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# The impact of waiting time on hearing outcome and patients' satisfaction after cholesteatoma surgery

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## ABSTRACT

**Background:** Cholesteatoma is a formation of epithelium mass in the middle ear. Surgery aims to prevent complications while maintain or improve hearing.

**Aims/Objectives:** To determine if waiting time until cholesteatoma surgery affects hearing outcome and patients' satisfaction.

**Material and Methods:** A retrospective cohort study performed at the only Ear Nose Throat clinic in one county in Sweden. Sixty concomitant surgeries, both first time and revisions, were included.

**Results:** Of the 60 surgeries, 33 (55%) were performed within a 3-month period. The mean waiting time was 1.4 months. In the remaining 27 cases, the mean waiting time was 8.6 months. Both groups had preoperatively similar air conduction pure tone average (AC PTA<sub>4</sub>), 47.3 dB and 47.0 dB respectively. The mean AC PTA<sub>4</sub> gain was greater in the group with waiting time ≤3 months (8.6 dB) compared to the >3 months group (1.2 dB,  $p=0.040$ ). The patients' satisfaction was lower in the latter group, but the difference was not statistically significant.

**Conclusions:** This study indicates that longer waiting time to cholesteatoma surgery has a negative impact on postoperative hearing results but not on patients' satisfaction.

**Significance:** The outcome of this study suggests that waiting time to surgery can be a factor determining postoperative hearing results.

## ARTICLE HISTORY

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Cholesteatoma; middle ear; surgery; hearing; satisfaction; waiting time

## Introduction



Middle ear cholesteatoma is a disease characterized by a formation of keratinizing stratified squamous epithelium mass in the middle ear and/or mastoid cells. The incidence is 6.8–12.6 per 100 000 adults [1–3]. Surgery aims to prevent complications by removing the keratin sac while maintain or improve hearing in the affected ear. In certain cases, the hearing may be worsened by the surgery [4].

The keratin accumulation has a tendency for a destructive growth and may lead to intra- and extra-aural complications [5,6]. Moreover, the cholesteatoma mass itself can lead not only to conductive hearing loss by eroding the middle ear ossicles, but also to an erosion of the otic capsule leading to sensorineural hearing loss or deafness [7]. Long duration of waiting time until surgery leads to a higher risk of serious complications [8], indicating that surgery should not be postponed. The clinically recommended standard in Sweden is to operate within 3 months from the decision of surgery. This time is in many cases longer due to shortcomings of the healthcare system and has been further extended as a consequence of the Covid-19 pandemic.

Current research in this area has shown lack of association between prolonged waiting time and recidivism [9], however, data is lacking regarding postoperative hearing results. Available studies from other surgical fields than ear-nose-throat (ENT) show that it is not necessarily the waiting time itself that is the most relevant factor shaping the quality of life, but rather experiencing the unpleasant physical symptoms and emotional distress associated with the disease [10]. The aim of this study was to determine if waiting time until cholesteatoma surgery affects hearing outcome and patients' satisfaction.

## Materials and methods

This is a retrospective study of outcomes in a cohort of cholesteatoma patients, in combination with a postoperative questionnaires' evaluation. The study was performed within a Swedish county of 150 000 inhabitants. We identified all patients who had been surgically treated for middle ear cholesteatoma over a 6-year period between 01/01/2015 and 31/12/2020. Both first time and revision surgeries were included, all performed by the same senior consultant.

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Exclusion criteria were patients under the age of 18 on the surgery day and cholesteatomas originating from other places than middle ear, such as the auditory canal or non-elective surgery. The study cohort consisted of 53 adult patients, in total 60 surgeries. Medical records were screened, and questionnaires were sent out and collected. Depending on the waiting time for surgery, defined as the day for decision of surgery to the surgery day, patients were divided into 2 groups: from hereafter referred to as waiting time  $\leq 3$  or  $>3$  months.

Medical records were screened for: age, sex, BMI, waiting time to the surgery, history of previous ipsilateral ear operations, pre- and postoperative audiograms, cholesteatoma distribution and staging according to EAONO-JOS classification [11], peroperative ossicular chain status, operating technique, performance of myringo- or/and ossiculoplasty, including the ossiculoplasty type: partial ossicular replacement prosthesis (PORP) or total ossicular replacement prosthesis (TORP), pre- and postoperative complications and antibiotics in relation to the surgery. Studies show that preoperative air-bone gaps (ABG's) tend to be small in isolated attic cholesteatoma while large ABG's are usually associated with growth in the tympanic cavity and mastoid cells [7,14]. Therefore, we divided patients into following subgroups: cholesteatoma expanding into the sinus tympani, cholesteatoma in the mesotympanon without growth into the sinus tympani and cholesteatoma in the atticus and/or mastoid cells without more inferior expansion.

## Outcomes

### Audiometry

All patients were examined with pre- and postoperative pure tone audiometry using audiometers that were calibrated according to the International Standard Organizations (ISOs) criteria. The examination was conducted in a soundproof cabin. Hearing was measured in decibels (dB) and measured for 6 air-conduction frequencies (250, 500, 1000, 2000, 4000 and 8000 Hz) and 4 bone-conduction frequencies (500, 1000, 2000 and 4000 Hz). Air-conduction variable was measured as Pure Tone Average for 4 frequencies, 0.5, 1, 2 and 4 kHz ( $PTA_4$ ). Air-conduction gain was defined as the change in  $PTA_4$  before and after the surgery. Hearing was classified according to the World Health Organization (WHO) with normal hearing  $PTA_4 \leq 20$  dB and impaired hearing  $PTA_4 >20$  dB.

Postoperative hearing tests were performed with a mean time of 11 months post-surgery (range 3–24 months, standard deviation (SD)  $\pm 7.0$ ).

### Self-reported hearing and satisfaction

Glasgow Benefit Inventory (GBI) questionnaire [12] and Patients-reported outcome measures from the National Swedish Quality Register for Ear Surgery (SwedEar PROM) were used. The latter is a non-validated questionnaire used to assess the change in symptoms after surgery, hearing

outcome and received hospital care (see Appendix 1). Both were sent by mail to patients at least 12 months post-surgery to assess their satisfaction with the received care, as well as hearing. Of 53 patients, 43 were available for follow-up with these questionnaires. Reasons for non-availability were dementia, death and non-fluent in Swedish. All questions from the SwedEar PROM questionnaire were analyzed separately. The submitted answers were divided into negative and non-negative categories for further analysis. From the GBI, questions 9, 10 and 14 were excluded to meet the standards for the new revised 15-items GBI with 5 factors (GBI-5F) [12,13] as the new implemented factors were found to give additional information regarding the area of benefit. The responses were scored on a 5-point scale from  $-2$  to  $+2$ . The questions were analyzed in 5 groups: *Quality of life, self-confidence, support, general health, and social involvement* and with the overall score. The score in each group was rescaled to fit the scale  $-100$  (maximum harm with the surgery) to  $+100$  (maximum benefit with the surgery).

### Statistical methods

Data were analyzed with IBS SPSS Statistics (Version: 28.0.1.0).

The two groups of different waiting times were compared regarding: 1) baseline characteristics using independent samples t-test and Chi-squared test, 2) postoperative AC- $PTA_4$  gain using independent samples t-test, 3) responses to the GBI and PROM questionnaires using Fisher's exact test and independent samples t-test.

To elucidate the impact of repeated surgeries within the same individual, a sensitivity analysis regarding AC  $PTA_4$  gain among first-time surgeries only was performed using independent samples t-test.

A p-value of  $\leq 0.05$  was regarded statistically significant.

### Ethical consideration

Ethical approval was obtained from Swedish Ethical Review Authority (D-nr 2021-06440-01).

The study was conducted according to the Declaration of Helsinki.

## Results

### Patient characteristics

In the group with waiting time  $\leq 3$  months the mean age was 55.4 years and among those waiting  $>3$  months 50.4 years. The surgery type was canal wall down with mastoid obliteration in 58 of 60 cases, the preferred technique of the operating surgeon. In cases needing ossiculoplasty cortical bone was the material of choice, no titanium prosthesis was used. There was no statistically significant difference between these groups regarding sex, age, surgery type, need for the ossiculoplasty, cholesteatoma distribution, or BMI. The characteristics are presented in Table 1.

**Table 1.** Characteristics and intraoperative findings of patients in the study.

		All surgeries, n (%)	Waiting time ≤3 months, n (%)	Waiting time >3 months, n (%)	p Value
Total		60 (100)	33 (55.0)	27 (45.0)	
Sex	Female	28 (46.7)	14 (42.4)	14 (51.9)	0.47 <sup>a</sup>
Age in years, mean (SD)		53.2 (19.4)	55.4 (18.7)	50.4 (20.1)	0.33 <sup>b</sup>
Surgery type	Revision	14 (23.3)	6 (18.2)	8 (29.6)	0.37 <sup>a</sup>
Ossiculoplasty	No	17 (28.3)	9 (27.3)	8 (29.6)	0.49 <sup>a</sup>
	TORP <sup>c</sup>	14 (23.3)	6 (18.2)	8 (29.6)	
	PORP <sup>c</sup>	29 (48.3)	18 (54.5)	11 (40.7)	
Surgery technique	Canal wall down	58 (96.7)	32 (97.0)	26 (96.3)	0.89 <sup>a</sup>
Cholesteatoma distribution	Atticus and/or mastoid cells only	13 (21.7)	8 (24.2)	5 (18.5)	0.39 <sup>a</sup>
	Mesotympanon without sinus tympani	28 (46.7)	17 (51.5)	11 (40.7)	
	Sinus tympani	19 (31.7)	8 (24.2)	11 (40.7)	
Intraoperative infection	No	56 (93.3)	30 (90.9)	26 (96.3)	0.41 <sup>a</sup>
BMI mean (SD)		27.3 (5.6)	27.9 (5.2)	26.5 (6.0)	0.35 <sup>b</sup>

<sup>a</sup>Calculated by Chi-square test.<sup>b</sup>Calculated by independent samples t-test.<sup>c</sup>TORP- total ossicular replacement prosthesis, PORP- partial ossicular replacement prosthesis.**Table 2.** Mean, minimal and maximal postoperative AC PTA<sub>4</sub><sup>a</sup> gain (dB) in patient groups with different waiting times.

	All surgeries	Waiting time ≤3 months	Waiting time >3 months	p Value <sup>b</sup>
Mean AC PTA <sub>4</sub> gain (SD)	5.3 (12.8)	8.6 (9.8)	1.2 (14.8)	0.04
Minimal gain	-30.0	-11.3	-30.0	
Maximal gain	31.3	31.3	26.3	

<sup>a</sup>Air conduction pure tone average.<sup>b</sup>Calculated by independent samples t-test.

## Hearing results

Audiometry was performed preoperatively for 59 of the 60 included surgeries, and postoperatively for 56. Six patients had normal hearing thresholds in preoperative AC PTA<sub>4</sub>, one in the ≤3 months group and 5 in the >3 months group. Of those, 3 in the latter group have acquired slight to moderate hearing impairment postoperatively. The mean preoperative hearing threshold was 47.1 dB (SD ±21.3) for all, and 47.3 dB (SD ±17.7) and 47.0 dB (SD ±24.9) respectively for patients waiting ≤3 or > 3 months for the surgery. The mean postoperative hearing threshold was 41.6 dB (SD ±23.8) for all, and 38.5 dB (SD ±20.0) and 45.5 dB (SD ±27.4) respectively for patients waiting ≤3 or > 3 months for the surgery.

The mean AC PTA<sub>4</sub> gain for the whole study population was 5.3 dB (SD ±12.8) with the range between -30.0 dB and +31.3 dB. No outliers were identified in either group. In patients waiting ≤ 3 months the mean AC PTA<sub>4</sub> gain was 8.6 dB (SD ±9.8) and in those waiting > 3 months 1.2 dB (SD ±14.8) (Table 2 and Figure 1). This difference was statistically significant with the p-value 0.040.

A sensitivity analysis of only first-time surgeries was performed revealing essentially the same results as in the main analysis with a superior AC PTA<sub>4</sub> gain among the group of waiting time 3 months or less ( $p=0.029$ ). The overall distribution of AC PTA<sub>4</sub> gain in the two groups with different waiting time is presented in Figure 2.

## Patients' satisfaction

Out of the 43 (81.1%) patients who were sent SwedEar PROM and GBI-5F questionnaires, 30 (56.7%) submitted answers. Of

those, 17 (56.7%) patients had a waiting time ≤3 months and 13 (43.3%) > 3 months. Tables 3 and 4 show the GBI-5F analysis and the proportion of non-negative answers to the SwedEar PROM respectively. Even though no statistically significant differences between the two groups were observed, there is a higher reported score in the group who waited ≤3 months.

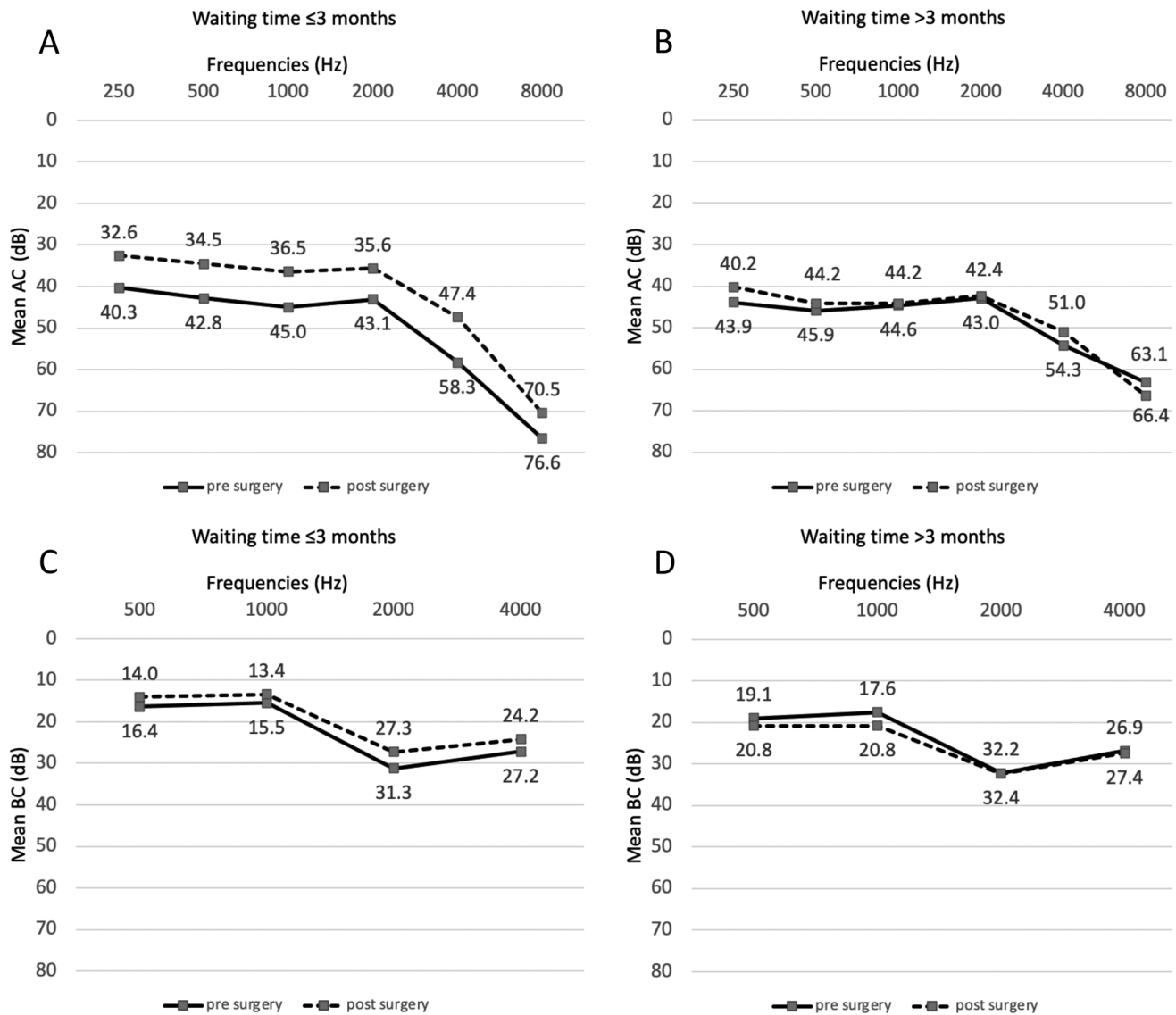
## Discussion

This study shows a significantly better hearing outcome in patients waiting less than 3 months until surgery compared to patients waiting longer. No statistically significant difference in patient satisfaction was observed. Among numerous challenges facing medical personnel working with middle ear cholesteatoma surgeries, the waiting time has become an issue due to the Covid-19 pandemic as well as shortcomings of many health care systems.

Besides the waiting time, there are multiple factors known to affect the results after middle ear cholesteatoma surgery. The localization of the cholesteatoma in the middle ear usually has an impact on the preoperative hearing by affecting the ossicular chain and therefore ABG. In this study, the distribution of the cholesteatoma did not differ significantly between the two groups why this factor could not explain the difference in hearing outcome.

During cholesteatoma surgery, ossiculoplasty is often needed to restore hearing. A post-surgery ABG of ≤20 dB is regarded as a clinically successful hearing outcome [15,16], while normal hearing is generally considered as the ABG ≤10 dB. This indicates that a need for ossiculoplasty in itself is a negative predictor for hearing outcome. In our study there was no significant difference in the need for, nor type of, ossiculoplasty between the two groups.

Autologous bone was used for the ossiculoplasty prosthesis in all cases in this study. The current literature is not consistent on whether titanium or bone prosthesis give better hearing results. Some studies suggest superiority of the titanium ones [17], while others show no difference between the two types [18]. When comparing partial and total prosthesis a comprehensive meta-analysis did not identify any statistically significant differences in the hearing gain between the two types in middle ear cholesteatoma surgery [14].



**Figure 1.** Mean pre- and post-surgery air (a and B) and bone (C and D) conduction pure-tone audiometry measured for given frequencies in the two patient groups.

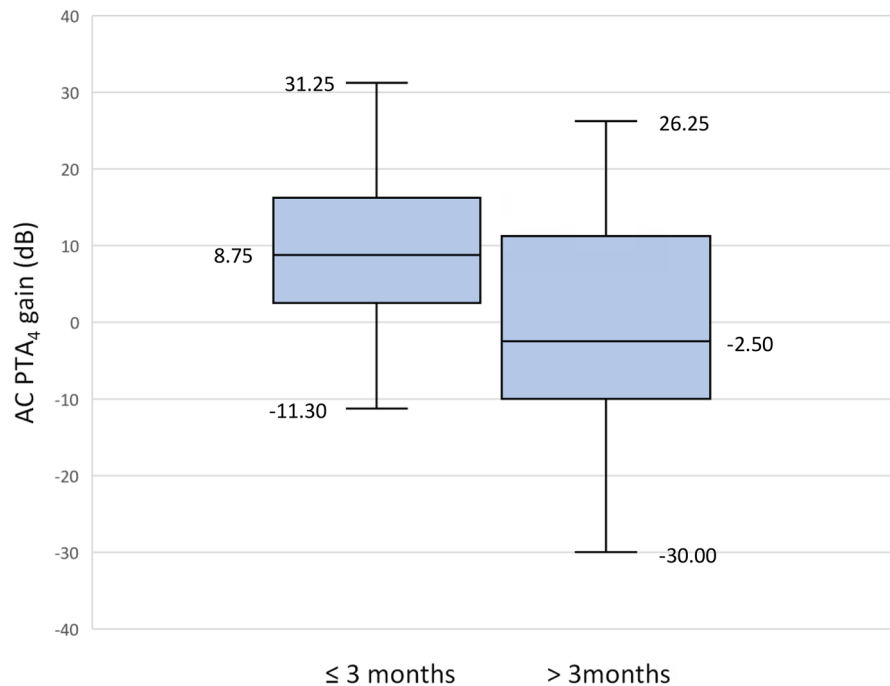
Other factors which could affect hearing outcome are type of surgery (primary or revision), intraoperative infection, and patients' sex, but no literature supporting this was identified. However, our patient groups did not differ statistically significant regarding these factors. With a retrospective study design, there are factors not available for investigation for example tubar dysfunction, immunological issues, anatomical factors. Further research is needed, both with larger cohorts and prospective designs.

This study did not show a statistically significant difference in patients' satisfaction postoperatively between the two groups. No other studies addressing the effects of waiting time on patients' satisfaction in the otosurgical field were identified. Available data from other fields focus predominantly on quality of life and experiences during the waiting time. Studies are non-consistent whether the chronological time in itself has an essential effect on the quality of life or patient's experience [10]. Nevertheless, patients with more accentuated symptoms, pain or depression are more prone

to seek healthcare prior to surgery [19]. Longer waiting times are often unacceptable by patients experiencing severe symptoms [20]. Cholesteatoma is a condition in which symptoms other than ear discharge and hearing deterioration e.g. facial palsy, vertigo, meningitis, or lateral sinus thrombosis, are commonly an indication for an emergency surgery. Only elective patients were included in this study. Therefore, we do not expect these factors to affect the satisfaction levels. However, we cannot rule out that the poorer satisfaction in  $> 3$  months group is based on unsatisfying postoperative hearing gain.

### Strengths and limitations

The strength of this study is the single-clinic, single-surgeon design limiting the effect of different surgical skills. However, this restricts the number of surgeries and limits the generalizability. Because of the small sample size, chance as an explanation for some results cannot be ruled out.



**Figure 2.** Post-surgery air conduction pure-tone average (AC PTA<sub>4</sub>) gain distribution in the two patient groups with different waiting time.

**Table 3.** Patients satisfaction measured with revised 15-item Glasgow Benefit Inventory (GBI) with 5 factors in the two patients' groups.

GBI-5 factors	Total mean (SD)	Waiting time ≤3 months, mean (SD)	Waiting time >3 months, mean (SD)	<i>p</i> Value <sup>b</sup>
Overall GBI-5F score	16.0 (26.2)	23.3 (29.1)	6.4 (18.8)	0.06
Quality of life	33.3 (42.4)	41.2 (40.9)	23.1 (43.9)	0.26
Self-confidence	14.4 (38.6)	24.5 (37.3)	1.3 (37.6)	0.10
Support <sup>a</sup>	10.3 (21.6)	13.7 (23.0)	5.6 (19.2)	0.31
General health	11.7 (30.4)	17.6 (33.1)	3.8 (25.6)	0.21
Social involvement	8.6 (33.3)	16.8 (38.9)	-2.2 (20.9)	0.10

<sup>a</sup>29 answers were submitted to this question.

<sup>b</sup>Calculated by independent samples t-test.

**Table 4.** Non-negative answers from SwedEar PROM questionnaires in the two patient groups.

SwedEar PROM question <sup>a</sup>	All patients, <i>n</i> (%)	Waiting time ≤3 months, <i>n</i> (%)	Waiting time >3 months, <i>n</i> (%)	<i>p</i> Value <sup>b</sup>
1.	29 (100)	16 (100)	13 (100)	
2.	29 (100)	16 (100)	13 (100)	
3	28 (96.6)	15 (93.4)	13 (100)	>0.99
4.	26 (89.7)	16 (100)	10 (76.8)	0.08
5.	27 (93.1)	16 (100)	11 (84.6)	0.19
6.	27 (93.1)	15 (93.4)	12 (92.3)	>0.99
7.	23 (79.3)	12 (75.0)	11 (84.6)	0.63
8.	26 (89.7)	14 (87.5)	12 (92.3)	>0.99
9. <sup>c</sup>	22 (78.6)	13 (81.3)	9 (75.0)	>0.99
10. <sup>c</sup>	23 (82.1)	14 (87.5)	9 (75.0)	0.62
11.	23 (79.3)	14 (87.5)	9 (69.2)	0.36
12. <sup>c</sup>	28 (100)	16 (100)	12 (100)	
13. <sup>c</sup>	28 (100)	16 (100)	12 (100)	
14. <sup>c</sup>	27 (96.4)	14 (93.3)	13 (100)	>0.99
15. <sup>c</sup>	25 (89.3)	15 (100)	10 (76.9)	0.87

<sup>a</sup>see Appendix 1 for the complete questionnaire in English.

<sup>b</sup>Calculated by Fisher's exact test.

<sup>c</sup>28 answers were submitted to this question.

definition only 55% were treated within the recommended timeframe of 3 months or less. However, that timepoint does not account for delays before decision of surgery, such as delays associated with possible health care system shortcomings, patients delay, difference in cholesteatoma growth rate or other factors influencing the severity of the disease. An attempt was made to analyze time from referral and time from first symptom, but these dates were not possible to reconstruct in a reliable manner.

## Conclusions

This single-center, single-surgeon study indicates that longer waiting time to cholesteatoma surgery has a negative impact on postoperative hearing results. A higher patients' satisfaction score in the group who waited less than 3 months is seen but without a statistically significant difference. Larger studies in this subject are needed.

## Disclosure statement

No potential conflict of interest was reported by the authors.

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## Appendix 1

1. When considering the past month, do you have more or less discharge/secretion from the operated ear?
    - Never had problem with ear secretion
    - No longer secreting
    - Secrets less
    - No difference
    - More secretion
  2. When considering the past month, do you have more or less bad odor from the operated ear compared to before the surgery?
    - Never experienced issues with bad odor
    - No longer smells from the ear
    - Smells less from the ear
    - No difference
    - Smells worse from the ear
  3. When considering the past month, can you get water in the ear, for example during a shower or bath, without experiencing any discomfort in the ear?
    - Don't know, I always avoid getting water in my ear.
    - Yes, I may have my ear under water without experiencing any discomfort
    - Yes, I can get a little water in the ear, for example, during a shower, without experiencing any discomfort
    - No, I always experience discomfort when water gets in my ear
  4. When considering the past month, do you have more or less tinnitus (e.g. ringing or buzzing) in the operated ear compared to before the surgery?
    - Never experienced tinnitus issues
    - No longer have tinnitus issues
    - Have less tinnitus issues
    - No difference
    - Have more tinnitus issues
  5. When considering the past month, do you have more or less dizziness compared to before the surgery?
    - Never experienced dizziness issues.
    - No longer have dizziness issues.
    - Have less dizziness issues.
    - No difference.
    - Have more dizziness issues.
  6. When considering the past month, do you have more or less pain in or around the ear compared to before the surgery?
    - Never experienced pain in or around the ear.
    - No longer have pain.
    - Have less pain.
    - No difference.
    - Have more pain.
  7. When considering the past month, do you experience reduced sensation in the operated ear compared to before the surgery?
    - Yes
    - No
  8. When considering the past month, do you have altered taste in your mouth compared to before the surgery?
    - Yes
    - No
  9. When considering the past month, what is your hearing like in the operated ear after surgery compared to before the surgery?
    - Much better
    - Somewhat better
    - No change
    - Somewhat worse
    - Much worse
  10. When considering the past month, how well do you feel you can recognize from which direction sound comes from, compared to before the surgery?
    - Much better
    - Somewhat better
    - No change
    - Somewhat worse
    - Much worse
  11. When considering the past month, how well do you feel you can hear in noisy sound environments compared to before the surgery? For example, restaurant visits, sporting events, dinner parties, bus trips or in the classroom.
    - Much better
    - Somewhat better
    - No change
    - Somewhat worse
    - Much worse
  12. Did the information you received before the operation match your experience of the surgery and the time after?
    - Yes, completely
    - Yes, to a great extent
    - No, not particularly
    - No, not at all
  13. Are you satisfied with the care you received in connection with the surgery?
    - Yes, completely
    - Yes, to a great extent
    - No, not particularly
    - No, not at all
  14. Are you satisfied with the follow-up care after the surgery?
    - Yes, completely
    - Yes, to a great extent
    - No, not particularly
    - No, not at all
  15. Are you satisfied with the results of the surgery?
    - Yes, completely
    - Yes, to a great extent
    - No, not particularly
    - No, not at all
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