Research Article **IRJO (2019) 2:8**

International Research Journal of Otolaryngology
(ISSN:2637-4684)

Halitosis as an indication for tonsillectomy in chronic hypertrophy tonsillitis

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ABSTRACT

Main purpose: This paper aimed to confirm a relationship between chronic hypertrophic tonsillitis (CHT) and bad mouth odour. To this end, detailed identification of the microbial flora inhabiting affected tonsils was carried out. The results obtained might be helpful in specifying indications for tonsillectomy.

Materials and method: From among 247 patients with clinically diagnosed CHT, 33 generally healthy individuals aged 18- 40 (10 male and 23 female) were selected. Patients in whom other causes could be the possible reason for their fetor ex ore (halitosis) were not included. Before and 2 to 3 months after tonsillectomy, organoleptic and halimeter testing was undertaken for each patient. A swab was collected from the interior of the enucleated tonsils in a sterile manner, and was inoculated onto surfaces enabling the culture of aerobic and anaerobic bacteria and fungi. A histopathological examination was subsequently performed.

Results: Fetor ex ore was initially found in 95% of the patients with CHT. In 90% of cases with confirmed halitosis, after tonsillectomy a significant reduction in its intensity was observed. On average, the concentration of VSC in the patient decreased by approximately 75 ppb (62%), which was statistically significant ($p < 0.0001$). It was also shown that the concentration of VSC in carriers of anaerobic bacteria, compared to carriers of only aerobic bacteria, was significantly reduced ($p < 0.05$). The results obtained confirm the role of CHT in the pathogenesis of halitosis.

Conclusions: Halitosis in patients with CHT requires a number of laboratory tests and specialist consultations to exclude other possible causes of fetor ex ore. A dental examination plays an important role in the differential diagnosis. Performing targeted microbiological testing to determine the patient's carrier state for anaerobes should eventually be considered. When these conditions are met, halitosis can be considered an independent indication for tonsillectomy.

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How to cite this article:
Agata Zalewska, Marek Bochnia, Monika Morawska-Kochman. Halitosis as an indication for tonsillectomy in chronic hypertrophy tonsillitis. International Research Journal of Otolaryngology, 2019, 2:8

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Website: https://escipub.com/

Introduction.

Halitosis, or bad mouth odour, is also known by the names *fetor ex ore*, *oral malodour* or *bad breath*. It is a widespread phenomenon in the world; it is believed that 25-30% of the population (1, 2, 3) is affected by it, although the true prevalence has not been thoroughly researched and may vary from 50 to 60% (4, 5, 6, 7, 8, 9). Halitosis is divided into the categories of genuine halitosis, which may be physiologic or pathologic, pseudohalitosis and halitophobia.

Physiologic halitosis occurs in the morning, upon waking up. It is due to the reduced production of saliva during the night, leading to drying of the oral mucosa (10). Pathologic halitosis, also called unpleasant mouth odour, is not acceptable (10), and can be divided into two categories based on the location of causative factors: oral halitosis, constituting 80-90% of cases, and extra-oral halitosis (4, 11, 12, 13, 14, 15) (Table 1). Pseudohalitosis is a condition in which the patient feels that he or she has bad breath, but it is not detected by others. However, halitophobia relates to patients who, after complete treatment of halitosis or pseudohalitosis, are still convinced of the disease. Such people fear social meetings, brush their teeth several times a day and use breath fresheners (16).

The occurrence of bad mouth odour can be caused by the presence of various substances in the exhaled air (17). The role of volatile sulfur compounds (3, 18) has been especially emphasised. In 90% of cases, they include methyl mercaptan, hydrogen sulfide and dimethyl sulfide (19, 20). These compounds are the products of bacterial metabolism and are formed by decomposition of proteins, peptides and amino acids containing thiol groups (21). The main substrates are cysteine and methionine, as well as lysine and tryptophan (22, 23, 24). The source of these amino acids include remnants of food deposited within the oral cavity, desquamated epithelial cells, dead leukocytes and bacterial cells, deposits at the dorsum of the tongue, components of the biofilm forming plaque, discharge dripping down the back of the pharynx (upper respiratory tract diseases), blood, or even the mucinous component of saliva (11, 19, 25, 26, 27, 28).

The oral cavity is colonised by over 700 bacterial species (21), and in patients with halitosis they are even far more varied. Based on the results of microbiological testing, a number of strains that are able to produce volatile sulfur compounds were identified. The prevailing view is that the main producers of these compounds are Gram-negative anaerobic bacteria (22, 23, 25, 29,30, 31). The greatest density of these bacteria is found on the root of the tongue and in plaque (19, 20, 22), where bacterial biofilms are formed. The most frequently mentioned bacteria, being components of the biofilm on the root of the tongue, include species belonging to the genera: *Veillonella*, *Prevotella*, *Actinomyces*, *Fuscobacterium*, and *Peptostreptococcus* (19, 20, 22). They are present both in patients with and without halitosis (20, 32, 33). It has been observed that in individuals with halitosis, especially on the root of the tongue, the number of bacteria producing volatile sulfur compounds increases. Thus, the occurrence and severity of halitosis is not caused merely by the presence of bacteria in the oral cavity, but by an increased number of them, and thereby an increased number of produced malodorous compounds (22, 32). The bacteria capable of producing volatile sulfur compounds are also a part of plaque. The most frequently mentioned plaque bacteria include: *Porphyromonas gingvinalis*, *Prevotella intermedia*, *Treponema denticola*, *Tanarella forsythenis*, *Porphyromonas endodentalis*, *Eubacterium spp*, *Bacteriodes spp*, *Streptococuss spp*, *Fuscobacterium spp*. (18, 19, 28). They are present both in patients with light and severe halitosis (34). Just like on the root of the tongue, there is a correlation between the severity of disease and the number of bacteria in the plaque's biofilm, with an

increased number of strains producing volatile sulfur compounds (34). Some of these bacteria, such as *Treponema denticola*, *Porphyromona gingvinalis*, *Prevotella intermedia*, *Tanarella forsythensis*, *Porphyromonas endodontalis and Eubacteriumm spp.*, belonging to the bacterial flora of the plaque, also produce short chain fatty acids, mainly butyric and valeric acid, and putrescine and skatole. For over a decade, research has been conducted on the relationship between the carrier state of *Helicobacter pylori* and halitosis. A breakthrough was the discovery that this bacterium also produces volatile sulfur compounds: hydrogen sulfate and methyl mercaptan (35, 36).

Materials and methods.

An attempt to demonstrate a possible relationship between chronic hypertrophic tonsillitis (CHT) and bad mouth odour required a restrictive selection of cases to be analysed. From among 247 patients who were diagnosed with CHT and were undergoing tonsillectomy, initially 149 generally healthy patients aged 18-40 were selected. With regards to ORL, they only complained of frequent tonsillitis (2-6 episodes in the previous year) or peritonsillar abscess or infiltration (recognised indications for tonsillectomy).

Within 2 weeks before the planned operation, all patients underwent routine laboratory tests, including blood tests (complete blood count, coagulation test, electrolytes, fasting glucose, AST, ALT, urea and creatinine) urine testing, chest X-ray and ECG. Ninety-eight patients whose laboratory test results showed no deviation from the norm qualified for further studies.

On admission to hospital, detailed histories were taken in the form of a two-part questionnaire. The first part included questions aimed at excluding patients with diseases of the respiratory tract, digestive tract and systemic diseases, which are considered to be causes of halitosis. The patients who indicated in the questionnaire that they experienced any symptoms of these diseases were eliminated from the study group. The second part of the questionnaire included questions (23) intended to eliminate persons with other possible causes of halitosis, namely some eating habits (e.g. a protein-rich diet), stimulants, smoking, alcohol or negligence of oral hygiene. On the basis of the questionnaire results, from the group of 98 patients, 56 people with CHT were selected.

In order to ensure that cases of oral halitosis had been eliminated, on the day of admission, each patient had a dental examination with an assessment of the condition of teeth, periodontium and oral hygiene. In the dental examination, the DMF index (decayed, missing, filled), plaque indices, namely API (according to Lange) and OHI (according to Green and Vermillion, CI + DI), gingivitis indices, namely PBI and GI (by Loe and Silness) and periodontal indices, namely pocket depth (PD) and Clinical Attachment Level (CAL), were determined. Individuals in whom gingival pocket depth went beyond the recognised standard (up to 2 mm, and at the back teeth, up to 3mm) and individuals in whom the CAL value exceeded 2.5 mm, were excluded from the study group. with coated tongue were also excluded from the study group. The dental examination eliminated 8 people, leaving 48 patients.

For the assessment of the bacterial flora in the oral cavity, each patient had the root of their tongue swabbed and inoculated (for the detection of aerobic bacteria, anaerobic bacteria and fungi). The study group included patients diagnosed with the presence of only normal flora. Three people were excluded, which reduced the group to 45 people.

Carriers of *H. pylori* were retrospectively excluded from the study group. The RAPID Hp STAR test with monoclonal antibodies was used. From the study group of 45 patients, 12 people were excluded, ultimately leading the study's group of 33 patients.

On the day of the operation, before

tonsillectomy, each patient underwent organoleptic and halimeter testing. Patients who qualified for the study could not take antibiotics in the three weeks preceding their operation, and they could not eat garlic, onion and spicy food or apply cosmetics such as perfumes, aftershaves or lipsticks for 24 hours. Within the 12 hours before the tonsillectomy, it was also recommended to avoid eating and drinking, brushing teeth, using breath fresheners and smoking. With the organoleptic testing, patients exhaled air into a transparent tube that had a length of 10 cm and a diameter of 2.5 mm. In order to assess the intensity of oral malodour, the 0-5 Rosenberg scale was used, with the following grades: 0- no odour, 1- barely noticeable odour, 2- slight odour, 3- moderate odour, 4- strong odour, and 5- severe odour.

For the objective assessment of *fetor ex ore*, each patient was tested using the Man-hal-II Halimeter. The test result is given in parts per billion (ppb). The range of concentration of VSC up to 100 ppb is considered normal, from 100-180 ppb is considered light, and above 250 ppb reflects a severe form of the disease (3).

After tonsillectomy, a swab was taken from the interior of the enucleated and cut tonsils, in a sterile manner. Immediately after taking the swab, it was placed on the transport medium. Upon delivery to the laboratory, the swab was inoculated onto surfaces, enabling the culture of aerobic and anaerobic bacteria and fungi. The removed tonsils were sent for histopathological examination.

In each patient, between the 2nd and 3rd months after the removal of the tonsils, when the healing process was fully completed, organoleptic and halimeter testing was repeated. The patients determined to have *fetor ex ore* in a control test underwent a contrast-enhanced X-ray of the oesophagus to exclude oesophageal diverticula.

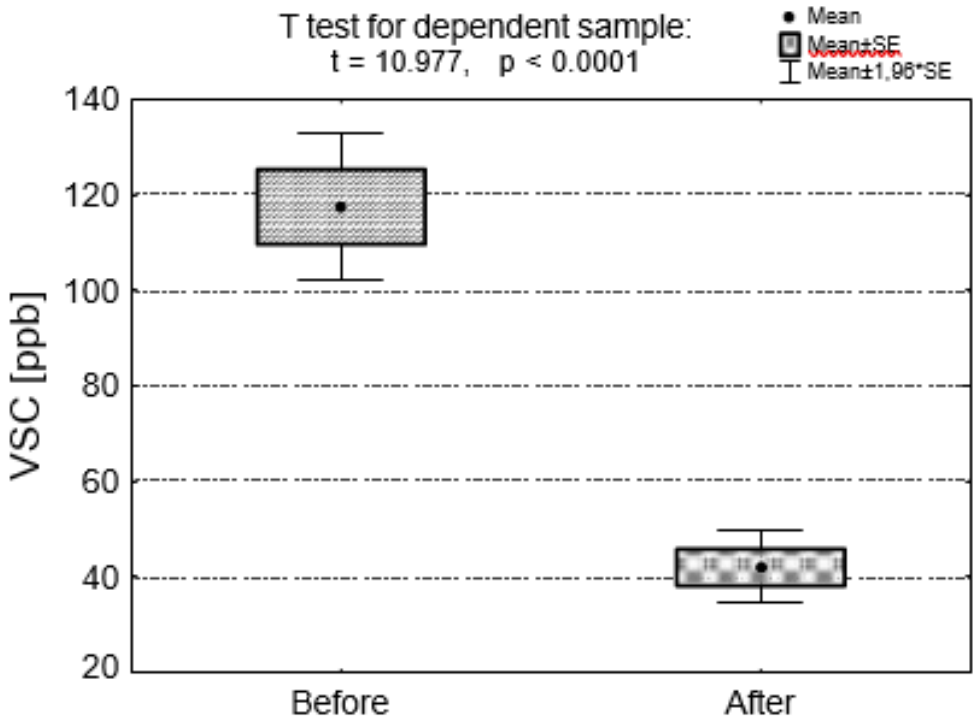
Study results

Objective and subjective measurements of *fetor ex ore*.

Table 1. Basic statistics of the concentrations of volatile sulfur compounds in the exhaled air

Feature	Women *n* = 23 100%	Men *n* = 10 100%	Total *n* = 33 100%	Comparison W vs. M
VSC before the operation [ppb]:				
mean	118.7	114.8	117.5	
standard deviation (SD)	29.4	71.5	45.1	p = 0.8218
median (Me)	119.3	107.8	118	
range ($x$min – $x$max)	76.3 ±185.0	24.7 ±238.0	24.7	
VSC after the operation [ppm]:				
mean	42.7	40.6	42.0	
standard deviation (SD)	19.8	27.6	22.0	p = 0.8098
median (Me)	40.3	32.3	34.7	
range ($x$min – $x$max)	7.7 ±80.0	20.3 ± 113.0	7.7 ±113.0	

No statistically significant difference in the concentration of volatile sulfur compounds in the air exhaled by women and men, both before and after the operation (p> 0.05) was observed. In patients, after the removal of the tonsils (regardless of sex), the concentration of VSC was reduced by approximately 75 ppm (62%) on average, which was statistically significant (p <0.0001).



T-test for Dependent Samples. Marked differences are significant at p < 0.05

	Mean	Std.Dv.	N	Diff.	Std.Dv. - Diff.	t	df	p
VSC 1	117.5	45.1						
VSC 2	42.0	22.0	33	75.5	39.5	10.977	32	0.000000

Table 2. The intensity of *fetor ex ore* in the Rosenberg scale, and the halimeter test

	VSC [ppm] before the operation			VSC [ppm] after the operation		
	N	Mean ± SD	*p**	*N*	Mean ± SD	*p**
Odour intensity according to the Rosenberg scale						
0 – no odour	2	66.7 ± 35.4		18	31.1 ± 14.1	
1 – barely noticeable odour	1	94	0.006	13	53.0 ± 16.0	<0.001
2 – slight odour	8	85.9 ± 25.2		0	-	
3 – moderate odour	15	122.2 ± 20.6		1	113	
4 – strong odour	4	170.9 ± 11.4		0	-	
5 – severe odour	3	149.2 ± 111.1		1	25	

* result of the analysis of variance

The analysis of variance showed that both before the operation (p = 0.006) and after the operation (p < 0.001), the intensity of halitosis in the study group of patients was significantly varied.

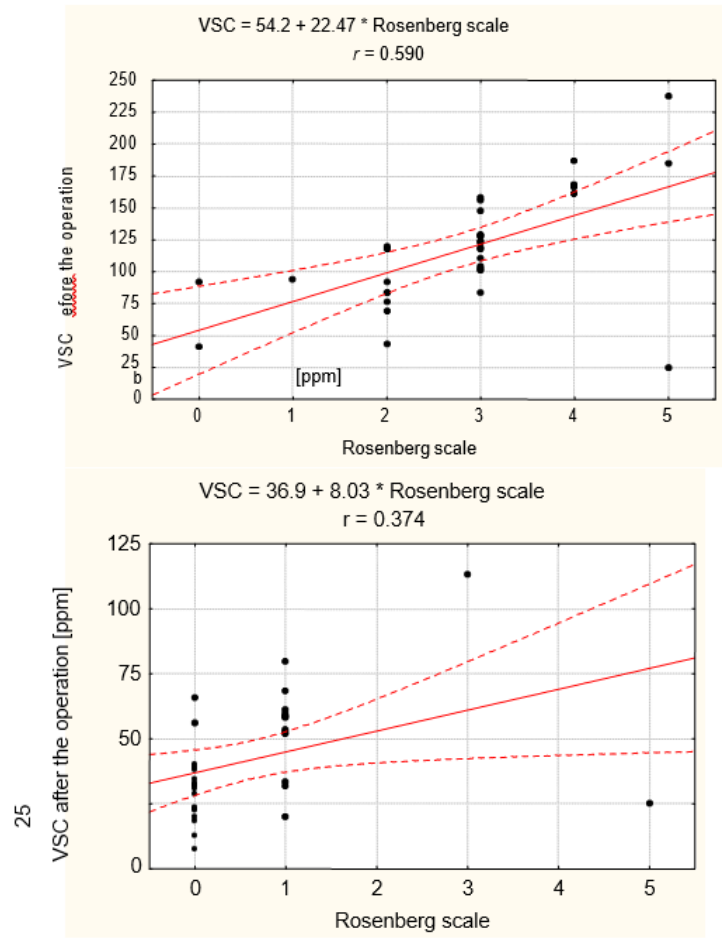


Fig.1. Pearson's linear correlation coefficient.

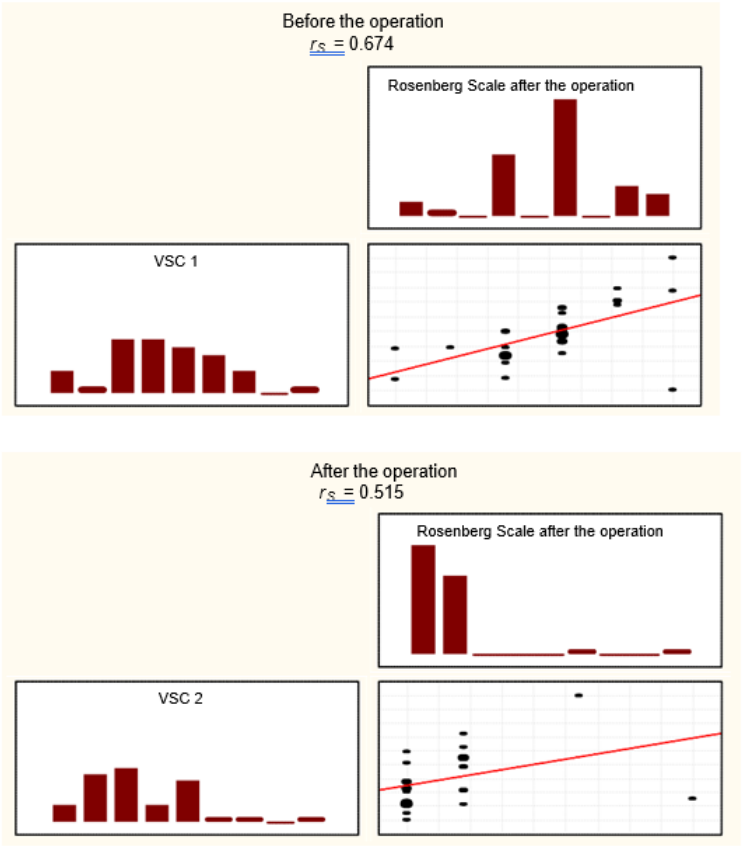


Fig.2. Spearman's rank correlation coefficient.

Both the Pearson's correlation coefficients and the Spearman's rank correlation coefficients are significantly different from zero (p <0.05). There is a strong positive correlation between the Rosenberg's degree and the concentration of VSC, both before and after the operation (Table 1) (Fig. 1, 2).

Microbiological testing.

Table 3. Concentrations of VSC (mean ± standard deviation) in the subgroups of patients (carriers of different groups of bacteria) and the results of the analysis of variance

Testing result	*N*	VSC before the operation [ppm]	*p*	VSC after the operation [ppm]	*p*
Bacteria:					
A. FF – normal flora	11	111.7 ± 28.3		39.1 ± 19.9	
B. S – staphylococci	14	123.4 ± 56.8		46.8 ± 23.9	
C. P – streptococci	2	142.0 ± 19.8	0.181	69.3 ± 15.1	0.172
D. E – the family Enterobacteriaceae	4	75.6 ± 37.0		26.1 ± 4.7	
E. R – rare	2	152.6 ± 25.7		35.1 ± 25.6	
Bacteria:					
anaerobic	6	99.2 ± 48.3	0.279	25.2 ± 10.7	**0.036**
aerobic	27	121.6 ± 44.3		45.8 ± 22.2	

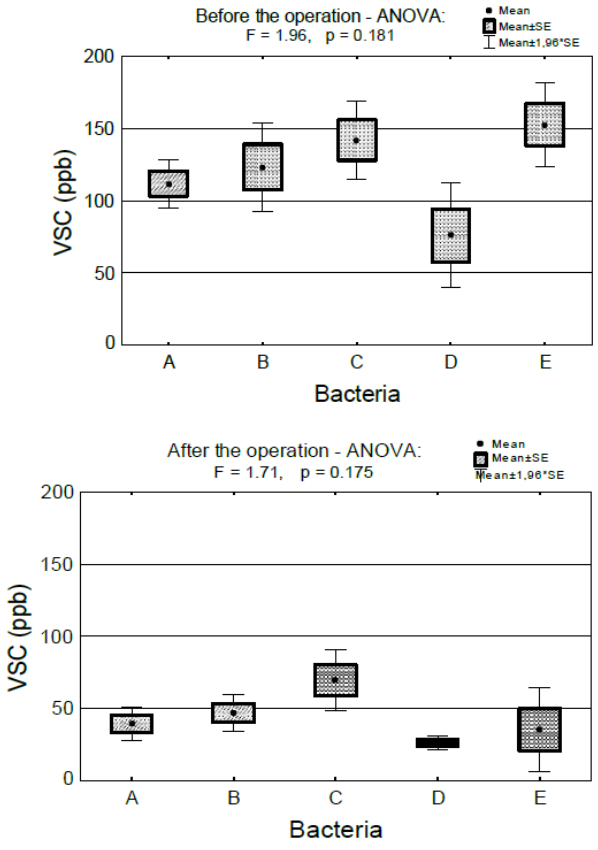


Fig. 3. Analysis of variance (ANOVA) and the concentration of VSC before and after tonsillectomy (p = 0.181> 0.05) in 5 subgroups of the identified bacteria (Tab.3)

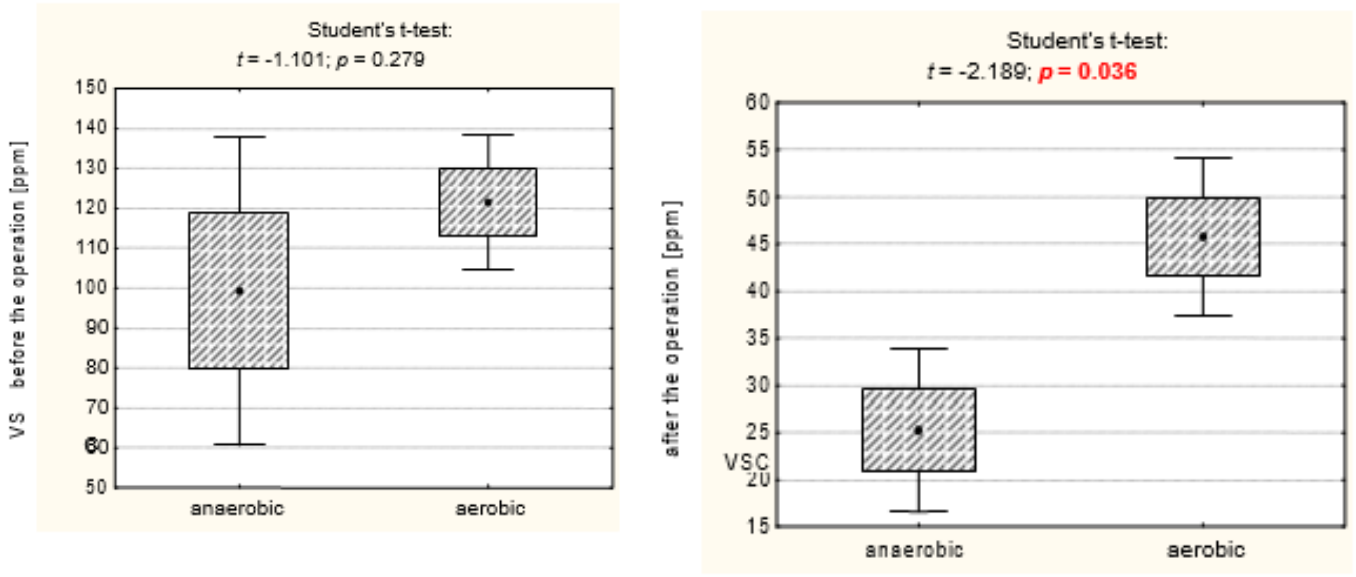


Fig. 4. The Student's t-test and the concentrations of VSC before and after the operation in patients with identified anaerobic bacteria and only aerobic bacteria (Tab. 3).

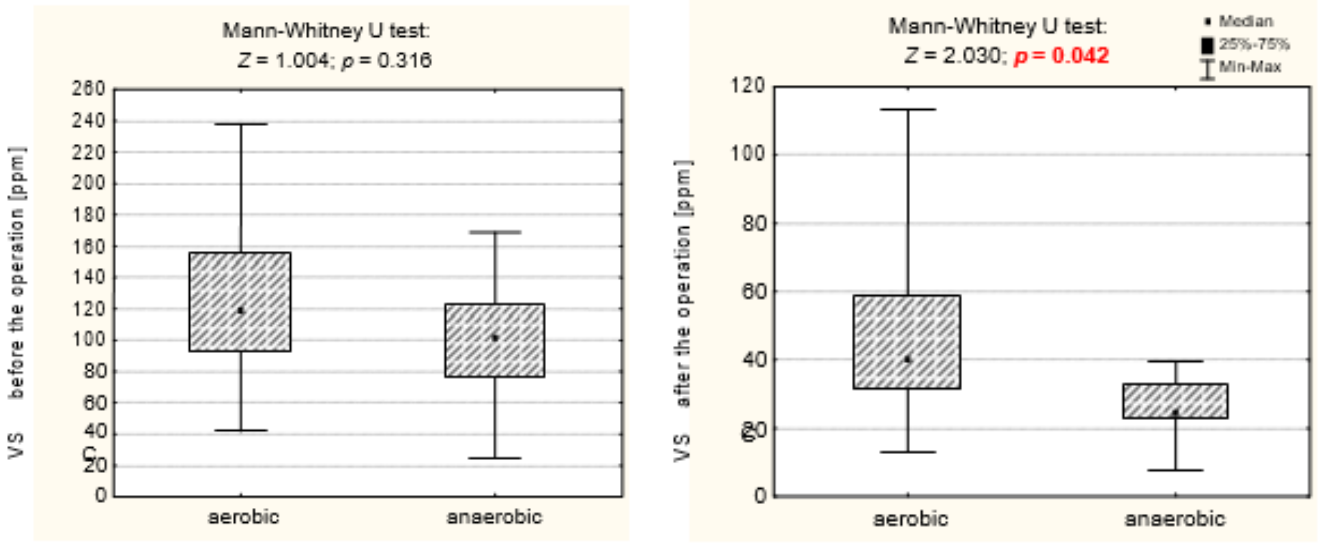


Fig. 5. The Mann-Whitney U test and the concentrations of VSC before and after the operation in patients with identified anaerobic bacteria and only aerobic bacteria (Tab. 3).

Both tests (the Student's t-test and the Mann-Whitney U test**)** showed that after tonsillectomy the concentration of VSC in patients with anaerobic bacteria was significantly lower ($p < 0.05$) than before the operation.

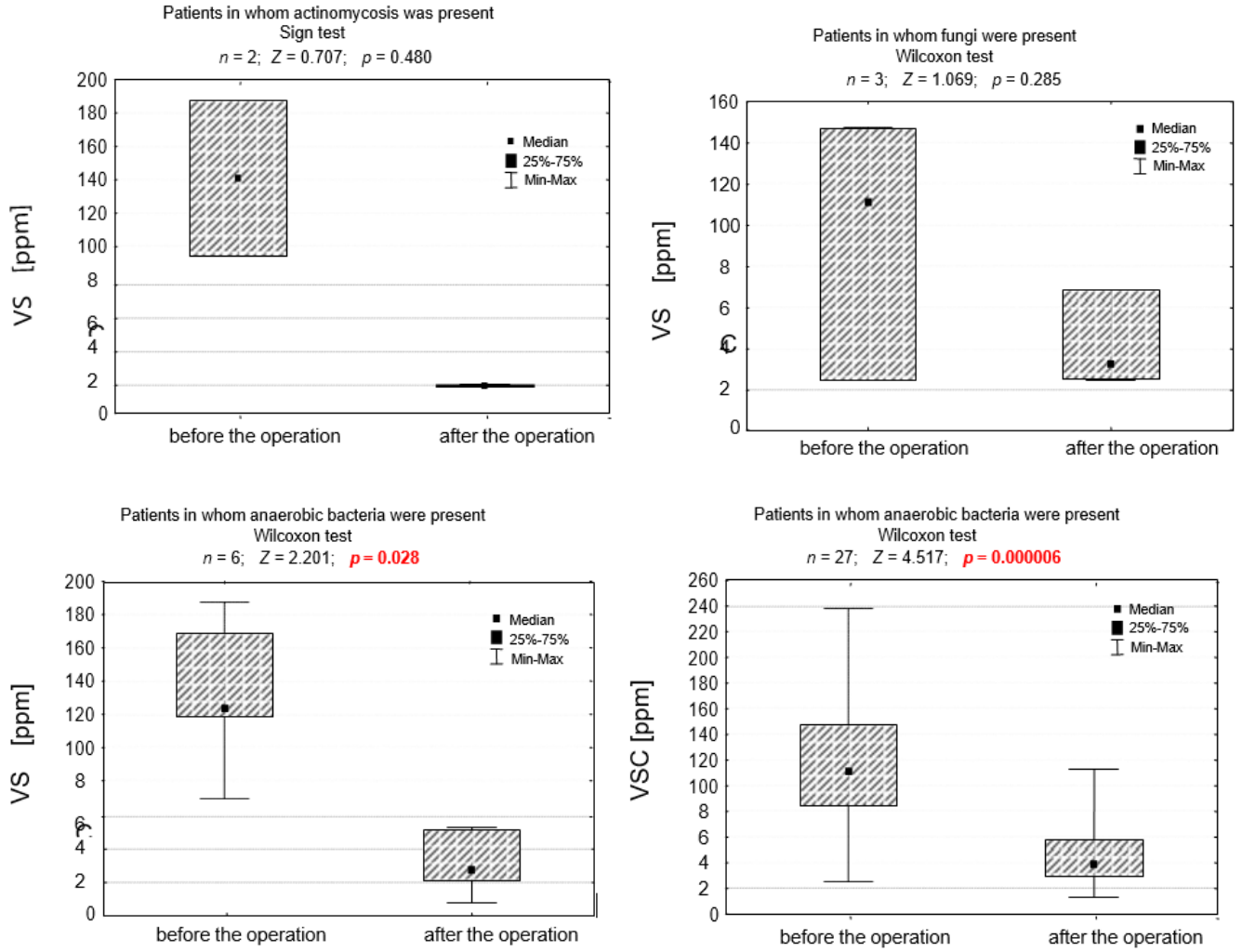


Fig. 6. Comparison of the concentration of VSC before and after the operation in patients with the presence and absence of actinomycosis, fungi, anaerobic bacteria and only aerobic bacteria, and the results of non-parametric tests (used due to the small number of patients in the study groups).

It was impossible to perform the Wilcoxon test in two patients (actinomycosis), therefore the sign test was performed. With such a small group, the result was negative ($p > 0.05$). At the same time, the graphs clearly show that the operation reduced the concentration of VSC, but in patients with identified actinomycosis and fungi, perhaps due to a very small number of patients in the groups, these differences were not statistically significant ($p > 0.05$).

Discussion.

The important role of tonsils in the functioning of the immune system meant that tonsillectomy was much more cautiously indicated in patients. Halitosis is still very controversial among the indications for this operation. According to several authors in the field of otolaryngology, persistent and long-term oral malodour is an indication for tonsilloctomy in patients with CHT (37). After excluding other causes of this disorder, similar recommendations are also formulated for children (38). Eugene N. Myers and co-authors of the textbook Operative Otolaryngology Head and Neck Surgery (39) refer to the guidelines of the American Academy of Otolaryngology- Head and Neck Surgery from 1995. *Fetor ex ore* in patients with CHT in whom there is no improvement after conservative treatment, is classified by them as one of the eight indications

for tonsillectomy. Snow et al. mention halitosis among the symptoms of chronic tonsillitis, stressing that malodour is associated with the colonisation of tonsillar crypts by streptococci and other bacteria (40). These authors also mention tonsil stones as the possible causes of halitosis. On the other hand, the recent literature does not identify a clear manner of dealing with patients with CHT and halitosis. Only a few authors have recently mentioned halitosis as a relative indication for tonsillectomy (38). Several studies have been performed on small groups of patients in whom a significant reduction in the intensity of oral malodour was observed post-tonsillectomy (41, 42). The clinical picture of the disease is not very typical. Patients usually complain of feeling an obstacle in the throat, tonsil soreness when pressed, an unpleasant taste in the mouth, *fetor ex ore* and slight increases in body temperature. In chronic tonsillitis, the tonsils can be enlarged or small, hidden behind the arches. Enlarged tonsils occur mainly in young people and are associated with the growth of adenoid tissue. In this case, it is believed that most frequently the causative agent is *H. influenzae*. Tonsils are large and red, with an uneven surface, and have numerous pits from which a semi-liquid purulent content is released when the front arc (glossopalatine) is pressed. Sometimes there are one or more deep pits from which highly malodorous, cream-coloured cheesy plugs can protrude. In the latter case, adenoid tissue atrophies and is replaced with connective tissue. Fibrous tonsils are small, and their surface can be slit-like and scarred; when the front arch is pressed, a liquid grey substance flows. There may be redness and congestion of the glossopalatine arches, with limitation of tonsillar mobility due to adhesions with surrounding structures.

In the period from 2010 to 2013, 247 patients were referred to undergo tonsillectomy because of CHT and were admitted under the Department of Otolaryngology- Head and Neck Surgery. Thirty- three young people with CHT were selected from this numerous group in whom other possible causative factors were excluded, so that CHT could be considered the only possible cause of halitosis. A histopathological examination was performed to diagnose *tonsilitis chronica hypertrophica*. In 17 of the patients (51%), after pressing the front arc, cheesy content was obtained and in 16 patients (49%), liquid content was obtained. At the same time, *fetor* was never a direct reason for deciding on surgical treatment, and patients were often unaware of its presence. Almost equally, often the patients themselves felt oral malodour (49%) as well as others around them (51%).

In the subjective organoleptic testing performed before tonsillectomy, the 0-5 Rosenberg scale was used.Ninety-four percent of the patients (31 out of 33 in the study) had oral malodour. In 15 out of 31 people, it was assessed as degree 3 (moderate odour), in 8 patients it was degree 2 (slight odour), in 4 patients it was degree 4 (strong odour), in 3 patients it was degree 5 (severe odour), and 1 patient was assessed to be degree 1 (barely noticeable odour). To objectively confirm the presence of *fetor ex ore*, each patient was tested using the halimeter. The average value of the concentration of VSC before tonsillectomy in the group of patients in the study was 117.5 ppb. This value corresponds to a mild form of halitosis. The mean value of the concentration of VSC above 180 ppb was recorded in three patients, corresponding to a moderate form of halitosis. It was observed that the form of discharge does not affect the concentration of VSC ($p > 0.05$).

Organoleptic and halimeter testing was repeated two to three months after the operation. With the organoleptic testing, it was found that 18 out of 33 patients (54.5%) had no bad mouth odour. In 13 patients, persistent fetor was assessed as degree 1 according to the Rosenberg scale (barely noticeable odour), in 1 patient it was degree 3 (moderate odour), and in one other case, halitosis was assessed as degree 5 (severe odour). The mean value of the

concentration of volatile sulfur compounds 2-3 months after tonsillectomy was 42 ppb. In organolepting testing before the operatio,n fetor was assessed as degree 5 in 3 patients, according to the Rosenberg scale. However, in one of these individuals, the result obtained in halimeter testing (25 ppb) did not confirm halitosis. The same patient was the only one in whom after tonsillectomy fetor was assesses as severe, and in halimeter testing, the same result of VSC concentration was obtained as before the operation. The patient had a contrast-enhanced X-ray of the oesophagus. The presence of a Zenker's diverticulum was not shown and ultimately the cause of the disease was not determined. It is very likely that the cause of malodour in the patient may be some substances present in the exhaled air other than volatile sulfur compounds. In the second individual of this group of three patients, halimeter testing before tonsillectomy determined the mean value of VSC concentration to be 238 ppb, and 117 ppb after tonsillectomy. The resulting improvement with partial disappearance of symptoms indicated tha tonsil disease could be not the only cause of malodour. It was impossible to do an X-ray in this case because the patient changed his/her place of residence. In the third patient with severe odour, halimeter testing before tonsillectomy revealed the mean value of the concentration of VSC to be 185 ppb and 58 ppb after tonsillectomy. It can be assumed that in this case, the cause of halitosis was only CHT.

Based on our statistical analysis, a strong positive correlation between the Rosenberg degree and the concentration of VSC was observed, both before and after the operation. This confirms the effectiveness of organoleptic testing. It was also observed that the mean concentration of VSC after the removal of the tonsils decreased by approximately 75 ppb (62%), which was statistically significant ($p < 0.0001$).

When restricting the cases to be included in the study, an effort was made to ensure CHT was the only cause of halitosis. The effectiveness of patient selection in the study group can be confirmed by the retrospective analysis of the questionnaire results (not only dental) in connection with the halimeter measurements. Both age, gender, place of residence, education and occupation did not influence the occurrence of halitosis in CHT. Summarising the results of the questionnaire, it was determined that 13 out of 33 patients visited the dentist once a year, 11visited every six months, 4 visited once a quarter, and 5 visited once every few years. In the group of people who visitied the dentist most frequently (once a quarter), the mean value of VSC was the highest (122.8 ± 34.6 ppb). Twenty-seven people stated that they brush their teeth twice a day, 4 brushed after each meal and 2 brushed once a day. When assessing this parameter, it was observed that in the 4 patients who brushed their teeth after every meal, the mean value of the concentration of VSC was the highest (124.2 ± 34.2 ppb). As mentioned previously, in the dental examination, DMF, API, OHI and PBI indices were assessed. Based on our statistical analysis, it was observed that in the study group, the oral hygiene index (OHI) of men was significantly higher than the OHI of women ($p < 0.05$) in the study. No statistically significant relationship between the values of other dental indices and the concentration of VSC ($p > 0.05$) was observed, except for the CI parameter before the operation. Given that oral halitosis constitutes up to 90% of cases of the disease, these results confirm the adequacy of the applied selection criteria in the study group.

Long-lasting tonsillitis leads to the formation of ulcers and adhesions in tonsillar pits, which is histologically evident as a form of metaplasia of the lymphoepithelial epithelium to squamous epithelium and resulting in the fibrosis of the tonsillar tissue. Consequently, the crypts that are formed are conducive to deposition of food remnants, desquamated epithelial cells and bacterial cells. Deep crypts have microaerophilic conditions, good for the growth

of aerobic and anaerobic bacteria, and fungi.

The formation of bacterial biofilms may play an important role in the pathogenesis of chronic purulent tonsillitis. Chole and Faddis (43) examined 19 cases in which tonsils had been removed because of chronic purulent tonsillitis and hypertrophy. In the study they used a light and electron microscope. In 11 out of 15 patients who underwent tonsillectomy due to chronic purulent tonsillitis and in 3 out of 4 patients in whom tonsillectomy was an indication for upper respiratory tract obstruction, tonsillar specimens revealed a polysaccharide biofilm containing bacteria in the tonsillar crypts. Kania et al. (2007) (44) examined the tonsils of 24 children who underwent tonsillectomy due to chronic tonsillitis. In the study they used confocal laser scanning microscopy (CLSM) with double fluorescent staining. The authors identified the presence of a bacterial biofilm in 17 out of the 24 cases studied.

In a study by Frączkowska et al. (45), swabs taken from tonsils post-tonsillectomy found streptococci in 40% of cases, often identified with *S. aureus*, and the remaining 20% harboured fungal infections (most frequently *Candida albicans* and *C.tropicalis*). Radosz-Komoniewska et al. (46) presented their microbiological analysis of swabs taken from 158 patients with chronic tonsillitis. In approximately 1/3 of cases, beta-hemolytic streptococci (*S.pyogenes* was most frequently isolated, 12%), *S.auresus* and *Haemophilus* bacilli were found. Zautner et al. (2010) (47) performed detailed microbiological testing on a group of 130 patients in whom the indication for tonsillectomy was recurrent purulent tonsillitis. In the microbiological swabs, the most frequently identified pathogen was *S. aureus* (57.7%). In addition, using three different techniques (FACS, FISH and an antibiotic protective test), the authors showed that almost all *S.aures* bacteria were intracellularly located and that as many as 87% of them were invasive strains.

In another study of microbial swabs in cases of chronic tonsillitis, the most frequently isolated pathogen was staphylococcus in 42% (14 patients), followed by streptococci in 6% (2 patients), *Enterobacteriaceae* (including *Klebsiella oxytoca*, *Morganella morganini*, *Escherichia coli*, *Enterobacter cloacae*, *Serratia maecescenes*) in 12% (4 patients), and rare bacteria (*Corynebacterium spp*, *Pseudomonas aeruginosa*) in 6% (2 patients). In 33% (11 patients), the presence of normal flora was found (e.g. *Streptococcus oralis*, *Neisseria spp*). Anaerobic bacteria were identified in 18% (6 patients). The species that were isolated included *Streptococcus constellatus*, *Prevotella melaninogenica*, *Veilonella parvula*, *Bacteriodes stercoris*, *Fuscobacterium spp.*, *Peptostrepto-coccus spp*, *Veilonella spp.*, and *Streptococcus spp.* In 3 patients, the presence of *Streptococcus oralis* was found, and in 3 other patients, *S. aureus.* Sterer et al. (23) claim that Gram-positive bacteria capable of producing galactosidase play an important role in the occurrence of halitosis. Galactosidase, an enzyme involved in the degradation of glycoproteins, provides free proteins from which the anaerobic bacteria produce volatile sulfur compounds. In their 2006 study, the authors showed a significantly higher concentration of volatile sulfur compounds with the incubation of anaerobic bacteria and *Streptococcus salivarius* simultaneously, compared to the incubation of anaerobic bacteria alone. In the study we conducted, the presence of *Actinomyces* was found in 2 of our patients on microbiological and histopathological examination. Actinomycosis is considered a rare cause of halitosis. Lubbert et al. (48) described the case of a patient who had been treated for halitosis for a year. After laryngological consultation, she qualified for tonsillectomy due to chronic tonsillitis, and a subsequent histopathological examination revealed the presence of actinomycosis. Six months after the operation, no disorder was observed in the patient. In 9% (3 patients), fungi were isolated, mainly *C. Albicans.*

In the study group of patients, the presence of streptococcus was found only in 2 patients. In one case, *beta-haemolytic Streptococcus group C* was isolated and in the second, *S.pyogenes* was isolated. This result can be explained by the method of patient selection for the study group. In order to obtain a homogeneous group of patients with chronic hypertrophic tonsillitis and halitosis, without any additional diseases, the study did not cover people with complications of angina for which streptococci, mainly *S.pyogenes,* is responsible.

In 6 patients, in whom anaerobic bacteria were identified in their tonsillar swabs, it was observed that the concentration of VSC was significantly lower (p <0.05) after tonsillectomy. This result confirms the hypothesis that anaerobic bacteria capable of producing volatile sulfur compounds (3, 5, 19, 22, 24) are primarily responsible for halitosis. The highest mean value of VSC (187 ppb) in halimeter testing was recorded in a patient in whom *S.constellatus, Prevotella melaninogenica* and *Veilonella parvula* were identified on culture. In the same patient, the control halimeter testing revealed a mean value of VSC of 61 ppb. In subjective organoleptic testing, a decrease in the intensity of halitosis by 3 degrees on the Rosenberg scale (from 4 to 1) was recorded. In the second patient with halitosis, assessed as degree 4, with a mean concentration of VSC before the operation of 167 ppb, *Peptostreptococcus spp.* was cultured. In subjective organoleptic testing performed after recovery from the operation, a decrease in the intensity of halitosis by 4 degrees was recorded. Such a significant improvement was confirmed by halimeter testing, in which a mean concentration of VSC 17 ppb was recorded.

In the study conducted, in 95% of the selected, young and generally healthy patients with isolated chronic hypertrophic tonsillitis, the presence of *fetor ex ore* was found. On the other hand, in 90% of patients with halitosis after performed tonsillectomy, a significant reduction in its intensity was recorded. The results obtained clearly confirm the role of CHT in the aetiology of halitosis and allow us to draw the following conclusions:

Conclusions

1. Halitosis in a patient with CHT requires a number of additional laboratory tests and specialist consultations that allow the exclusion of other possible causes of *fetor ex ore.*

2. A dental examination plays an important role in the differential diagnosis of halitosis, because, as it is known, it may be caused by even minimal negligence of oral hygiene.

3. The possibility of performing targeted microbiological testing for anaerobes should eventually be considered in patients with CHT and halitosis prior to consideration of tonsillectomy.

When these conditions are met, halitosis in patients with CHT can be considered an independent indication for tonsillectomy.

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