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ORIGINAL ARTICLE

Olfactory rehabilitation after total laringectomy

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KEYWORDS
Laryngectomy;
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Abstract
Objectives: To analyse the olfactory function in patients after total laryngectomy and evaluate the outcomes of using the nasal airflow-inducing manoeuvre.
Material and methods: A prospective clinical intervention study was carried out with 41 patients who had undergone total laryngectomy, of which 39 were male and 2 female. After verifying that there were no anatomical disorders, the patients were given an olfaction test that classified them into two groups, those with olfactory perception and those without. All underwent rehabilitation using the induced nasal airflow technique and, subsequently, the olfaction test was repeated to enable a comparison with the first results obtained. A semi-structured interview was held to evaluate the senses of taste and smell of the participants, also taking into account their own opinion.
Results: Out of the 41 patients included in the study, 9 had olfactory perception before rehabilitation, according to the first olfaction test. The use of the nasal airflow manoeuvre meant the recovery or improvement of the olfactory capacity in 90.24% of the patients.
Conclusions: The nasal airflow-inducing technique enables an important recovery of olfaction and improvement of taste after total laryngectomy. This technique is easy to learn and to repeat. It does not require expensive materials. The recovery of olfaction and taste implies an improvement in quality of life for the patient, so this technique should be included in all protocols of comprehensive rehabilitation after total laryngectomy.

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PALABRAS CLAVE
Laringectomía;
Trastornos de la olfacción;
Rehabilitación

Rehabilitación olfativa tras la laringectomía total

Resumen
Objetivos: Examinar la función olfatoria en pacientes laringectomizados y evaluar los resultados de la aplicación de la maniobra de inducción de flujo aéreo nasal.
Material y métodos: Se realizó un estudio prospectivo de intervención con 41 pacientes laringectomizados, 39 hombres y 2 mujeres. Tras la comprobación de ausencia de alteraciones anatómicas, los participantes fueron sometidos a un test olfatométrico que los dividía en pacientes con olfato y pacientes sin olfato. Todos fueron sometidos a la rehabilitación del olfato mediante la técnica de inducción de flujo aéreo nasal y, posteriormente, a un segundo test olfatométrico para comparar los resultados con el primero. La valoración del sentido del gusto y del olfato de los pacientes se realizó a través de una entrevista semiestructurada en la que se tuvo en cuenta la opinión de cada uno de ellos.
Resultados: De los 41 pacientes incluidos en el estudio, 9 tenían capacidad olfativa previa a la rehabilitación según el primer test olfatométrico. La realización de la rehabilitación supuso la recuperación o mejoría de la capacidad olfativa para el 90,24% de los pacientes.
Conclusiones: La inducción de flujo aéreo nasal es una técnica que permite la recuperación del olfato y mejora del gusto a personas laringectomizadas. Es de fácil aprendizaje y realización. No precisa de medios técnicos costosos. La recuperación del olfato y el gusto mejoran la calidad de vida del paciente, por lo que esta técnica debería incluirse en los protocolos de rehabilitación integral del paciente laringectomizado.

Introduction

At first sight, the most striking result of a total laryngectomy is the loss of the phonatory function, but all preoperative functions of the larynx are affected after this surgery. The loss of the sphincter function of the larynx has implications on the mechanism of coughing, sneezing and the ability to perform the Valsalva manoeuvre. The conditioning process of inhaled air (heating, humidifying and filtering) that takes place in the nostrils is also lost. Moreover, the absence of nasal airflow prevents the stimulation of the olfactory epithelium (located at the top of the nostrils), which results in anosmia or hyposmia. Indirectly, because of the interrelationship between smell and taste, laryngectomized patients can suffer ageusia or hypogeusia.[1-3] Anosmia/hyposmia associated with the ageusia/hypogeusia appearing after total laryngectomy is, therefore, the loss of more than 1/5 of the sensory capacity of the patient.

Alterations of smell can be in perception, when there is disruption of the epithelium or the olfactory tract; in transmission, when the olfactory tract is intact, but there is an abnormality that prevents odour molecules from stimulating the olfactory epithelium; or mixed when both are combined.[4] In laryngectomy, we would face a case of anosmia/hyposmia by transmission. After the surgery, the passage of air through the upper airway is interrupted permanently, so that odour particles cannot reach the olfactory epithelium. Therefore, if there was no prior neurosensory alteration, after laryngectomy there is anosmia/hyposmia by transmission. However, in theory the sense of smell would be intact and therefore capable of being rehabilitated.

Traditionally, rehabilitation of the laryngectomized patient focused only on voice. The fact of having survived cancer and the disability caused by voice loss made alterations of smell and taste go unnoticed from a clinical point of view and, sometimes, also for the patient. Some authors have developed different techniques to restore nasal airflow, such as the laryngeal bypass or glossopharyngeal pressure, but none is included in routine rehabilitation methods for laryngectomized patients.

In the year 2000, Hilgers et al.[5] described the nasal airflow-inducing manoeuvre (NAIM) or "polite yawn" technique. Since then, several studies have confirmed their results.[6-8] The aim of this study was to examine the qualitative olfactory ability of laryngectomized patients and to evaluate the results obtained from applying the nasal airflow-inducing manoeuvre.

Material and methods

The study included 42 laryngectomized volunteers, 32 of them members of the Association of Laryngectomees of Leon (*ALLE* in Spanish) and 10 patients at the *Hospital Virgen de la Salud* in Toledo. All patients had their nasal fossae examined by nasal endoscopy to rule out anatomical alterations that could interfere with the rehabilitation process. The patients were also assessed by the speech therapist to evaluate possible anatomical or neurological deficits that could interfere with the proper conduct of the exercises. Subsequently, there was a semi-structured interview that included the questions presented in Figure 1. The patient responded on a scale of 0 to 100, where 0 was "very bad" and 100 "very good". Later, there were questions about the impact caused by the alterations of smell and taste, if any, in their daily lives.

First interview *(before rehabilitation)*

1. How do you consider your olfaction before surgery?
2. How do you consider your sense of taste before surgery?
3. How do you consider your olfaction at the moment?
4. How do you consider your sense of taste at the moment?*

Second interview *(after rehabilitation)*

1. How do you consider your olfaction after rehabilitation?*
2. How do you consider your sense of taste after rehabilitation?*
3. What is you opinion about the nasal airflow-inducing manoeuvre?
4. Has something changed in you life after rehabilitation? If so, what?*

*Answer the following questions with a score from 0 to 100, **where 0 is "very bad" and 100 "very good"**

Figure 1 Mandatory questions in the semi-structured interview.

Next, the patients were subjected to a qualitative olfactometric test before and after olfactory rehabilitation. Based on the results of the first test, patients were classified as patients with olfaction or patients without olfaction. Once this classification was performed, the first test was repeated but with the help of the laryngeal bypass described by Mozell et al.[9] to verify that the patient's olfactory capacity was intact, that is, that there was no neurosensory anosmia. Subsequently, all were subject to the rehabilitation process by the technique of inducing nasal airflow or the "polite yawn" developed at the Dutch Institute of Cancer.[5]

The laryngeal bypass is a tube connecting the tracheostoma with the patient's mouth (Figure 2) in such a manner that upon inhaling the air enters the nostrils; from there it travels to the mouth and from the mouth, through the tube, into the lungs. During exhaling, the air would follow the reverse path, thus generating a nasal airflow that allows the odour particles to stimulate the olfactory epithelium.

The nasal airflow-inducing manoeuvre consists in the generation of positive and negative pressures in the oral cavity through mouth movements so that these pressures are transmitted, through the nasopharynx, to the nostrils to produce the entrance and exit of air thereof. As mentioned above, the lower airway and digestive tract become totally independent after total laryngectomy. To create a negative pressure within the oral cavity, the patient has to perform a downward motion of the jaw and tongue with sealed lips, so that this negative pressure is transmitted to the nostrils and makes air flow into them. Then, the patient makes an upward movement with the jaw and tongue to touch the palate (always with sealed lips). This movement generates a positive pressure in the mouth that expels the previously introduced air through the nostrils (Figure 3). With this manoeuvre, the oral cavity acts as a bellows with the nostrils as the tip of the bellows. The repeated completion of these movements generates a stream of air that is sufficient to stimulate the olfactory epithelium. This technique is also called the "polite yawn" because trying to perform the movements described above is like trying to yawn without opening the lips.

Figure 2 Laryngeal bypass.

During the initial training, the successful implementation of the technique was tested with a water manometer, based on the properties of communicating vessels. A "U" shaped-tube (Figure 4) with a coloured liquid inside was inserted into a holder that gave it stability. One end of the tube was connected to one nostril and the other end was free (Figure 5). The other nostril was occluded. When the nasal

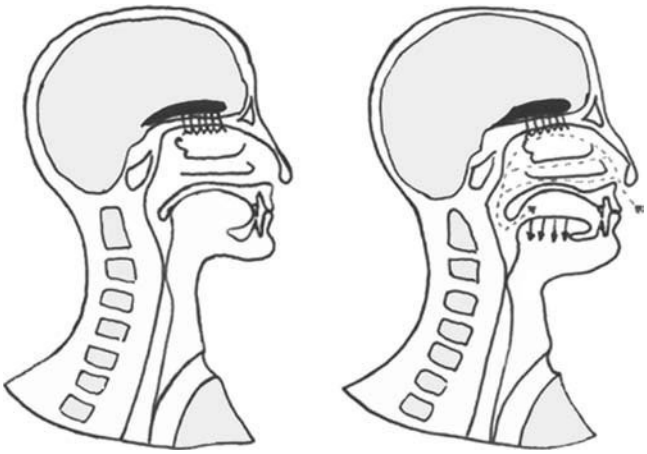

Figure 3 Nasal airflow inducing manoeuvre.

Figure 4 Manometer.

Figure 5 Placement of the manometer.

airflow-inducing manoeuvre was performed, the positive and negative pressures generated in the oral cavity were transmitted to the nose and through it, to the tube and the manometer. If the technique was done successfully, the liquid inside the pressure gauge travelled closer to the nose upon creating negative pressure, and away from it when positive pressures were generated. This movement of liquid in the "U" tube was observed by the patient, who could thus see whether the mouth movements made were appropriate. Once the patient learned the movements by noting that the water column moved properly, she/ he was urged to practice these movements at home with odorous sources (flowers, food, perfumes, etc.) as many times as possible.

Between 1 to 4 months (average: 13.1 weeks) after the completion of the first olfactometric test, the second test was conducted, this time using the nasal airflow-inducing manoeuvre. After this second test, the semi-structured interview was repeated, questioning the patients about their ability to smell and taste after rehabilitation. The responses were collected again on a scale of 0 to 100, with the same interpretation as in the first interview.

Three identical and opaque containers were used to carry out the qualitative olfactometric test. One of them was empty, as control, and the others contained coffee and floral scent. It was considered as a negative result if the patient was not able to detect the presence or absence of odour and as a positive if he/ she did, even if the scent could not be identified. The scents used were chosen from among the 8 used in the test of olfaction in diskettes, developed and validated by Briner et al.[10] The odours of coffee and floral scent were chosen because they were considered easy to recognise in our environment. The presentation form of the aromas was similar to that used by Van Dam et al.[3] in their adaptation of the qualitative olfaction test described by Doty and Kobal.[11] In other words, the odours were set presented at their maximum concentration at the beginning, instead of presenting increasing concentrations until the threshold was detected. This form of presentation avoids unnecessary testing and

the frustration of the patients when, after several tests with low concentrations, they do not detect anything. In our test we did not present decreasing concentrations; by using the maximum concentration, we classified the patients into with and without olfaction. The test was performed qualitatively and with only 2 substances and a control vessel; the aim was to detect the presence or absence of olfaction in patients with regard to a future rehabilitation. All patients with positive results in the first test were susceptible of being rehabilitated.

We also collected data on current age, date of laryngectomy and phonatory ability. The phonatory ability was classified into poor, regular, good or very good. Poor, if the patient was not able to articulate words; regular, when able to articulate single words, but with difficulty in generating sentences; good, when able to articulate sentences, and very good, when the patient could hold a fluid conversation. The average sample age was 65.04 years (44-90). Of all patients, 9.75% (4/41) had poor phonatory ability; 21.95% (9/41) regular; 36.6% (15/41) good: and 31.70 % (13/41) very good (Figure 8). All patients had received speech and language rehabilitation with oesophageal voice techniques and none wore a phonatory prosthesis. The average time from surgery was 4 years (0.5-20).

The study protocol was developed in the following order: patient examination by an otolaryngologist and a speech pathologist, first semi-structured interview, first olfaction test, repetition of the first olfaction test with laryngeal bypass, rehabilitation period, second olfaction test and second semi-structured interview.

For the statistical data analysis, we used SPSS version 11.0 for Windows XP.

Results

Of the 42 participants in the study, 40 were male and 2 female. Of the males, one had to be excluded from the study due to tumour recurrence during the period of olfactory rehabilitation. Both otolaryngological exploration and speech therapy study were normal in all patients.

The duration of the first training session was variable for each patient (from several minutes to one hour), since that meeting did not terminate until it was ascertained that the patient was able to perform the movements of the mouth properly and mobilised the liquid column effectively. Only four of the 41 cases (10.86%) did not succeed in learning the technique, despite several training sessions.

After the first qualitative test of olfaction in the 41 patients, 9 (21.95%) were able to identify the presence/absence of odour before they learned the technique. In the repetition of this test with the laryngeal bypass, all patients were able to detect the presence/absence of odour, and in the case of the 9 patients who had olfactory capacity without any assistance, the use of the bypass clearly enhanced this capacity. After a variable period of time for each patient (from one to 4 months) the second qualitative olfactometric test was carried out, and it was found that, out of all the patients, 37 (90.24%) were able to identify the presence/absence of odour using the nasal airflow-inducing manoeuvre. Of the 32 patients classified as without olfaction after the first test, 28 (88%) obtained positive results in the second test (Figure 6). In the case of the four patients with negative results in the second test, it was observed that they did not perform the technique adequately. The differences obtained in the results of the olfaction test before and after rehabilitation were analysed using the McNemar test for paired testing, with statistically significant results ($P<.0001$).

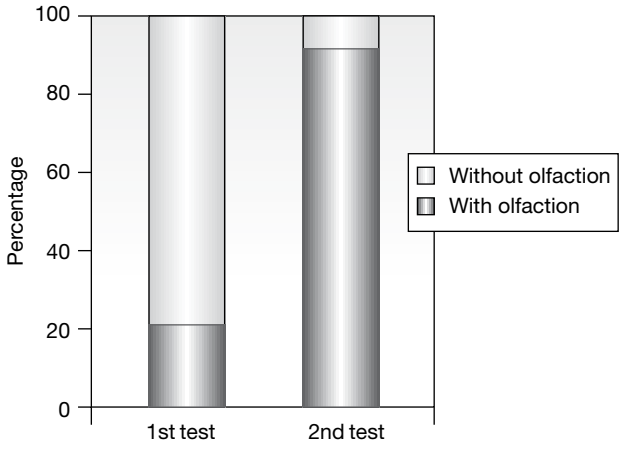

Figure 6 Results of patients after first and second test of olfaction.

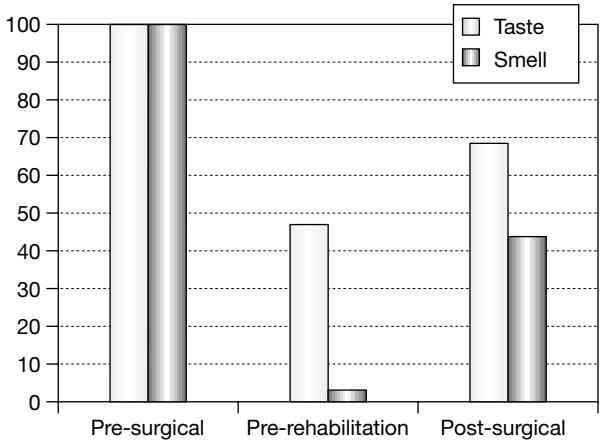

Figure 7 Pre and post-rehabilitation evaluation of taste and smell.

The 9 patients with olfactory capacity before training had good or very good phonatory ability and 6 of them were speech therapy professionals. Of the 4 patients who did not pass the second test, 2 had poor phonatory ability, one regular and another good.

According to the questionnaire on gustatory and olfactory ability (Figure 1), patients considered their pre-surgical status as 100%. The surgery resulted in a loss of 53% of gustatory capacity and 97.5% of olfactory capacity, while after rehabilitation, the patients considered these capacities as 69% and 44%, respectively (Figure 7). These

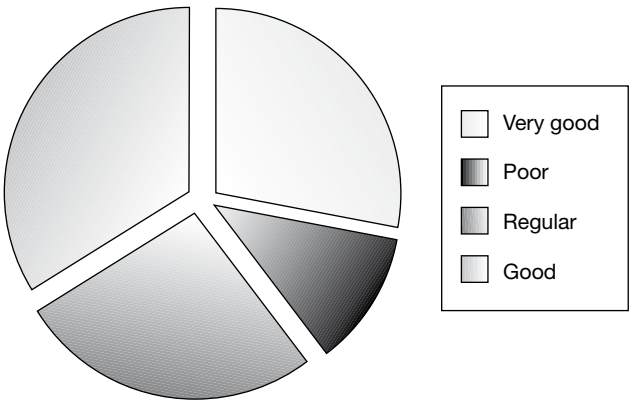

Figure 8 Phonatory capacity.

differences (Figure 8) were analysed with the Wilcoxon test and the result was statistically significant ($P<.0001$).

In the comments made by patients, the overall evaluation of rehabilitation with this manoeuvre was good. All patients who learned the nasal airflow-inducing manoeuvre had the sensation their quality of life improved, since they could appreciate odours in food, at their homes, in parks, their own body odour and perfumes that had previously disappeared for them. Patients who had the ability to smell before rehabilitation found it much easier to perceive odours and perceived them with greater intensity after rehabilitation. According to their comments, regaining a sense that had been lost to them brought them hope, confidence and security.

Discussion

The loss of smell after laryngectomy is an obvious fact. Although anosmia passes into the background after cancer surgery due to the prognostic implications this disease has, once the first few months have passed, the patient becomes aware of the limitations posed by the loss of this sense. Anosmia is associated with an altered sense of taste to a greater or lesser extent and exposes the patient to risk situations, as he may be unable to detect the odour of smoke, a gas leak or food in bad condition; in addition, the inability to perceive body odour creates insecurity.[12] According to the results of the study, total laryngectomy creates a major alteration in the patient's gustatory and olfactory ability. After surgery, approximately 78% (32/41) of patients become anosmic.

No validated test was used for olfactometric assessment as the study sought to detect the patient's ability to smell, without paying attention to the quantity of odour that could be perceived. Despite this limitation, our results in the olfactometry, in patients with or without olfaction after laryngectomy and before rehabilitation, are consistent with those of other published series.[5,7] The best results in terms of olfactory recovery after rehabilitation, approximately 90% (37/41) of patients, compared with other series[5,7] are not comparable because the methods used for the assessment of olfactory ability were different.

The fact that rehabilitation is possible regardless of how long a person has been laryngectomized implies that neuroepithelium does not become atrophied after surgery. The study of Fuji et al.[13] showed that a year after laryngectomy the olfactory epithelium had not become atrophied.

Most studies of quality of life in patients with head and neck cancer use the European Organization for Research and Treatment of Cancer (EORTC) questionnaire QLQ-C 30, supplemented with the specific module for head and neck EORTC QLQ-H&N35.[7,8,14,15] The questionnaire[16] has 48 questions in all, 2 of which are specific to smell and taste. Another questionnaire related with quality of life for cancer patients used in head and neck patients is the one developed by the University of Washington, UW-QOL v4.[17] This questionnaire consists of 9 domains and 3 general questions; one of the domains refers to taste, but there are none for olfaction. The application of these questionnaires has not always enabled valid conclusions to be drawn.[8,18] Furthermore, the concept of quality of life is broad and can have different interpretations for each individual. According to the World Health Organization (WHO), quality of life is defined as "the perception that an individual has of his place in life, in the context of culture and value system in which he lives and in relation to his objectives, expectations, standards and concerns". All this, coupled with the fact that an excessive number of questions slows down the interview with the patient, has made us consider that our study did not require the use of such questionnaires.

To evaluate the impact of olfactory rehabilitation in the daily life of the patient, the scores in the questionnaire about the smell and taste, along with personal opinion and experiences of each individual, were assessed following the learning process. One of the most important values that the rehabilitation technique brought to their lives is hope, the possibility of regaining the ability to perceive odours and the improvement of taste makes their lives seem, despite the mutilation, a little closer to the preoperative situation.

Once the technique is acquired, it is important for the patient to repeat the movements again and again throughout the day, especially when changing rooms or in any change of environment, until they become automatic. In this way, it is possible to mimic the passive olfaction that takes place in normal circumstances during inspiration. Habituation to the technique is also effective in maintaining the long-term effects.[6,8]

The limitation of the numbers in the sample does not allow for statistical associations between phonatory capacity and olfactory capacity to be established, but it seems that people who have a better phonatory ability learn the nasal airflow-inducing manoeuvre earlier and more effectively. In our study, the majority of these patients had the ability to smell before undergoing rehabilitation. This could be explained by the fact that people with very good phonatory ability have very well-developed buccal and lingual movements and unconsciously, in their eagerness to perceive odours, they make movements that can generate positive and negative intraoral pressures that create a nasal airflow similar to that produced by the manoeuvre developed by Hilgers et al.[3,13,19]

As others have suggested, the rehabilitation of smell should be included in rehabilitation protocols for laryngectomized patients.[6,7,12] The nasal airflow technique should be included in these protocols; there are several reasons for this: it is easy to learn, it requires no expensive technical resources, it has proved effective in various studies and the patient can smell without using any additional tools. Any patient having no olfactory problems prior to the laryngectomy should be susceptible of being rehabilitated.

Conclusions

- Induction of nasal airflow is a technique that allows the recovery of smell and improves taste, objectively, in laryngectomized persons.
- It is easy to learn and to conduct.
- It does not require costly technical means.
- The recovery of smell and taste has a positive effect on the daily life of the patient, so this technique should be included in comprehensive rehabilitation protocols for laryngectomized patients.

"The best medicine for the laryngectomized patient is hope". Gumersindo Rodriguez Esteban.

Conflict of interests

The authors declare no conflict of interests.

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