The ability of the nasal airflow-inducing maneuver to restore sense of smell in laryngectomy patients: a before-and-after study

Original Article

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Abstract

Purpose: Total laryngectomy (TL) leads to olfactory dysfunction due to disconnection of the upper and lower airways. This study assessed the efficacy of the nasal airflow-inducing maneuver (NAIM) in restoring sense of smell in TL patients.
Materials and Methods: A two-center before-and-after study was conducted with 19 TL patients. Olfactory testing was evaluated subjectively with a visual analogue scale and objectively with the butanol threshold test and the Sniffin' Sticks identification test. The tests were performed before (pre-NAIM) and one month after learning the NAIM (post-NAIM).
Results: 84.2% of patients managed to recover sense of smell with significant improvements from baseline being observed in all olfactory tests ($p < 0.001$) post-NAIM.
Conclusions: NAIM is a simple, effective technique for olfactory rehabilitation after TL. It should be integrated into standard postoperative care to enhance quality of life in such patients.

Keywords: Smell; Olfaction disorders; Olfactory rehabilitation; Laryngectomy

Introduction

Patients who have undergone total laryngectomy (TL) have a permanent separation of the upper and lower respiratory tracts, suffering profound changes on fundamental domains of their lives, such as respiration, phonation, and swallowing. These alterations cause a deep negative impact on their quality of life (QoL)[1]. Whilst underestimated, the inability to inhale through the nose leads to olfactory dysfunction, further diminishing QoL and predisposing individuals to depression and social ostracism[2,3].

Rehabilitation of speech and swallowing after TL is considered standard of care, being universally applied in these patients[4,5]. Olfactory rehabilitation, however, is seldom offered, leaving them less able to enjoy smells and food, or to detect danger (e.g., spoiled food, leaking gas) and body odor[6].

In order to overcome this obstacle, Higers et al. developed the nasal airflow-inducing maneuver (NAIM), a simple technique that can be easily taught to patients by instructing them to yawn with their mouth closed – the "polite yawning" technique[7]. The foundation of the maneuver resides in restoring nasal airflow, which is absent in TL patients after the disconnection of the upper and lower airways, by inducing a negative pressure in the oral cavity and the oropharynx. This is achieved by performing a repeated extended yawning movement with the lips closed, lowering the jaw, floor of the mouth, tongue and soft palate[7]. Despite the recognition that other factors may contribute to olfactory dysfunction in these patients, such as the atrophy of the olfactory neuroepithelium due to the lack of stimulation, is it known that restoring nasal airflow is paramount for attempting olfactory rehabilitation[7-9]. To the best of our knowledge, none of the main oncology centers in Portugal provide olfactory rehabilitation after TL. This study aims to assess the efficacy of the NAIM in olfactory rehabilitation of laryngectomy patients hoping to offer them a new tool to enhance their QoL.

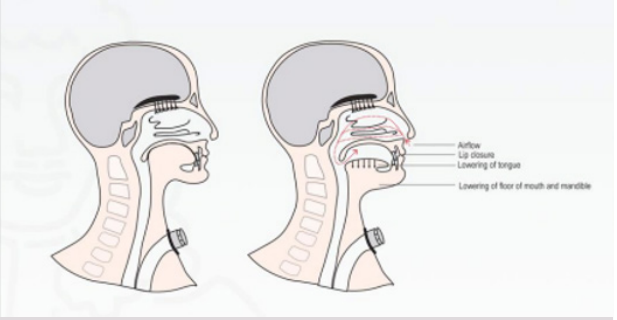
Materials and methods

Study design

This study was approved by the Research and Ethics Committee and followed the tenets of the Declaration of Helsinki for biomedical research. A two center before-and-after study was conducted with TL patients who did not have olfactory rehabilitation after surgery, irrespective of the time elapsed since the surgery. All TL patients presenting for follow-up visits at both Otorhinolaryngology departments between March and November of 2024 were invited to participate, and an informed consent was obtained from each participant. Exclusion criteria were refusal to participate, present treatment with radiotherapy or chemotherapy, other causes for olfactory dysfunction, and lack of cognitive skills necessary to complete the olfactory tests and learn the NAIM.

Participants were asked to subjectively characterize their olfaction with a visual analogue scale (VAS, 0-10) and were submitted to psychophysical olfactory testing for odor threshold and identification in two occasions: i) before learning the NAIM; ii) one month after learning the maneuver. After completion of the first olfactory tests patients were referred to the speech therapist to learn the NAIM and were instructed to actively practice the maneuver at home (see figure 1). Clinical and demographic variables were obtained from medical history with full ear, nose, and throat (ENT) examination, as well as through the patient's records.

Figure 1
Description of the NAIM and instructions to patients



- Keep the lips securely closed during the maneuver.
- Yawn with your mouth closed: lower your jaw and tongue. Then move your tongue as if you are pushing food against the roof of the mouth.

Olfactory evaluation

All enrolled patients were submitted to subjective assessment with a VAS and psychophysical olfactory testing for odor threshold and identification, as recommended by Whitcroft *et al*[10]. The olfactory tests employed were the Connecticut Chemosensory Clinical Research Center (CCCRC) butanol threshold test (BTT) for odor threshold, and the Sniffin' Sticks (SnSt) identification test with 16 pens

(Burghart Messtechnik) for odor identification, which was previously validated for the Portuguese population[11,12,13].

Statistical analysis

Statistical analysis was performed using IBM SPSS Statistics for Windows, version 29.0. Armonk, NY. Two groups were obtained to compare the olfactory results before and after NAIM: pre-NAIM and post-NAIM. The Wilcoxon test was used to compare both groups. The Mann-Whitney U test and the independent t-test were applied accordingly to search for relations between the olfactory tests score variations and other variables such as radiotherapy, chemotherapy, time elapsed since laryngectomy and phonatory prosthesis (PP).

Results

Of the twenty-six patients who initially agreed to participate, seven did not complete the study due to refusal to perform the olfactory tests post-NAIM (n = 5) or failure to attend either the follow-up consultation (n = 1) or speech therapy sessions (n = 1). Of the nineteen patients who completed the study, there was one female and eighteen male (94.7%), with a mean age of 62.3 ± 1.8 (mean ± SD). The mean time elapsed between TL and the start of NAIM training was 3.3 ± 3.9 years. Fourteen patients had a PP (73.7%), sixteen received adjuvant radiotherapy (84.2%) and four needed adjuvant chemotherapy (21.1%). Table 1 presents the basic data from the participants. Before smell testing, every patient considered their sense of smell to be no more than 5 on the 0-10 VAS. The pre-NAIM BTT score showed anosmia in seventeen patients (89.5%) and hyposmia in two patients (10.5%), while the pre-NAIM SnSt scores revealed anosmia in all patients (100%). The pre-NAIM VAS score was 1.6 ± 0.4, the mean BTT score was 0.5 ± 0.3, and the mean SnSt score was 3.6 0.5. The post-NAIM VAS score was 5.9 ± 0.5, mean BTT score was 3.8 ± 0.5, and mean SnSt score was 8.2 ± 0.5. The VAS,BTT and SnSt scores post-NAIM were all significantly higher than pre-NAIM ($p < 0.001$). Five patients (26.3%) post-NAIM achieved olfactory scores compatible with normosmia, while three patients (15.8%) did not improve sense of smell, as they could not learn the NAIM. The remaining sixteen patients (84.2%) were able to learn the maneuver and exhibited improvements in olfactory threshold and identification, after one (n = 13) or two (n = 6) sessions with the speech therapist. Comparison of the olfactory tests scores before and after NAIM can be found in Table 2.

Table 1
Basic data of the participants

Age (years)	62.3 ± 1.8	
Patients	19	100
Male	18	94.7
Female	1	5.3
Time since total laryngectomy (years)		
Over 4 years	6	31.6
Under 4 years	13	68.4
Adjuvant treatment	16	84.2
Radiotherapy	16	100
Radiotherapy plus chemotherapy	4	25
Number of sessions with speech therapist		
One	13	68.4
Two	6	31.6
Able to learn the NAIM	16	84.2
Unable to learn the NAIM	3	15.8

Six patients (31.6%) had undergone TL more than 4 years prior (maximum duration of 15 years), while thirteen patients (68.4%) had their surgery within the last3 years. Time elapsed since surgery did not impact in the ability to improve smell scores. No differences were found between pre-NAIM and post-NAIM scores regarding the use of PP or having received adjuvant radiotherapy or chemotherapy.

Table 2
Comparison of olfactory tests scores before and after the NAIM

Olfactory evaluation (n = 19)	preNAIM	postNAIM	
Visual Analogue Scale	1.6	5.9	p < 0.001
Butanol Threshold Test	0.5	3.8	p < 0.001
Sniffin' Sticks 16-pen identification test	3.6	8.2	p < 0.001

Discussion

The NAIM has the potential to positively impact QoL in TL patients by allowing them to regain sense of smell. Our results are in concordance with a systematic review and meta-analysis published in 2024, where seven studies with 290 TL patients were analyzed and concluded that NAIM intervention increased the probability of patients achieving normosmia[14]. Whereas the NAIM has been effectively adopted in other countries, this study marks its initial introduction and evaluation in the Portuguese context[15-19]. In a modern era where QoL is increasingly important, olfactory rehabilitation after TL should be offered to all patients in association with voice, pulmonary, and swallowing rehabilitation[20].

Other forms of olfactory rehabilitation have been tried, the larynx bypass[21]. Despite encouraging results, it is not practical to be used on daily life, limiting its usefulness[22]. The NAIM, however, is a safe, simple, easily taught technique, that can be reproduced in daily-life situations without the need for any device[14]

In our study 84.2% of the cohort significantly improved its sense of smell after one or two sessions with the speech therapist. Scores compatible with normosmia, however, were only achieved in 26.3% of the patients with both the BTT and the SnSt identification test[11,23]. Our findings are consistent with previous studies, in which normosmia was achieved in approximately 20% of the cohort[16,19]. While higher rates of normosmia have been observed in other studies, these discrepancies may be attributed to several variables, including the type of olfactory test that was used, the number of speech therapy sessions, patient cooperation, and the time elapsed since learning the NAIM. The efficacy of this procedure in improving olfactory outcomes is well documented; however, the degree to which recovery is achievable remains undetermined and may vary according to patient-related variables[14,17]. In our cohort, patient's compliance and motivation to keep developing the technique and apply it in their daily life was essential to obtain positive results. Previous research has suggested that the time elapsed after TL might hinder olfactory rehabilitation, potentially due to time-dependent atrophy of the olfactory neuroepithelium. Our findings, however, do not corroborate this theory, as NAIM restored olfaction regardless of postoperative interval, aligning with the conclusions of similar studies[14,18]. It has been theorized that the use of a PP enhance olfactory function compared with esophageal speech, as trachea-esophageal speech with the PP allows airflow between the upper and lower airways[24]. However, our study found no significant difference in olfactory outcomes between those with PP versus those with esophageal speech. Also, adjuvant radiotherapy and chemotherapy did not influence olfactory results in our study, as expected[9]. This study presents several limitations that must be acknowledged. The lack of a control group might limit generalization of our findings. However, since both the BTT and the SnSt are objective tests with long-term reproducibility of olfactory performance, we believe the differences found in our pre-post study are attributable to the NAIM[12]. Olfactory evaluation was performed one month after patients learned the NAIM, with some requiring a second session with the speech therapist to adequately learn the maneuver. Consequently, the variability in training sessions and the relatively short

follow-up period limit our ability to assess the long-term sustainability of the NAIM. We did not include a specific olfactory-related QoL assessment in our study, as we consider that existing instruments – such as the brief version of the Questionnaire of Olfactory Disorders-Negative Statements (bvQOD-NS) are not adequate for TL patients[25]. Many items in these questionnaires likely reflet issues inherently present in this population (e.g., negative impact on daily life activities, less visits to restaurants, worried about not recovering), which could confound the interpretation of olfactory-specific QoL outcomes. The construction of an adapted questionnaire to this population would be interesting to evaluate the real effect the NAIM can produce. Lastly, we found that patient motivation was vital to the success of the NAIM. Of the initial patient cohort, seven declined re-evaluation after being taught the maneuver, and among those who completed the study, three were unable to acquire the technique and declined further training sessions.

Conclusion

The NAIM demonstrates promise as an effective and accessible method for restoring olfactory function after TL. Incorporating olfactory rehabilitation alongside voice and swallowing therapies at the earliest opportunity is recommended for all laryngectomees, enabling them to recover an essential sensory function and enhancing their QoL by bridging the gap to what was lost with surgery.

Conflict of interests

The authors declare that there is no conflict of interest regarding the publication of this paper.

Data confidentiality

The authors declare having followed the protocols used at their working center regarding patient data publication.

Protection of humans and animals

The authors declare that the procedures were followed according to the regulations established by the Clinical Research and Ethics Committee and the 2013 Helsinki Declaration of The World Medical Association.

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Availability of scientific data

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Declaration of generative AI and AI-assisted technologies in the writing process

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