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Acceptance of a tongue vacuum cleaner among children and evaluation of tongue cleaning at home

KEYWORDS

Tongue cleaning
 Tongue vacuum cleaner
 Oral hygiene
 Pedodontics

SUMMARY

The anaerobic microenvironment of the grooved tongue surface provides optimal conditions for the survival of microorganisms. These microbes may promote caries, periodontitis marginalis, periimplantitis as well as halitosis. A new device, the TS1 tongue vacuum cleaner, is designed to remove bacterial biofilm from the tongue's surface. The aim of the present study was to both examine the acceptance of this tongue vacuum cleaner by children at the School Dental Clinic Basel as compared to a child's manual tooth brush, and tongue cleaning at home for a 1-month period. This study did not investigate the cleaning effect. One hundred and sixty-two children aged 5 to 18 years participated in this study. The acceptance of the tongue vacuum cleaner was significantly higher

with 8.9 cm on the visual analogue scale (VAS) (0–10 cm) in comparison to a child's manual tooth brush with 7.8 cm ($p < 0.001$). After professional tongue cleaning, the children were asked to clean their tongues at home for a 1-month period, and to return a completed questionnaire ($n = 66$). The children estimated their acceptance of daily tongue cleaning with 8.3 cm on the VAS, their parents with 8.7 cm. Fifty-eight children reported willingness to continue cleaning their tongues at home after the 1-month examination time. The data show that the use of the tongue vacuum cleaner, as part of a professional oral prophylaxis, is well accepted by children and may help promote, along with professional instruction, home tongue cleaning on a regular basis.

Introduction

The anaerobic microenvironment of the rough keratinized surface of the tongue, benefiting from papillae, grooves and pits, provides optimal conditions for microorganisms to colonize, which other smooth less keratinized oral epithelia do not (MARSH & MARTIN 2003; FILIPPI 2009; FILIPPI ET AL. 2014), and

is home to about two-thirds of all bacteria in the oral cavity (JACOBSON ET AL. 1973; YAEGAKI & SANA-DA 1992; DE BOEVER & LOESCHE 1995; FILIPPI 2008, 2011).

These microorganisms are embedded in a thin mucus layer of complex extracellular polymeric substances, the so-called biofilm, and can promote caries, periodontitis marginalis as

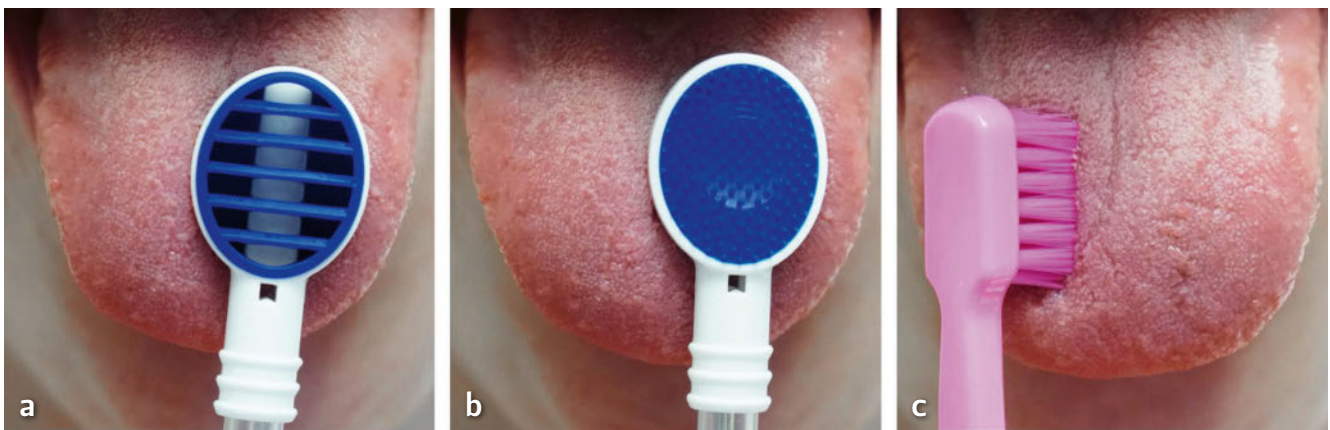


Fig. 1a-c a) Rubbing the tongue with the nubby side of the tongue vacuum cleaner. b) Sucking the tongue with the slats of the tongue vacuum cleaner. c) Cleaning with the child's manual tooth brush

well as periimplantitis (GILMORE & BHASKAR 1972; GILMORE ET AL. 1973; MARSH & BRADSHAW 1995; ALMAS ET AL. 2005; MATSUI ET AL. 2014). Many of these bacteria produce volatile sulphur compounds (VSC), which can cause halitosis and may intensify the clinical conditions mentioned above (TONZETICH & RICHTER 1964; TONZETICH 1971, 1977; PERSSON ET AL. 1990; LANG & FILIPPI 2004A; WHITE & ARMALEH 2004; NALCACI & BARON 2007; ZÜRCHER & FILIPPI 2012).

Biofilm on the tongue can be reduced and controlled by adequate tongue hygiene (HYDE ET AL. 1981; LANG & FILIPPI 2004B; QUIRYNEN ET AL. 2004; FILIPPI & MÜLLER 2006; PATIL ET AL. 2015). There are a wide range of cleaning devices on the market such as tongue brushes, scrapers, and pastes (HOSHI & VAN STEENBERGHE 1996; BRUNETTE ET AL. 1998; GERLACH ET AL. 1998). Analogous to tooth cleaning, tongue cleaning should be conducted two to three times daily with a tongue brush in combination with paste (FILIPPI 2011; SEEMANN ET AL. 2014). Child's tongue cleaning should preferably be conducted with a child's manual tooth brush until the end of the second school year in order to imprint this procedure as a necessary part of a daily oral homecare regime. Starting with third grade, the use of a tongue scraper has been suggested (SPIESSHOFER 2014; UNIVERSITÄRES ZENTRUM FÜR ZAHNMEDIZIN BASEL 2017).

In addition to tongue cleaning at home, a new device, the TS1 tongue vacuum cleaner (TSpro GmbH, Karlsruhe, Germany), allows for professional tongue cleaning in the dental practice. This single-use tongue vacuum cleaner can be connected to the dental unit by placing it on the disposable suction tip. The nubby front of the vacuum tip facilitates application of the tongue paste (Fig. 1a), which at the same time will loosen the adhering biofilm. Use of the slats on the back of the vacuum tip (Fig. 1b) facilitates the suctioned removal of both the paste and the loosened biofilm (ZÜRCHER & FILIPPI 2016). The aim of the present study was to both evaluate the acceptance, excluding usefulness and cleanliness, of this tongue vacuum cleaner compared to a child's manual tooth brush as part of a professional prophylaxis and their willingness to clean their tongues at home with their manual tooth brush for a 1-month trial period.

Materials and methods

During the 2016/2017 school year, the acceptance of a professional tongue cleaning using the tongue vacuum cleaner was investigated in 162 children at the School Dental Clinic Basel,

Switzerland. Nine prophylaxis assistants (PA) performed professional tongue cleaning. Curaprox (Curaden Germany GmbH, Stutensee, Germany), Trisa (Trisa AG, Triengen, Switzerland) and Candida (Mibelle Group, Buchs, Switzerland) were the manufactures of the child's manual tooth brushes that were used randomized as intraindividual control. Likewise, these brushes with soft bristles and equal head size are used daily in the School Dental Clinic Basel.

Participation was voluntary and could be discontinued at any time. Included in the study were systemically healthy 5 to 18-year-old children. Until the age of 14, they had to be accompanied by a legal guardian. Exclusion criteria were: physical symptoms such as dry mouth, mucosal burning and/or tongue burning, intellectual inabilities, a strong gag reflex, a short lingual frenulum preventing a child from extending her/his tongue, immunodeficiencies and acute oral infections. In the second part of the study, i.e. the daily tongue cleaning at home, exclusion criteria also included: physical disability of the arms, comprehension problems due to language difficulties and family organizational problems.

The Ethics Committee of Northwest and Central Switzerland approved this study (EKNZ 2016-00591) according to the procedure for medical devices of category A.

The study was divided into a clinical part and a second part conducted at home.

To ensure uniform implementation, the PAs were stringently instructed and identically trained, with demonstrations and flow charts of the process and procedure of the study. The application of the tongue vacuum cleaner and the child's tooth brush was unified regarding applied pressure and pace as well as used wording to explain the process. The clinical part of the study compared the acceptance of tongue cleaning with either the tongue vacuum cleaner or the child's manual toothbrush. A child's willingness to participate in the study was recorded on a case report form by the PA. Age, nationality, and gender were recorded. Nationalities were classified in three categories: "Non-EU" excluding Switzerland, "EU" and "Switzerland". After the parents or legal guardian (or the child him-/herself, when older than 14 years) completed the declaration of consent, the PA cleaned the child's left tongue half using the tongue vacuum cleaner (Fig. 1a/b) and the right side using a child's manual tooth brush (Fig. 1c) in randomized order for 10 seconds on each side. The PA recorded on a questionnaire (Fig. 2) whether the tongue is being

Questionnaire Clinical Examination



General Questions

Is your tongue being cleaned at home as well? yes no



Please assess the tongue cleaning (cross off within the line)

How was the administered tongue cleaning on...

...the left side with the tongue sanitizer

 _____ 

...the right side with the children's manual tooth brush

 _____ 

Would you allow cleaning with the tongue sanitizer again? yes no

Would you allow cleaning with the children's manual tooth brush again? yes no

Fig. 2 Questionnaire part one: clinical part

cleaned at home and whether the tongue vacuum cleaner or the child's manual tooth brush could be re-used at the next recall appointment according to the patient's wish. The children assessed the cleaning by tongue vacuum cleaner and child's toothbrush on a visual analogue scale (VAS, 0–10 cm, 0 not accepted; 10 completely accepted). The time frame for part one of the study, the clinical part, contained 10 minutes for each child.

For part two of the study, the children were urged to continue tongue cleaning at home for one month. To execute this part of the study the children were each given the used child's manual tooth brush and a questionnaire to be completed by both the children and parents and returned after the 1-month study period (Fig. 3). Questions were asked about the regularity of tooth cleaning, the amount of oversight by the parents and about the likelihood of continuation of tongue cleaning beyond

Questionnaire tongue cleaning at home

Questions in connection with cleaning

Was tongue cleaning possible every day? yes no



Did your parents check after you finished cleaning (teeth and tongue)? yes no

Were there problems during tongue cleaning? yes no



If yes, what kind of? _____

Please assess the tongue cleaning (cross off within the line)

Child: What do you think about daily tongue cleaning?

 _____ 

Parents: What do you think about daily tongue cleaning in your child?

 _____ 

Will you continue tongue cleaning at home? yes no

Fig. 3 Questionnaire part two: daily tongue cleaning at home

the time of examination. Additionally, any problems could be recorded. Furthermore, the parents and the children were asked to assess the value of daily tongue cleaning at home on the VAS.

Statistical evaluation was performed with the statistic program R version 3.1.2. Data with descriptive character such as yes/no answers with one parameter were evaluated as a normal distribution with the Student's *t*-test using means and standard deviations or percentage distributions. Non-parametric data including multiple variables such as age, gender and nationality were compared with either the Wilcoxon rank-sum test, Kruskal-Wallis test, chi-squared test or the Fisher's exact test using median and interquartile range as well as 95% confidence intervals. VAS data were calculated using a linear regression model. The significance level was set at $\alpha = 0.05$.

Results

Over the 1-year study period, 162 school children aged 5 to 18 years (84 boys and 78 girls, \bar{x} 11.4 years, SD 3.2) participated in the study. Their nationalities ($n = 159/162$) varied with 39.0% being from Switzerland ($n = 62/159$), 14.5% from EU countries ($n = 23/159$), and 46.5% from non-EU countries ($n = 74/159$). A further 56 children had to be excluded from the study: 33 were unwilling to participate, 9 couldn't find time to conduct the cleaning at home, 7 did not understand the language, 6 were not accompanied by a legal guardian, and 1 child had an immunological disorder. Acceptance of the tongue vacuum cleaner was at 8.9 cm (IQR 7.3/9.5) on the VAS, and did not show any statistical differences depending on gender (IQR 7.3/9.5, $p = 0.775$), age (95%CI -0.27/2.06, $p = 0.131$), and nationality (IQR 7.3/9.5, $p = 0.590$). The children assessed the acceptance of tongue cleaning with a child's manual toothbrush with 7.8 cm (IQR 5.0/9.0) on the VAS. Opposed to gender (IQR 5.0/9.0, $p = 0.947$), age (95%CI -0.58/2.3, $p = 0.238$), and nationality (IQR 5.0/9.0, $p = 0.991$) no statistical differences were apparent. Acceptance of using the tongue vacuum cleaner was thus all in all higher than acceptance with a child's manual tooth brush ($p = 0.001$). The mean variation of the tongue vacuum cleaner was smaller than of the child's manual tooth brush (Fig. 4). Altogether 93% ($n = 158/162$, yes 147; no 11) of the children would allow the tongue vacuum cleaner to be used again. Thus more ($p < 0.001$) than the repeated usage of a child's manual tooth brush (71%, $n = 155/162$, yes 110; no 45). However, older children (\bar{x} 13 years, 5–18 years, IQR 9.1/14) would be more likely to allow professional cleaning with a child's manual tooth brush ($p = 0.014$) than younger children (\bar{x} 10.1 years, 5–16 years, IQR 9.0/12.5). This statement also applies for the tongue vacuum cleaner, although hardly any statistical difference ($p = 0.724$) was seen here (yes \bar{x} 12 years, 5–18 years, IQR 9.0/14.0; no \bar{x} 11.1 years, 8–16 years, IQR 9.5/13.3).

Furthermore, it was also evaluated whether the tongue was being cleaned at home prior to the study. Of 161 children, 92 (57.1%) answered with yes, 69 (42.9%) with no. Older children cleaned their tongues rather before the study period than younger children (yes \bar{x} 11.9 years, 5–17 years, SD 3.2; no \bar{x} 10.9 years, 5–18 years, SD 3.1). As far as nationalities were concerned, it was noticeable that children from EU ($n = 15/23$) and non-EU countries ($n = 46/73$) cleaned their tongues more frequently prior to the study than Swiss children ($n = 29/62$).

For part two of the study, the daily tongue cleaning at home, 40.7% ($n = 66/162$) of the questionnaires were returned. For-

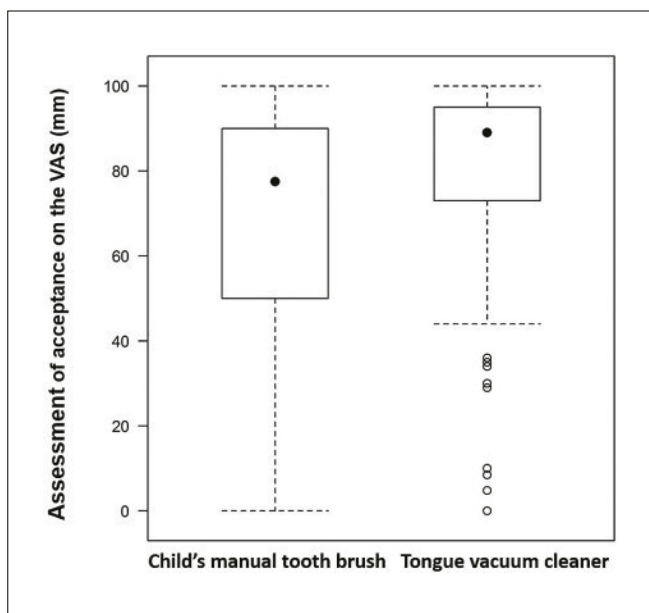


Fig. 4 Box Plot: Assessment of the acceptance of the tongue vacuum cleaner and the child's manual tooth brush

ty-two children ($n = 64$) cleaned their tongue every day. It was shown that older children (\bar{x} 11.3 years, 5–17 years, SD 3.3), in contrast to younger children (\bar{x} 9.9 years, 5–16 years, SD 3.5), performed daily tongue cleaning more often ($p = 0.126$). Children from non-EU countries (yes 25; no 5) conducted daily tongue cleaning about five times more frequently ($p = 0.015$) than children from EU countries (yes 4; no 4) and from Switzerland (yes 12; no 13).

For 37 children ($n = 64$), the parents monitored their tongue cleaning. With $p < 0.001$ statistical evidence, it reveals that parents of younger children (\bar{x} 8.7 years, 5–14 years, SD 2.3) checked their cleaning more often than that of older children (\bar{x} 13.3 years, 8–16 years, SD 2.8).

Four of the 66 participants stated the following keywords when asked about possible problems: gag reflex (twice), not wanting to exhibit the tongue (once), and that cleaning hurt due to a wound on the tongue (once). The children's average VAS assessment of daily tongue cleaning at home was 8.3 cm (IQR 6.6/9.5), while the parents' assessment was 8.7 cm (IQR 7.3/9.6). Fifty-eight children ($n = 64$) report their intention to continue tongue cleaning at home beyond the time period being evaluated.

Discussion

The results of this study show that the children accepted the use of the tongue vacuum cleaner by the PA at a statistically significant higher level than the use of a child's manual tooth brush. They would prefer the tongue vacuum cleaner to be used again at the next professional tongue cleaning. Thus, the recommendation is to incorporate the concept of professional tongue cleaning into children's dentistry protocol, and to integrate the use of the tongue vacuum cleaner as part of regular recalls to help promote tongue cleaning. To achieve an adequate number of participants for this study, not only one but nine PAs executed the procedure. Possible differences in technique were reduced with an elaborate instruction. A flow chart displayed in detail the procedure. With practical exercises, wording to explain the process, used pressure and pace of every

PA were severely approximated. The elementary handling of the tongue vacuum cleaner as well as the child's tooth brush keeps variation in treating low. As for the simple objective of this study, the possible modest differences were accepted. Likewise, possible differences arose with the use of the three different child's tooth brushes but were neglected since they all constitute equivalent brush head size and contain soft bristles that prevent mucosal trauma (LINDENMÜLLER & LAMBRECHT 2011; CIF-CIBASI ET AL. 2014). In many patients, tongue cleaning triggers the gag reflex (ROWLEY ET AL. 1987; CHRISTENSEN 1998; QUIRYNEN ET AL. 2002). However, in the present study none of the children complained of gagging during the professional cleaning with the tongue vacuum cleaner. Through the sucking forward-outward draft of the tongue vacuum cleaner gag reflex is less stimulated than with the backward-downward pressure of a tooth brush (ZÜRCHER & FILIPPI 2016).

Older children were more willing to allow for another professional tongue cleaning. The tongue cleaning at home in the second part of the study was performed more often daily by the older children, whereas the parents monitored the younger children more often. Older children, who are beginning to understand that tongue cleaning is related to a reduced incidence of oral diseases, are more likely to both allow professional tongue cleaning during exams and conscientiously conduct daily tongue cleaning on their own (GARZ 2009; SIEGLER ET AL. 2016).

Data about the epidemiology of tongue cleaning is rare and limited. Most studies address halitosis and not tongue cleaning itself. Studies from Japan (MIYAZAKI ET AL. 1995), China (LIU ET AL. 2006) and Switzerland (BORNSTEIN ET AL. 2009) show consistent percentage rates of halitosis between 24 and 28% whereas a study from Sweden (SÖDER ET AL. 2000) showed with 2.4% a lower percentage rate. A survey of the American Dental Association revealed that an extrapolated 50% of the North American residents suffer halitosis (STASSINAKIS ET AL. 2002). Anyhow, research reveals tongue coating as a severe factor for halitosis (MIYAZAKI ET AL. 1995; DELANGHE ET AL. 1997; SÖDER ET AL. 2000; LIU ET AL. 2006; BORNSTEIN ET AL. 2009). Finally, no adequate research could be found that confirms the outcome of this study that tongue cleaning is more common among the children from non-EU countries and EU countries than among children from Switzerland. Possibly, an explanation may be found in the history of oral hygiene with cultural and religious distinction. Asian countries like India, China and Japan integrated tongue cleaning into oral hygiene long ago (2000 B.C. – 6 A.D.). Explanation for this was the belief of Buddhism as well as Chinese medicine that the mouth is the entrance to the body (BHISHA-GRATNA 1911; CHRISTEN & SWANSON 1978), and a portal through which many diseases can enter and flourish if not kept clean (LUTZE 2011; SCHMINCKE 2014). In Europe, tongue cleaning was not established in public until the 18th/19th century. From the 20th century onward the first scientific papers were published recommending the cleaning of the tongue (CHRISTEN & SWANSON 1978). In Switzerland today, tongue cleaning is integrated in teaching dental hygiene in schools with certain regional variations (SPIESSHOFER 2014; UNIVERSITÄRES ZENTRUM FÜR ZAHNMEDIZIN BASEL 2017).

In summary, the recommendation is to include the tongue vacuum cleaner as an integral part of regular oral prophylaxis to accustom children to tongue cleaning, and to give instructions for daily tongue cleaning at home, with a child's manual tooth brush or a tongue scraper starting third grade in school.

Zusammenfassung

Einleitung

Das anaerobe Mikromilieu der rauen Zungenoberfläche bietet Mikroorganismen optimale Bedingungen zur Besiedlung und beherbergt rund zwei Drittel aller Bakterien im Mund. Neben der Zungenreinigung zu Hause erlaubt ein neues Gerät eine professionelle Zungenreinigung in der zahnärztlichen Praxis: der TS1 Zungensauger. Ziel der vorliegenden Studie war es, die Akzeptanz des Zungensaugers bei Kindern im Vergleich zur Zungenreinigung mit einer Kinder-Handzahnbürste zu untersuchen und die häusliche Zungenhygiene mit einer Kinder-Handzahnbürste über die Dauer von einem Monat zu beobachten. Die Reinigungswirkung des TS1 Zungensaugers wurde nicht getestet.

Material und Methoden

Bei 162 Kindern wurde im Schuljahr 2016/2017 an der Schulzahnklinik Basel die Akzeptanz der Zungenreinigung mit dem Zungensauger untersucht. Eingeschlossen wurden allgemeinmedizinisch gesunde Kinder im Alter vom 5. bis zum 18. Lebensjahr. Im klinischen Teil wurde den teilnehmenden Kindern die linke Zungenseite mit dem Zungensauger und die rechte Zungenseite mit der Kinder-Handzahnbürste in randomisierter Reihenfolge für je zehn Sekunden gereinigt. Auf einem Fragebogen mit einer visuellen Analogskala (0 nicht akzeptiert – 10 ganz akzeptiert) gaben die Kinder eine entsprechende Bewertung ab.

Im Anschluss an die professionelle Zungenreinigung wurden die Kinder angehalten, die Zungenreinigung zu Hause für die Dauer von einem Monat fortzusetzen. Dafür wurde den Kindern die benutzte Kinder-Handzahnbürste sowie ein Fragebogen mitgegeben, den die Kinder sowie die Eltern nach dem Monat der häuslichen Reinigung ausfüllen sollten.

Resultate

Die Akzeptanz des Zungensaugers lag auf der VAS bei durchschnittlich 8,9 cm (IQR 7.3/9.5) und war höher ($p < 0,001$) als die Akzeptanz der Kinder-Handzahnbürste bei durchschnittlich 7,8 cm (IQR 5.0/9.0).

Die Reinigung mit dem Zungensauger ($n = 158/162$, Ja 147, Nein 11) würden die Kinder eher wieder zulassen ($p < 0,001$) als die Reinigung mit der Kinder-Handzahnbürste ($n = 155/162$, Ja 110, Nein 45). Die Kinder bewerteten die tägliche Zungenreinigung zu Hause auf der VAS bei 8,3 cm (IQR 6.6/9.5), die Eltern bei 8,7 cm (IQR 7.3/9.6). 58 Kinder ($n = 64$) haben die Absicht, die Reinigung zu Hause über den Untersuchungszeitraum hinaus weiter zu führen.

Diskussion

Die Ergebnisse dieser Studie zeigten, dass Kinder nach der professionellen Zungenreinigung den Zungensauger besser bewerteten als die Kinder-Handzahnbürste und die Reinigung mit dem Zungensauger eher wieder zulassen würden als die Reinigung mit der Kinder-Handzahnbürste. Zusammenfassend lautet die Empfehlung, den Zungensauger grundsätzlich in das oral-prophylaxe Recall miteinzubeziehen und eine tägliche Zungenreinigung zu Hause mit einer Kinder-Handzahnbürste, oder ab dem 3. Schuljahr mit einem Zungenreiniger, zu instruieren.

Résumé

Introduction

Le micromilieu anaérobie de la surface rugueuse de la langue offre aux micro-organismes les conditions idéales à la colonisation et héberge près de deux tiers de toutes les bactéries dans la cavité buccale. En plus du nettoyage de la langue à la maison, un nouvel appareil permet un nettoyage professionnel de la langue dans les cabinets dentaires : l'aspirateur lingual TS1. Le but de cette étude était d'examiner l'acceptation de cet aspirateur lingual par les enfants en comparaison avec une brosse à dents manuelle pour enfants ainsi que d'observer l'hygiène linguale domestique à l'aide d'une brosse à dents manuelle pour enfant sur une durée d'un mois.

Matériel et méthodes

À la clinique dentaire scolaire de Bâle durant l'année scolaire 2016/2017, l'acceptation du nettoyage de la langue à l'aide d'un aspirateur lingual a été analysée chez 162 enfants. Pour être inclus dans cette étude, les enfants devaient être en bonne santé et âgés de 5 à 18 ans. Dans la partie clinique, la moitié gauche de la langue des participants a été nettoyée avec l'aspirateur lingual, alors que la moitié droite de la langue a été nettoyée avec une brosse à dents pour enfants, chacune pendant dix secondes et de manière randomisée. Les enfants ont ensuite manifesté leur ressenti dans un questionnaire comprenant une échelle visuelle analogique (EVA, 0 pas accepté – 10 entièrement accepté). À la suite du nettoyage professionnel de la langue, il a été demandé aux enfants de continuer le nettoyage de la langue à la maison pour une durée d'un mois. Pour ce faire, la brosse à dents utilisée lors du nettoyage professionnel a été donnée aux enfants en plus d'un questionnaire à remplir par les enfants et les parents après le mois passé à nettoyer la langue à la maison.

Résultats

L'acceptation de l'aspirateur lingual se trouvait en moyenne à 8,9 cm sur l'EVA (IQR 7.3/9.5) et était plus grande ($p < 0,001$) que l'acceptation de la brosse à dents manuelle pour enfants avec en moyenne 7,8 cm (IQR 5.0/9.0).

Les enfants se sont montrés plus prêts ($p < 0,001$) à un nouveau nettoyage avec l'aspirateur lingual ($n = 158/162$, oui 147, non 11) qu'avec la brosse à dents manuelle pour enfants ($n = 155/162$, oui 110, non 45). Les enfants ont évalué le nettoyage quotidien de la langue à la maison à 8,3 cm sur l'EVA (IQR 6.6/9.5), alors que les adultes l'ont évalué à 8,7 cm (IQR 7.3/9.6). 58 enfants ($n = 64$) ont l'intention de continuer le nettoyage de la langue à la maison après la fin de la période d'examination.

Diskussion

Les résultats de cette étude ont montré que les enfants ont évalué l'aspirateur lingual de meilleure manière que la brosse à dents manuelle à la suite du nettoyage professionnel de la langue. Ils ont aussi montré que les enfants préféreraient un nouveau nettoyage avec l'aspirateur lingual plutôt qu'avec la brosse à dents manuelle pour enfants. En résumé, il peut être conseillé d'intégrer l'aspirateur lingual lors des contrôles dentaires ainsi que d'enseigner aux enfants un nettoyage quotidien de la langue à la maison à l'aide d'une brosse à dents manuelle pour enfants ou un racleur de langue à partir de la troisième année scolaire.

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