ORIGINAL CONTRIBUTION

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The significance of rhinomanometry in evaluation of postlaryngectomy olfactory rehabilitation by polite yawning technique*

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SUMMARY

Objective: *To corroborate the result of postlaryngectomy olfactory rehabilitation evaluating the efficacy of the Polite Yawning Technique (PYT) with rhinomanometry and odours with the Smell diskettes Olfaction test (SDOT).*
Materials and methods: *Thirty-two laryngectomised patients were subjected to olfactory rehabilitation consisting of 15-minute training and independent exercising for two weeks. The sense of smell and nasal airflow in laryngectomised patients were examined before and after implementation of PYT.*
Results: *The differences in SDOT results prior to and after introduction of PYT were statistically significant, most patients achieving better results after rehabilitation. A significant positive correlation was obtained in results of SDOT and rhinomanometry prior to and after introduction of PYT. The results of measurements after rehabilitation showed that 75% of patients had improved nasal breathing, 78% of patients had a better sense of smell and 40% of patients became normosmic.*
Conclusions: *PYT has proved to be an effective method in olfaction rehabilitation following total laryngectomy. Using rhinomanometry, evaluation of the rehabilitation success is substantiated while the technique is simplified.*

Key words: olfactory rehabilitation, Polite Yawning, rhinomanometry, Smell Diskettes Olfaction Test, laryngectomy

INTRODUCTION

Following total laryngectomy, patients no longer breathe through the nose but through a tracheostoma. In this way, the olfactory region in the nose is bypassed and the sense of smell is lost.

The importance of the sense of smell is realised only when it is lost [1]. Without olfaction, food and drink lose part of their taste [2]. The inability to detect smoke or dangerous gases increases the feeling of fear and exposes us to danger. The inability to be aware of one's own body odour causes insecurity and excessive use of perfume, excessive cleaning and showering. Even libido and sexual activity have been shown to be reduced [3,4].

To achieve a better quality of life for laryngectomised patients, olfactory rehabilitation should be undertaken as soon as possible. Airflow through the nose must be established once again, and with it the sense of smell. What had previously been an automatic action must now be consciously and actively performed. One of the methods of rehabilitating the sense of smell is the Nasal Airflow - Inducing Maneuver ('Polite Yawning') [5]. This has proven to be a successful method [6], although it is dependent on the patient's cooperation and factors over which doctors have no influence. Smoking [7], age and environmental factors not only have impact on the development of laryngeal carcinoma, but also cause degeneration of the olfactory epithelia with consequent hyposmia or anosmia.

MATERIALS AND METHODS

Patients

Members of the Laryngectomised Patients' Club sponsored by the Clinic of Otorhinolaryngology, Head and Neck Surgery KBC Rijeka, participated in the study. The Club meetings are held twice a month and attendance is voluntary. All patients who attended the lecture on the importance of Olfactory Rehabilitation were included in the study. The study

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Figure 1. Laryngectomised patient using a rhinomanometer.

population comprised 29 men (91%) and 3 women (9%). The mean age was 60.81 ± 7.92 years, ranging from 48 to 75 years. The interval duration following total laryngectomy was from 6 months to 12 years, with an average of 3.19 ± 3.11 years. Prior to study enrolment, endoscopic evaluation was carried out and all patients in whom we could not assess the olfactory groove endoscopically were excluded from the study. All patients gave their informed consent and the study was approved by the Medical-Ethical Protocol Institutional Review Board.

Olfactory rehabilitation

The objective of PYT is to establish airflow through the nose by creating negative pressure in the oral cavity and oropharynx. The theory of PYT was explained to the subjects in a 10-minute session during group meetings. The practical part of carrying out the technique was explained individually during a period of approximately 5 minutes. The technique includes getting the patient to yawn with closed mouth. The lips are kept closed while at the same time the jaw, floor of the mouth, tongue, base of the tongue and soft palate are lowered [8]. The movements must be quickly repeated several times to achieve maximal effect. The patients practice the technique for 2 weeks at home. This time period was chosen since we estimated that patients may lose interest afterwards.

Active anterior rhinomanometry

Rhinomanometry is a dynamic and objective method [9,10]. Its purpose is to measure nasal airflow, pressure and resistance in the nostrils [11]. Active anterior rhinomanometry (AAR) measures the pressure difference between the nasal entrance and the choane. In AAR, one nostril is closed with a measuring pressure probe, while the other nostril is used for rhinomanometric measuring [12]. It provides relevant data of nasal flow in relation to the respiratory activity being carried out by the patient. The curves of the air volume seen on the monitor of the rhinomanometer give direct visual feedback. Simultaneous display of the pressure–flow curve is provided so if the mask leaks or other problems with data collection occur, they can be detected during the test. In the study, the Rhinomanometer 300 (Atmos, Lenzkirch, Germany) was used. AAR was employed while the patient performed PYT to measure its effectivity on results of nasal inspiration. The applied technique was standard [10], apart from the fact that the patient held the mask with one hand while closing the stoma with the other. The purpose of this was for the patient to concentrate on the technique and avoid hyperventilation [13] (Figure 1). We evaluated the results of the rhinomanometric measurements with 0, 1 and 2 (Figures 2A-C). Zero was defined as a measurement without any airflow, 2 as a measurement with measurable airflow and numeric value. One represented an intermediate value: airflow was detected on the graph curve but was insufficient (not transpassing the dotted vertical line) to be numerically evaluated by the rhinomanometer computer processor.

The Smell Diskettes Olfaction Test

The Smell Diskettes Olfaction Test (SDOT) is a screening test designed to show whether the sense of smell is functioning properly or not. The test consists of 8 reusable diskettes with different odours (coffee, vanilla, peach, grass, pineapple, rose, chocolate and fish). The patient had to choose one of three answers provided for each smell. The fragrances were contained in special cassettes and opened by the patients themselves. Cassettes were placed beneath the nostrils and the odour inhaled. For each correct answer subjects got 1 point from a maximum of 8. A result of 7 or 8 points represents normal olfactory function, while 6 or less indicates hyposmia, anosmia or lack of cooperation. The possibility of an anosmic individual achieving 7 or 8 correct answers is 0.26% [14,15]. To obtain a better concentration on the technique during olfactory testing, the patient held the cassette with one hand while closing the stoma with the other. The SDOT was chosen based on research performed by Hilgers et al. and its relatively simple application [8,22].

Statistical analysis

All the data were evaluated by the Paired Samples t-test and χ^2 test. Spearman's Correlation Coefficient was used because of the relatively small number of subjects and irregular distribution. Probability (p) values of less than 0.05 were regarded as significant. SPSS 16.0 for Windows (SPSS Inc, Chicago, IL, USA) was used for all analyses.

RESULTS

Rhinomanometry results

The first rhinomanometric measurement (R1) was marked "0" in 18 patients (56.2%), "1" in 10 patients (31.2%) and "2" in 4 patients (12.6%). Rhinomanometric measurements were repeated after 15-minute training and two-week individual practicing (R2). Two patients had a graph curve marked as "0" (6.2%), 6 patients had a graph curve "1" (18.8%), while 24 patients had a graph curve "2" (75%). Significantly improved rhinomanometric measurements (from score 0 to 2) were achieved in 12 patients (37.5%), while 8 patients showed no change in their score (25%)(Table 1). When the relationship

Table 1. Rhinomanometry results.

Rhinomanometry	Prior to rehabilitation N	(%)	After rehabilitation N	(%)
Finding type 0	18	(56.2)	2	(6.2)
Finding type 1	10	(31.2)	6	(18.8)
Finding type 2	4	(12.6)	24	(75)

Finding type 0 - no airflow, no curve or numeric finding on graphic presentation.
Finding type 1 - airflow detected on the graph curve but without numeric value.
Finding type 2 - the curve of airflow with numeric value.

between rhinomanometric measurements was examined, the values in R1 did not significantly correlate with those in R2 (r_s = 0.26; p = 0.151). Between R1 and R2 there was also no significant difference (χ^2 test = 2.963; ss = 4; p = 0.564).

Olfactory results

Before the introduction of PYT, none of the patients had 7 or 8 correct answers in SDOT. After a repeated test, 3 patients (9.4%) had all 8 answers correct and 10 (31.2%) had 7 correct answers, allowing the conclusion that they achieved complete olfactory rehabilitation. Twenty-five patients (78.2%) improved their test results (Table 2).

When the correlation between the scores achieved in SDOT1 and SDOT2 was examined (Smell Diskette Olfaction Test prior to and after rehabilitation), it was established that the scores in SDOT1 and SDOT2 had a high positive correlation (r_s = 0.51; p = 0.003). Consequently, when the subjects achieved higher values in SDOT1 (guess smell), the values in SDOT2 were also higher.

Furthermore, the differences between SDOT1 and SDOT2 were examined and a statistically significant difference was obtained between them (t = 6.828; p < 0.001). Most of the subjects achieved higher scores in the second measurement (SDOT2, M = 5.72) than in the first one (SDOT1, M = 3.78). It is interesting to note that none of the subjects had lower values in SDOT2 than in SDOT1.

Comparison of rhinomanometry and olfactory results

The relation between SDOT and rhinomanometry measurements was analyzed. A significantly positive correlation was obtained between SDOT 1 and R1 (r_s = 0.64; p < 0.001) and between SDOT2 and R2 (r_s = 0.54; p = 0.002). Consequently, when the values of rhinomanometry (R1 and R2) were higher, the patients had better scores in the smell tests (SDOT1 and SDOT2), and vice versa (Table 3).

Comparison of peak inspiratory velocity at the pressure of 75 Pa and olfactory results

SDOT1 was not significantly connected with any analysed variable, while SDOT2 was significantly positively connected with Fl2 (Peak inspiratory velocity at the pressure of 75 Pa of the left nostril after rehabilitation) (r_s = 0.579; p = 0.001) and Fr2 (Peak inspiratory velocity at the pressure of 75 Pa of

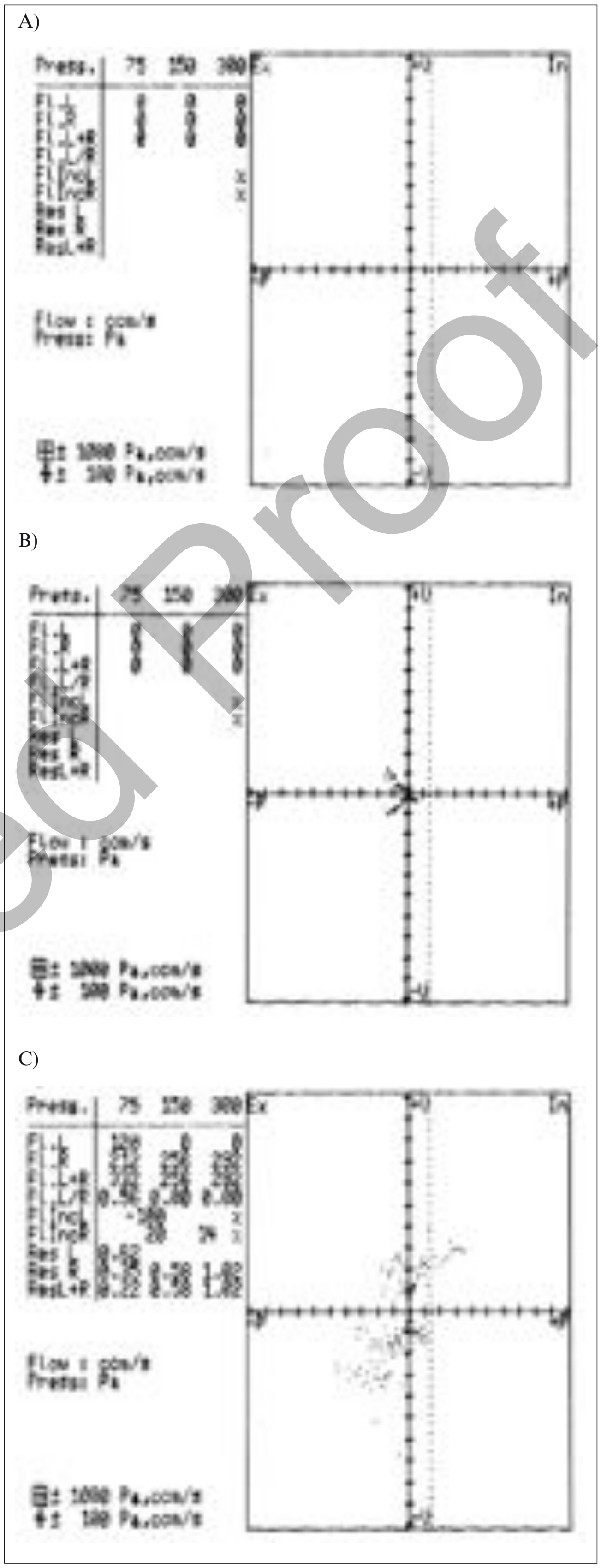

Figure 2. A) Rhinomanometric finding type 0. No airflow. No curve or numeric finding on graphic presentation. B). Rhinomanometric finding type 1. Airflow detected on the graph curve but without numeric value. C). Rhinomanometric finding type 2. Shows the curve of airflow with numeric value.

Table 2. Smell Diskette Olfactory Test (SDOT) results.

Correct answers	Prior to rehabilitation N	(%)	After rehabilitation N	(%)
0	1	(3.1)	0	(0)
1	2	(6.3)	0	(0)
2	5	(15.6)	0	(0)
3	5	(15.6)	3	(9.4)
4	8	(25)	5	(15.6)
5	4	(12.5)	6	(18.8)
6	7	(21.9)	5	(15.6)
7	0	(0)	10	(31.2)
8	0	(0)	3	(9.4)
Mean ± SD	3.78 ± 1.70		5.72 ± 1.53	

Table 3. Correlation between Smell Diskette Olfactory Test (SDOT) and rhinomanometry measurements prior to (R1) and after rehabilitation (R2).

	R_s	p	N
SDOT1 / R1	0.64	0.001	32
SDOT1 / R2	0.01	0.938	32
SDOT2 / R1	0.29	0.106	32
SDOT2 / R2	0.54	0.002	32

r_s - Spearman's Correlation Coefficient.

Table 4. Correlation between Smell Diskette Olfactory Test (SDOT) and Peak inspiratory velocity at the pressure of 75 Pa of the left nostril (Fl1) and the right nostril (Fr1) prior to, and the left nostril (Fl2) and the right nostril (Fr2) after rehabilitation.

	r_s	p	N
SDOT1 / Fl1	0.327	0.068	32
SDOT1 / Fr1	0.315	0.079	32
SDOT2 / Fl1	0.135	0.461	32
SDOT2 / Fr1	0.123	0.503	32
SDOT1 / Fl2	0.306	0.088	32
SDOT1 / Fr2	0.263	0.146	32
SDOT2 / Fl2	0.579	0.001	32
SDOT2 / Fr2	0.572	0.001	32

r_s - Spearman's Correlation Coefficient.

the right nostril after rehabilitation) (r_s = 0.572; p = 0.001). Consequently, the higher the SDOT2, the higher were the values of Fl2 and Fr2 variables (Table 4).

Comparison of rhinomanometry and olfactory results with patient's age and time elapsed from surgery

Scores of all analysed variables were lower given the patient's age at a statistically significant level ($p < 0.05$). Accordingly, the values of SDOT1, SDOT2, R1 and R2 were lower in older patients. Laryngectomy elapsed time was not significantly correlated to any other variable. These correlations were negative (the longer the treatment time, the lower the rhinomanometry scores) (r_s = -0.23; p = 0.212 with SDOT1 and r_s = -0.26; p = 0.151 with SDOT2), but without statistical significance. The number of patients was relatively low, letting us assume that in a larger sample, these correlations would probably be statistically significant.

DISCUSSION

This study evaluates the capacity to improve the possibility to perceive odours post laryngectomy by training PYT. Smell disorders are generally differentiated into sensorineural and conductive ones. Using endoscopy, we aimed at excluding subjects with conductive smell disorders, while expecting the majority to have normal sensorineural capacity to sense odour. A drawback of our study is the missing olfactory testing prior to laryngectomy to prove this assumption. Due to recently reported anosmia incidence of 5.8% in an epidemiological study in Sweden [16], we have to admit that a proportion of our non-responders to treatment may actually suffer from undetected sensorineural loss of smell. This issue should be evaluated in a prospective study. It should be pointed out that the authors adhered to SDOT criteria for normal olfactory sensitivity (7 or 8 of the odours scored correctly). Some of the patients achieved fewer than 7 correct answers and could be considered to some extent hyposmic, which might lead to an underestimation of olfactory rehabilitation results. SDOT is a subjective method and as such dependent on the patient's cooperation. One of the patient's remarks regarding SDOT was that although sensing odours, they were unable to confidently identify them, even if in authentic situations they found it easier to recognize odours. Another important patient's observation related to the saturation of olfactory receptors by a previous odour or some other fragrance in the immediate vicinity, which prevented recognition of the fragrance provided.

Rhinomanometry is a fast and relatively simple method that describes the volume and speed of inhaled and exhaled air and gives an objective state of nasal airflow. Simultaneous display of the pressure-flow curve is provided so that not properly performed PYT or mask leaks can be detected during the test and corrections made accordingly in real time. Adjustments in real time, from our experience, simplified and enhanced technique explanation to the patient, compared to standard olfactory rehabilitation carried out at our clinic [17]. In a review of available literature data, we were unable to find applications of rhinomanometry in the evaluation of olfactory rehabilitation success in laryngectomised patients [18,19].

For rehabilitation of their patients some authors use a manometer - tube in the form of letter U containing colored fluid. Correctly using the PYT technique, and creating negative pressure, the fluid in the manometer comes towards the nostril and flows away generating positive pressure [17]. From our experience, at the initial learning phase, it is difficult for the patient to control the colored fluid in the manometer. It often spills out of the tube causing aspiration and contamination of the working place, which is not the case with rhinomanometry. Other authors tried to enhance the success of rehabilitation by videotaping the patient while performing PYT. The registered videotape is analysed by the physician and speech therapist and possible mistakes are pointed out to the patient [20].

Our results of olfactory rehabilitation using PYT were slightly poorer (40% vs. 46%) compared with the results of other investigations [8]. One probable reason could be the short individual training period [20,21]. As all the patients were members of the Laryngectomised patients Club, we intended to introduce group training of PYT during their meetings. The aim was for PYT to become standard practice, which could be applied in everyday use with expert advice and patients' consent.

CONCLUSION

The application of rhinomanometry substantiates the evaluation of postlaryngectomy olfactory rehabilitation. Explaining the method to the patient is simplified by presenting a chart of nasal flow generation in relation to the movement of PYT that is being carried out. The curves and volume of air seen on the monitor of the rhinomanometer give direct visual feedback. PYT has proved to be an effective method in olfactory rehabilitation. The importance of olfactory rehabilitation should not be underestimated and should be carried out as an integral part of the postlaryngectomy rehabilitation programme.

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