This is an Accepted Manuscript for *The Journal of Laryngology & Otology*
DOI: 10.1017/S0022215121004382

Improving heat and moisture exchanger therapy with a hydrogel base adhesive in laryngectomized patients: an open randomized crossover trial

Miguel Mayo-Yáñez, MD, MSc* (1,2,3), Vanesa Balboa-Barreiro. MSc (4), Jérôme R. Lechien, MD, PhD (3,5,6), Christian Calvo‐Henríquez MD, MSc (2,3,7), Carlos Chiesa-Estomba, MD, MSc (3,8), Jesús Herranz González-Botas MD, PhD (1,9), Irma Cabo-Varela, MSc (1).

1. Otorhinolaryngology – Head and Neck Surgery Department, Complexo Hospitalario Universitario A Coruña (CHUAC), 15006, A Coruña, Galicia, Spain.
2. Clinical Research in Medicine, International Center for Doctorate and Advanced Studies (CIEDUS), Universidade de Santiago de Compostela (USC), 15782, Santiago de Compostela, Galicia, Spain.
3. Young-Otolaryngologists of the International Federations of Oto-Rhino-Laryngological Societies (YO-IFOS) Study Group, Paris, France.
4. Support Investigation Unit, Complexo Hospitalario Universitario A Coruña (CHUAC), 15006, A Coruña, Galicia, Spain.
5. Human Anatomy & Experimental Oncology Department, Faculty of Medicine UMONS Research Institute for Health Sciences and Technology, University of Mons (UMons), Mons, Belgium.
6. Otorhinolaryngology and Head and Neck Surgery Department, Elsan Hospital, Paris, France.
7. Otorhinolaryngology – Head and Neck Surgery Department, Complexo Hospitalario Universitario Santiago de Compostela (CHUS), 15706, Santiago de Compostela, Galicia, Spain.
8. Otorhinolaryngology – Head and Neck Surgery Department, Hospital Universitario Donostia, 20014, Donostia, Euskadi, Spain
9. School of Medicine and Odontology, Universidade de Santiago de Compostela (USC), 15782, Santiago de Compostela, Galicia, Spain.

*Correspondence: Otorhinolaryngology – Head and Neck Surgery Department, Complexo Hospitalario Universitario A Coruña (CHUAC). As Xubias 84, 15006, A Coruña, Spain. miguel.mayo.yanez@sergas.es

ORCID:

Miguel Mayo-Yáñez: 0000-0002-1829-6597; Jérôme R. Lechien: 0000-0002-0845-0845; Christian Calvo‐Henríquez: 0000-0003-3580-0967; Carlos Chiesa-Estomba: 0000-0001-9454-9464; Jesús Herranz González-Botas: 0000-0003-2469-357X

TWITTER:

Miguel Mayo-Yáñez: @Mayo_ORL, @ORLCHUAC, @GabComCHUAC; Jérôme R. Lechien: @JeromeLechien; Carlos Chiesa-Estomba: @OrlChiesa

https://doi.org/10.1017/S0022215121004382 Published online by Cambridge University Press

ABSTRACT:

Objective: To assess individual's preference, symptoms and compliance between habitual use of Provox XtraFlow and the combination of Provox XtraFlow during the day and Provox Luna during the night for heat and moisture exchanger therapy in laryngectomized patients.

Methods: Open randomized crossover trial for 25 days. After this first follow-up and a 5 days wash-out period, a treatment switching was performed for another 25 days.

Results: A total of 28 subjects, were enrolled. Differences were found (p=0.009) in the incidence of dermatological problems with XtraFlow (46.4%) versus Provox Luna (14.3%), as well as in the need to abandon the use of adhesives (46.4%vs.10.7%; p=0.003). The 60.7% of the patients referred the Provox Luna system as their preference for heat and moisture exchanger therapy.

Conclusions: The Provox Luna system is a viable additive to heat and moisture exchanger therapy, especially in the setting of compliance concerns and in subjects who desire dermatological relief overnight.

KEYWORDS:

Laryngectomy; Tracheostomy; Hydrogel; Surgical Stomas; Speech.

https://doi.org/10.1017/S0022215121004382 Published online by Cambridge University Press

INTRODUCTION:

Total laryngectomy (TL) leads to an alteration of the normal physiology of the upper respiratory tract. Inspired air bypasses the upper airway due to the placement of a permanent tracheostoma, impeding physiological airway conditioning (warming, filtration, and humidification).[1] TL is associated with marked histological changes to the tracheal mucosa, including the loss of ciliated epithelial cells and goblet cell hyperplasia, which impairs mucociliary clearance.[2,3]

Heat and moisture exchangers (HME) are passive airway reconditioning devices that are positioned at the opening of the tracheostoma, improving tracheal climate, particle filtering, and increased respiratory resistance.[4] They retain heat and moisture in the core media, thereby warming and humidifying the inspired air and producing a beneficial effect on tracheal climate, pulmonary symptoms and related aspects.[5] This series of benefits causes a reduction of coughing, forced expectoration, external humidifier use, and healthcare costs.[6,7]

The obtaining of these results is totally dependent on the time of use of the HME.[8] Over time, technological advances have led to improvements in the design of this type of device, achieving greater adherence to its use.[5] Despite this, there is room for improvement, as approximately 20% of subjects report skin irritation at the adhesive site and discomfort while sleeping with the HME device.[9] This is probably related to the inflexible synthetic materials of the conventional HME and peristomal adhesives. With the intention of solving these kinds of problems, Atos Medical (Malmö, Sweden) has developed the Provox® Luna™, with a hydrogel-based soft adhesive and soft silicon housing design for night use.[10] The aim of this study is to assess individual's preference, symptoms and compliance between habitual use of Provox XtraFlow and the new combination of Provox XtraFlow during the day and Provox Luna during the night for heat and moisture exchanger therapy in laryngectomized patients.

MATERIALS AND METHODS:

Trial design

https://doi.org/10.1017/S0022215121004382 Published online by Cambridge University Press

An open randomized crossover trial where subjects acted as their own control in order to limit bias and provide a valid control interval was conducted (figure 1). This research involved human participants and was approved by the Hospital's Ethics Committee. Informed consent was obtained from all individual participants included in the study.

After baseline data collection and a 15 days-running-in period in which the participants had to use their usual HME with larytube, but without adhesive. A simple randomization in two groups was performed: Group A started using HME XtraFlow and adhesive 24 hours a day for 25 days (XF). The Group B started using a combination of HME XtraFlow and adhesive for 12 hours a day and HME and adhesive Luna for 12 hours at night for 25 days (XF+PL). After this first follow-up and a 5 days wash-out period, data were collected and a treatment switching was performed for another 25 days. After this second follow-up and a 5 days wash-out period data were collected again (figure 1). These rest periods were based on previous studies where the adhesive abandonment time was analyzed and planned in order to rest the skin and reduce the possible effect of irritations/ adverse reactions of previous adhesive and memory bias.[11] Subjects were supplied with Luna and XtraFlow HMEs, Luna and regular adhesives, a shower cap, and additional protective adhesive strips.

The assessment and follow-up of patients was made by an otolaryngologist and a speech therapist every week during follow-up to ensure they were recording daily observation and to solve any problem or adverse reaction. All subjects were given a tally sheets and instructed to record the daily HME use, type of HME or alternative used during the night, the number of episodes of disrupted sleep due to coughing every night, the presence of skin irritation problems, and psychosocial aspects.

Participants

Patients were recruited from the departments of the Otorhinolaryngology—Head and Neck Surgery Service of a tertiary university hospital. All laryngectomised patients belonging to the hospital are under prospective follow-up in a database in which device changes and causes are collected.[12,13] The inclusion criteria were: >18 years old, at least 3 months post-total laryngectomy, at least 3 months post-radiotherapy/ chemotherapy in the case of having received this type of treatment, being treated with proton-pump inhibitors and had at least three months experience with the Provox voice prosthesis, HME and adhesives. Subjects were excluded on the basis of prior medical problems

https://doi.org/10.1017/S0022215121004382 Published online by Cambridge University Press

preventing HME or adhesive use, recurrent or metastatic disease, use of another phonation method instead of the voice prosthesis, functional incapacity to insert and remove an HME or adhesive independently, inability to understand or provide informed consent, impaired cognitive ability, or regular use of any type of cannula.

Interventions

The Provox XtraFlow HME cassette (figure 2) is a single-use device that features a calcium chloride–treated foam sponge in a plastic housing, intended for patients breathing through a tracheostoma. It is an HME that heats and humidifies inhaled air by retaining heat and moisture from exhaled air in the device. It partially restores lost breathing resistance. Provox FlexiDerm Adhesive (figure 2) is a disposable device intended to hold Provox HME Cassettes in front of the tracheostoma, as well as guaranteeing the airtightness of said cassettes. The Provox Luna System (figure 2) is a single use heat and moisture exchanger and adhesive for a night-time designed to improve comfortably, skin and lung health. Its adhesive base is a skin-friendly hydrogel intended for comfort and skin rest.

Outcomes

The primary outcome measure in this study was the subjective comparison and preference of HME therapies. Secondary outcomes included objective comparison of HME therapies, pulmonary and dermatological effects, sleeping, and psychosocial aspects, based on previous structured questionnaires,[14,15] through dichotomous or/ and categorical responses with a single possible option according to the Likert methodology and the EuroQol five-dimensions instruments.[16]

Sample size

Sample size was calculated based on a statistical model for a binary outcome in a crossover group superiority trial.[17] We determined that 28 patients per group were required to have an 80% chance of detecting, as significant at the 5% level, an increase in the primary outcome measure from 78% in the control group to 100% in the experimental group. These reference values were taken from previous studies of adherence to HME therapy.[5,18,19]

Statistical analysis

https://doi.org/10.1017/S0022215121004382 Published online by Cambridge University Press

The statistical analysis was performed sequentially: phase 1, baseline data description; phase 2, descriptive of each treatment modality independently; phase 3, inference between XF treatment and XF + PL treatment; phase 4, inference between treatment groups (group A versus group B) according to the order of administration. Analysis was performed with IBM® SPSS® Statistics version 24.0 for Windows (Armonk, USA) where the tests were 2 tailed with a 95% confidence interval. Incomplete responses were excluded from analysis. Normality was evaluated by the Kolmogorov-Smirnov test and variances using the Levene test. Qualitative variables were expressed as frequency and percentage. The differences between groups were evaluated by the $\chi 2$ test, Fisher exact test, or its variants as appropriate.

RESULTS AND ANALYSIS:

Subjects Description

A total of 28 subjects were enrolled in the study (table 1), 26 (92.86%) men and 2 (7.14%) women. The mean age was 63.54±9.44 years old. Regarding complementary treatment, 15 (53.6%) did not require, 8 (28.6%) received radiotherapy (RT), 2 (7.1%) chemotherapy (CT) and 3 (10.7%) RT-CT. With the randomization, 14 patients were included in group A and 14 in group B. The mean age of group A was 61.07±7.63 years, and for the B was 66 ± 10.67 years (p=0.393). There were no differences in the distribution of gender, RT or CT. No dropouts were collected and compliance with data collection in the diary was 100%. The results of the different outcomes are summarized in table 2.

Primary Outcome

At the final evaluation, all 28 subjects were asked about their overall subject experience comparing the Provox Luna system to the Provox XtraFlow (table 3). Most of the patients (n=17;60.7%), reported preferring PL therapy subjectively, not finding statistically significant differences in any of the items according to the order of treatment.

Respiratory outcome

In patients with XF, 10 (35.7%) had no problems compared to 18 (64.3%) who reported difficulty in passing air or dyspnea using this type of filter. Of these 18, half reported it at rest and half during physical efforts. The need for forced expectoration or coughing

https://doi.org/10.1017/S0022215121004382 Published online by Cambridge University Press

spells was evaluated, finding that 12 (42.9%) required doing it regularly: 6 (21.4%) 1-2 times a day, 4 (14.3%) 3-4 times a day, and 2 (7.2%) ≥5 times a day. With the XF + PL treatment, the results in relation to difficulty in passing air or dyspnea were identical, 10 (35.7%) had no problems versus 18 (64.3%) that did. Of these, 7 (25%) reported it at rest and 11 (39.3%) during physical efforts (p=0.502). The need for forced expectoration or coughing spells was referred by 12 (42.9%) patients, doing it regularly: 7 (25%) 1-2 times a day, 4 (14.3%) 3-4 times a day, and 1 (3.6%) ≥5 times a day.

According to the group of treatment (A vs. B), there were no differences in the reporting of difficulty in passing air, although there was a higher frequency of dyspnea during physical efforts versus dyspnea at rest in patients when they switched to using PL, than vice versa (p=0.003). There were no differences in the need for expectoration (p=0.127) or its frequency (p=0.165).

Dermatological outcome

According to the treatment modality, 24 (85.7%) patients with XF required a daily cleaning of the stoma compared to 4 (14.3%) who required twice daily. Of the 28 volunteers, 13 (46.4%) had dermatological problems (itching, irritation, inflammation or redness) compared to 15 (53.6%) who did not. Of these 13 with problems, 5 (17.9%) presented them every day, 5 (17.9%) every week, 2 (7.1%) at least once every 2 weeks, 1 (3.6%) at least once every ≥2 weeks. All needed to leave the adhesives to improve, 7 (25%) every night and 6 (21.4%) on demand. Patients with XF+PL treatment required a daily cleaning of the stoma in a 10.7% (n=3) compared to 25 (89.3%) who required two daily cleanings (p=0.000). On the contrary, 4 (14.3%) had dermatological problems (itching, irritation, inflammation or redness) compared to 24 (85.7%) who did not (p=0.009). Of these 4 with problems, 2 (7.1%) presented them every day, 1 (3.6%) every week, 1 (3.6%) at least once every 2 weeks (p=0.868). Of these, only 3 needed to leave the adhesives to improve (p=0.003), 2 (7.1%) every night and 1 (3.6%) on demand.

Regarding the treatment group (A vs. B), there were no differences in relation to the cleaning of the stoma (p=0.098), the appearance of skin problems (p=0.256) or their frequency (p=0.414), or the need to leave the adhesives (p=0.058).

Sleeping outcome

https://doi.org/10.1017/S0022215121004382 Published online by Cambridge University Press

In XF group, a total of 9 (32.1%) patients were routinely receiving hypnotic medication. Regarding the characteristics of sleep, 7 (25%) reported difficulty falling asleep between 1 and 3 times a week. A total of 15 (53.6%) reported difficulty in maintaining sleep, with frequent nocturnal awakenings (n=11;39.3%) or always (n=3;10.7%). Despite these data, the majority of the patients reported that their sleep quality was good (n=18;64.3%) or very good (n=6;21.4%). The same number of patients routinely received hypnotic medication in the XF+XL group. Difficulty falling asleep between 1 and 3 times a week was reported in 8 (28.6%) patients (p=0.763). A total of 14 (50%) reported difficulty in maintaining sleep (p = 0.789), with frequent nocturnal awakenings (n=12;42.9%) or always (n = 2; 7.1%). The majority of the patients reported that their sleep quality was good (n=19;67.9%) or very good (n=6;21.4%) (p=0.948).

According to the treatment group (A vs. B), there were no differences in sleep conciliation (p=0.385) or the frequency of this type of problem (p=0.823). Neither in presentation (p=0.705) or frequency of awakenings, need for medication, or quality of sleep (p=0.446).

Psychosocial outcome

All social interactions in the XF group were considered good (n=23;82.1%) or acceptable (n=5;17.9%). Attending specifically to the different emotions, 14 (50%) patients reported being nervous, occasionally (n = 11; 39.3%) or always (n=3;10.7%), when interacting with other people. A 64.3% (n=18) reported concern, occasionally (n=16;57.1%) or always (n = 2; 7.1%). A 25% (n = 7) irritability, occasionally (n = 6; 21.4%) or always (n=1;3.6%). And a 25% (n=7) sadness, occasionally (n=4;14.3%) or always (n=3;10.7%). In the XF+PL group, 25 (89.3%) participants considered social interactions as good and 3 (10.7%) as acceptable (p=0.705). Attending specifically to the different emotions, 13 (46.4%) patients reported being nervous (p=0.789), occasionally (n=12;42.9%) or always (n=1;3.6%), when interacting with other people (p=0.596). A 60.7% (n=17) reported concern (p=0.783), occasionally (n=16;57.1%) or always (n=1;3.6%) (p=0.226). A 25% (n=7) occasionally irritability, and a 21.4% (n=6) sadness (p=0.752), occasionally (n=5;17.9%) or always (n=1;3.6%) (p=0.131).

Finally, the analysis according to the treatment group (A vs. B), did not show differences in the quality of interactions (p=0.326), in nervousness (p=1.000) or their frequency (p=0.192), in concern (p=0.430) or its frequency (p=0.477), in irritability

https://doi.org/10.1017/S0022215121004382 Published online by Cambridge University Press

(p=1.000) or its frequency (p=0.429), or in sadness (p=1.000) or its frequency (p=1.000).

DISCUSSION:

After TL, the upper airway is permanently separated from the respiratory tract, thereby no longer contributing heating/ cooling, moisturizing, and filtering of the inspired air, and causing an increase in coughing, sputum production, and frequent forced expectorations. A correlation between these consequences and perceived quality of voice, life, and psychosocial aspects like anxiety or depression has been established.[20,21]

Numerous HME devices have been developed in order to compensate the impairment of the respiratory function of upper aerodigestive tract, e.g. heating, cooling, filtering or air, and to improve quality of life of laryngectomized patients.[5,11,22] The aim of this open randomized crossover trial was to compare a new nocturnal HME (Provox Luna) versus the standard HME therapy (Provox XtraFlow) by objective measurements (tally sheets) and subjective (questionnaires).

Several studies comparing different models of HME have been published,[5,9,22] but there is only one study that analyzed the new Provox Luna.[23] The design of the present work is slightly different, considering a running-in and wash-out periods, and only comparing one type of HME (XtraFlow) with the Provox Luna in order to achieve a robust comparison and reduce the risk of bias. Owing to the randomized crossover trial design of the study, the subjects were their own controls, thus allowing for meaningful comparison of compliance and preferences of the subjects between the two periods. The demographic characteristics of the respondents (the distribution of age, sex, puncture, voice prosthesis, TNM-stage or surgery…) were comparable to previous studies in the literature,[5] and subsequent analysis according to randomization revealed no significant impact on all observable outcomes, suggesting that the study design was appropriate for the comparative assessment of HME use and results. Furthermore, long-term conclusions are difficult to draw from the short follow-up interval.

Analysis of the dataset revealed a significant improvement in compliance and skin problems overnight during the Luna period, being this aspect an important determinant of compliant HME use overnight. These data should be viewed with caution. Receiving weekly follow-up and stressing the compliant use creates a situation with an artificially increased compliance. The compliance reported during the Provox Luna care period was

https://doi.org/10.1017/S0022215121004382 Published online by Cambridge University Press

89.3%, higher than previous reports in the literature and in the study of Ratnayake et al.[23] Despite the fact that the non-use of HME devices during the night could cause a worsening of the quality of rest,[5,24] no subjective or statistically significant differences were found in this aspect regarding the treatment with HME used or adherence to it. This may have resulted from the increased subject education with which the importance of HME use is stressed. It is true that a significant number of patients received hypnotic treatment on a regular basis, an aspect that could lead to bias and that it is necessary to evaluate in future studies with a longer follow-up than pre-requisite drug withdrawal.

Taking into account the respiratory symptoms, our results suggest that coughing might reduce over time when the treatment was changed to Luna HME and adhesive. These results are consistent with the previous ones.[23] The overall satisfaction of the patients was similar for the two types of treatment, and no statistically significant differences were demonstrated in the secretions, expectoration or dyspnea. Where differences were seen was when switching from XF to XF+PL, this may be due to the new architecture of the Luna HME filter, with which the patients reported the need for a greater inspiratory effort at the beginning of its use. Despite this, pulmonary issues might be an underlying cause of many other issues, including experienced limitations in daily activities and avoiding social activities. This aspect was also evaluated in our study. Most of the patients did not report problems in terms of their usual social interactions, or differences according to the type of HME used. This results are in line with previous studies that the quality of life rating is mainly influenced by the ability to do meaningful activities and the age of the patient, and less by purely physical consequences of TL.[15,22]

BULLET POINT SUMMARY:

- Currently, 20% of subjects report skin irritation at the adhesive site and discomfort when sleeping with the HME device.
- The new Provox Luna for night-time is a skin-friendly hydrogel base adhesive.
- Using Provox Luna causes significant improvements in night compliance and skin problems
- 60.7% of the patients studied prefer to continue using the Provox Luna system

CONCLUSION:

https://doi.org/10.1017/S0022215121004382 Published online by Cambridge University Press

This open randomized crossover-trial compared compliance, the dermatological, pulmonary and psychosocial outcomes of adding the Provox Luna system during the night in laryngectomized subjects. Significant improvements in night compliance and skin problems were observed with the Luna system. At the conclusion of the study, 17 (60.7%) indicated to continue using the Provox Luna system. The 39.3% (n=11) who were indicated not to further use it mentioned that they perceived no advantages or that they disliked changing the adhesive more often or that it was more difficult for them to inhale air during use. Therefore, the Provox Luna system is a viable additive to HME therapy, especially in the setting of compliance concerns and in subjects who desire dermatological relief overnight.

DISCLOSURES:

Competing interests: None. Sponsorships: None. Funding source: None.

AUTHOR CONTRIBUTIONS:

MMY, conception or design of the work, the acquisition, analysis, or interpretation of data for the work, drafting the work, final approval of the version to be published, agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved**; VBB**, the interpretation of data for the work, data analysis, revising the paper critically for important intellectual content, final approval of the version to be published, agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved**; JRL**, revising the paper critically for important intellectual content, final approval of the version to be published, agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved; **CHH,** revising the paper critically for important intellectual content, final approval of the version to be published, agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved; **CMCE**, revising the paper critically for important intellectual content, final approval of the version to be published, agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy

https://doi.org/10.1017/S0022215121004382 Published online by Cambridge University Press

or integrity of any part of the work are appropriately investigated and resolved; **JHGB**, conception or design of the work, the acquisition of data and analysis, drafting the work, final approval of the version to be published, agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved; **ICV**, conception or design of the work, the acquisition, analysis, or interpretation of data for the work, drafting the work, final approval of the version to be published, agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

REFERENCES:

1. Cole P. Recordings of respiratory air temperature. J Laryngol Otol 1954;68:295–307

2. Williams R, Rankin N, Smith T, Galler D, Seakins P. Relationship between the humidity and temperature of inspired gas and the function of the airway mucosa. Crit Care Med 1996;24:1920–9

3. Rosso M, Prgomet D, Marjanović K, Pušeljić S, Tićac R, Mihaljević I. Histopathological Changes in Tracheal Mucosa Following Total Laryngectomy. Coll Antropol 2016;40:123–6

4. Scheenstra RJ, Muller SH, Vincent A, Sinaasappel M, Hilgers FJM. Influence of breathing resistance of heat and moisture exchangers on tracheal climate and breathing pattern in laryngectomized individuals. Head Neck 2010;32:1069–78

5. Herranz J, Espiño MA, Morado CO. Pulmonary rehabilitation after total laryngectomy: a randomized cross-over clinical trial comparing two different heat and moisture exchangers (HMEs). Eur Arch Otorhinolaryngol 2013;270:2479–84

6. Retèl VP, van den Boer C, Steuten LMG, Okła S, Hilgers FJ, van den Brekel MW. Cost-effectiveness of heat and moisture exchangers compared to usual care for pulmonary rehabilitation after total laryngectomy in Poland. Eur Arch Otorhinolaryngol 2015;272:2381–8

https://doi.org/10.1017/S0022215121004382 Published online by Cambridge University Press

7. Zuur JK, Muller SH, de Jongh FHC, van Zandwijk N, Hilgers FJM. The physiological rationale of heat and moisture exchangers in post-laryngectomy pulmonary rehabilitation: a review. Eur Arch Otorhinolaryngol 2006;263:1–8

8. Ackerstaff AH, Hilgers FJ, Balm AJ, Tan IB. Long-term compliance of laryngectomized patients with a specialized pulmonary rehabilitation device: Provox Stomafilter. Laryngoscope 1998;108:257–60

9. Hilgers FJM, Dirven R, Wouters Y, Jacobi I, Marres HAM, van den Brekel MWM. A multicenter, prospective, clinical trial evaluating a novel adhesive baseplate (Provox StabiliBase) for peristomal attachment of postlaryngectomy pulmonary and voice rehabilitation devices. Laryngoscope 2012;122:2447–53

10. Provox Luna [Online]. Available from: https://www.atosmedical.es/wp-content/uploads/2019/02/11014_ifu-luna_2018-05-28_original_web.pdf [Accessed Mar 21 2020]

11. Ackerstaff AH, Fuller D, Irvin M, Maccracken E, Gaziano J, Stachowiak L. Multicenter study assessing effects of heat and moisture exchanger use on respiratory symptoms and voice quality in laryngectomized individuals. Otolaryngol Head Neck Surg 2003;129:705–12

12. Mayo-Yáñez M, Cabo-Varela I, Suanzes-Hernández J, Calvo-Henríquez C, Chiesa-Estomba C, Herranz González-Botas J. Use of double flange voice prosthesis for periprosthetic leakage in laryngectomized patients: a prospective case-crossover study. Clin Otolaryngol 2020;45:389-393

13. Mayo-Yáñez M, Cabo-Varela I, Dovalo-Carballo L, Calvo-Henríquez C, Martínez-Morán A, Herranz González-Botas J. Provox 2®and Provox Vega®device life-time: a case-crossover study with multivariate analysis of possible influential factors and duration. Eur Arch Otorhinolaryngol 2018;275:1827-1830

14. Ackerstaff AH, Hilgers FJ, Aaronson NK, De Boer MF, Meeuwis CA, Knegt PP, et al. Heat and moisture exchangers as a treatment option in the post-operative rehabilitation of laryngectomized patients. Clin Otolaryngol Allied Sci 1995;20:504–9

15. Leemans M, Sluis KE van, Son RJJH van, Brekel MWM van den. Interaction of functional and participation issues on quality of life after total laryngectomy. Laryngoscope Investigative Otolaryngology 2020;5:453–60

16. European Quality of Life-5D [Online]. Available from: https://euroqol.org/ [Accessed Mar 21 2020]

17. Sealed Envelope Ltd. 2012. Power calculator for binary outcome superiority trial. [Online] Available from: https://www.sealedenvelope.com/power/binary-superiority/ [Accessed Sep 1 2020]

18. Macri GF, Bogaardt H, Parrilla C, et al. Patients' experiences with HMEs and attachments after total laryngectomy. Clin Otolaryngol 2016;41:652-659

19. Pedemonte-Sarrias G, Villatoro-Sologaistoa JC, Ale-Inostroza P, López-Vilas M, León-Vintró X, Quer-Agustí M. Chronic adherence to heat and moisture exchanger use in laryngectomized patients. Acta Otorrinolaringol Esp 2013;64:247-252

20. Hilgers FJ, Ackerstaff AH, Aaronson NK, Schouwenburg PF, Van Zandwijk N. Physical and psychosocial consequences of total laryngectomy. Clin Otolaryngol Allied Sci 1990;15:421–5

21. Mohide EA, Archibald SD, Tew M, Young JE, Haines T. Postlaryngectomy quality-of-life dimensions identified by patients and health care professionals. Am J Surg 1992;164:619–22

22. Parrilla C, Minni A, Bogaardt H, Macri GF, Battista M, Roukos R, et al. Pulmonary Rehabilitation After Total Laryngectomy: A Multicenter Time-Series Clinical Trial Evaluating the Provox XtraHME in HME-Naïve Patients. Ann Otol Rhinol Laryngol 2015;124:706–13

23. Ratnayake CBB, Fles R, Tan IB, Baijens LWJ, Pilz W, Meeuwis CA, et al. Multicenter randomized crossover trial evaluating the provox luna in laryngectomized subjects. Laryngoscope 2019;129: 2354–2360

24. Ackerstaff AH, Hilgers FJ, Aaronson NK, Balm AJ, van Zandwijk N. Improvements in respiratory and psychosocial functioning following total laryngectomy by the use of a heat and moisture exchanger. Ann Otol Rhinol Laryngol 1993;102:878–83

TABLES:

Table 1. Baseline data

	Population	Group A	Group B	p-value
	N (%)	N (%)	N (%)	
Gender	28	14	14	-
Man	26 (92.86)	12 (85.7)	14 (100)	0.481
Woman	2 (7.14)	2 (14.3)	0	
Location	N (%)	N (%)	N (%)	-
Glottic	8 (28.57)	3 (21.43)	5 (35.71)	0.942
Supraglottic	4 (14.29)	2 (14.29)	2 (14.29)	
Subglottic	1 (3.57)	1 (7.14)	0	
Transglottic	4 (14.29)	2 (14.29)	2 (14.29)	
Hypopharynx	11 (39.29)	6 (42.86)	5 (35.71)	
pT-stage	N (%)	N (%)	N (%)	-
T1b	3 (10.71)	1 (7.14)	2 (14.29)	1
T2	5 (17.86)	2 (14.29)	3 (21.43)	
T3	7 (25)	4 (28.57)	3 (21.43)	
T4a	13 (46.43)	7 (50)	6 (42.86)	
pN-stage	N (%)	N (%)	N (%)	-
N0	21 (75)	12 (85.71)	9 (64.29)	0.020
N2a	2 (7.14)	2 (14.29)	0	
N3a	5 (17.86)	0	5 (35.71)	
Stage	N (%)	N (%)	N (%)	-
I	1 (3.57)	1 (7.14)	0	0.432
II	4 (14.29)	1 (7.14)	3 (21.43)	
III	4 (14.29)	3 (21.43)	1 (7.14)	
IVa	19 (67.86)	9 (64.29)	10 (71.43)	
Puncture	N (%)	N (%)	N (%)	-
Primary	25 (89.29)	11 (78.57)	14 (100)	0.222
Secondary	3 (10.71)	3 (21.43)	0	
Neck dissection	N (%)	N (%)	N (%)	-
No	4 (14.29)	2 (14.29)	2 (14.29)	1
Unilateral	3 (10.71)	2 (14.29)	1 (7.14)	
Bilateral	21 (75)	10 (71.43)	1 1 (78.57)	
Complementary treatment	N (%)	N (%)	N (%)	-
No	15 (53.6)	5 (35.7)	10 (71.4)	0.212
RT	8 (28.6)	5 (35.7)	3 (21.4)	
CT	2 (7.1)	2 (14.3)	0	
RT-CT	3 (10.7)	2 (14.3)	1 (7.1)	
	Mean±SD	Mean±SD	Mean±SD	p-value
Age (years)	63.54±9.44	61.07±7.63	66±10.67	0.393

RT, radiotherapy; CT, chemotherapy

https://doi.org/10.1017/S0022215121004382 Published online by Cambridge University Press

Table 2. Outcomes

	XF			XF+PL			p-value (XF vs. XF+PL)
	Yes N (%)	No N (%)	p-value (Group A vs. Group B)	Yes N (%)	No N (%)	p-value (Group A vs. Group B)	
RESPIRATORY							
Dyspnea	18 (64.3)	10 (35.7)	1	18 (64.3)	10 (35.7)	1	1
At rest	6	-	**0.003**	7 (25)	-	1	0.502
During physical efforts	6	-		11 (39.3)	-		
Forced expectoration	12 (42.9)	16 (57.1)	0.127	12 (42.9)	16 (57.1)	0.127	1
1-2 times a day	6 (21.4)	-	0.165	7 (25)	-	0.533	1
3-4 times a day	4 (14.3)	-		4 (14.3)	-		
≥5 times a day	2 (7.2)	-		1 (3.6)	-		
DERMOLOGIC							
Stoma Cleaning	28 (100)	0	1	28 (100)	0	-	1
Daily	24 (85.7)	-	0.098	3 (10.7)	-	1	**0.000**
Twice daily	4 (14.3)	-		25 (89.3)	-		
Dermatological problems	13 (46.4)	15 (53.6)	0.256	4 (14.3)	24 (85.7)	0.596	**0.009**
Every day	5 (17.9)	-	0.414	2 (7.1)	-	0.513	0.868
Every week	5 (17.9)	-		1 (3.6)	-		
Every 2 weeks	2 (7.1)	-		1 (3.6)	-		
All follow-up	1 (3.6)	-		0	-		
Needed to leave the adhesives	13 (46.4)	15 (53.6)	0.058	3 (10.7)	25 (89.3)	1	**0.003**
Every night	7 (25)	-	0.559	2 (7.1)	-	1	1
On demand	6 (21.4)	-		1 (3.6)	-		
SLEEPING							
Hypnotic medication	9 (32.1)	19 (67.9)	1	9 (32.1)	19 (67.9)	1	1
Difficulty falling asleep	7 (25)	21 (75)	0.385	8 (28.6)	20 (71.4)	0.678	0.763

https://doi.org/10.1017/S0022215121004382 Published online by Cambridge University Press

Difficulty in maintaining	15 (53.6)	13 (46.4)	0.705	14 (50)	14 (50)	0.450	0.789
PSYCHOSOCIAL							
Nervous	14 (50)	14 (50)	1	13 (46.4)	15 (53.6)	0.705	0.789
Occasionally	11 (39.3)	-	0.192	12 (42.9)	-	0.462	0.596
Always	3 (10.7)	-		1 (3.6)	-		
Concern	18 (64.3)	10 (35.7)	0.430	17 (60.7)	11 (39.3)	0.699	0.783
Occasionally	16 (57.1)	-	0.477	16 (57.1)	-	0.471	0.226
Always	2 (7.1)	-		1 (3.6)	-		
Irritability	7 (25)	21 (75)	1	7 (25)	21 (75)	1	1
Occasionally	6 (21.4)	-	0.429	7 (25)	-	-	1
Always	1 (3.6)	-		0	-		
Sadness	7 (25)	21 (75)	1	6 (21.4)	22 (78.6)	1	0.752
Occasionally	4 (14.3)	-	1	5 (17.9)	-	1	0.131
Always	3 (10.7)	-		1 (3.6)	-		

XF, XtraFlow group; XF+PL, XtraFlow + Provox Luna.

Table 3. Overall Satisfaction between HME devices

	Better with XF N (%)	No differences N (%)	Better with XF+PL N (%)	p-value (Group A vs. Group B)
Forced expectoration	0	25 (89.3)	3 (10.7)	0.246
Tracheal secretions	0	25 (89.3)	3 (10.7)	1
Dyspnea	3 (10.7)	21 (75)	4 (14.3)	0.827
Skin problems	2 (7.1)	6 (21.4)	20 (71.4)	0.648
Comfort	2 (7.1)	6 (21.4)	20 (71.4)	1
Quality of life	1 (3.6)	13 (46.4)	14 (50)	0.584
Sleep quality	1 (3.6)	21 (75)	6 (21.4)	0.424
Confidence in relationships	0	28 (100)	0	-
PREFERENCE	11 (39.3)	-	17 (60.7)	0.246

XF, XtraFlow group; XF+PL, XtraFlow + Provox Luna.

https://doi.org/10.1017/S0022215121004382 Published online by Cambridge University Press

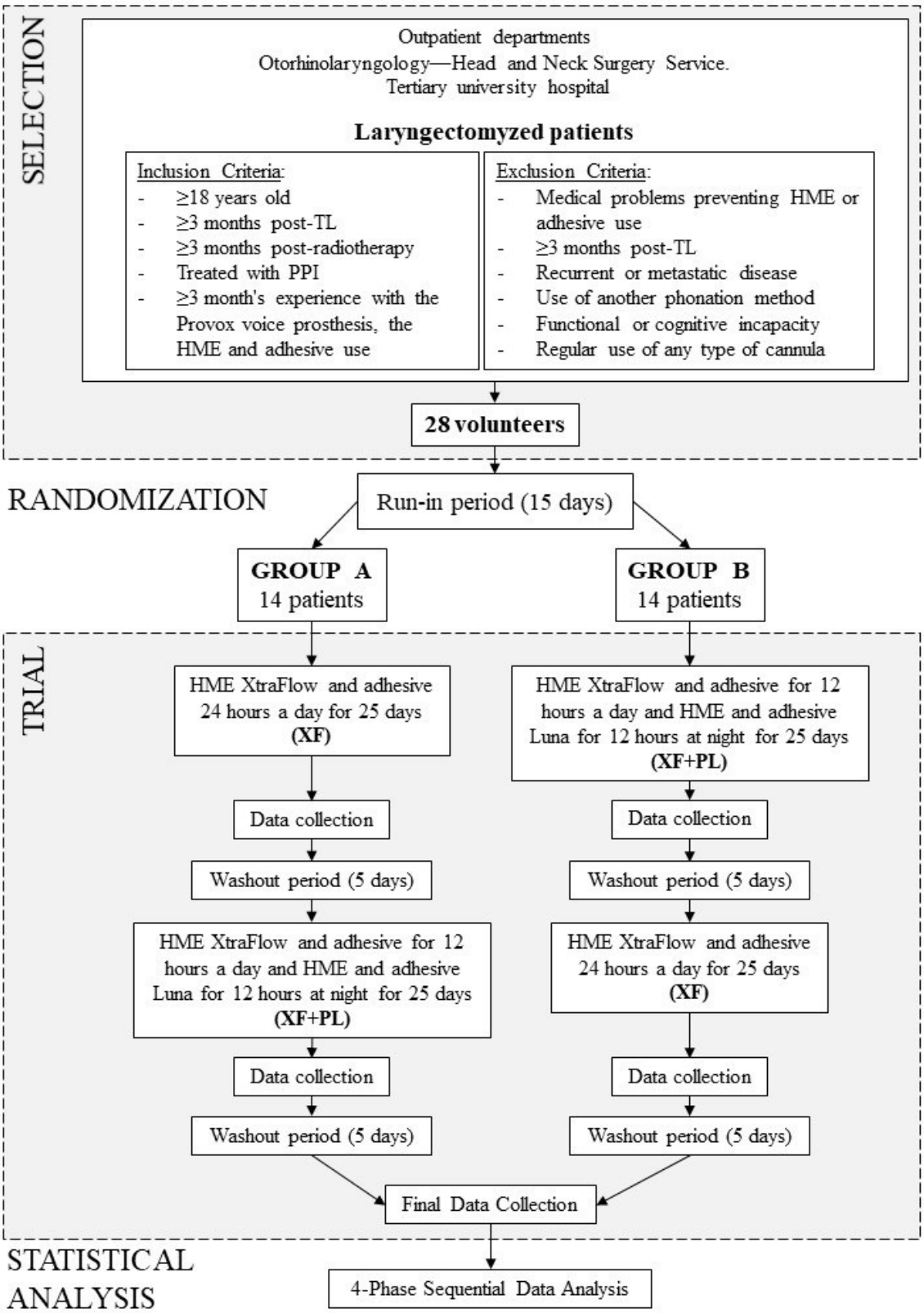

Figure 1. Study design

https://doi.org/10.1017/S0022215121004382 Published online by Cambridge University Press

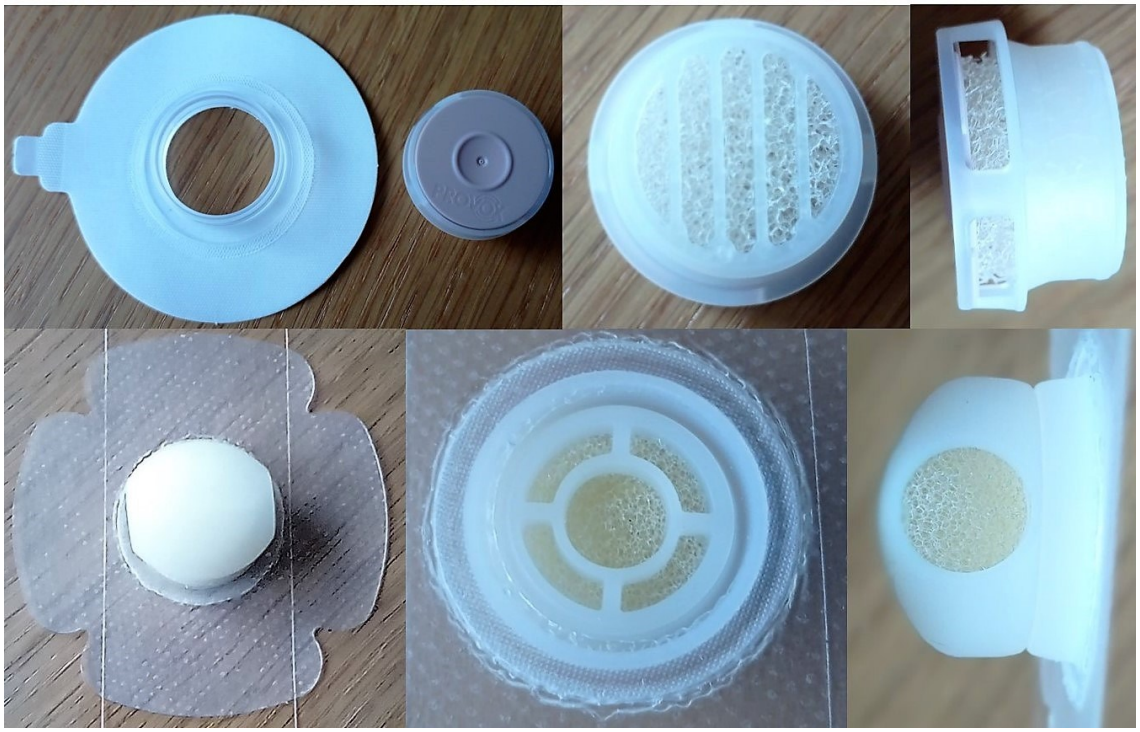

Figure 2. HME systems evaluated. The images above are of the HME XtraFlow system and its adhesive. The images below are of the new Provox Luna night-time system with its hydrogel adhesive and a different HME.

https://doi.org/10.1017/S0022215121004382 Published online by Cambridge University Press