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Main Articles

Revision surgery for chronic otitis media: recurrent-residual disease and hearing

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Abstract

The aim of this study was to determine the effect of surgical approach, intact canal wall (ICW) or canal wall down (CWD), upon the success of revision surgery for chronic otitis media (COM). A retrospective analysis of 367 patients (including 65 children aged <15 years) who underwent revision tympanoplasty because of persistent disease was performed. Single-staged tympanoplasty was performed, preserving the canal wall when present. Hearing was reconstructed with allograft incus. Follow-up ranged from one to 15 years. Hearing was determined by pre- and post-operative air-bone gaps.

Post-operative re-perforation, aural discharge and/or cholesteatoma rates were similar for CWD and ICW. Cholesteatoma could present following the revision, even though it was not apparent at surgery. Following tympanoplasty, the final hearing was not significantly affected by the surgical approach or presence of cholesteatoma. Improvement in hearing was adversely affected by cholesteatoma or an absent stapes suprastructure.

Revision ICW and CWD operations were both successful in controlling signs of COM. Cholesteatoma is a peripheral risk in COM and may become apparent after revision surgery.

Key words: Cholesteatoma, Middle Ear; Otitis Media, Suppurative; Surgical Procedures, Operative; Reoperation

Introduction

Specialist Otological Clinics are often asked to assess patients that have failed surgery for chronic otitis media. For these patients, there is little literature to guide the clinical ecision making, since most papers report primary surgery or a planned second stage. This literature cannot be applied easily to revision cases, where a prior knowledge of pathology and treatment is unavailable. Furthermore, the treatment options available are limited by the decisions made by the previous surgeon. This paper attempts to provide some surgical guidelines for the Otologist practicing revision surgery. A large series of revision operations (420 patients; 482 revision operations) is reported, that were referred to our clinic following primary surgery at another centre. These patients suffered from chronic otitis media with, or without, cholesteatoma, and were followed up for a minimum of one year. The outcomes represent the success of a consistent surgical philosophy in dealing with the pathology seen at revision.

The surgical philosophy in these revision cases was to maintain the canal wall whenever possible, if it had not been taken down by the previous surgeon, in both cholesteatomatous and noncholesteatomatous disease. If a canal wall down (CWD) procedure had been done at the previous operation, this was revised. The study compares the outcomes of the intact canal wall (ICW) and CWD procedures. In all patients a goal was to create a dry, safe ear and to prevent recurrent disease. Extensive removal of the remaining air cells was performed routinely. In most cases the sound transformer system was reconstructed, but in a sub-group of patients this was not performed for a variety of reasons e.g. a pre-operative dead, but draining ear with, or without, cholesteatoma, pre-operative severe sensorineural hearing loss, ears with a totally destroyed middle ear or an only hearing ear with cholesteatoma. Given this surgical philosophy the following questions were addressed: (1) in revision surgery, does the post-operative presence of the posterior canal wall affect the incidence of residual disease such as otorrhoea,

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the re-perforation rate of the tympanic membrane (TM), and cholesteatoma? Series of revision ICW[1] and CWD[2,3] surgery have been reported, but few[4] compare the success of these alternative approaches; (2) are outcomes of revision age dependent (≤15 years old, as compared to >15 years), as is reported following primary surgery?[2]; and (3) which factors determine the surgical success of the procedures in reducing the conductive hearing deficit? Results from primary surgery suggest that hearing is poorer in the absence of a stapes suprastructure[5,6] or the presence of cholesteatoma.[7] We investigate whether these factors, and the presence of the canal wall affect hearing following revision surgery.

Materials and methods

A retrospective analysis of sequential cases of revision surgery, performed by one author (J.E.V.) from 1981–1997 in the Department of Otorhinolaryngology, University Medical Centre, Utrecht, the Netherlands, is presented. All cases analysed had signs of chronic otitis media, such as tympanic membrane perforation, aural discharge or cholesteatoma. Operations solely for hearing, in which there was no sign of chronic otitis media, were excluded. The paper relates to cases from 367 patients, comprising 65 children (≤15 years old) and 302 adults (>15 years old). In this series 223 ended up as an ICW and 144 as a CWD (modified radical). Sixty patients of this series had a second operation, either as a planned staged procedure or due to persistent or recurrent disease. Results of surgery are reported following the end of surgical treatment, that is, following the last operation under our care. The minimum follow up was 12 months, and ranged from one to 15 years.

The classification of cholesteatoma becomes problematic in patients operated on previously by other surgeons, since categories such as 'residual' or 'recurrent' assume a prior knowledge of the pathology and treatment.[8] Since categorization is not reliable in these situations, it can be argued that a distinction between residual or recurrent cholesteatoma should not be attempted in revision surgery, where the primary operation was performed elsewhere.[9] Thus cholesteatoma found at revision is termed 'residual/recurrent'. Similarly, if a cholesteatoma is first noticed *following* the revision, it is not possible to categorize this cholesteatoma along classical lines unless the pathology present at the first operation is known.[8] In recognition of this difficulty with classification we introduced the term *de novo* cholesteatoma[9] to describe cholesteatomas first noticed following the revision, that were not apparent during the revision. Since the classification of cholesteatoma is problematic in revision surgery, so is the application of the surgical literature, since treatment assumes a prior knowledge of the presenting pathology.

Within this series, in 144 adult patients, the only goals were to create a dry and safe ear and to prevent recurrent disease, but not to perform a tympanoplasty. Reconstruction of the sound transformer system was not performed for a variety of reasons e.g. a pre-operative dead, but draining ear with, or without, cholesteatoma, pre-operative severe sensorineural hearing loss, ears with a totally destroyed middle ear or an only hearing ear with cholesteatoma. Thus 210 adult patients and 34 children had a revision tympanoplasty. Persistent or recurrent otorrhoea, re-perforation of the TM and recurrent/residual cholesteatoma and/or *de novo* cholesteatoma formations are delineated for all surgical cases, in both age groups, subdivided into adults and children, who ended up with an ICW and CWD procedure.

Tympanoplasties were performed with autogenous fascia and autograft or allograft incudes.[9] Attic reconstruction in ICW procedures was done with allograft rib cartilage. Allografts came from our own tissue bank.

The functional hearing results are based upon the residual air-bone gap (ABG) at 0.5, 1 and 2 kHz ('Fletcher Index') pre-operatively, post-operatively (the last audiogram during the follow-up period of a maximum 15 years, the 'Final Fletcher Index') and the difference between these measurements ('improvement in the Fletcher Index'). Factors which might have influenced the post-operative hearing, such as the presence of the canal wall, the presence of cholesteatoma, the presence/absence of a stapes suprastructure and the effect of tympanoplasty were subjected to an analysis of variance (ANOVA).

TABLE I
COMPLICATIONS OCCURRING BEFORE AND AFTER REVISION: ADULTS (N = 302, EXCLUDING RADICAL MASTOIDECTOMIES)

	Per-operative		Post-operative	
	N	%*	N	%
ICW (N = 179)				
Otorrhoea	63	35	17	9
TM perforation	122	68	13	7
Residual/Recurrent Cholesteatoma	22	12	2	9**
De novo cholesteatoma			8	4
CWD (N = 123)				
Otorrhoea	86	70	9	7
TM perforation	97	79	12	10
Residual/recurrent Cholesteatoma	53	43	4	7**
De novo cholesteatoma			1	1

*% of patients in that subgroup, e.g. there were 179 adults with ICW operations and of these 63, or 63/179 × 100% had otorrhoea.
**% of those with cholesteatoma found at revision.

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TABLE II
COMPLICATIONS OCCURRING BEFORE AND AFTER REVISION: CHILDREN (N = 65, EXCLUDING RADICAL MASTOIDECTOMIES)

	Pre-operative		Post-operative	
	N	%*	N	%
ICW (N = 44)				
Otorrhoea	21	48	8	18
TM perforation	34	77	3	7
Residual/Recurrent Cholesteatoma	6	14	1	16**
De novo cholesteatoma			3	8
CWD (N = 21)				
Otorrhoea	16	76	2	10
TM perforation	17	81	4	19
Residual/Recurrent Cholesteatoma	4	9	2	50**
De novo cholesteatoma			0	0

*% of patients in that subgroup, e.g. there were 44 children with ICW operations and of these 21, or 21/44 × 100% had otorrhoea.
**% of those with cholesteatoma found at revision.

Results

Disease state before and after revision surgery

Pre- and post-operative findings (otorrhoea, TM perforations and cholesteatoma) are summarized in Tables I and II. Patients were classified according to age (adult or child) and operation (ICW or CWD).

Persistent and recurrent otorrhoea was higher in the paediatric ICW group (18 per cent) than the ICW adult group (nine per cent). However, in the CWD groups the incidence of post-operative otorrhoea were similar for children (10 per cent) and adults (seven per cent).

The percentage of reperforations of the TM was similar in the ICW and CWD adult groups (seven per cent versus 10 per cent), but much higher in the paediatric CWD group (19 per cent). In the ICW procedure the failure rate for children and adults was the same (both seven per cent).

Cholesteatoma was present in 15 per cent of the children and in 25 per cent of the adults at the time of revision surgery. The residual/recurrence rate of cholesteatoma in these revision cases was 30 per cent for children and eight per cent for adults. From Tables I and II it is apparent that *de novo* cholesteatoma occurred after ICW procedures in both children and adults (eight versus five per cent). Development of *de novo* cholesteatoma was seen in one adult CWD case.

Hearing

The hearing results are analysed in detail for the adults only, since the numbers of children were inadequate for an analysis of variance.

The Final Fletcher Index is as good for ICW as for CWD when tympanoplasty was performed, with over 70 per cent of patients achieving ABG closure of <30 dB (Table III). When the sound transformer system was not reconstructed (no 'tympanoplasty' group), CWD performed more poorly than ICW. These impressions were confirmed by the ANOVA, as the effect of canal wall (ICW or CWD) on the Final Fletcher Index was not significant ($p<0.20$, Table IV) when a tympanoplasty was performed, but was significant ($p<0.0015$), if tympanoplasty was not performed.

The performance of a tympanoplasty improved the Fletcher Index in the CWD group (Table V, and $F(1,116) = 3.99$, $p<0.048$), but not the ICW group where final hearing results were similar irrespective of the performance of tympanoplasty.

The presence of cholesteatoma at revision made little difference to the Final Fletcher Index, but the Improvement in Fletcher Index was much less if cholesteatoma was found at the first revision. ANOVA validated these findings (Table IV for Final Fletcher Index and Table VI for Improvement in Fletcher Index).

The presence, or absence of a stapes suprastructure did not make a difference to the Final Fletcher Index for ICW or CWD, or the Improvement in Fletcher Index for CWD operations. However, for ICW the Improvement in Fletcher Index was greatest when the stapes suprastructure was absent (Table V). These results are consistent with the interpretation that during revision surgery ossiculoplasty with an allograft incus onto the stapes footplate tends to be successful.[9]

Comparable analyses, while less detailed due to smaller numbers, were conducted on children. The most notable departure from the results presented for adults was a highly significant effect of the canal wall on the Final Fletcher Index in children ($F(1,60) = 9.6$, $p<0.0032$). Following ICW procedures the Final Fletcher Index (n = 43, mean = 25.5 dB) was much better than for CWD (N = 19, mean = 36.4), and this is seen regardless of whether the ossicular chain was reconstructed, or not. Neither did the presence, or absence of cholesteatoma nor the stapes suprastructure influence the poorer hearing seen in CWD cases.

TABLE III
FINAL FLETCHER INDEX IN ADULTS (IN CUMULATIVE %)

	Tympanoplasty		No tympanoplasty	
Fletcher Index	ICW	CWD	ICW	CWD
0 to < 10	6	1	9	0
10 to < 20	39	32	49	7
20 to < 30	71	70.8	71	20
30 to < 40	88	89	89	63

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TABLE IV
ANOVA ADULTS, DEPENDENT VARIABLE: FINAL FLETCHER INDEX

Factor	Tympanoplasty		No tympanoplasty	
Cholesteatoma	F (1,197) = 0.22	$p<0.64$	F (1,82) = 0.11	$p<0.75$
Canal wall	F (1,197) = 1.67	$p<0.20$	F (1,82) = 10.8	$p0.0015$
Stapes	F1(1,197) = 0.60	$p<0.44$	F (1,82) = 1.93	$p0.17$

Missing data: 8 in tympanoplasty group and 4 in No tympanoplasty group

Discussion

The surgical philosophy presented here was to maintain the canal wall whenever possible, unless it had been taken down or removed by the previous surgeon. The results suggest that performing on ICW mastoidectomy was as successful as revising a CWD mastoidectomy for achieving a disease-free ear. Our findings are consistent with the interpretation that it is the technical success of the operation, rather than the type of operation or the disease itself, that determines the achievement of a dry ear.

It was our philosophy to retain the canal wall when cholesteatoma was found at revision. This approach was successful for treatment of cholesteatoma found during revision, since disease-free rates were similar following ICW treatment and revision of a CWD operation. However, ICW revision procedures were associated with a higher incidence of *de novo* cholesteatoma than CWD revisions. *De novo* cholesteatoma behaves much like recurrent cholesteatoma seen following primary surgery, being more common following an ICW procedure than a CWD procedure. (It must be stressed that, by definition, for disease to be classified as *de novo* there must be no evidence of cholesteatoma at the revision.) In summary, ICW revisions are successful at treating cholesteatoma present at revision surgery, but these procedures are associated with a higher incidence of *de novo* cholesteatoma formation following revision surgeries. This suggests that the apparent absence of cholesteatoma at ICW revision should not lead the surgeon to consider the ear to have a low cholesteatoma forming potential.

The rates of cholesteatoma formation following both ICW and CWD revisions were much lower than the incidence of cholesteatoma found at the revision. This suggests that the technical execution of the revision procedure has as stronger influence on the success of the operation than the disease itself. If the converse were true, we might have expected similar rates of cholesteatoma during and after revision, but this is not the case.

The post-operative complications for children were similar to those of adults, but several differences between these groups are worthy of discussion. The incidence of post-revision cholesteatoma is higher than for adults. These results must be interpreted tentatively as the numbers of patients was small, but the results are consistent with other reports[2] which show that, in children, residual and recurrent cholesteatoma is more common than in adults. Both the cholesteatoma results, and the higher incidence of post-revision otorrhoea (following ICW surgeries) and tympanic membrane perforation (following CWD revisions) argue for more aggressive chronic otitis media in children than adults. This is consistent with the literature, and has been attributed to immaturity of the eustachian tube. However, our results show that most children undergoing a revision procedure can be given a safe, dry ear and that surgery need not be delayed until adolescence, as has been argued previously.[10,11]

Factors influencing the air-bone gap

The disease-related factor that impacted most upon hearing results was the presence or absence of cholesteatoma at the first revision. Regardless of the state of the canal wall at revision, the presence of cholesteatoma decreased the Improvement in the Fletcher Index. Similar affects of cholesteatoma on hearing have been reported in primary surgery.[7]

Following ICW procedures hearing results tended to be similar, irrespective of whether an ossicular chain reconstruction (OCR) was performed or not. The reason for this relates to our attitude towards OCR and the state of the stapes suprastructure. An OCR was always performed if the stapes suprastructure was missing, meaning that a large air-bone gap was not allowed to persist. If the stapes

TABLE V
MEANS OF FLETCHER INDEX IN ADULTS (PLANNED REVISION TYMPANOPLASTY ONLY, N = 205)

Cholesteatoma	Canal wall	Stapes present	Final Fletcher Index	Improvement over treatment of Fletcher Index	Number of patients
no	ICW	no	22.8	17.1	20
no	ICW	yes	25.0	5.1	95
no	CWD	no	28.3	9.2	14
no	CWD	yes	25.1	10.6	29
yes	ICW	no	25.0	5.0	4
yes	ICW	yes	25.4	1.4	12
yes	CWD	no	23.5	2.1	8
yes	CWD	yes	32.5	–2.5	23

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TABLE VI
ANOVA ADULTS, DEPENDENT VARIABLE: IMPROVEMENT OF FLETCHER INDEX

Factor	Tympanoplasty		No tympanoplasty	
Cholesteatoma	F (1,197) = 10.3	$p<0.0015$	F (1,82) = 0.01	$p<0.92$
Canal wall	F (1,197) = 0.36	$p<0.55$	F (1,82) = 4.89	$p<0.03$
Stapes	F (1,197) = 2.67	$p<0.10$	F (1,82) = 4.2	$p<0.04$

Missing data (where one of the dependent variables was missing): 8 in tympanoplasty group and 4 in No tympanoplasty group

suprastructure was present, a myringostapediopexy restored hearing even when an OCR was not performed.

Some authors have concluded that the presence, rather than the absence, of an intact stapes suprastructure is predictive of better hearing results.[5,6] This is not our experience, presumably because ossicular chain reconstruction with allograft incus was equally successful in restoring hearing whether the stapes suprastructure was present, or absent. Consistent with this analysis is our finding that hearing improved most when the stapes suprastructure was absent.

Our results indicate that for the best hearing results it is important to perform a tympanoplasty with a CWD mastoidectomy, and demonstrate the success of allografts in this situation. Allografts have the advantage of allowing an ossiculoplasty at the first revision, due to their low risk of extrusion compared with prostheses.

Conclusions

In revision surgery, surgical technique would appear to be a greater determinant of post-operative success (a dry ear, intact tympanic membrane and cholesteatoma-free ear) than the type of procedure or the disease itself. Cholesteatomas seen at revision ('residual/recurrent') can be controlled by either ICW or CWD procedures, although, it is important to note that a 'cholesteatoma-free ear' *during ICW revision* may present with cholesteatoma at a later date. Continued surveillance of the ear is mandatory.

Revision tympanoplasty is successful in children, but the complication rates are slightly higher than in adults as seen following primary surgery. This is likely due to more refractory middle-ear disease in children, possibly secondary to immaturity of eustachian tube function and/or the immune system.

Cholesteatoma found at revision predicts for poorer improvements in the air-bone gap post-operatively. Hearing results are improved by performing an allograft incus OCR or CWD mastoidectomy. However, following ICW procedures hearing results tended not to be influenced by ossiculoplasty provided that the stapes suprastructure was present. If the stapes suprastructure was absent hearing was reliably restored with an allograft incus.

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