ORIGINAL ARTICLE

Rehabilitation of Olfaction After Laryngectomy by Means of a Nasal Airflow-Inducing Maneuver

The "Polite Yawning" Technique

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Objective: To develop a nasal airflow-inducing maneuver and apply it in the olfactory rehabilitation of patients who have undergone laryngectomy.

Design: Intervention study; before-and-after trial.

Setting: National cancer center.

Patients: Forty-four patients who underwent laryngectomy; 34 men and 10 women; mean age, 64 years (range, 42-80 years); mean time since surgery, 6 years (range, 8 months to 18 years).

Intervention: In a prospective clinical intervention study, we assessed the effectiveness of a nasal airflow-inducing maneuver ("polite yawning," ie, yawning with closed lips). Speech therapists trained the patients in the maneuver, and its effectiveness in inducing nasal airflow was checked with digital and water manometers.

Main Outcome Measures: Olfactory acuity was assessed before and after the intervention by means of an odor detection test and a structured questionnaire concerning olfaction, taste, and appetite. Patients were categorized as "smellers" and "nonsmellers" on the basis of the results of the odor detection test and the present odor perception scale derived from the questionnaire.

Results: The nasal airflow-inducing maneuver could be taught to all patients, mostly in only one 30-minute therapy session. Fifteen of the 33 patients in the pretreatment nonsmeller category converted to smellers, for a success rate of 46% ($P<.001$).

Conclusion: The nasal airflow-inducing maneuver (the "polite yawning" technique) allowed almost half of the patients to recover their sense of smell.

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ALTHOUGH deterioration of olfaction after total laryngectomy is reported by the majority of patients,[1] this unpleasant side effect has not received widespread attention. Moreover, olfactory rehabilitation has been given much less consideration than other more obvious sequelae of this operation, ie, vocal and pulmonary rehabilitation.[2] In several overviews on the "total rehabilitation of laryngectomees," olfactory problems as a consequence of the laryngectomy were not even mentioned.[3-5] It was thought that the anosmia, noted immediately after the operation, was an inevitable result of the laryngectomy and that no return of olfactory acuity occurred as long as 8 years after operation.[6,7] Others, however, have reported improvement in olfaction during the first 6 months after surgery[8] and the presence of a relatively normal sense of smell in some laryngectomees.[9,10] A recent study in our clinic showed that patients who have undergone laryngectomy could be divided into 2 groups on the basis of an odor detection and/or an odor differentiation test, ie, "smellers" and "nonsmellers."[10] These tests were performed without artificial devices to generate a nasal airflow. The results of these "natural" tests indicated that one third of the patients could be classified as smellers. This category of patients reported not only a better sense of smell than the nonsmellers but also a better sense of taste and appetite.

The consequences of the loss of the sense of smell can be profound. Anosmia results, for instance, in the loss of the signal function to detect smoke or leaking gas. The inability to detect bodily odors can cause insecurities in daily life, and the inability to perceive agreeable odors or fragrances can be experienced as a significant loss.[11] Since most so-called tastes (eg, chocolate, coffee, tea, meat, etc) are dependent on retronasal stimulation of the olfactory receptors, the perception of such tastes will also be negatively influenced by the loss of the sense of smell.[12]

Although factors such as atrophy of the olfactory neuroepithelium and/or bulb may also play a role in the olfactory problems of patients after laryngectomy,[13] restoring nasal airflow is a prerequisite for rehabilitation of olfactory acuity in such patients.[9,14-16] The main reason for the lack of an adequate nasal airflow is the disconnection of the upper and lower airways. By creating an artificial airflow with insufflation of the odors into the nose, using squeeze bottles,[8,9] other nebulizers,[7] or a so-called larynx bypass,[14,15,17-19] it became clear that in many laryngectomees the sense of smell is more or less preserved. However, because of their artificial nature and cumbersome application in daily life, these devices to restore nasal airflow are not extensively used. Others have described more unobtrusive methods to generate some degree of nasal airflow by creating volume changes in the pharynx with the mouth closed, such as the buccopharyngeal maneuver,[15] buccopharyngeal sniffing,[9] or glossopharyngeal press,[20] but these also are not widely applied.

In our previous study, the smellers significantly more often had developed their own technique to improve olfaction, such as movements of the jaw and/or muscles in the face and floor of mouth and mastication muscles.[10] On the basis of observations in our previous study and on remarks by patients and partners, we developed a nasal airflow-inducing maneuver (NAIM) in which a repeated extended yawning movement is performed, lowering the jaw, floor of mouth, tongue, base of tongue, and soft palate while keeping the lips securely closed. This is easily taught to patients by describing it as yawning with the mouth closed, ie, "polite yawning." This maneuver induces a negative pressure in the oral cavity and oropharynx, which generates a nasal airflow, enabling odorous substances to reach the olfactory epithelium again.

We describe an intervention study with this NAIM to assess whether patients can acquire this technique and whether it leads to an improvement of olfactory acuity.

PATIENTS AND METHODS

Fifty consecutive patients with laryngectomies visiting the outpatient clinic of the Netherlands Cancer Institute, Amsterdam, during a 6-month period were enrolled in the study. All patients' surgeries had been performed at least 6 months previously. Twenty-four of these patients, both smellers and nonsmellers, had also participated in our previous olfaction study[10] 9 to 10 months earlier. Patients were invited to participate by one of the otolaryngologists and received information about the results of the first study and its implications for this intervention study. Written informed consent was obtained from all patients. Flexible nasal endoscopy was carried out to detect any intranasal anatomical anomalies. The speech therapist assessed anatomical or neurological deficits potentially interfering with lip closure, intraoral or extraoral mobility, and swallowing. The study was approved by the medical ethics committee of the Institute.

INTERVENTION METHOD

The purpose of the NAIM is to create negative pressure in the oral cavity and oropharynx to induce nasal airflow, thus enabling odorous substances to reach the olfactory epithelium again. The NAIM consists of an extended yawning movement with simultaneous lowering of the jaw, floor of mouth, tongue, base of tongue, and soft palate while keeping the lips securely closed (polite yawning). This movement can be repeated several times. By closing the nose with the fingers, the negative pressure in the nose and eustacian tubes can easily be noticed by most people. This maneuver is schematically shown in **Figure 1**.

The instruction and training in this maneuver by the speech therapist takes approximately 30 minutes for most patients. During the training session, both a digital and a water manometer are used to visualize the nasal airflow (**Figure 2**). A negative value on the digital manometer, and a movement of the water column toward the nasal vestibule, can easily be identified by the speech therapist and the patient. Additionally, patients are offered 6 easily recognizable odors ("smelling sticks": vanilla, vinegar, anise, flowers, peppermint, and an herbal scent) while practicing the maneuver. The smelling sticks and the manometers are used as training devices only.

Patients are instructed to actively use the maneuver as often as possible, since they have to realize that they must intentionally trigger the nasal airflow to perceive any olfactory stimulus. On the basis of the correct performance of the maneuver, the results obtained with the digital and water manometer, and the identification of odors with the smelling sticks, the speech therapist judges whether the patient performs the maneuver adequately or needs additional training. Some patients with a neurological or anatomical problem need an additional training session and/or an adapted instruction, eg, to optimize lip closure in case of a marginal facial nerve weakness as a result of a neck dissection, or to sufficiently enlarge the oral cavity volume. Patients also receive written instruction material to support and stimulate practice at home. For the study, patients were assessed again between 1 and 4 months (mean, 6 weeks) after the intervention.

ASSESSMENT OF OLFACTION

Odor Detection Test

Before the intervention and at the follow-up visit, olfactory acuity was tested with the adapted odor detection test (ODT) of Hulshoff Pol,[21] as described earlier.[10] In short, this test consists of 16 trials with 2 coded 250-mL bottles, one containing the odorless solvent dipropylene glycol and the other dipropylene glycol with phenylethyl alcohol, a liquid with a floral nontrigeminal odor. The concentration of phenylethyl alcohol is lowered stepwise with 0.5 log (from −1 log

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vol/vol to −4.5 log vol/vol). Every concentration is offered twice, resulting in a maximum of 16 trials. If patients were unable to smell something in the first 2 trials, 2 additional trials with the same and strongest concentrations were added. Patients had to indicate which bottle contained the floral scent. As in other studies,[9,15] progressively lower concentrations were applied to prevent fatigue and saturation of the patients. The time interval between 2 samples was at least 45 seconds to prevent olfactory saturation. The ODT was ended when the patient indicated that in 2 successive trials no odor was detected, or when 4 successive trials were judged incorrect. The ODT was considered positive if at least the 2 first trials with the highest concentration of phenylethyl alcohol were correctly indicated. If only the first 2 trials were correct, the 2 additional trials with the same concentration had to be correct as well. All other test results were considered incorrect.

During the ODT, the speech therapist observed whether the patient applied a personal technique, which was then noted on the study form.

Questionnaire Concerning Olfaction, Taste, and Appetite

The questionnaire concerning olfaction, taste, and appetite (QOTA) was derived from de Jong et al,[22] who studied olfaction and gustation of 156 self-supporting and institutionalized senior citizens (48 men and 108 women) with a mean age of 79 years (SD, 6 years),[22] and was also used in our previous study.[10] The QOTA consists of 31 multiple-choice questions concerning both the present situation and the period before the operation. Questions were divided into 5 scales: present odor perception, odor perception now in comparison with the past, gustation, appetite, and feeling hungry. The lower scores on these scales reflected a lower degree of the attribute being judged. In case of the scales "odor perception now in comparison with the past," "gustation," and "appetite," a low score also indicated that these aspects were decreased in comparison with the period before the operation. A high score, in contrast, indicated an improvement in these areas. According to the study by de Jong et al,[22] the reliability (Cronbach α) of these scales ranged from .70 (odor perception now in comparison with the past) to .88 (appetite).[22] In our own study, we found similar values ranging from .61 to .90.[10] The results of the study by de Jong et al were used as a reference group for comparison with the results of the present study. We considered patients to have a normal olfactory acuity if the score on the present odor perception scale (POPS), which has a range of 3 to 15, was equal to or better than the mean score of the reference group, ie, 10 or more.

CATEGORIZATION AS SMELLERS AND NONSMELLERS

On the basis of the performance on the ODT and the score on the POPS, patients were categorized as smellers or nonsmellers: smellers are patients who either passed the ODT or had a POPS score of 10 or greater, or a combination of both.

STATISTICAL ANALYSIS

The SPSS for Windows 8.0 (SPSS Inc, Chicago, Ill) was used for all statistical analysis. Differences in the different QOTA scores before the operation, before the intervention, and at the follow-up visit were tested with a general linear model for repeated measures. Relationships between the ODT results and the QOTA scores were analyzed by testing the mean differences of the QOTA scores between the patients who passed and did not pass the ODT using *t* tests. Changes in the numbers of smellers and nonsmellers before and after the intervention were assessed with the McNemar 2 related samples test. Finally, the relationship between sociodemographic and clinical variables, intervention criteria, and interview data, and smelling or nonsmelling status were analyzed by logistic regression analysis.

RESULTS

PATIENTS

Of the 50 patients entered in the study, 6 had to be excluded from the analysis. Five patients could not be assessed after the intervention (4 because of an intercurrent illness interfering with the follow-up visit and 1 because anosmia already existed before the laryngectomy). One patient refused to carry out the second odor detection test. These 6 patients (2 of whom also participated in the first olfaction study) did not differ from the remaining 44 with respect to sociodemographic and clinical variables.

During nasal endoscopy and regular ear, nose, and throat examination, no abnormalities were detected in any of the patients. Sociodemographic and relevant clinical data are given in **Table 1**.

INSTRUCTION IN THE NAIM

According to the speech therapist, the NAIM could be mastered successfully at the first therapy session by 39 patients. One patient was unable to accomplish the NAIM during this training, and in 4 patients there was some doubt: these 5 patients received an additional training session, after which they reached an acceptable level. No obvious anatomical reason for this difficulty was found at ear, nose, and throat examination.

ASSESSMENT OF OLFACTION

The ODT

The reliability of the ODT was assessed by comparing the results of the subset of 22 patients with evaluable data who had participated in both the present and the previous olfaction study 10 months previously.[10] Nineteen of them could be classified in the same categories, ie, 17 patients had negative results and 2 had positive results in both instances. One patient had positive results the first time and negative results the second time, and the opposite was the case in 2 patients. This implies an identical ODT result in 86% of the patients.

The effect of the intervention based on the ODT is given in **Table 2**: at the preintervention assessment, 7

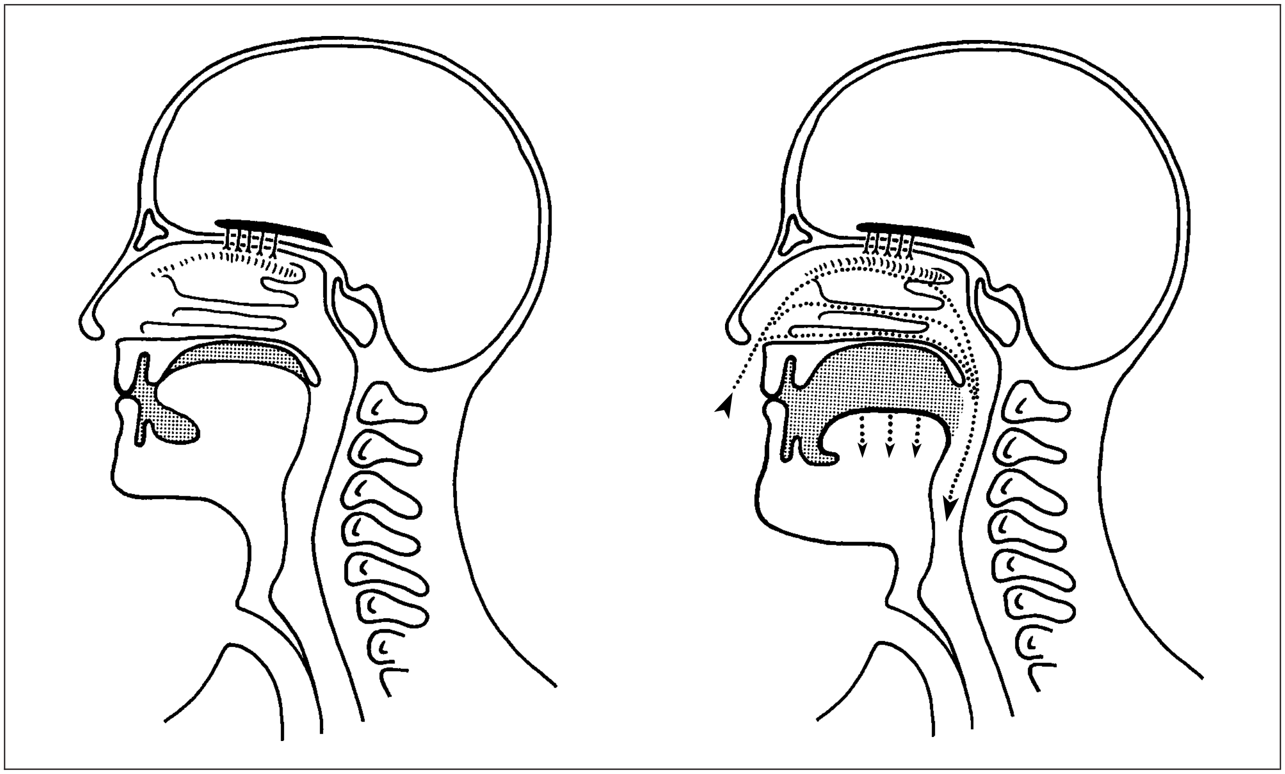

Figure 1. *Left, Schematic drawing of the situation before the nasal airflow-inducing maneuver. Right, Schematic drawing of the nasal airflow-inducing maneuver, creating a volume increase in the oral cavity and oropharynx by lowering the jaw, floor of the mouth, tongue, base of tongue, and soft palate with the lips securely closed. In this way, negative pressure and thus nasal airflow are induced, allowing odorous substances to reach the olfactory epithelium.*

Figure 2. *Left, The nasal airflow-inducing maneuver with digital manometer connected to one nostril through a tube with an "olive" and the other nostril closed with a finger, to demonstrate the negative pressure in the nasal cavity by the negative value on the display. Right, The nasal airflow-inducing maneuver with water manometer connected to one nostril through a tube with an "olive" and the other nostril closed with a finger, to demonstrate the negative pressure in the nasal cavity by displacement of the water column toward the nose.*

patients (16%) passed the ODT, and at the postintervention assessment, 20 patients (46%) did. One patient passed the ODT before the intervention but failed to do so after intervention. Therefore, the increase in the incidence of positive ODT results was 14 of 37 (ODT-negative) patients, or 38% ($P<.001$).

The QOTA

The Cronbach α for present odor perception was .77; for present compared with past odor perception, .70; for gustation, .89; for feeling hungry, .87; and for appetite, .76. All patients reported having had normal olfaction, taste, and appetite before the laryngectomy. The reliability of the questionnaires was also assessed by comparing the results of the subset of 22 patients with evaluable data who had participated in both the present and the previous olfaction study.[10] With the use of the cutoff point of 10 for the POPS, 20 patients scored identically and 2 had a lower score at the start of the study, indicating a correspondence of 91%.

Combining the results of the ODT and POPS in these 22 patients showed an identical score in 18 patients (82%) on both variables.

Table 1. Sociodemographic and Clinical Data of the 44 Patients Completing the Intervention

Characteristic	Finding
Sex, No. (%)	
M	34 (77)
F	10 (23)
Education, No. (%)	
Primary school	13 (30)
Middle school	7 (16)
High school	20 (45)
College and university	4 (9)
Age, y	
Mean (SD)	64 (10)
Range	42-80
Time since surgery	
Mean (SD)	6 (4) y
Range	8 mo–18 y
Personal smell technique, No. (%)	
Yes	16 (36)
No	28 (64)

Table 2. Number of Patients Passing the Odor-Detection Test (ODT) at the Preintervention and Postintervention Assessment*

	Postintervention, No.		
Preintervention	ODT Negative	ODT Positive	Total
ODT negative	23	14	**37**
ODT positive	1†	6	**7**
Total	**24**	**20**	**44**

*McNemar 2 related samples test, $P<.001$.
†In this patient, the ODT result changed from positive to negative and the score on the present odor perception scale was less than 10 both before and after intervention.

Table 3. Score on the Present Odor Perception Scale (POPS) at the Preintervention and Postintervention Assessment*

	Postintervention		
Preintervention	POPS <10	POPS ≥10	Total
POPS <10	28	10	**38**
POPS ≥10	1†	5	**6**
Total	**29**	**15**	**44**

*McNemar 2 related samples test, $P<.01$.
†In this patient, the POPS score changed from 10 or more to less than 10, but the odor detection test result changed from negative to positive.

The effect of the intervention is given in **Table 3**: before intervention, 6 patients (14%) had a POPS score of 10 or more, and after intervention this was the case in 15 patients (34%). One patient scored 10 or more before the intervention and less than 10 afterward. This represents an increase of 10 of the 38 patients with a score on the POPS of 10 or more, or 26% ($P=.01$).

At the preintervention assessment, patients who passed the ODT scored significantly higher on the POPS than the patients with a negative ODT result ($P<.001$). At the postintervention assessment, both ODT-positive and ODT-negative patient groups scored significantly higher on some of the other QOTA scales, ie, the scales "present compared with past odor perception" and "gustation," compared with the preintervention testing ($P<.001$), indicating an improvement in these variables.

Table 4. Number of "Smellers" and "Nonsmellers" Before and After the Intervention*

	Postintervention		
Preintervention	Nonsmeller	Smeller	Total
Nonsmeller	18	15	**33**
Smeller	1†	10	**11**
Total	**19**	**25**	**44**

*"Smellers" were patients who had positive results on the odor detection test (ODT) or a present odor perception scale (POPS) score of 10 or more, or both. "Nonsmellers" had negative results on the ODT and a POPS score less than 10. McNemar 2 related samples test, $P<.001$.
†In this patient, the ODT result changed from positive to negative and the POPS score was less than 10 before and after the intervention.

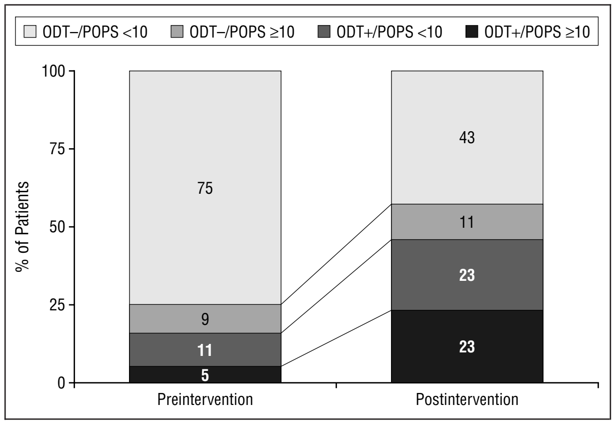

Figure 3. *Subcategorization in percentages of "smellers" (positive result of odor detection test [ODT] and present odor perception scale [POPS] score ≥10; ODT result positive and POPS score <10; ODT result negative and POPS score ≥10) and "nonsmellers" (ODT result negative and POPS score <10), indicating a significant improvement after the intervention (McNemar 2 related samples test, $P<.001$).*

CATEGORIZATION AS SMELLERS AND NONSMELLERS

Patients were categorized as smellers on the basis of the combination of the ODT and the POPS results. Before the treatment there were 33 nonsmellers (75%) and 11 smellers (25%). After treatment there were 19 nonsmellers (43%) and 25 smellers (57%) (**Table 4**). The pretreatment smellers could be subcategorized as follows: 5 patients passed the ODT, 4 had a POPS score of 10 or more, and 2 had positive results according to both criteria. After treatment there were 25 smellers (57%): 10 ODT-positive patients (23%), 5 patients with POPS scores of 10 or more (11%), and 10 patients positive for both criteria (23%) (**Figure 3**). The increase in the number of smellers after the intervention was highly significant ($P<.001$). Only 1 patient converted from a smeller to a nonsmeller because of change in the ODT from positive to negative. The patient whose POPS score converted from

10 or more to less than 10 appeared to have an ODT result that converted from negative to positive, and thus had to be considered to be a smeller after the intervention. This means that 15 of the 33 preintervention nonsmeller candidates converted to smellers, ie, a success rate of 46%.

LOGISTIC REGRESSION ANALYSIS

Of the factors possibly related to the success of the intervention (tested in logistic regression analysis), only the presence of a personal pretreatment smell technique approached significance ($P = .06$), whereas age, sex, time since surgery, and the other sociodemographic and clinical data were not significantly related to the outcome of the intervention.

COMMENT

Loss of olfactory acuity after total laryngectomy is a disturbing side effect of this debilitating surgical procedure. The majority of the patients report a complete loss of the sense of smell.[1,23] In an earlier study, using an ODT and an odor differentiation test, we found that 32% of the patients were still able to smell, whereas 68% were unable to detect or differentiate any of the odorous substances offered in these tests.[10] Patients who applied some sort of personal technique to smell were significantly more often successful in accomplishing these olfactory tests. It also became clear that the loss of olfaction from total laryngectomy was not consistently addressed during rehabilitation sessions.

On the basis of the literature and observations made during our previous study, a NAIM was developed and tested in an intervention study. To the best of our knowledge, this is the first study to show a positive effect on the olfactory acuity of patients after laryngectomy by applying a special maneuver. The improvement in a substantial number of the patients, increasing the percentage of smellers from 25% to 57% in this sample, is very promising. Preservation of olfactory ability in patients after laryngectomy by teaching the NAIM is thus an attainable goal in postlaryngectomy rehabilitation, as already postulated by Schwartz et al,[15] who used a buccopharyngeal sniffing technique.[15] Furthermore, it was encouraging that most patients mastered the "polite yawning" technique in one 30-minute session. The patients easily understood the description and demonstration of the technique as a polite yawning movement.

As demonstrated by the use of a water or a digital manometer, the NAIM creates a negative pressure in the oral and nasal cavity, thus generating a nasal airflow. Using a comparable method, Tatchell et al[16] found a mean volume of nasal airflow of 5.4 L/min, which is about 15% of the norm. They also found that increasing the nasal airflow, by using a laryngeal bypass, increased the olfactory threshold and odor discrimination. It could be demonstrated with this artificial device that laryngectomees, although generating a slightly but significantly lower airflow, scored the same as normal controls.[16] The method by which patients generated a nasal airflow in the study of Tatchell et al, however, is somewhat unclear. They probably applied some form of personalized technique of buccopharyngeal sniffing but were nevertheless able to generate a nasal airflow. It can be hypothesized from the results of our study that better and more consistent results can be obtained by teaching the NAIM. The use of a manometer is very helpful in this respect; the simple water manometer, in particular, is an inexpensive and easy-to-use tool in the instruction of the NAIM during the rehabilitation sessions.

Because of the design of this intervention study, with the use of preintervention and postintervention olfaction assessments without randomization for treatment or no treatment, some placebo effect might be responsible for the improvement found on the POPS. This might be concluded from the improvements seen in some of the other QOTA scores (present compared with past odor perception, and gustation) not only in the smellers but also in the nonsmellers. The attention given to their olfaction problem and the identification of the smelling sticks during the instruction of the NAIM might have given some patients the idea that their sense of smell was not as bad as they thought. However, the results of the ODT are not prone to being confounded by a placebo effect. The very stable results in all tested variables (ODT and QOTA scores) in the subset of patients who were analyzed twice with an interval of 10 months can also be considered an indication that the effects measured are a result of the intervention and not caused by a placebo effect.

An interesting observation was that patients who clearly demonstrated an improved sense of smell during testing, with the use of the NAIM, still did not think that their olfaction was improved. They often explained that they still were unable to automatically smell odors in their environment. This implies that patients should be instructed to always use the NAIM when entering a new room or environment and to repeat the maneuver regularly to compensate for the loss of passive smelling, always present during normal nasopulmonary breathing or sniffing.[24,25] Olfactory rehabilitation, therefore, should focus not only on the maneuver itself, but also on regular use of the technique during the day, to mimic passive smelling. The present results were obtained with only 1 therapy session in the majority of patients. As with other aspects of postlaryngectomy rehabilitation (eg, voice and pulmonary status), olfactory rehabilitation might benefit from early and repeated attention. Others who might benefit from this polite yawning technique include quadriplegic patients receiving permanent ventilation via a cuffed trachea cannula. It is well known that these patients also suffer from anosmia. Since their cranial nerve function is intact, they should be able to acquire this NAIM as well, thus improving their olfactory acuity.

It is interesting that some of our patients who were already able to smell before the intervention still considered their sense of smell improved, because by conscientiously applying the NAIM they were better able to smell at will.

The interesting discrepancy between loss of olfaction and gustation, the latter being much less disturbed after total laryngectomy than the former,[1] might be explained by the existence of a retronasal route through which odor molecules can reach the olfactory epithelium.[12] In fact, most patients are instructed by their speech therapist during rehabilitation sessions to chew their food carefully to stimulate this retronasal olfaction route. The fact that this is apparently effective also underscores the conclusion that the olfactory neuroepithelium still functions normally after total laryngectomy.[9,16,18] An additional explanation for the effect of chewing on olfaction might be that, during chewing, provided the lips stay closed, a small nasal airflow is generated regularly, such as during the NAIM.

The criteria used in this study to distinguish between smellers and nonsmellers deserve some attention. The ODT appears to be reliable, considering the concordance of more than 80% between the results obtained in a subset of 22 patients, tested within a 10-month interval. However, the preintervention results of 16% of the patients passing the ODT are somewhat lower than the results of our earlier study, in which we applied both odor detection and discrimination tests.[10] The reason only 1 olfaction test was used in this intervention study was to keep the whole test and instruction session within reasonable time limits to prevent fatiguing and oversaturation of the patient. The use of only 1 test, however, might have led to an underestimation of the number of preintervention smellers, but this will probably also hold true for the postintervention results. In fact, there is evidence that more patients benefited from the NAIM than can be concluded on the basis of the ODT results. The QOTA indicated an improvement in some additional patients. This led to the assumption that the results of the QOTA also might be useful to judge the effect of the intervention. The QOTA showed a good consistency over time in the subset of 22 patients participating in both olfaction studies within a 10-month interval. Therefore, a POPS score equal to or better than the mean score of a reference group of senior citizens, ie, 10 or more, was considered indicative of normal olfactory acuity.[22] By combining the ODT results and the POPS scores at the preintervention assessment, 30% of the patients could be categorized as smellers, which is much more in concordance with our earlier study and is an additional argument for the potential use of the POPS score of 10 or more as an indication of normal olfaction acuity. The ODT we used is probably a relatively insensitive test; for this type of study, one of the newer olfaction tests, discriminating in a more simplified way between normal olfaction, hyposmia, and anosmia, may be more effective,[26-29] including the recently described elegant diskette test.[30]

In conclusion, olfactory acuity can be rehabilitated after laryngectomy in approximately 50% of the patients by applying a NAIM, best described as repeated yawning with closed lips (polite yawning).

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