Halitosis is often caused by a change in the oral biofilm, primarily located on the surface of the tongue. A suction tongue cleaner enables professional cleaning of the tongue. The aim of this study was to investigate the acceptance and efficiency of a suction tongue-cleaning device in adults in comparison to a conventional manual tongue cleaner in an office (professional) setting. Both were tested simultaneously on 100 individuals with a split-mouth (i.e. half-tongue) design, between the ages of 19 to 31, at the University Center for Dental Medicine Basel UZB. To evaluate the efficiency of the cleaning, photos were taken before and after the cleaning and later assessed by using a modified coating tongue index by Winke (WTCI). Both cleaning devices significantly reduced the coating on the tongue (p < 0.001). In 58 cases, the side cleaned with the suction tongue cleaner resulted to be cleaner in comparison to the side which was cleaned manually. There were no significant differences in acceptance on a visual analogue scale (VAS, 0–10 cm) between the devices (p = 0.259). However, 53 subjects favored the manual method in comparison to 36 who favored the suction device. The remaining 11 did not convey any preference for either. Both devices triggered an equally frequent gag stimulus. With 95%, the majority of the patients who had this treatment would undergo it a second time. In conclusion, both cleaning devices resulted in a significant reduction of tongue coating, and the usage in general can be highly recommended. While it does not matter which one is used, the suction tongue-cleaning device offers a good alternative to manual tongue-cleaning devices in dental clinics and can be considered a viable adjunct for in-office use.
Introduction

Changes in the oral biofilm are often responsible for the development of halitosis. Between 60 and 80% of the bacteria present in the oral cavity may be found coating the dorsum of the tongue (De Boever & Loesche 1995; Filippi 2011a, 2011b). This aggregation plays an important role in halitosis. In 40–50% of diagnosed cases, this dorsal coating has been found to be the sole cause of the patient’s bad breath (DeLange et al. 1999; Quirynen et al. 2009; Filippi 2011a). The odor active components of some bacteria found on the tongue’s surface, when metabolically activated, result in the formation of volatile sulfur compounds, which have a noxious smell (Tonzetich & Richter 1964; Tonzetich 1971; McNamara et al. 1972; Tonzetich 1977; Schmidt et al. 1978; Delange et al. 1997; Van Steenberghe et al. 2001; Filippi & Meyer 2004; Quirynen et al. 2004; Lang & Filippi 2004a; Krespi et al. 2006; Filippi 2011b). Biofilm can be reduced through mechanical cleaning of the tongue’s surface (Delange et al. 1997; Quirynen et al. 2004; Lang & Filippi 2004b; Krespi et al. 2006; Matsui et al. 2014; Seemann et al. 2014), leading to a reduction or elimination of the odorous components and decreasing/eliminating bad breath (Tonzetich & NG 1976). Tongue-cleaning should therefore be carried out during professional halitosis consultations.

The topic of bad breath is of increasing importance in today’s world consequently increasing the spectrum of various devices ranging from brushes to scrapers that the patient is able to choose from. Nevertheless, tongue-cleaning treatments have not been incorporated into dental treatment in most dental offices (Zürcher & Filippi 2016b). This leads primarily to the fact that tongue-cleaning takes place at home.

The University Center for Dental Medicine Basel UZB has been offering halitosis consultations since 2003. In addition to the general and special halitosis medical history, further findings and saliva diagnostics permit the development of an individual therapy plan for each patient (Zürcher et al. 2012; Zürcher & Filippi 2016a; Schumacher et al. 2017). Once a coating of the tongue is diagnosed, its cleaning will follow (Zürcher & Filippi 2016a). For home usage, tongue-cleaning should be embedded into our daily routine, performed two to three times per day (Filippi 2011b; Seemann et al. 2014; Schumacher et al. 2017).

In 2015, a novel tongue-cleaning device (TSI, TSpro GmbH, Karlsruhe, Germany) appeared on the market. This disposable appliance is connected to the suction device of a dental unit and may be used to perform professional tongue-cleaning (Zürcher & Filippi 2016a, 2016b).

In a previous clinical study (Rickenbacher et al. 2019), the acceptance of the TSI suction tongue cleaner was tested on children. 162 children between the ages of 5 and 18 were asked to evaluate the treatment on a visual analogue scale, ranging from 0 (not acceptable) to 10 (highly acceptable), comparing the TSI with a conventional toothbrush to clean their tongue. The second part of the study comprised an evaluation of the motivation of the children who then independently cleaned their tongues with a manual toothbrush over a period of a month. In this case the efficiency of the bacterial reduction of the tongue was not evaluated.

The aim of the present study was to investigate professional (in-office) usage between a manual tongue cleaner and the TSI suction device if used on adults. Differences are divided into a primary outcome (efficiency) and a secondary outcome (acceptance).

Materials and methods

The TSI was used on 100 participants. The minimum sample size was calculated by the Clinical Trial Unit at the University of Basel (CTU) to be 29 participants. It was raised up to 100 participants to further increase confidence in the analysis. The subjects were recruited at the University Center for Dental Medicine Basel UZB by showing up voluntarily on various preset time schedules. The time schedules were announced at the University Center for Dental Medicine Basel UZB prior to the cleaning. In order to participate, volunteers had to be between the ages of 19 and 31 and systemically healthy. Currently suffering from halitosis was not necessary to join the study. Further criteria that excluded the participation were the intake of antibiotics, acute sinusitis, currently suffering from asthma or hay fever and a pronounced gag reflex. The volunteers were informed verbally and in written form about the course of the study and confirmed their participation with their signature.

The study was approved by the Ethics Commission in North-west and Central Switzerland EKNZ (No. 2015/218).

The devices used for tongue-cleaning were a novel tongue-cleaning device (TSI, TSpro GmbH, Karlsruhe, Germany) and manual tongue cleaner. The manual tongue cleaner is equipped with four rubber blades with a flat and a scraping side and nubs on the flat side, which would allow easier application of tongue gel.

Prior to cleaning, the participants had to answer a questionnaire composed of general and specific questions relevant to the topic. On a visual analogue scale ranging from 0 cm (no stimuli) to 10 cm (strong stimuli), they were asked to evaluate their gag reflex as well as their personal experience with tongue-cleaning devices, addressing the frequency and the product used (Fig. 1).

In order to obtain a non-subjective assessment of the cleaning, volunteers were asked to close their eyes during the procedure. A special device was attached to the manual tongue cleaner, not to allow the subject to identify either of the two methods through sound (Fig. 2). Both cleaners were moistened with water before usage, to improve the gliding capacity. A photo (Nikon D7100: focal length 105, f-number 29, exposure time 1/125, ISO 200) was taken to evaluate the clinical situation before cleaning.

The cleaning was carried out by an expert (standing in front of the subject, while the subject was sitting straight in a dental chair) during a single appointment with a split-mouth (i.e. half-tongue) design, hence each side of the tongue was cleaned consecutively with a different device, for 40 seconds. The sequence (which device would start) was randomized (Research Randomizer, www.randomizer.org) and then noted on the result sheets.

During the first 20 seconds, serpentine-like movements were performed with the knobbed side of the suction tongue cleaner, while with the manual tongue cleaner, circular movements were done on the flat side. This was executed, while the practitioner held the tip of the tongue with a damp compress. This step was followed by removing (20 seconds) the previously loosened biofilm with the back of the device. This meant that the TSI’s lamella side was used and the manual version was used with its scraping edge facing the tongue. The cleaning was performed from the posterior to the tip of the tongue on the respective dorsal half. Another post–cleaning picture was taken for evaluation purposes.

After each side was cleaned, the participant was able to judge the procedure via using a visual analogue scale, assessing
how pleasant the treatment was, ranging from 0 cm (very unpleasant) to 10 cm (very pleasant), and if they would undergo treatment again. In the case of varying results between both methods, the subject was asked to give a reason in key words, which treatment she or he stipulated was preferred (Fig. 3). In the meantime, the examiner noted whether one of the two devices had resulted in stimulating a gag reflex during cleaning. The strength of this stimulus was scrutinized by using the Gagging Severity Index (GSI) (Dickinson & Fiske 2005). With a wooden spatula, the back of the tongue and its sides were lightly touched in order to receive a better idea of the person’s gag reflex (1 normal to 5 pronounced) as compared to undergoing the procedure with one of the devices. The photos taken before and after the tongue-cleaning were used to evaluate the efficiency of the procedure. This was assessed by the two people in charge of the halitosis consultation in a lecture hall, where the images were projected and enlarged, while not knowing which tongue-cleaning devices had been used on which side.

An evaluation of the coating of the tongue was performed using a modified coating tongue index by Winkel (WTCI, Winkel Tongue Coating Index) (Winkel et al. 2003). The tongue was divided into two anterior and two posterior fields. The evaluation per field ranged from 0 = no tongue coating (pink), 1 = light coating (pink tongue color is still visible under the coating) and 2 = strong coating (no more pink tongue color visible). The summary of all values of the four fields resulted in a WTCI value between 0 and 8. Eventually, the side that was visually cleaner was written down in order to compare the similarity between the visual cleanliness of the tongue-cleaning and the WTCI (Fig. 4).

All data was calculated with the statistics program R Version 3.5.1. Non-parametric analyses were undergone so as to create a disparity of the score values regarding its distribution when performing a group comparison (Wilcoxon Rank-Sum...
Test of Wilcoxon Sign Rank Test for paired data). Additionally, a general linear model was calculated in order to enable a comparison between purified vs. unpurified. All tests were performed with a statistical discrepancy of 5% error probability ($\alpha \leq 0.05$). Due to the purely explorative nature of the study, the significant variance for multiple comparisons was not adjusted. The result is a ratio including 95% CI and p-value. For 2×2 contingency tables a Fisher’s exact test was performed and the estimated odds ratios including 95% CI and p-value were presented. The significance level was $\alpha \leq 0.05$.

**Results**

In total there were 100 participants, 60 females and 40 males, between the ages of 19 and 31 (± 23.97; SD 2.56). Since the recruitment took place at the University Center for Dental Medicine Basel UZB, the majority of the participants were dental...
students (90%). The remaining 10% were students from other departments. When assessing the subjective perception of the treatment with a manual device ($\bar{x} = 6.9$ cm; SD 2.0 cm) in comparison to the TS1 suction tongue cleaner ($\bar{x} = 6.8$ cm; SD 1.8 cm), no significant statistical data was noted (median difference 0.3, 95%CI -0.25/0.85, $p = 0.259$), as displayed in Figure 5. Whereas 53% of the participants favored the manual tongue cleaner, 36% of the subjects preferred the TS1 suction tongue-cleaning device. The remaining 11% considered either one as being equally pleasant.

The most frequently used word to describe a negative sensation was “rough”, followed by “tickling”, “dry” and “scratchy”. Other words, such as “pleasant”, “gentle” and “soft”, were applied when reflecting a positive connotation and experience of the cleaning procedure (Fig. 6).

There was no statistical difference in the acceptance between the TS1 suction tongue cleaner and a manual tongue cleaner (OR 1, 95%CI 0.2/4.5, $p = 1$). Five volunteers could not imagine undergoing treatment again with either of the tongue cleaners.

The number of stimulated gag reflexes did not vary statistically between the devices used (manual tongue cleaner, $n = 8$, and suction tongue cleaner, $n = 9$) (OR 1.14, 95%CI 0.37/3.55, $p = 1$).

The nine participants who had to choke with either of the tongue cleaners had estimated beforehand a high likeliness of choking on the visual analogue scale. This estimate was in fact higher in their case than with the rest of the participants ($n = 91$) who did not have to choke during the cleaning procedure (median difference 4.2, 95%CI 2.4/6.0, $p < 0.001$). In the GSI score eight out of nine subjects showed a gag reflex with a value of 2
300-307_T1-1_rhyn_EDF.indd   305

volunteers had a thick coating on the tongue before cleaning

p = 0.493). It is important to note, that a total of 23 out of 100
cleaner and the manual tongue cleaner (median difference 0.5,
tically there was no difference between the suction tongue

cleaner. Although in 58 of 100 cases the side cleaned by the TS1

decreased by a factor of 0.63 (95%CI 0.58/0.7, p < 0.001) after using the manual tongue

applying the TS1 suction tongue cleaner and by a factor of 0.68

tween the acceptance of the suction tongue-cleaning device

suction tongue cleaner and that there was no difference be-

results showed that the volunteers were motivated to use the TS1

The glossectomy, under local anesthesia, performed in the sulcus

to the TS1 and the manual tongue cleaner. In 95% of the cases the participants would agree to repeat the treatment with a TS1

Discussion

The results of the present study reflect that the TS1 suction tongue cleaner removes the tongue coating as well as a manual tongue cleaner. The subjective assessment of tongue-cleaning showed no difference on the visual analogue scale between the TS1 and the manual tongue cleaner. In 95% of the cases the participants would agree to repeat the treatment with a TS1 suction tongue cleaner and a manual tongue cleaner. The results showed that the volunteers were motivated to use the TS1 suction tongue cleaner and that there was no difference between the acceptance of the suction tongue-cleaning device and the manual tongue cleaner on a visual analogue scale, even though the manual cleaner was slightly preferred subjectively as shown in Figure 6. However, it should be noted that only a few subjects (23 out of 100) had a thick tongue coating with a WTCI of 3 or more measured per half of the tongue. Further, water was used instead of a tongue paste in this study to increase the gliding capacity, so that the taste did not distract the volunteers.

One problem with tongue-cleaning is the long-term effectiveness. A study reported that tongue coating returned to its baseline (i.e., prior to cleaning) after only two days of not cleaning the tongue anymore (Chérel et al. 2008). Another study did not show either any significant difference when comparing the WTCI after three and ten days prior to cleaning when compared to subjects who did not clean their tongue at the beginning (Matsui et al. 2014).

Therefore, tongue-cleaning should be performed on a daily basis (as stated earlier). This means that periodic professional de-plaquing cannot substitute daily home tongue-cleaning. The idea of professional tongue-cleaning in a dental office can rather be seen as a tool to inform patients about tongue-cleaning. to teach and help patients to perform correct tongue-cleaning (with providing information about the many devices available for home usage), or to just remind patients to clean their tongue regularly. Nevertheless, there is still a scientific need to study novel professional tongue-cleaning products to better understand their efficiency in improving and guaranteeing successful, professional treatment (professional tongue-cleaning) in dental appointments, such as in professional halitosis consultations.

Another benefit of professional tongue-cleaning is the obvious inspection of the tongue coating and possible help with further treatment where needed. While tongue coating caused by bacterial overgrowth has already been mentioned earlier in this study, it is important to distinguish between fungal overgrowth and bacterial overgrowth. Fungal overgrowth on the tongue is an infection, known as candidiasis or thrush, caused by any of the Candida species (Sing et al. 2014). The difference is that candidiasis presents itself on the tongue as a whitish-yellow creamy confluent plaque (Patil et al. 2015), which can be removed but will leave an underlying erythematous and occasionally bleeding surface (Ashman & Farah 2005; Farah et al. 2010), whereas tongue coating caused by bacterial overgrowth will not leave such a mark. Using a tongue cleaner will not result in a successful treatment of fungal overgrowth, it is therefore recommended to get help from a doctor for further treatment such as antifungal medicine.

There were differences between adults in the current study and children in an earlier study regarding the acceptance of the TS1 tongue cleaner. For adults the acceptance on the visual analogue scale in the present study was 6.8 cm out of 10 cm. Children rated the TS1 slightly higher at 8.9 cm (Rickenbacher et al. 2019). However, the initial and maximum values of the visual analogue scales were not considered identical in both studies. In this study, it was presented as a range displayed by the values 0 = very unpleasant and 10 = very pleasant, whereas the visual analogue scale in children ranged from 0 = not accepted to 10 = accepted. Furthermore, in children the acceptance of the TS1 was better in comparison to the manual toothbrush (Rickenbacher et al. 2019). However, adults in this study did not demonstrate any difference in the acceptance between the two. In 93% of the cases, children would agree to repeat this procedure with the TS1 suction tongue cleaner (Rickenbacher et al. 2019).

The gag reflex has a major influence on the acceptance of the treatment. The posterior region of the dorsal surface of the tongue is a typical trigger zone for gag stimulation (Meeker &
Magalee 1986). Diese Ergebnisse wurden in eine statische Analyse übernommen, um die Wirkung der professionellen Zungenreinigung zu quantifizieren.

Diskussion
Die Ergebnisse dieser Studie lassen sich in einem zusammenfassenden Abschnitt zusammenfassen. Die professionelle Zungenreinigung bietet ein gutes Verhältnis von Wirkung und Akzeptanz im Vergleich zu manuellen Reinigern. Im Allgemeinen erwiesen sich die Ergebnisse als stabil und konsistent, metrische Maße wie der Belagindex Winkel (WTCI) zeigten, dass der Zungenbelag nach professioneller Reinigung signifikant reduziert wird. Die Probanden zeigten eine hohe Akzeptanz der Reinigungstechnik, insbesondere was den Komfort während des Prozesses und die zügige Wirkung anbelangt.

Material und Methoden

Résumé

Matériel et méthodes L’aspirateur lingual TSI et le nettoyeur-langue furent testés intra-individuellement et intra-individuellement chacun sur un côté de la langue de 100 participants au centre universitaire pour la médecine dentaire à Bâle (UZB). Afin d’être éligibles pour cette étude, les participants devaient être adultes, âgés entre 19 et 31 ans, et ne pas souffrir de maladie ou encore d’un réflexe nauséeux extrême. À l’aide d’une échelle analogique visuelle, les participants ont évalué leur réflexe nauséeux (0 = pas de réflexe nauséeux, 10 = réflexe nauséeux très fort) ainsi que le nettoyage de la langue (0 = très désagréable, 10 = très agréable). Pour l’évaluation du nettoyage de la langue, des photos avant/après ont été prises durant l’exa-
men, puis évaluées à l'aide de l’index de dépôt lingual de Winkel (WCTI) modifié.

Résultats

L’évaluation subjective de l’acceptation montre qu’il n’existe aucune différence sur l’échelle analogique visuelle entre le nettoie-langue (x ¯ 6,9 cm ; SD 2,0 cm) et l’aspirateur lingual (x ¯ 6,8 cm ; SD 1,8 cm) (différence de médiane 0,3, 95 %CI -0,25/0,85, p = 0,259). De plus, il n’existe aucune différence statistique entre l’acceptation d’un nouveau traitement (OR 1,95 %CI 0,2/4,5, p = 1) ainsi que le nombre de réflexes nauseaux survenus avec un aspirateur lingual ou avec un nettoie-langue (OR 1,14, 95 %CI 0,37/3,55, p = 1). De plus, l’évaluation du WCTI montre d’une part que le dépôt lingual diminue de 0,63 fois après l’utilisation de l’aspirateur lingual (95 %CI 0,58/0,7, p < 0,001) et de 0,68 fois après l’utilisation du nettoie-langue (95 %CI 0,62/0,75, p < 0,001). D’autre part, il n’existe aucune différence statistique entre l’aspirateur lingual et le nettoie-langue (différence de médiane 0,5, p = 0,493). Dans la présente étude, les femmes ont plus d’expérience avec le nettoyage de langue que les hommes (OR 3,2, 95 %CI 1,2/8,8, p = 0,013).

Discussion

Les résultats de cette étude ont montré que l’aspirateur lingual TSI nettoie le dépôt lingual aussi bien qu’un nettoie-langue. Aucune différence n’a été constatée entre l’acceptation de l’aspirateur lingual et le nettoie-langue, et le réflexe nauseux ne fut déclenché que rarement. Pour les deux types de nettoyage, 95 % des participants accepteraient un nouveau nettoyage de langue. On peut donc conclure que l’aspirateur lingual TSI constitue une bonne alternative au nettoie-langue et peut donc être conseillé pour un nettoyage professionnel en cabinet.

References