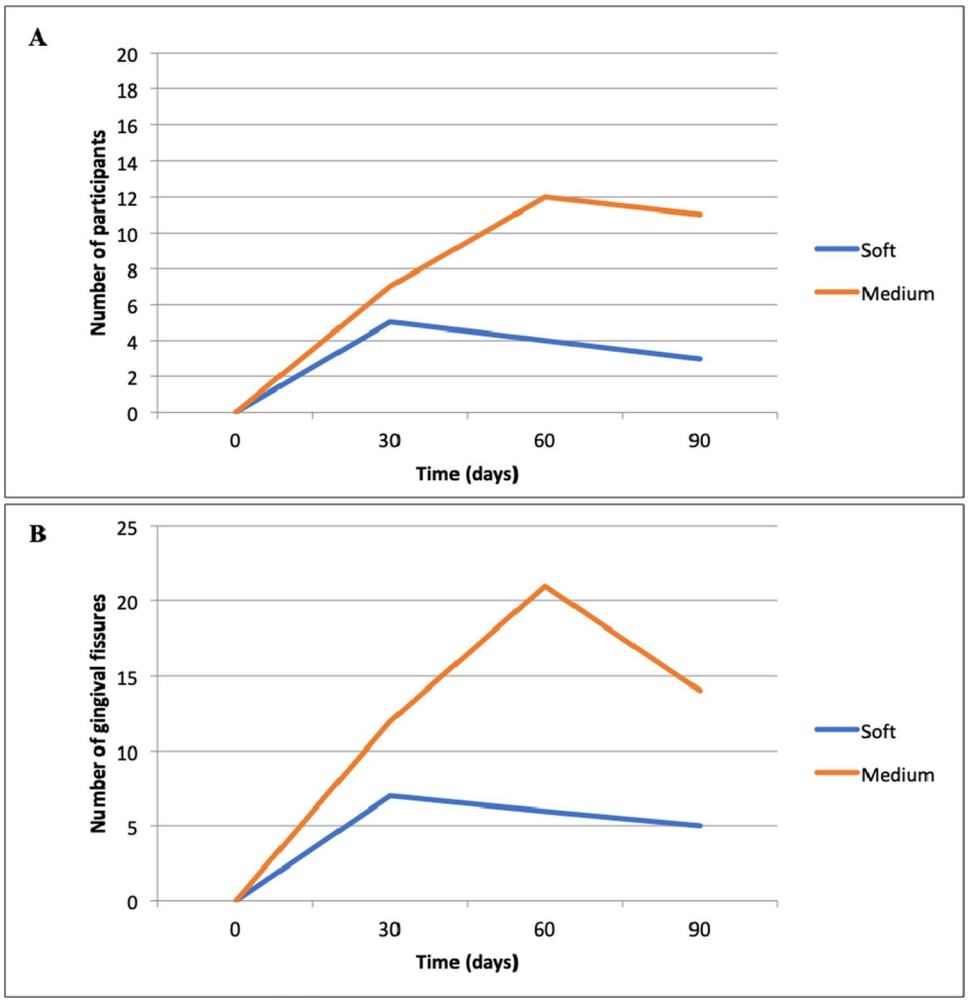

Fig. 2 **A** Number of patients presenting at least one new gingival fissure, at each examining session, over three months of the use of soft and medium toothbrushes. **B** Number of new gingival fissures at each examining session over three months of the use of soft and medium brushes

and the accumulation of plaque ($p = 0.150$), while the use of medium toothbrushes determined a 3.582 times greater risk of developing new fissures ($p = 0.005$).

Carry-over effect was not observed on the incidence of GFs (mean number of GFs with the use of soft toothbrushes at 1st phase vs. 2nd phase: $0.3 \pm 0.9\%$ vs. $0.4 \pm 0.5\%$; $p = 0.773$; mean number of GFs with the use of medium toothbrushes at 1st phase vs. 2nd phase: $1.8 \pm 1.9\%$ vs. $1.1 \pm 1.3\%$; $p = 0.353$). In the same way, the inclusion of the variable "sequence" in regression models was not significant statistically ($p = 0.622$).

Fig. 3 shows clinical photographs from right quadrants of a participant of the study (#13, female, medium bristle brush) at days 0 (baseline), 30, 60, and 90. At day 30 image, two gingival fissures could be observed on the gingival margin of second premolar and first molar on upper quadrant.

Table 4 presents the perception of the patients regarding the use of both toothbrushes at the end of the study. Fourteen out of 17 participants (82.4%) were able to identify correctly the toothbrush used at each phase of the study, and the same percentage of individuals (82.4%) reported having liked to use the soft brushes more than the medium toothbrushes. Ten (58.8%) participants reported having observed gingival bleeding (20%) or gingival soreness (70%). In all these cases, the alterations were associated with the use of medium toothbrushes. 64.7% of all patients reported to have reduced the force used in brushing, especially when using the medium toothbrush (81.8%).

Discussion

The present study showed that 65% of the participants had at least one GF over the 3 months period of daily toothbrushing. The analysis also showed that the use of medium brushes was associated with a greater number of individuals

Table 3 Poisson regression models on the association between the incidence of at least one new gingival fissure during the examining sessions of the study and independent variables

	Model 1 (crude association)			Model 2 (adjusted association)		
Variables	IRR	95% CI	*p* value*	IRR	95% CI	*p* value*
Toothbrush bristle type						
Soft	Ref			Ref		
Medium	3.500	1.383–8.859	0.008	3.582	1.459–8.795	0.005
Sex						
Female	Ref					
Male	0.817	0.323–2.064	0.669			
Experimental examination						
Day 30	Ref					
Day 60	1.310	0.647–2.651	0.454			
Day 90	1.053	0.523–2.120	0.886			
Self-reported toothbrush frequency						
Up to twice/day	Ref					
3 or more times/day	1.500	0.610–3.690	0.377			
Self-reported toothbrush technique						
Vertical/circular	Ref					
Horizontal	0.857	0.400–1.835	0.691			
Mean attachment loss (buccal site)	0.530	0.033–8.430	0.653			
Plaque accumulation (buccal site)						
Absent	Ref					
Present	2.273	0.686–7.534	0.179	2.380	0.731–7.747	0.150
Sequence						
1st phase	Ref					
2nd phase	0.800	0.329–1.943	0.622			

* Poisson regression models by generalized estimating equation (GEE)

developing at least one fissure, as well as a greater cumulative occurrence of fissures over the three months. These findings are in agreement with previous observations that the greater the bristle hardness, the greater the prevalence of other gingival lesions such as abrasions and recessions [5, 22, 30, 31]. Taking these observations together, these results are unprecedented in the literature and support that GF are traumatic lesions associated bristle hardness.

To the best of knowledge, only one study has addressed the relationship between brushing and GF longitudinally. Greggianin et al. [23] observed a higher GFs incidence associated with the use of medium brush as compared to soft type in a 28-day panel [23]. The present results are in agreement with these findings. However, in the present study, it was observed an even higher incidence of GF associated with the use of medium brushes. This difference may be explained by the extended experimental period of this study allowing the detection of the peaks of incidence for both brushes. Following these peaks, the incidence of GFs decreased gradually. There are reports showing a higher prevalence of GR associated with frequent changes of toothbrushes [32].

In the present study, no significant relationship was found between the amount of biofilm present at the buccal sites and the incidence of GFs. Previous studies have reported that abrasions and fissures were associated with small amounts of biofilm [33–35]. One possible explanation is that, in the present study, only biofilm present at the buccal surfaces was considered. In addition, the high standards of oral hygiene presented by the participants, measured by the presence of marginal bleeding and visible plaque, may have influenced the analysis.

The use of medium brushes determined a risk 3.58 times greater of occurrence of GFs when compared to the use of soft brushes. This association proved to be independent of plaque accumulation, daily brushing frequency, and the self-reported usual technique. These results are similar to those by Greggianin et al. [23]. There are many studies dedicated to examining the relationship between brushing with GA and GR [8, 9]. In general, they show that the hardness of the bristles [5, 14], the frequency and time of brushing [21, 22], and the brushing method [19–21, 32] are associated with these lesions. Nevertheless, it is not clear if these studies included GFs as a GR. Additionally, it is relevant to observe

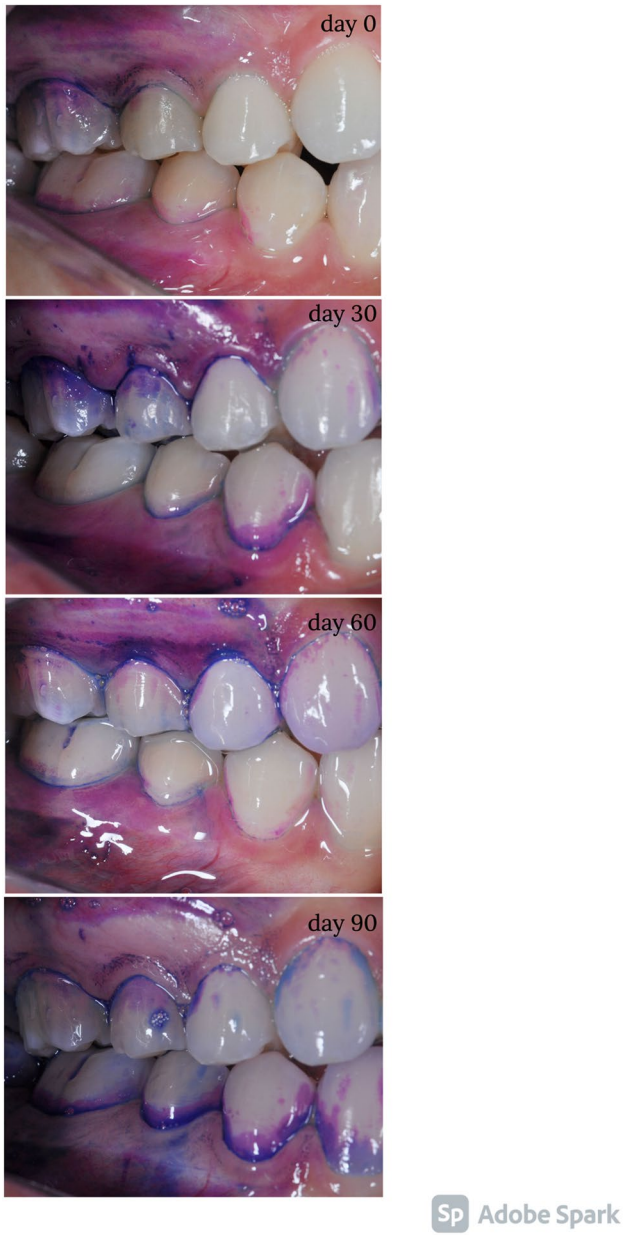

Fig. 3 Clinical photographs from right quadrants of a participant of the study (#13, female, medium bristle brush) at days 0 (baseline), 30, 60, and 90. Gingival fissures were observed at day 30 related to second premolar and first molar on upper quadrant

that GA and GF are different types of lesions making it difficult direct comparisons.

The clinical and histological descriptions of the fissures indicate that these are one-off attachment losses. Little is known about the evolution of these injuries, either developing into a frank recession or even regressing [3, 36, 37]. The occurrence of GR, especially in periodontal healthy young individuals, indicates that causal factors other than destructive forms of periodontal disease may be involved [9]. The study participants were young people with excellent oral hygiene standards. The presence of CAL, even if minimal, is a sign that these factors have been at work since very early in people's lives.

Regarding the limitations and strengths of the study, some aspects deserve mention. The carry-over effect was assumed to be minimized by allowing a 10-day washout period in accordance with Greggianin et al. [23]. The relative short period was also compensated as pre-existing GF were not computed for the incidence of fissures at each experimental period. As a result, the inclusion of the variable "sequence" in the regression model was not significant. There is a clear need for additional studies aiming at the clinical behavior of gingival fissures. There was no significant association between GFs incidence and previous levels of CAL. This may have been influenced by the relatively small CAL values observed in the sample. The participants were recommended to keep their usual brushing habits throughout the study. It is well known that toothbrushing factors that might be associated with gingival recession are toothbrushing frequency, a horizontal or scrub toothbrushing method, bristle hardness, toothbrushing duration, and the frequency of changing a toothbrush [6]. Of all these variables, bristle hardness and frequency of changing the toothbrush are the only ones that do not depend on the cooperation of the individual. It is well known that individuals tend to regress to their established oral hygiene habits shortly after receiving instructions and motivation [7, 38]. Thus, in our study, we chose not to standardize the oral hygiene habits except for bristle hardness and frequency of changing the toothbrush. Moreover, the use of a standardized dentifrice minimized the eventual effect of formulation compounds that are known to be associated with traumatic lesions of the gums and teeth [39, 40]. The participants were able, throughout the study, to identify the assigned brush. Thus, the possibility that this may have affected the behavior in relation to their use cannot be ignored. Although the presence of the Hawthorne effect cannot be ruled out, it is possible that, in cross-over designs, where participants are their own controls, this effect, if present, may have been present in both study phases [41]. Three months was chosen as the experimental period because it is the time normally indicated for replacing the brushes [24, 25].

The present study corroborated the concern with GFs [16, 23, 33–35]. The results expand the knowledge about the incidence of these fissures in young and periodontal healthy individuals. GR in these populations is a growing problem that has demanded the attention of Periodontics [10]. Assuming that GFs can be an indicator for

Table 4 Perception of the participants regarding the use of soft versus medium bristle brushes at the end of the study

Question	Sample ($n=17$) †
Did you notice which was the toothbrush used at each phase?	
No	3 (17.6%)
Yes	14 (82.4%)
Which toothbrush did you like more?	
Soft	14 (82.4%)
Medium	3 (17.6%)
Did you notice any alteration on your gums during the use of the toothbrushes?	
No	7 (41.2%)
Yes	10 (58.8%)
With which toothbrush?	
Soft	0
Medium	10 (100%)
What was the alteration?	
No reported	1 (10.0%)
Gingival bleeding	2 (20.0%)
Gingival soreness	7 (70.0%)
Did you have to decrease the strength during toothbrushing at some point?	
No	6 (35.3%)
Yes	11 (64.7%)
Which toothbrush?	
Soft	2 (18.2%)
Medium	9 (81.8%)

†The participants lost (Figure 1) did not answer this final questionnaire

the development of permanent GR, the present results indicates that, after 3 months of observation, significant differences can be observed when using soft or medium toothbrushes.

It can be concluded that the use of brushes with medium bristles determined a risk 3.58 times greater of developing GF in comparison to the use of soft bristles. Thus, the use of soft brushes can be considered safer in preventing these traumatic gingival injuries.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s00784-021-04138-6.

Author contribution All authors contributed to the study conception and design. Material preparation and data collection were performed by D Romitti, AV Fagundes, and PDM Angst. Analysis, guidance, and supervision were performed by PDM Angst, MS Gomes, SC Gomes, and RV Oppermann. The first draft of the manuscript was written by D Romitti and RV Oppermann, and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Declarations

Ethics approval All procedures performed were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments. The Ethics Committee of the Federal University of Rio Grande do Sul approved the study protocol (#CAAE 80127117.9.0000.5347).

Informed consent Informed consent was obtained from all individual participants included in the study.

Conflict of interest The authors declare no competing interests.

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