ORIGINAL ARTICLE

Long-term Results of Olfaction Rehabilitation Using the Nasal Airflow–Inducing ("Polite Yawning") Maneuver After Total Laryngectomy

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Objectives: To study the long-term results of the nasal airflow–inducing maneuver (NAIM) as an olfaction rehabilitation tool after laryngectomy and to investigate the effectiveness of a new, simpler odor detection test (ODT) called the smell disk test (SDT), or *Zürcher Geruchstest*.

Design: Intervention study.

Settings: National cancer center.

Patients: Forty-one laryngectomees who received olfaction rehabilitation training with the NAIM 4 months to 2 years earlier. This so-called polite yawning maneuver creates an "underpressure" in the oral cavity, which, in turn, generates a nasal airflow that enables odor molecules to again reach the olfactory epithelium.

Main Outcome Measures: Olfaction acuity testing with a standard ODT, along with a questionnaire, providing a subjective olfaction score (present odor perception scale [POPS]), and the SDT, as well as assessment of the patients' correct execution of the NAIM by speech-language pathologists on video recordings made during odor testing and long-term assessment of olfaction acuity.

Results: The correlation between the previously used ODT-POPS combination and the SDT was $\kappa = 0.56$ ($P < .001$). Based on these results, we preferred to use the much simpler SDT instead of the laborious combination of the ODT-POPS. Based on the SDT results, 19 (46%) of the 41 laryngectomees were "smellers" and could be considered normosmic. There was a significant relationship ($P = .03$) between the patient's correct execution of the NAIM and whether or not the laryngectomee was a smeller according to the SDT.

Conclusions: The effectiveness of the NAIM, or so-called polite yawning technique, for the rehabilitation of olfaction in individuals who have undergone total laryngectomy was reconfirmed. Long-term olfaction rehabilitation was achieved in about 50% of the patients, but more intensified training may be needed to increase the percentage of successfully rehabilitated individuals. The SDT is an effective and simple test for the assessment of olfaction acuity after laryngectomy.

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TOTAL LARYNGECTOMY has a wide range of adverse effects, mainly as a result of the permanent disconnection of the upper and lower airways. Not only is the natural voice lost, but other physiological systems, which require a more or less normal nasal airflow, are disrupted and/or hampered as well. This change in anatomy often leads to deterioration in pulmonary function, with an associated range of physical and psychosocial problems, and a loss (or at least a serious decrease) of the sense of smell and taste.[1,2]

Olfaction is either a passive process that occurs during normal nasal breathing (so-called passive smelling) or an active process (so-called active-smelling or sniffing). Total laryngectomy inevitably results in the loss of passive smelling, and only a minority of patients are still able to actively smell anything. In a recent study of 63 laryngectomees, we found that about two thirds of the patients were anosmic and that the rest had difficulty in smelling.[3] Several techniques have been described that might generate an airflow in the nose and thereby restore olfactory function.[4-7] However, these techniques have not been incorporated into routine rehabilitation methods, and their effectiveness has not yet been evaluated either.

Recently, we developed a technique that makes use of a simple physical mechanism by creating an "underpressure" in the oral cavity, which then generates a flow of air through the nose.[8] Patients are instructed to make an extended yawning movement while keeping their lips securely closed and simultaneously lowering their jaw, floor of the mouth, tongue, base of the tongue, and soft palate. The underpressure thus created in the oral cavity results in an airflow

PATIENTS AND METHODS

PATIENT SELECTION AND SOCIODEMOGRAPHIC DATA

Thirty-five patients who were trained with the nasal airflow–inducing maneuver (NAIM) about 1½ to 2 years earlier were available for this study. Four patients declined to participate (1 "smeller" and 3 "nonsmellers"). The study population was augmented with 10 patients who had recently undergone laryngectomy, and at least 4 months had to have past since their operation or postoperative radiotherapy. None of this latter group had participated in the original intervention study, and during their speech rehabilitation program they were taught how to use the NAIM. Finally, the study population consisted of 31 men (76%) and 10 women (24%); the mean age was 63 years, with a range of 43 to 81 years; and the time since total laryngectomy ranged from 4 months to 20 years, with a mean of 6.5 years (**Table 1**). All patients underwent an otorhinolaryngological examination to rule out nasal obstruction. If anosmia was suspected, a well-known odorous substance was applied in the nose, while a nasal airflow was induced by means of a larynx bypass.[6,9] The medical-ethical protocol institutional review board approved the study, and all patients gave their informed consent.

OLFACTION REHABILITATION

The NAIM is intended to restore a nasal airflow by creating an underpressure in the oral cavity and oropharynx,[8] which in brief is achieved by having the patient make an extended yawning movement while keeping the lips securely closed and simultaneous lowering the jaw, floor of the mouth, tongue, base of the tongue, and soft palate (which is best explained to the patient as a polite yawning movement). This movement has to be repeated rapidly several times to increase its effectiveness. The NAIM is schematically shown in **Figure 1**. The initial instruction and training of this maneuver by the speech-language pathologist (SLP) takes approximately 30 minutes for most patients. During the training session, a simple water manometer is used to visualize the nasal airflow (**Figure 2**). A movement of the water column toward the nasal vestibule gives the SLP and the patient real-time visual feedback as to whether the maneuver is being executed correctly. Furthermore, odors well known to most patients, such as vanilla, flowers, mint, and anise, are used to support the training.

OLFACTION ACUITY TESTING

In brief, the ODT[10] (the standard test used in our previous study[3]) consists of 16 trials with 2 coded 250-mL bottles, one containing the odorless solvent dipropylene glycol and the other containing 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 to –4.5 log vol/vol). Each 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 concentration were added. Patients had to indicate which bottle contained the floral scent. Progressively lower concentrations were applied to prevent fatigue and olfactory saturation. To prevent olfactory saturation, the interval between applications of the 2 samples was at least 45 seconds. 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 result was considered positive

Continued on next page

through the nose. This technique, which is easily mastered by the patient, is taught by explaining that this movement resembles what one does when yawning with the mouth closed, ie, so-called polite yawning. This polite yawning maneuver has to be repeated rapidly to increase its effectiveness. In an intervention study, we were able to show that after only one 30-minute training session, 25 (57%) of the 44 laryngectomees were able to smell using this technique.[8]

Although this polite yawning technique is potentially an important adjunct to the rehabilitation process, no data are available on the long-term use of this technique; eg, do patients continue to apply this method after some months or years and do they apply it in daily life? Therefore, a follow-up study was conducted to study long-term results. Also, because our original studies used complicated techniques to assess olfactory function,[3,8] in the present study we also assessed whether a new simple odor detection test (ODT) could replace our previous method of odor testing.

RESULTS

OLFACTION ACUITY TESTING

Results of the 3 odor tests are given in **Table 2**. When the criteria of the former study (positive ODT results and/or POPS score ≥10) were applied to the present study, 19 (46%) of the 41 patients were categorized as smellers (compared with 57% of the patients in our previous study). On the SDT, 19 patients (46%) identified 7 or 8 odors correctly (mean [SD] score, 5.7 [2.3]) and thus met the criteria for a normal sense of smell.

The correlation between the cutoff score of the ODT-POPS combination for smell and the cutoff score of 7 or more for smellers on the SDT is given in **Table 3**. The correlation between the combination of ODT-POPS (previously used by us to assess olfactory sensitivity) and the SDT was 0.56 (Cohen κ; $P < .001$), with 32 patients being classified as smellers or nonsmellers on both tests. Three patients who had negative results according to the previous criteria had positive results on the SDT, and 6 who had positive results according to the previous criteria had negative results on the SDT. Based on these findings, we decided to use the easier applied and user-friendlier SDT to classify patients into smellers (normosmia) or nonsmellers (hyposmia or anosmia) in the present study.

USE OF THE NAIM

Twenty patients (49%) reported that they used the NAIM in daily life: 7 (17%) on a daily basis; 6 (15%) less fre-

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. This test can be demanding for a laryngectomee to accomplish and generally takes up to 30 minutes to be completed.

The smell disk test (SDT), or *Zürcher Geruchstest*, was recently developed as a rapid screening test for hyposmia and anosmia.[11,12] This ODT (Novimed Medizin Technik, Dietikon, Switzerland) consists of 8 different odors (coffee, vanilla, smoke, peach, pineapple, rose, coconut, and vinegar) that have to be identified correctly by the patient. The patient receives a multiple-choice list with 3 options per odor, from which the correct one has to be identified (**Figure 3**). The odors are contained within special cassettes, which can be opened by the test person, setting a surplus (well above the normal olfaction threshold) of the scent free. According to the original description of the SDT, there is a normal sense of smell if the test person identifies 7 or 8 of the odors correctly. In all other cases, the test person is either hyposmic or anosmic. The likelihood that an anosmic individual by chance scores 7 or 8 odors correctly is only 0.26%.[11,12] The SDT can be easily performed by a laryngectomee and generally takes only a few minutes to complete. The much weaker smelling ODT was always conducted well in advance of the much stronger smelling SDT; moreover, care was taken to bring the latter test into the room only immediately before testing in order to prevent saturating the room with strong-smelling scents.

Each patient's subjective experience was assessed with a smell-and-taste questionnaire consisting of 31 questions.[13] Each question has 5 answer categories from which the patient has to choose. For the present study, we report only on the present odor perception scale (POPS), which consists of 3 questions that indicate how well the patient thinks he or she can smell. Patients are considered to have a normal olfaction acuity if the POPS score (range, 3-15) is equal to or better than 10.[8]

We compared the combination of the ODT and the POPS[3,8] (which was used in our previous study as the criterion for the ability to smell) with the SDT.[11] If the SDT proved to yield similar results to the ODT-POPS combination, then clinicians would have a user-friendlier test at hand to assess the laryngectomee's ability to smell. Finally, patients were interviewed about the use of the NAIM in everyday life.

VIDEO ASSESSMENT OF THE NAIM

During the ODT, a video recording was made of the patient and later judged by 2 SLPs who independently filled in a checklist on which the constituent parts of the NAIM were itemized. Furthermore, the number of times the NAIM was performed within a certain time frame was counted. Finally, the SLPs gave an overall judgment on the quality of the patient's execution of the NAIM as a whole (poor, insufficient, sufficient, good).

STATISTICAL ANALYSIS

All analyses were performed with SPSS 9.0 statistical software (SPSS Inc, Chicago, Ill) and a *t* test for independent samples was used to test for possible differences in POPS scores between smellers and nonsmellers. Logistic regression analysis was used to test whether sociodemographic and clinical data were associated with olfaction acuity and the use of the NAIM. Cohen κ statistics were calculated for the interobserver reliability for the independent judgments of the video recording of the NAIM and for the concordance between the results of the ODT-POPS and the SDT. All other relationships were tested with a χ^2 test.

quently, but regularly; 5 (12%) sometimes; and 2 (5%) only occasionally. The majority of the patients reported that they applied the maneuver only if they expected to smell something. Only 2 patients made this maneuver into an "automatism," ie, whenever there was a change in their environment (eg, entering a room or meeting another person). Among the patients who no longer used the NAIM (51%), the reasons given included "smell is not important to me" (n=2), "forgot how to perform it" (n=5), "too obvious a movement" (n=4), "technique is not effective" (n=5), and "my smell is good without it" (n=5); not one patient reported thinking that the maneuver was too difficult to perform.

Assessment of the execution of the NAIM (based on video recording) was performed in 40 of the 41 patients: 1 patient was tested at home, where no video equipment was available. The items judged are shown in **Table 4**; there was good interrater agreement between the 2 SLPs (Cohen κ, 0.73).

The results of the overall judgment of the NAIM were dichotomized as negative (poor or insufficient) and positive (sufficient or good). Sixteen patients (40%) received an overall positive judgment and 24 (60%) a negative judgment for their execution of the NAIM. We analyzed whether the smellers could be discriminated from the nonsmellers with regard to their performance of the NAIM. The judgments for the different subaspects of the NAIM are given in **Table 5**. It can be seen that there is a significant relationship between correct execution of the NAIM and the ability to smell ($P=.03$). The 6 patients who were judged to execute the NAIM incorrectly but who were nevertheless smellers according to the SDT received a negative judgment because of simultaneous deep inhalation during the maneuver. Although they could smell, the inhalation was considered unfavorable because it might cause hyperventilation. The 5 patients who were judged to execute the NAIM correctly but who were nevertheless nonsmellers according to the SDT might have failed to create an airflow (movement of the water column in the water manometer would have confirmed or denied this). Furthermore, the number of repetitions of the maneuver was significantly higher in the smellers (mean number of repetitive movements, 19 times in 15 seconds in the smeller group vs 3 times in the nonsmeller group; $P<.001$).

Logistic regression analysis showed no relationship between the ability to smell and any of the sociodemographic variables studied (age, sex, level of education, vocal rehabilitation method, oral denture status, and time since laryngectomy; data not shown).

COMMENT

The correlation between the ODT-POPS combination and the SDT seems sufficient to justify our decision to replace this laborious combination (used in our previous study) with the much simpler SDT. The results with the combination are slightly better (54% vs 46%), however, which could mean that the threshold for being classified as a smeller might be somewhat lower with the combination ODT-POPS than with the SDT. This outcome might be attributable to the strict criterion of separating normosmia on the one hand from hyposmia/anosmia on the other. The SDT has a proven validity and reliability,[11,12] and for routine clinical practice the use of a single objective measure has clear advantages. Similar results were recently reported using the Sniffin' Sticks odor test in a series of laryngectomees.[14] This latter test, however, consists of more odors and uses different concentrations and is therefore much more time consuming. The simple SDT requires only a few minutes to be completed.

Table 1. Characteristics of the Study Population*

Characteristic	Patients (N = 41)
Sex	
M	31 (76)
F	10 (24)
Age, y	
Mean (SD)	63 (10)
Range	43-81
Education	
Primary school	13 (32)
Technical school	10 (24)
High school	16 (39)
College/university	2 (5)
Follow-up	
Mean (SD), y	6.5 (5)
Range	4 mo-20 y
Voice	
Prosthesis	35 (85)
Esophageal	1 (2)
Prosthesis and esophageal	4 (10)
Electrolarynx	1 (2)
Dentures	
Upper	3 (7)
Upper and lower	20 (49)
Partial	6 (15)
None	12 (29)

*Values are number (percentage) unless otherwise indicated.

The main aim of the study was to establish whether a single training session in the past had a permanent effect on the use of the NAIM in daily life. The majority of the patients who participated in the original intervention study also took part in the present study (31 [63%] of 49 patients). Because only 4 patients refused to participate (one of them being a smeller), selection bias concerning the long-term results is probably minor.

It is remarkable that the percentage of smellers in this follow-up study is very similar to that found in the earlier intervention study (54% vs 57%, respectively).[8] The effectiveness of the NAIM could be confirmed: there is a relationship between the correct execution of the NAIM, as judged on the video recording, and whether the laryngectomee was a smeller or a nonsmeller. However, the small number of patients (16) who are still performing the NAIM correctly indicates that a single training session may be insufficient to achieve effective long-term results. On the other hand, 2 patients made use of the

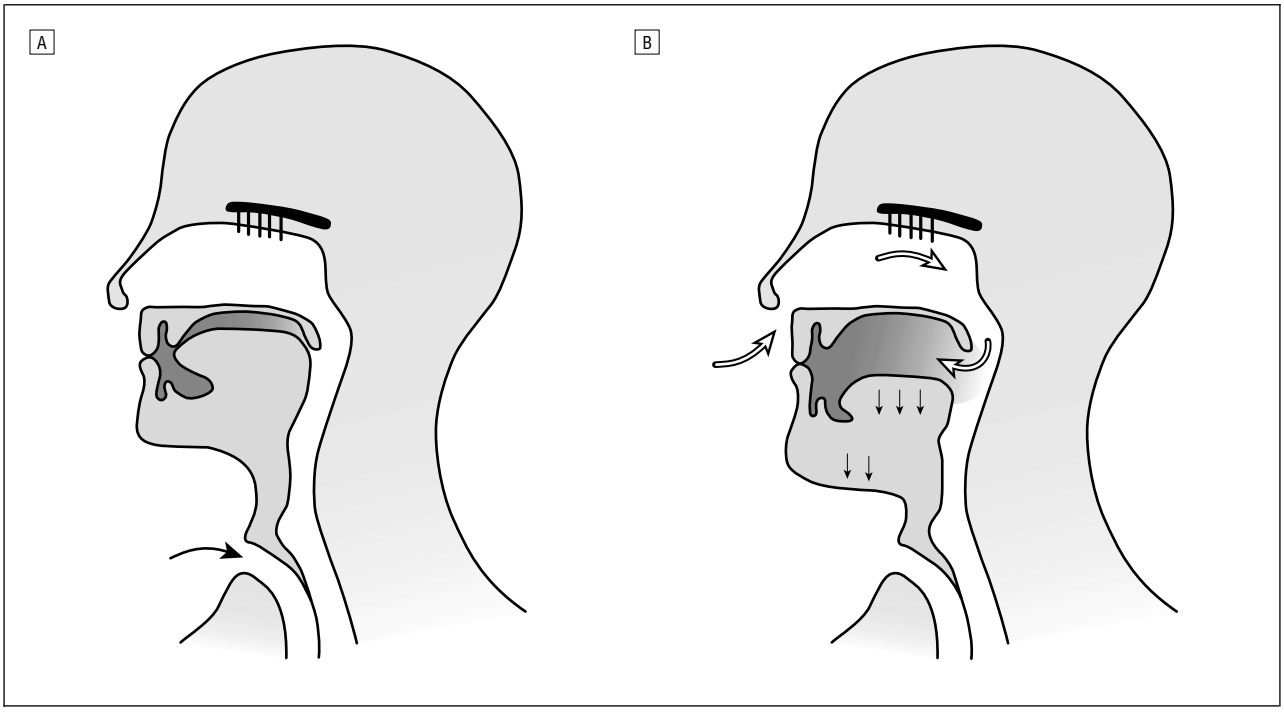

Figure 1. A, Schematic drawing before use of the nasal airflow–inducing maneuver. B, Schematic drawing of the nasal airflow–inducing maneuver, during which a volume increase in the oral cavity and oropharynx is created by lowering the jaw, floor of the mouth, tongue, base of the tongue, and soft palate with the lips securely closed. In this way, an "underpressure" is induced and a nasal airflow is generated, allowing odorous molecules to again reach the olfactory epithelium.

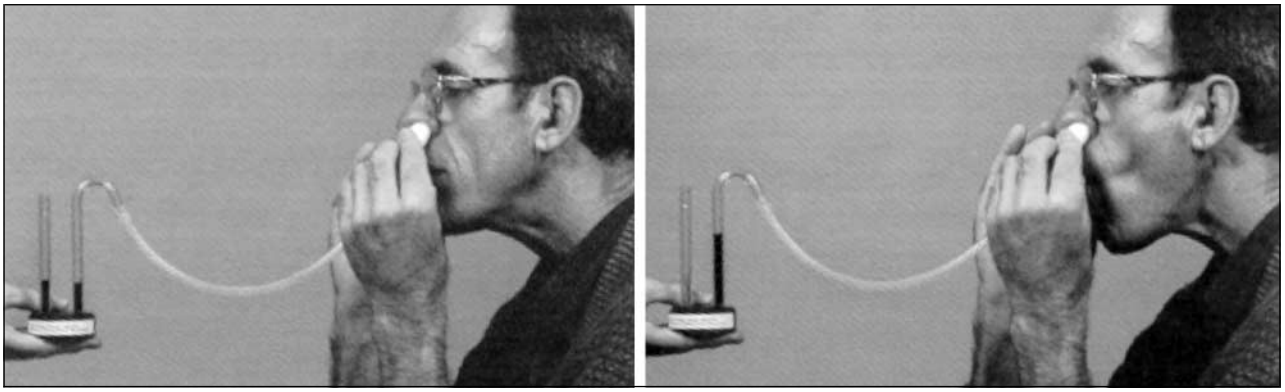

Figure 2. Simple water manometer shows the movement of a column of air toward the nose during the nasal airflow–inducing maneuver, providing the patient and the speech-language pathologist with real-time visual feedback about the correct execution of the maneuver.

Figure 3. The smell disk test, or *Zürcher Geruchstest*, during which the patient identifies the different scents. A total score of 7 or 8 correctly identified odors indicates a normal sense of smell (from Simmen et al[11] and Briner and Simmen[12]).

Table 2. Results of the 3 Olfaction Tests*

Test	Results
ODT	
Positive	16 (39)
Negative	25 (61)
POPS	
≥10	15 (37)
<10	26 (63)
Mean score (SD)	8.7 (2.5)
SDT	
7/8 correct	19 (46)
<7 correct	22 (54)
Mean correct (SD)	5.7 (2.3)

*Values are number (percentage) unless otherwise indicated. ODT indicates odor detection test; POPS, present odor perception scale according to de Jong et al[13] (maximum score, 15; score ≥10 indicates a normal sense of smell); and SDT, smell disk test, or *Zürcher Geruchstest* (maximum score, 8; 7 or 8 corrrectly identified odors indicates a normal sense of smell).

Table 3. Comparison Between the ODT-POPS Combination and the SDT*

	SDT 7-8	SDT <7	Total
ODT positive/POPS ≥10	16	6	**22**
ODT negative/POPS <10	3	16	**19**
Total	**19**	**22**	**41**

*ODT indicates odor detection test; POPS, present odor perception scale (score of ≥10 indicates normal sense of smell); and SDT, smell disk test, or *Zürcher Geruchstest* (7 or 8 correctly identified odors indicates a normal sense of smell). Cohen κ, 0.56; $P<.001$.

NAIM an automatism whenever something in the environment urged them to do so. In this way, they compensated for the loss of passive smelling, which is a "bonus" of normal nasal breathing and an important aspect of natural olfaction. As with other speech-language pathology problems, behavioral changes are difficult to achieve and repetition of the training is often a key to success. More intense training, focusing on the important movements (lowering of the floor of the mouth and the jaw while simultaneously avoiding breathing in) and the fast repetition of the NAIM is needed to restore olfaction in a higher percentage of patients and to make the NAIM into an automatism that may allow passive smelling to occur again. Two other aims are to perform the maneuver as discreetly as possible by trying to lower only the floor of the mouth and to reduce the movement of the jaw. This attempt to make the NAIM more inconspicuous is relevant, because one of the reasons reported by patients for no longer using the maneuver was that it was too noticeable.

Whether the patency of the nose and the volume of air that can be moved with the polite yawning maneuver have an influence on olfaction acuity is a question that cannot be answered by the findings of the present study. Although none of our patients had overt nasal obstruction, which was more or less ruled out by nasal endoscopy, it remains unclear whether improvement of nasal patency would have a beneficial effect on the olfactory end result, as recently has been suggested.[15] Along with studies on the volume of air that can be moved with the NAIM, rhinometry could maybe provide more insight in this respect.[16]

Some of the older literature suggests that there is a positive correlation between the quality of the esophageal voice and the olfaction acuity of the patient.[17,18] We were not able to evaluate this aspect because all but 2 of

Table 4. Data on the Different Subaspects of the NAIM Judged by the SLPs to Have Been Correctly and Incorrectly Executed*

Subaspect	NAIM Correctly Executed (n = 16)		NAIM Incorrectly Executed (n = 24)	
	Yes	No	Yes	No
Lip closure	15 (94)	0 (0)	21 (88)	1 (4)
Lowering floor of mouth	16 (100)	0 (0)	9 (38)	14 (58)
Lowering jaw	15 (94)	1 (6)	9 (38)	15 (62)
Isolated movements of nasal ala†	0 (0)	16 (100)	0 (0)	24 (100)
Bite gesture†	0 (0)	16 (100)	2 (8)	21 (88)
Chewing movement	8 (50)	8 (50)	1 (4)	23 (96)
Inhalation as olfaction attempt†	2 (13)	11 (69)	22 (92)	1 (4)
Breathing synchronous with olfaction attempt†	5 (31)	10 (63)	7 (29)	4 (17)
Closing stoma during olfaction attempt†	0 (0)	16 (100)	1 (4)	23 (96)
Type of breathing				
Thoracic†	8 (50)	7 (44)	23 (96)	1 (4)
Abdominal	7 (44)	8 (50)	1 (4)	23 (96)
Head and neck posture				
Relaxed	9 (56)	7 (44)	13 (54)	11 (46)
Partly tense	7 (44)	9 (56)	9 (38)	15 (62)
Tense†	0 (0)	16 (100)	2 (8)	22 (92)

*All values are number (percentage). NAIM indicates nasal airflow–inducing maneuver; SLPs, speech-language pathologists.
†Not recommended for optimal execution of the "polite yawning" technique.

the patients were using a voice prosthesis. Nevertheless, the aforementioned relationship might be merely a result of the better control of the oropharyngeal musculature in good esophageal speakers, enabling them to "pump" air into the nasal cavity retronasally, as has been advocated in the past.[4] However, we think that this retronasal route is not very important and that in the majority of cases the oropharyngeal movements result in an anteronasal flow of air.

It should also be noted that the SDT criterion of a normal sense of smell was strictly followed, ie, 7 or 8 of the odors scored correctly.[11,12] Some of the patients scored fewer than 7 odors correctly and could be considered to be to some extent hyposmic and probably not totally anosmic, which might lead to an underestimation of the results of the olfaction rehabilitation. However, by applying the cutoff scores of the SDT, the norms of "normal" smelling can be used to compare the results of laryngectomees.

Recently, Miwa et al[19] reconfirmed the effects of olfactory impairment on the quality-of-life and level of disability. Patients reporting persistent olfactory impairment after previously documented olfactory loss indicate a higher level of disability and a lower quality of life than those with perceived resolution of olfactory compromise. These observations are in agreement with our earlier finding that laryngectomees who were able to smell reported having a better taste and appetite.[3] They emphasize the benefits that can be gained from olfaction rehabilitation in laryngectomees.

CONCLUSIONS

Odor testing in individuals who have undergone a total laryngectomy is now possible in a relatively simple way using the easily applied SDT. The NAIM (best explained to the laryngectomee as a polite yawning technique) is a patient-friendly method that can restore the sense of smell. However, a single training session is probably insufficient, and most patients may need more training. This intensified training may then serve to rehabilitate olfaction in a higher percentage of patients and to make this maneuver an automatism to compensate for the loss of passive smelling after total laryngectomy. In view of this reconfirmation that it is possible to restore olfaction in individuals after total laryngectomy, rehabilitation of the sense of smell should form an integral part of the multidisciplinary postlaryngectomy rehabilitation program.

Table 5. Relationship Between Correctness of NAIM Execution and Whether the Patient Is a "Smeller" or a "Nonsmeller"*

	NAIM Correctly Executed	NAIM Incorrectly Executed	Total
Smeller	11	8†	**19**
Nonsmeller	5‡	16	**21**
Total	**16**	**24**	**40**

*Values are number of patients (video recording not available in 1 patient). NAIM indicates nasal airflow–inducing maneuver. $P = .03$.
†In these patients, the negative judgment was based on an undesirable deep inhalation pattern during the olfaction attempt, whereas the remainder of the maneuver was performed correctly.
‡The judgment was based on the video images and not on results obtained with the water manometer, which would have shown whether or not the maneuver was effective.

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With the January 2001 issue, the ARCHIVES OF OTOLARYNGOLOGY introduced nonmedical photographs as cover art for the journal. We are bombarded with medical and technical information every minute of every day and this is our way of offering you, our readers, a moment to reflect, smile, breathe a little more deeply, maybe even escape for just a second and relax a bit. Do you have a scenic photograph you have taken that you think would make a great cover shot? We'd love to see it! Submissions should be from our readers, reviewers, authors, or anyone affiliated with the journal, and MUST be formatted horizontally. They can be black and white or color and at least 3.5×5 in but no larger than 8×10 in. If you wish to submit a digital photograph, please call our office at (404) 778-2322 for guidelines. Due to legal concerns, no recognizable people should appear in the picture, and please include details about where the picture was taken, how you happened to be there, and anything else you think is interesting about the image. We need the photographer's complete name, highest academic degree, city and state of residence, and a statement explaining how he or she is affiliated with the journal. Send submissions to ARCHIVES OF OTOLARYNGOLOGY, 1440 Clifton Rd NE, Suite 400, Atlanta, GA 30322. If you would like your photo returned, please enclose a self-addressed, stamped envelope. Cover photos will be chosen at the discretion of the ARCHIVES editorial staff.

Michael M. E. Johns, MD
Editor