

Main Article

Dr J R Costa takes responsibility for the integrity of the content of the paper

Cite this article: Costa JR, Castro A, Lino J, Soares T, Almeida e Sousa C. External auditory canal exostoses: long-term surgical satisfaction and its relationship with surgical complications. *J Laryngol Otol* 2021;**135**: 684–690. <https://doi.org/10.1017/S0022215121001547>

Accepted: 13 December 2020
First published online: 18 June 2021

Key words:

External Auditory Canal; Exostoses; Conductive Hearing Loss; Quality Of Life

Author for correspondence:

Dr Joana Raquel Costa,
Largo Prof. Abel Salazar, 4099-001 Porto,
Portugal
Email: joana_cccosta@hotmail.com

Abstract

Objective. The main purpose of the present study was to evaluate whether complications related to surgery for exostoses are associated with a decrease in patients' quality of life.

Methods. This was a retrospective study for which the following information was collected: sex, age, pre- and post-operative symptoms, pre- and post-operative audiological evaluation results, surgical approach, instruments used, complications, and Glasgow Benefit Inventory score.

Results. The study included 67 patients (94 ears). The three main complaints reported were wax retention, otitis externa and hearing loss. Surgical complications occurred in 14.9 per cent of patients. Patients experienced a significant benefit from surgery, especially in relation to somatic state, with a global Glasgow Benefit Inventory score of +44.3. No significant difference was found between the global Glasgow Benefit Inventory changes and surgery-related complications ($p = 0.093$).

Conclusion. After surgery for exostoses, the vast majority of patients showed improvement. Complications related to surgery in general do not seem to influence patients' satisfaction with surgery.

Introduction

External auditory canal exostoses are benign growths of periosteal bone. They usually present as broad-based, multiple and bilateral lesions that originate along the anterior, inferior and posterior surfaces of the bony external auditory canal, with no definitive predilection for a specific canal wall site established.¹

Wong *et al.* reported a prevalence of 30.7 per cent in coastal inhabitants, compared with 2.3 per cent in valley inhabitants and 0 per cent in mountain inhabitants, with women much more rarely affected than men.² Many studies have established exposure to cold water by swimming, surfing or diving as a risk factor in the development of exostoses.^{2,3}

In fact, external auditory canal exostoses are not an uncommon condition, and the majority of cases do not present to medical care. However, when the stenosis caused by this condition exceeds a certain limit, it can cause several problems, such as recurrent wax retention, chronic inflammatory conditions and otorrhoea, otalgia, and hearing loss. This limit has been defined by Whitaker *et al.* as greater than 80 per cent stenosis. In such cases, surgery is indicated to restore normal physiology.⁴ Other less frequent but significant indications include conditions in which access to the middle ear is required; for example, because of chronic suppurative otitis media or otosclerosis.

Therapy for symptomatic patients involves removal of the exostoses, usually with chisels and/or drills. Surgery can be performed either through an endaural approach or with a post-auricular incision, depending on exposure needs and surgeon preference.

Vasama reported symptom relief in 66 per cent of the operated patients, whereas the symptoms remained the same in 29 per cent and even worsened in 4 per cent.⁵ Similar results have been reported by Hempel *et al.*, in which 70 per cent of the patients were free of any complaints post-operatively.⁶ Fisher and McManus found major complications for exostosis surgery in 5 per cent of cases, including ear canal stenosis, temporomandibular joint prolapse, tympanic membrane perforations and inner-ear damage.⁷ Hempel *et al.* showed that complications related to surgery are the most important factor for the lack of patient benefit from the operation or even a negative impact on a patient's health-related quality of life.⁶

The present study aimed to: (1) evaluate the operative outcomes of external auditory canal exostosis surgery, analysing patients' complaints in the pre- and post-operative period and measuring the patients' quality of life after surgery; and (2) understand whether complications related to exostosis surgery are associated with a decrease in the quality of life reported by patients after surgery.

Table 1. Modified Glasgow Benefit Inventory

How did surgery for external auditory canal exostoses affect your life?
1. Have the results of the surgery for external auditory canal exostoses affected the things you can do?
2. Have the results of the surgery for external auditory canal exostoses made your overall life better or worse?
3. Since your surgery for external auditory canal exostoses, have you felt more or less optimistic about the future?
4. Since your surgery for external auditory canal exostoses, do you have more or less self-confidence?
5. Since your operation for external auditory canal exostoses, do you feel better or worse about yourself?
6. Since your operation for external auditory canal exostoses, have you found it easier or harder to deal with company?
7. Since your operation for external auditory canal exostoses, do you feel more or less confident about job opportunities?
8. Since your operation for external auditory canal exostoses, do you feel more or less embarrassed when with a group of people?
9. Since your operation for external auditory canal exostoses, do you feel more or less self-conscious?
10. Since your operation for external auditory canal exostoses, do you feel more or less inconvenienced by your (specific) problem?
11. Since your operation for external auditory canal exostoses, have you been able to participate in more or fewer social situations?
12. Since your operation for external auditory canal exostoses, have you been more or less inclined to withdraw from social situations?
13. Since your operation for external auditory canal exostoses, do you have more or less support from your friends?
14. Since your operation for external auditory canal exostoses, do you have more or less support from your family?
15. Since your operation for external auditory canal exostoses, are there more or fewer people who really care about you?
16. Since your operation for external auditory canal exostoses, have you been to your doctor, for any reason, more or less often?
17. Since your operation for external auditory canal exostoses, have you had to take more or less medicine, for any reason?
18. Since your operation for external auditory canal exostoses, have you been more or less inconvenienced by your other health problems?

Materials and methods

A retrospective analysis was performed using data from the clinical records and a questionnaire administered to all patients who underwent surgery for severe exostoses from January 2010 to December 2018.

The following information was recorded from the clinical notes: sex, age, laterality, visits to the emergency department associated with otological complaints related to exostoses in the year prior to surgery, results of pre- and post-operative audiological evaluation, surgical approach, instruments used (chisels with or without a drill), and complications (in the intra- and post-operative periods).

Regarding the data on patients' pre-operative symptoms, exposure to water activity and complaints after surgery, the information was obtained from clinical records if available and supplemented by a questionnaire administered by telephone.

The pre-operative auditory evaluation was performed by analysing the last tonal audiometry results (in the frequencies 0.5, 1, 2 and 4 kHz for air conduction and bone conduction). The post-operative auditory evaluation involved observing the best audiometry results within a period of up to six months after surgery, also in the frequencies 0.5, 1, 2 and 4 kHz for air conduction and bone conduction.

Patients who had undergone surgery to enable access to the middle ear, for example because of chronic suppurative otitis media or otosclerosis, were not included in the study. Patients with incomplete surgical reports, those who did not answer the telephone call, and those who did not agree to answer the questionnaire and participate in the study were also excluded. Sixty-seven patients, 94 ears, were included in the study. The relevant data needed for the study were collected at least one year after surgery.

The pre- and post-operative symptoms evaluated were: wax or water retention, tinnitus, complaints of intermittent or persistent hearing loss, otorrhoea and chronic inflammatory

conditions, otalgia, feeling of pressure or filling, and difficulty in placing hearing aids.

The intra- and post-operative complications assessed included: exposure of the temporomandibular joint, with chronic pain or subluxation; tympanic membrane perforation; facial nerve injury; hearing loss caused by damage to the ossicular chain or the inner ear; hearing loss resulting from acoustic trauma; tinnitus that did not exist prior to surgery; injury to the chorda tympani nerve; ear canal stenosis or development of cholesteatoma; and delayed healing.

This study had two main objectives. The first aim was to compare the patients' complaints before and after the surgery, and measure the patients' quality of life after surgery. This aim was achieved using a modified Glasgow Benefit Inventory survey (Table 1).

The Glasgow Benefit Inventory is a measure of patient benefit developed especially for otorhinolaryngological interventions. Patient benefit is the change in health status resulting from healthcare intervention. The Glasgow Benefit Inventory is an 18-item post-intervention questionnaire developed to be patient-oriented and maximally sensitive to otorhinolaryngological interventions. Each response is based on a scale of five levels, ranging from a 'big change for the better situation' to a 'big change for the worse situation', so the patients themselves evaluate whether there has been an improvement and no statistical analysis is necessary. A final score is obtained by subtracting 3 from the mean score of the 18 items and multiplying it by 50. It is translated into a benefit score ranging from -100 (maximum negative benefit) to +100 (maximum positive benefit), where 0 signifies no changes. This questionnaire can be divided into three subscales: general health (items 1, 2, 3, 4, 5, 6, 9, 10, 14, 16, 17 and 18), social interaction (items 7, 11 and 15), and physical or somatic state (items 8, 12 and 13). The Glasgow Benefit Inventory final score is considered 'remarkable' when it is above or equal to 40.

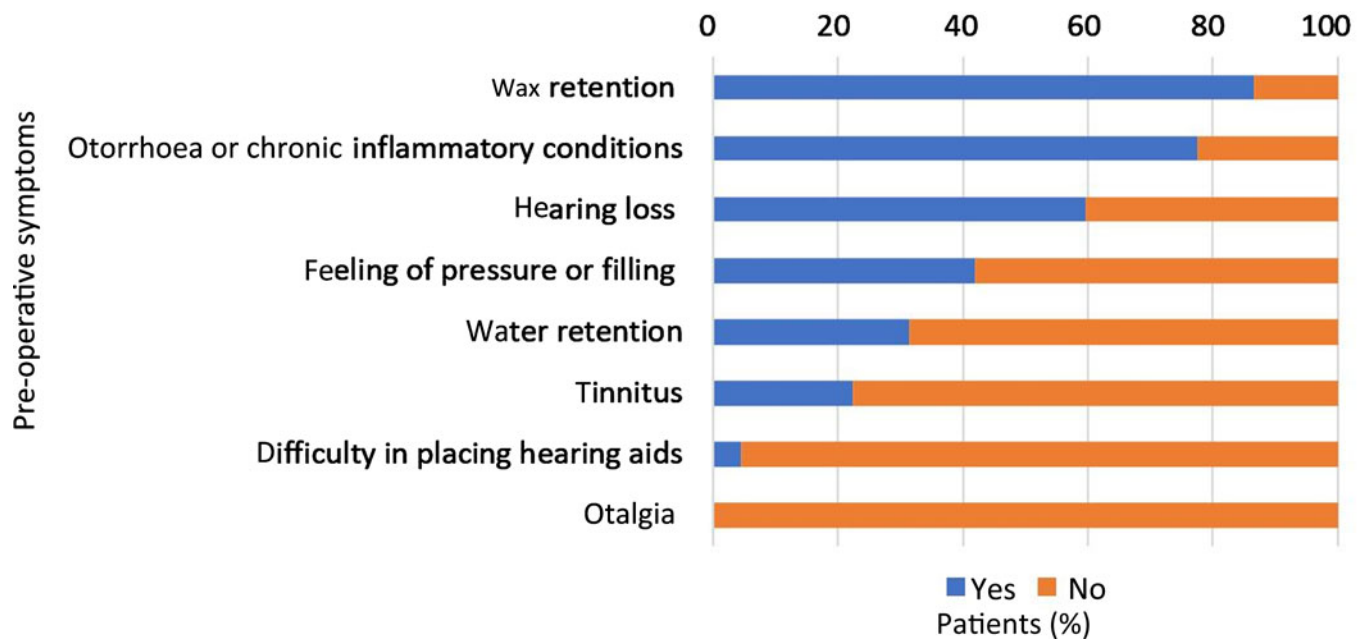


Fig. 1. Symptoms reported by patients in the pre-operative period.

The second aim was to understand whether complications related to exostosis surgery are associated with a decrease in the quality of life reported by patients after surgery.

In order to address our proposed objectives, statistical analysis was performed using IBM SPSS® software, version 24.0. Continuous variables were represented as means \pm standard deviations, while categorical data were represented as numbers and percentages. Categorical variables were compared between groups using the Pearson chi-square test, applied in the evaluation of the relationships between: the complaints before and after surgery; surgical complications and the two surgical approaches and instruments used; and surgical complications and the patient's satisfaction with the surgery. All differences associated with a chance probability of 0.05 or lower were considered statistically significant.

Results

The study comprised 64 male (95.5 per cent) and 3 female (4.5 per cent) patients, providing a sample size of 94 ears. The patients' mean age was 46.8 years (range, 20–70 years).

In 27 patients (40.3 per cent), the degree of exostosis and/or symptoms justified surgery bilaterally. The second intervention occurred an average of 19 months after the first intervention.

In 26 patients (38.8 per cent), there was a history of exposure to cold water associated with: surfing ($n = 17$), fishing ($n = 7$), diving ($n = 5$), and other water sports or frequent contact with cold water ($n = ??$).

Figure 1 shows the pre-operative symptoms reported by the patients. The vast majority of patients presented with more than one symptom, with the main four complaints being: wax retention (86.5 per cent), otitis externa (77.6 per cent), notion of intermittent or persistent hearing loss (59.7 per cent), and feeling of pressure or filling (41.8 per cent).

Of the patients, 14.9 per cent had visited the emergency department in the last year before surgery because of otological complaints related to exostoses; 27.0 per cent of patients went to the emergency department two to three times, and 18.9 per cent went more than four times, in the 12 months prior to surgery.

Table 2 shows the average values of the pre- and post-operative thresholds for air conduction, bone conduction and air–bone gap. A reduction in air–bone gap was observed, decreasing from 20.5 dB pre-operatively to 16.5 dB post-operatively.

Most patients underwent retroauricular surgery (87.2 per cent); the remaining patients underwent an endaural approach (12.8 per cent). In 22.3 per cent of the cases, only a chisel was used during the surgical process, while in most cases (77.7 per cent) a drill was used to regularise the canal after removal of exostoses with a chisel.

Surgical complications are described in Figure 2. These occurred in 14 cases (14.9 per cent of cases). There were five tympanic membrane perforations, all detected during surgery, and myringoplasty was performed at the same surgical time. In three cases, there was prolonged healing (more than eight weeks). There were three cases of tinnitus without evidence of hearing loss (in two of the cases, this resolved after about one year). There were two cases of sensorineural hearing loss (SNHL), with an isolated increase in auditory thresholds at 4 kHz in pure tone audiometry, suggestive of acoustic trauma. In addition, there was one case of cholesteatoma of the canal, requiring surgical intervention.

Of the 14 cases with reported complications, only 4 could not be resolved and became permanent: 1 perforation of the

Table 2. Average pre- and post-operative tonal audiometry thresholds

Audiometry parameter	Pure tone levels (mean (SD); (dB))	
	Pre-operative	Post-operative
Air conduction		
– 0.5 kHz	34.2 (21.7)	30.3 (19.8)
– 1 kHz	35.7 (22.9)	30.4 (21.0)
– 2 kHz	32.2 (22.8)	28.3 (24.3)
– 4 kHz	35.0 (26.9)	30.2 (24.2)
Bone conduction		
– 0.5 kHz	10.1 (11.7)	10.2 (14.3)
– 1 kHz	8.5 (13.5)	8.9 (14.1)
– 2 kHz	17.3 (16.3)	15.1 (17.7)
– 4 kHz	19.4 (18.3)	19.0 (20.1)
Air–bone gap	20.5 (9.7)	16.5 (13.1)

SD = standard deviation

tympanic membrane that persisted after myringoplasty, for which the patient did not want to undergo another intervention; 1 case of tinnitus, which has become permanent and continuous; and 2 cases of acoustic trauma. No complications, such as temporomandibular joint exposure, facial nerve injury, hearing loss associated with ossicular chain damage, chorda tympani nerve injury or ear canal stenosis, were reported.

No statistically significant difference was found in relation to complications when comparing the two surgical techniques (retroauricular or endaural) ($p = 0.875$) or in relation to the instruments used (chisel vs chisel and drill) ($p = 0.600$). However, in both cases of acoustic trauma and in the three cases of tinnitus, a drill was always used during surgery.

Regarding complaints in the post-operative period (Table 3) and comparing them with pre-operative complaints, 88.1 per cent of the patients said that they were symptom-free, with total resolution of the complaints. The following complaints were not recorded in the post-operative period in any patient: wax and water retention, maintenance or worsening of hearing loss, otalgia, and feeling of pressure or filling. Five patients reported persistent episodes of otitis externa, although all of them mentioned a reduction in frequency, and two patients with normal hearing thresholds reported persistence of tinnitus that they already had prior to surgery. Although tinnitus and recurrent external otitis were the only two symptoms reported to persist after surgery, there was a statistically significant difference between the pre- and post-operative periods for both symptoms ($p = 0.001$ and $p = 0.039$, respectively), showing a significant improvement.

Patients experienced a significant benefit following the procedure, with a Glasgow Benefit Inventory overall mean score (\pm standard deviation) of $+44.3 \pm 24.1$. The somatic state subscale score was $+79.5 \pm 28.9$ and the general health subscale score was $+72.3 \pm 22.0$. Social interaction was the area with the lowest level of improvement (subscale score of $+2.3 \pm 33.2$). The data for Glasgow Benefit Inventory global rate and its subscales are presented in Table 4.

No statistically significant difference was found between the global Glasgow Benefit Inventory changes (improved, unchanged and deteriorated after surgery) and complications related to surgery ($p = 0.093$). This means that the patients

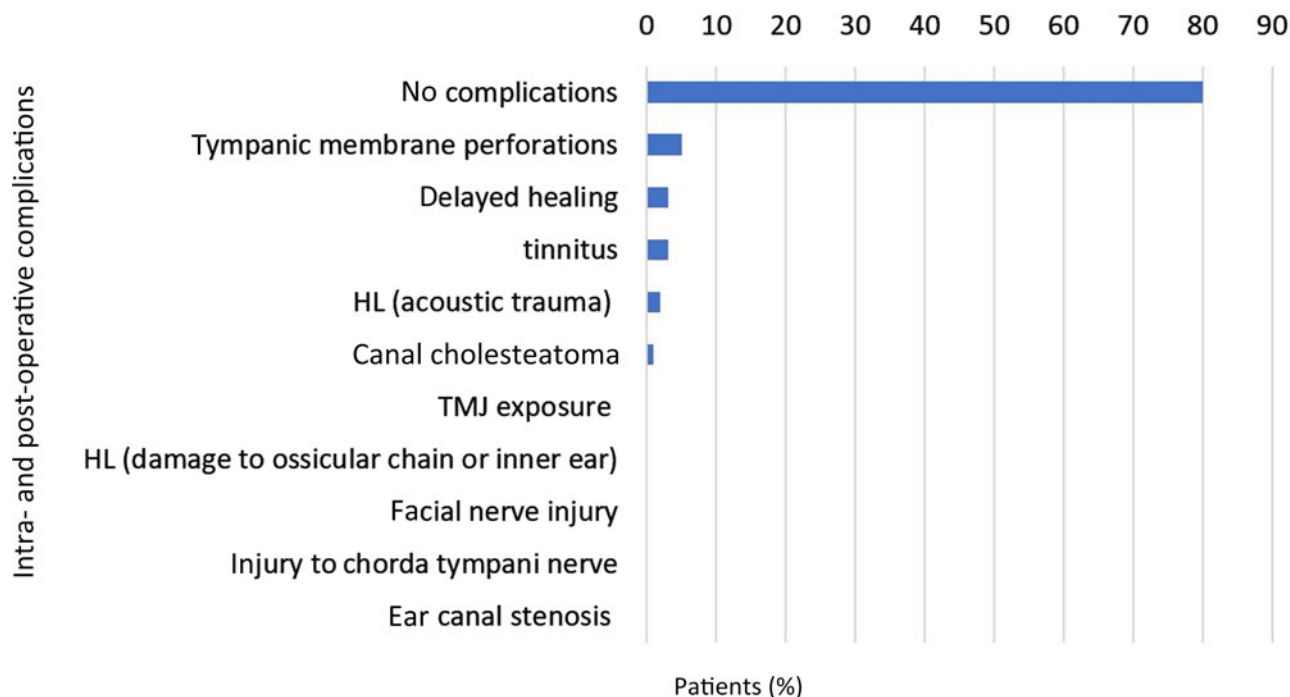


Fig. 2. Complications in the intra- and post-operative periods. HL = hearing loss; TMJ = temporomandibular joint

Table 3. Pre- and post-operative symptoms

Complaints	Before surgery	After surgery
Wax retention	86.50	0
Otorrhoea & chronic inflammatory conditions*	77.60	5.32
Notion of intermittent or persistent hearing loss	59.70	0
Feeling of pressure or filling	41.80	0
Water retention	31.30	0
Tinnitus*	22.40	3.19
Difficulty in placing hearing aids	4.48	0
Otalgia	0	0
No symptoms*	0	88.10

Data represent percentages of patients. *Indicates significant (pre- vs post-surgery) difference ($p < 0.05$).

who were not satisfied with surgery (in the global Glasgow Benefit Inventory scale, classified as having 'no changes' or 'deterioration after surgery') were not the same patients who had more complications in the intra- or post-operative period.

Discussion

Although exostoses are often asymptomatic, without any implications for patients, if they are large and/or multiple, several permanent or intermittent symptoms may arise, which can impact patients' quality of life. Patients need to implement additional care daily to protect the external auditory canals, and will need to visit the emergency department to resolve acute complaints related to exostoses.

The removal of symptomatic exostoses may be challenging because the narrow aperture of the external auditory canal makes visualisation of landmarks challenging; however, it can significantly improve patients' complaints. In our study, 88.1 per cent of the patients said that they were symptom-free

after surgery, with total resolution of the complaints. These values are slightly higher than those observed in some studies in the literature showing that approximately 70.0 per cent of the patients were symptom-free post-operatively.^{5,6} When complaints are assessed individually, most of the symptoms reported in the pre-operative period are no longer referred to in the post-operative period, such as wax and water retention, feelings of pressure, or the experience of hearing loss. Only two symptoms continue to be reported in the post-operative period: recurrent external otitis and tinnitus. However, a statistically significant reduction in both symptoms was observed when comparing the pre- and post-operative periods.

Regarding satisfaction with the surgery, patients experienced a significant benefit following the procedure, with a Glasgow Benefit Inventory score of +44.3 overall, and with particular improvements in somatic state and general health. Similar results were observed by Hempel *et al.*, in which 90 per cent of the patients were satisfied with the result of the operation and would decide in favour of the operation in retrospect.⁶

Although surgery for ear canal exostoses achieves effective and satisfying results, it must not be forgotten that complications can occur, as in any operation. Complication rates are reported in the literature, ranging from 5 per cent of major complications to 8–14 per cent if all intra- and post-operative complications are considered.^{5,8} In our study, 14.9 per cent of patients had complications in the intra- or post-operative period; however, permanent complications or complications that required a new surgical intervention were observed in only 5.32 per cent of the cases.

Numerous studies have addressed the surgical management of exostoses, and debated different approaches and operative instruments (e.g. drill vs osteotome). While the use of a high-speed drill allows precise bone removal and is believed to decrease the risk of injury to surrounding structures, it may result in SNHL caused by the direct transmission of sound to the cochlea.^{9,10} In fact, the cases of acoustic trauma and

Table 4. GBI scores, and percentages of patients with improved, unchanged or deteriorated scores after surgery

GBI parameter	Median GBI score (range)	Mean GBI score (SD)	GBI change (% patients)		
			Improved	Unchanged	Deteriorated
Global GBI	42.0 (0 to 95.0)	44.3 (24.1)	88.7	9.1	2.2
General health subscale	69.7 (0 to 95.3)	72.3 (22.0)	77.3	20.5	1.9
Social interaction subscale	1.1 (0 to 33.3)	2.3 (33.2)	7.9	92.1	0
Somatic state subscale	74.3 (-14.1 to 95.8)	79.5 (28.9)	89.1	8.7	2.2

GBI = Glasgow Benefit Inventory; SD = standard deviation

tinnitus after surgery reported in our study occurred in surgical procedures in which a drill was used. The osteotome may avoid the risks of tinnitus and SNHL; however, in previous studies concerns have been raised regarding the risk of injury to the facial nerve, tympanic membrane and temporomandibular joint caused by lack of landmarks and visualisation.¹¹ In our study, no statistically significant difference was found in relation to the risk of complications between patients where the chisel plus drill were used versus only the chisel ($p = 0.413$).

Sheehy recommended a retroauricular approach in all cases of diffuse exostoses of the external auditory canal because of the incidence of complications in patients operated on by other approaches.¹² In some case series, the permeal approach seems to be favoured, particularly in the hands of an experienced surgeon,⁷ although House and Wilkinson conclude from a series of more than 400 ears that the retroauricular approach results in minimal complications.¹³ In our study, only two approaches were performed, retroauricular and endaural, and we did not find a statistically significant association between the type of surgical approach and the risk of complications ($p = 0.732$), not forgetting, however, that the retroauricular route was widely used.

Hempel *et al.* also showed that complications are the most important factor for the lack of patient benefit from the operation, and complications had a negative impact on patients' quality of life.⁶ In the present study, this relationship was not found. Patients who reported no changes or a deterioration after surgery in the global Glasgow Benefit Inventory scale were not the same individuals who had more complications in the intra- or post-operative period, which may partly be because some of the reported complications were corrected in the intra-operative period. An example is the repair of tympanic membrane perforations without affecting other middle-ear structures. All perforations were detected during the intra-operative period, and tympanoplasty was performed. The post-operative care following myringoplasty is similar to that already expected by the patient in recovering from surgery for exostosis. In the case of tinnitus, of the three cases observed, two of them had resolved after one year, with no long-term implications for the patient's quality of life. In cases of acoustic trauma, none of which had associated tinnitus, the patients did not report any negative effects on their overall hearing.

Thus, in our opinion, the relationship between intra- and post-operative complications and a possible lower rate of patient satisfaction is not linear. We believe that only serious, permanent complications which require new surgical interventions will affect the satisfaction rate. Such complications fortunately occur in only a small number of patients. Nevertheless, serious, permanent complications should not be neglected,

and may affect 5 per cent of patients undergoing this surgery, as observed in our study and that by Fisher and McManus.⁷

- External auditory canal exostosis surgery has good results if the indications are appropriate
- Symptoms tend to resolve or significantly reduce post-operatively
- Surgery should be reserved for patients with symptoms, given the risk for complications
- There is a potential risk of several important complications in around 5 per cent of patients
- Complications related to surgery in general do not seem to implicate patients' quality of life post-operatively

This study has some limitations. First, the time of data collection and questionnaire completion was different for each patient, which could affect the results in terms of satisfaction with the surgery. However, in all patients, the data were collected at least one year after surgery. Second, the collection of information was carried out retrospectively, possibly introducing memory bias, especially in cases operated on a long time ago. Finally, complications resulting from surgery for exostoses, and severe complications like damage to the facial nerve and middle-ear structures, are rare; as such, studies with large samples are necessary for better precision of results and significance.

Conclusion

Surgery for ear canal exostoses can significantly improve patients' quality of life, with the vast majority showing a clear improvement in symptoms with a significant positive effect on quality of life. However, surgery should be reserved for patients with symptoms, because even in experienced hands there is the potential for several important complications, affecting around 5 per cent of patients.

Although complications related to surgery in general do not seem to have implications for the degree of patient satisfaction, serious and permanent complications, and those that require further surgical intervention, may occur, and these can have a significant negative effect on quality of life.

Competing interests. None declared

References

- 1 O'Connell BP, Lambert PR. *Exostoses and Osteomas of External Auditory Canal. Encyclopedia of Otolaryngology, Head and Neck Surgery.* Berlin: Springer, 2013
- 2 Wong BJ, Cervantes W, Doyle KJ, Karamzadeh AM, Boys P, Brauel G *et al.* Prevalence of external auditory canal exostoses in surfers. *Arch Otolaryngol Head Neck Surg* 1999;**125**:969–72
- 3 Hurst W, Bailey M, Hurst B. Prevalence of external auditory canal exostoses in Australian surfboard riders. *J Laryngol Otol* 2004;**118**:348–51

- 4 Whitaker SR, Cordier A, Kosjakov S, Charbonneau R. Treatment of external auditory canal exostoses. *Laryngoscope* 1998;**108**:195–9
- 5 Vasama JP. Surgery for external auditory canal exostoses: a report of 182 operations. *ORL J Otorhinolaryngol Relat Spec* 2003;**65**:189–92
- 6 Hempel JM, Forell S, Krause E, Muller J, Braun T. Surgery for outer ear canal exostoses and osteomata: focusing on patient benefit and health-related quality of life. *Otol Neurotol* 2011;**33**:83–6
- 7 Fisher EW, McManus TC. Surgery for external auditory canal exostoses and osteomata. *J Laryngol Otol* 1994;**108**:106–10
- 8 Barrett G, Ronan N, Cowan E, Flanagan P. To drill or to chisel? A long-term follow-up study of 92 exostectomy procedures in the UK. *Laryngoscope* 2015;**125**:453–6
- 9 Timofeev I, Notkina N, Smith IM. Exostoses of the external auditory canal: a long-term follow-up study of surgical treatment. *Clin Otolaryngol* 2004;**29**:588–94
- 10 Frese K, Rudert H, Maune S. Surgical treatment of external auditory canal exostoses [in German]. *Laryngorhinootologie* 1999;**78**:538–43
- 11 Hetzler D. Osteotome technique for removal of symptomatic ear canal exostoses. *Laryngoscope* 2007;**117**(1 Pt 2 suppl 113):1–14
- 12 Sheehy JL. Diffuse exostoses and osteomata of the external auditory canal: a report of 100 operations. *Otolaryngol Head Neck Surg* 1982;**90**:337–42
- 13 House JW, Wilkinson EP. External auditory exostoses: evaluation and treatment. *Otolaryngol Head Neck Surg* 2008;**138**:672–8