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Otology

Early and late surgical site infections in ear surgery

Complicanze infettive locali precoci e tardive nella chirurgia otologica

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SUMMARY

A retroauricular approach is routinely used for treating chronic otitis media. The incidence of surgical site infections after ear surgery is around 10% in contaminated or dirty procedures. This observational prospective study describes surgical site infections after chronic otitis media surgery with the retroauricular approach and investigated their potential predictive factors. This observational prospective study included patients suffering from chronic otitis media and eligible for therapeutic surgery with a retroauricular approach. During follow-up, surgical site infections were defined as "early" if occurring within 30 days after surgery or as "late" if occurring thereafter.
The data of 102 patients were analysed. Concerning early surgical site infections, four cases were diagnosed (3.9%) and a significant association was found with preoperative antibiotic therapy, wet ear at pre-operative examination, class III (contaminated) in the surgical wound classification, NNIS (National Nosocomial Infection Surveillance) index > 1, and oral post-operative antibiotic use. Seven late surgical site infections were diagnosed (7.1%) between 90 and 160 days after surgery and were significantly correlated to otorrhoea during the 6 months before surgery, surgery duration ≤60 minutes, canal wall down technique and use of fibrin glue. Surgical site infections after chronic otitis media surgery seem to be associated with factors related to the inflammatory state of the middle ear at the time of surgery in early infections and with chronic inflammation in late infections.

KEY WORDS: Otitis media • Otologic surgical procedure • Surgical wound infection • Nosocomial infection

RIASSUNTO

La via retroauricolare rappresenta l'approccio di scelta nel trattamento dell'otite media cronica. Nelle procedure "sporche" l'incidenza della complicanza infettiva locale è del 10%. Il presente studio analizza le infezioni del sito chirurgico dopo la chirurgia dell'otite media cronica e ne investiga i potenziali fattori predittivi. Il presente studio, dal design osservazionale prospettico, ha incluso pazienti affetti da otite media cronica e candidati alla chirurgia mediante approccio retroauricolare. Sono state definite precoci le complicanze postoperatorie insorte entro i 30 giorni e tardive quelle insorte oltre i 30 giorni. Sono stati analizzati i dati di 102 pazienti. Sono stati registrati 4 casi (3,9%) di infezione precoce, per la quale è stata evidenziata un'associazione significativa con l'antibioticoterapia preoperatoria, l'orecchio in fase secernente all'esame otoscopico preoperatorio, una classe III (contaminato) nella classificazione delle ferite chirurgiche, indice NNIS (National Nosocomial Infection Surveillance) >1 e assunzione di antibiotici per OS nel postoperatorio. Sono state inoltre registrate 7 complicanze tardive (7,1%), occorse fra i 90 e i 160 giorni dall'intervento, significativamente correlate alla presenza di otorrea nei sei mesi precedenti la chirurgia, una durata del tempo chirurgico inferiore o uguale a 60 minuti, una tecnica aperta e all'uso della colla di fibrina. L'infezione del sito chirurgico sembra essere associata ai fattori correlati allo stato infiammatorio dell'orecchio medio al momento della chirurgia nelle infezioni precoci e all'infiammazione cronica nelle infezioni tardive.

PAROLE CHIAVE: *Otite media • Procedura chirurgica • Infezione della breccia chirurgica • Infezione nosocomiale*

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Introduction

The term chronic otitis media (COM) covers a wide range of otological pathologies characterised by the presence of chronic inflammation of the middle ear and mastoid cavities mucosa [1]. Dry or suppurative tympanic perforations, cholesteatomas and inflammatory mediated ossicular lesions are the main presentations of COM [2]. The retroauricular approach, which is routinely performed for treating COM, allows access to the tympanic membrane, middle ear cleft and mastoid through a retroauricular incision. The goals of COM surgery differ according to the type of lesions: removal of infective and devitalized tissues within the mastoid, cholesteatoma excision, opening of all the air cells in a common cavity, and repair of the tympanic membrane or sound-conducting mechanisms [3 4]. As infectious complications may arise spontaneously in COM both intra- and extra-cranially, there is a potential for surgical site infection (SSI) after intervention [5]. The incidence of SSI after ear surgery is around 10% in contaminated or dirty procedures [6]. The three main sources of contamination are flora of the normal middle ear and rhinopharynx, flora of the skin through the external auditory

canal (EAC) or retroauricular incision, and pathogenic bacteria within infected mastoid cells [6].
Local infection after tympanoplasty may require antibiotic treatment, hospitalisation and even re-intervention. Moreover, infection may impair tympanic graft uptake and long-term functional results of hearing and mastoid cell ventilation [7].
The aim of this work was to study potential predictive factors for SSI after COM surgery performed with a retroauricular approach.

Materials and methods

This observational prospective study was conducted by the ENT department of a tertiary referral centre in association with an infection control unit. This study protocol was approved by the local ethics committee.
All the patients suffering from COM and eligible for therapeutic surgery with a retroauricular approach were consecutively included. Exclusion criteria were: presence of another active otologic disease including acute otitis media or external, retroauricular cutaneous infection at the time of surgery, history of previous head and neck radiotherapy, previous SSI of the operated ear 30 days before surgery. Patients receiving intradermal corticosteroid injections for the treatment of a retro-auricular keloid at the same time were also excluded.
Patients were admitted on the evening before or day of surgery in ambulatory or conventional hospitalisation. The day before and the morning of surgery, patients took a povidone-iodine shower including shampoo. Retroauricular hair was clipped at admission. All the patients were operated on by one of two experienced senior surgeons. The operative field was scrubbed with povidone-iodine scrub solution then painted with povidone-iodine solution associated with a povidone-iodine ear bath. Subcutaneous tissues were infiltrated using adrenalinated lidocaine solution from the hypoderma to the periosteum. The retroauricular approach was performed in every patient by a retroauricular cutaneous incision to reach the middle ear by dissection along the osseous EAC and/or by drilling through the mastoid cavities. According to the disease, several other procedures may have been performed, such as antromastoidectomy using the canal wall up (CWU) or canal wall down (CWD) method, cholesteatoma removal, ossiculoplasty, or tympanoplasty. These techniques may have used autologous (auricular cartilage, ossicle, fascia temporalis) or foreign materials (titanium ossicular prosthesis, myringotomy tube, fibrin glue, gelatine sponge). After the procedure, single interrupted suturing was used with nylon monofilament in adults and polymeric absorbable suture in children. Ear packing was then set into the EAC using silicone sheets and ear wicks. Retroauricular incision care included daily cleaning, disinfection with an antiseptic and dressing by a nurse at the patient's home.
According to applicable standards [8], antibiotic prophylaxis was not given systematically. Intravenous intra-operative and oral post-operative antibiotic treatments were given in the event of an active infectious or inflammatory state discovered in the middle ear during surgery. However, all patients received local antibiotics (auricular ofloxacin) during packing and for 10 days after its removal.
Packing duration and delay between total packing removal and first control visit depended on the characteristics of the patients and the interventions performed.
Follow-up ended at the first control visit (one month or more later after total packing removal depending on the type of surgery) or in the event of an SSI diagnosis. SSI were defined by one or more of the following criteria: inflammation of the retroauricular scar, retroauricular purulent discharge, purulent otorrhoea or otitis media. All SSI diagnoses were validated by the surgeons responsible for patient care. SSI were defined as "early SSI" if occurring within 30 days after surgery or as "late SSI" if occurring thereafter. Early SSI patients were excluded from the analysis of late SSI.
Pre-, intra- and post-operative data were recorded by a member of the surgical team at each follow-up. Parameters were patient age and sex, tobacco use, existence of previous surgery on the same ear, ear discharge during the six months before surgery, rhinosinusitis or antibiotic treatment (systemic or topical use) during the two weeks before surgery, results of pre-operative ear examination, month of surgery, type of hospitalisation (ambulatory or conventional), order of the intervention in the day's planning of the operating theatre, duration of surgery, presence of cholesteatoma in the middle ear cavities, need for bone drilling, use of CWU or CWD technique, need for autologous graft (bone, cartilage, fascia), foreign material (gelatine sponge, fibrin glue, non-resorbable implant), resorbable suture, use of intravenous intra-operative or post-operative oral antibiotics, and ear packing duration.
According to the pre-operative otoscopic examination, "wet ear" patients were differentiated from "dry ear" patients. Wet ears were defined as a non-purulent otorrhoea of the EAC. This state was different from infected ears, which were excluded, and was considered as a sign of active COM. We also determined the American Society of Anesthesiologists (ASA) score and the surgical wound contamination class for each patient in order to calculate the National Nosocomial Infection Surveillance (NNIS) index [9-11]. Contaminated surgery included wet ears and ears where an inflammatory state was diagnosed after opening the middle ear. Other interventions were classified as clean-contaminated.
Analyses were done with Microsoft Access 2007 for Windows and GraphPad Prism V6.01 for Windows (GraphPad Software, Inc., San Diego, CA). Associations between SSI and characteristics of patients and surgery were analysed using Fisher's exact test. Results were are expressed as hazard ratio (95% confidence interval) [HR (95% CI)]). A $P < 0.05$ was considered as statistically significant.

Results

Between November 2011 and June 2012, 111 patients were included. Of these, three were excluded because the inclusion criteria were not respected. Five patients were lost to follow-up after complete packing removal. One patient was excluded for acute otitis media diagnosed during surgery. Analyses were performed on the remaining 102 patients. There were 62 men and 40 women with a mean age of 34.5 ± 19.5 years. A canal wall up approach was needed in 94% of interventions and 44% needed bone drilling. Cholesteatoma was found in middle ear cavities in 62 patients. Mean follow-up was 124.7 ± 83.2 days.
Eleven SSI were diagnosed during the follow-up (overall SSI rate 10.8%). Characteristics of patients and SSIs are described shown in Table I.

Early SSI

Four early SSI were diagnosed (early SSI rate 3.9%) between 3 and 30 days after surgery. The symptoms were mainly purulent otorrhoea and scar inflammation. In univariate analysis, the following factors were significantly correlated with early SSI: pre-operative antibiotic therapy, wet ear at pre-operative examination, class III (contaminated) in surgical wound classification, NNIS score >1 and, oral post-operative antibiotic use (Table II).

Late SSI

Seven late SSI were diagnosed amongst the 98 remaining patients (late SSI rate 7.1%) between 90 and 160 days after surgery. The most common presentation of late SSI was purulent otorrhoea. In univariate analysis, the following factors were significantly correlated with late SSI: ot-

Table I. Characteristics of SSI patients. Eleven patients were diagnosed with SSI during the follow-up. *(CWU: Canal Wall Up, CWD: Canal Wall Down, Scar infl.: scar inflammation, Purulent otor.: purulent otorrhoea, Atb: antibiotic therapy, Hosp.: hospitalisation).*

	Early SSI				Late SSI						
Case number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Age (y)	53	39	59	16	48	31	23	68	12	17	40
Sex	F	M	M	M	M	F	F	F	M	M	M
Otorrhoea during the previous 6 months	No	Yes	Yes	No	Yes	Yes	Yes	No	No	No	Yes
Pre-operative antibiotic therapy	No	Local	Oral, Local	No	No	No	No	No	No	No	No
Pre-operative ear examination	Wet	Wet	Wet	Dry	Wet	Dry	Dry	Dry	Dry	Dry	Wet
Cholesteatoma	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes
Drilling	No	No	Yes	Yes	No	Yes	Yes	Yes	No	No	Yes
Technique	CWU	CWU	CWD	CWU	CWU	CWU	CWU	CWD	CWU	CWU	CWD
Autologous graft	Cartilage	Cartilage, fascia, bone	Cartilage	No	Fascia	Cartilage, fascia	Cartilage, fascia, bone	Cartilage	Cartilage, fascia	Cartilage	Cartilage, fascia
Foreign material	No	No	Fibrin Glue	No	Gelatine Sponge	Gelatine Sponge	No	Fibrin Glue	No	No	Fibrin Glue
Resorbable suture	No	No	No	No	No	No	Yes	No	Yes	No	No
Intravenous intra-operative antibiotic administration	No	Yes	No	No	Yes	No	No	No	No	No	Yes
Oral post-operative antibiotic administration	Yes	Yes	No	Yes	Yes	No	No	No	No	No	Yes
NNIS score [a]	2	2	2	1	1	0	1	1	1	1	2
Clinical examination at SSI diagnosis	Scar infl., purulent otor.	Scar infl.	Purulent otor.	Purulent otor.	Purulent otor.	Purulent otor.	Purulent otor.	Purulent otor.	Pain, purulent otitis media	Purulent otor.	Pain, purulent otor.
Time to SSI diagnosis after surgery (days)	3	7	11	30	90	100	116	122	150	157	160
Treatment of SSI	Atb, hosp., surgery	Atb, hosp.	Atb	Atb	Atb	Atb	Atb	Atb	Atb	Atb	Atb

[a] *NNIS score: one point given for each of the following criteria: ASA score of 3-5, contaminated or dirty-infected surgery and surgery lasting longer than 60 minutes.*

Table II. Univariate analysis of early SSI of patients and intervention characteristics. The statistical association between early SSI and patients or interventions characteristics was studied using Fisher's exact test. P values in bold are statistically significant. (*HR: Hazard Ratio, CI: Confidence interval; CWU: Canal Wall Up, CWD: Canal Wall Down*).

		Total	SSI	No SSI	HR [95% CI]	p =
		n = 102	n = 4	n = 98		
Age	≤ 15	32	0	32	1.13 [0.35; 3.6]	1.00
	> 15	70	4	66		
Gender	M	62	3	59	1.93 [0.2; 17.97]	1.00
	F	40	1	39		
Tobacco use	Yes	28	1	27	0.88 [0.1; 8.12]	1.00
	No	74	3	71		
Number of interventions on same ear	First	54	1	53	0.34 [0.03; 2.76]	0.34
	Second or more	48	3	45		
Otorrhoea during previous six months	Yes	22	2	20	3.64 [0.54; 24.38]	0.20
	No	80	2	78		
Infectious episodes during previous 15 days	Yes	5	0	5	0 [+∞; -∞]	1.00
	No	97	4	93		
Pre-operative antibiotic therapy	Yes	10	2	8	9.2 [1.45; 58.43]	**0.047**
	No	92	2	90		
Pre-operative ear examination	Wet	12	3	9	22.5 [2.54; 199.53]	**0.005**
	Dry	90	1	89		
Day off surgery	Yes	31	0	31	0 [+∞; -∞]	0.31
	No	71	4	67		
Surgery duration (min)	≤ 60	46	2	44	1.22 [0.18; 8.31]	1.00
	> 60	56	2	54		
Surgical wound classification	III	19	4	15	48.48 [2.48; 947.3]	**0.0009**
	II	83	0	83		
NNIS score	> 1	17	4	13	57 [2.9; 1120]	**0.0006**
	≤ 1	85	0	85		
Cholesteatoma	Yes	62	2	60	0.65 [0.09; 4.4]	0.64
	No	40	2	38		
Drilling	Yes	45	2	43	1.27 [0.19; 8.64]	1.00
	No	57	2	55		
Technique	CWU	96	3	93	0.19 [0.02; 1.54]	0.22
	CWD	6	1	5		
Autologous graft	Yes	97	3	94	0.15 [0.02; 1.24]	0.18
	No	5	1	4		
Foreign material	Yes	48	1	47	0.38 [0.04; 3.49]	0.62
	No	54	3	51		
Fibrin glue	Yes	5	1	4	6.47 [0.81; 51.64]	0.18
	No	97	3	94		
Non-resorbable foreign material	Yes	10	0	10	0 [+∞; -∞]	1.00
	No	92	4	88		
Resorbable suture	Yes	33	0	33	0 [+∞; -∞]	0.30
	No	69	4	65		
Intravenous intra-operative antibiotic administration	Yes	16	1	15	1.79 [0.2; 16.17]	0.50
	No	86	3	83		
Oral post-operative antibiotic administration	Yes	18	3	15	14 [1.54; 127.1]	**0.02**
	No	84	1	83		
Ear packing duration (d)	≤ 7	56	2	54	0.82 [0.12; 5.61]	1.00
	> 7	46	2	44		

orrhoea during the 6 months before surgery, surgery duration ≤60 minutes, canal wall down technique and use of fibrin glue (Table III).
The number of SSI cases in each group was insufficient to perform multivariate analysis.

Discussion

Early and late SSI after surgery for COM with the retroauricular approach were associated with various predictive factors, underlining the fact that the two types of infection do not share the same physiopathology.
Early SSI are linked to the inflammatory state of the ear at the time of surgery. Surgical procedures on inflammatory tissues seem to promote the proliferation of bacteria already present in the middle ear or on the patient's skin. The five predictive factors we found significantly associated with early SSI are related and reflect the inflammatory state of the middle ear in the days before or during the surgery. Some authors distinguish active vs. inactive COM [4 12]. The difference is based on the presence or absence of ear discharge at pre-operative examination [12] or within one month in the pre-operative period [4]. Wet ear in COM can be caused by mucosal oedema or myringitis along the edge of the perforation [4]. The distinction between wet and dry ear is based on the surgeon's assessment just before the intervention and may be more reliable than patient anamnesis and more related to COM activity on the day of surgery.
Our definition of early SSI matches with that of nosocomial SSI given by the Center for Disease Control (CDC) [13], and can also be considered as being due to pathogens brought to the surgical site by various manoeuvres in spite of the preventive measures taken pre-, intra- and post-operatively. Nosocomial SSI has received much attention in the literature, although data on SSI in ear surgery are relatively scarce and lack specific or standardised definitions and indices. For example, the delay used to consider an infection as nosocomial varies from 2 weeks to 3 months, whereas the CDC consider it as 30 days [6 14-18]. Moreover, the CDC definitions of nosocomial SSI differentiate incisional infections (superficial and deep) and specific organ/space infections [13]. The CDC considers the ear and mastoid as a specific organ/space. Owing to communication created between the mastoid cavities and the subcutaneous plane by the retroauricular approach, the distinction between incisional and organ/space infection may be difficult in the event of retroauricular purulent discharge. It is also difficult to specify the origin of purulent otorrhoea. It may be due to superficial incisional infection of the EAC skin, to mechanical discharge of middle ear cavity infection through the separation planes, or to residual tympanic perforation. Exact diagnosis may require mastoid exploration surgically or by CT scan. However, the recent tendency is to apply a more helpful and clinically relevant definition that distinguishes only wound infection from middle ear infection [14].
The determination of Altemeier's surgical wound contamination class is a matter of debate in ear surgery. The middle ear is covered by a respiratory epithelium and communicates with the pharynx through the auditory tube. It can be considered as a part of the respiratory tract and thus middle ear surgery should be considered at least as clean-contaminated surgery according to Altemeier's terms. However, some authors feel that ear surgery can be classified as clean surgery in the absence of purulent ear discharge and outside the context of COM [14]. In our study, both wet ears and dry ears with a intra-operative diagnosis of local inflammation were classified as contaminated, while other ears i.e. dry ears without middle ear inflammation, were considered as clean-contaminated. The pre-operative distinction between dry and wet ears has some advantages compared to the exact determination of Altemeier contamination class. The latter can be determined only during surgery after opening the middle ear. In the study by Mills et al., mucosal disease was found in 28% of ears classified as inactive COM after otoscopic examination compared to 83% in active ears [12]. Calculation of the NNIS index requires the determination of the T cut point, which differentiates short and long operations. In the initial description of the NNIS index, the T time for ENT interventions (except head and neck surgery) was defined as the 75th percentile of the distribution of duration of surgery, rounded to the nearest whole number of hours. The authors obtained a T time equal to 3 hours from a pool of 1,061 ear, nose, mouth and pharynx interventions [11]. In our study, we used a T time equal to one hour, as recommended by the French SSI surveillance program (RAISIN). This value is also applicable to a wide range of non-otologic interventions. In our study on 102 interventions, the calculated T time was 105.75 minutes rounded to 2 hours. It may be useful to determine a more specific T time in a large population of ear interventions in order to increase the accuracy of the NNIS index in this specific context.
Our sample size was too small to determine the interdependence between antibiotic use, wet ear, surgical wound classification and NNIS score. Nevertheless, it appears that wet ear is the most clinically relevant factor predictive of early SSI. However, in the event that wet ear is diagnosed before surgery, there is no consensus as to whether the intervention should be postponed or whether antibiotic prophylaxis should be administered. Some authors have found that healing and functional results of tympanoplasty in ears with active COM are poorer than those in ears with inactive COM [19 20]. The wet/dry distinction has already been included in prognostic scores used in middle ear surgery and for predicting anatomical and functional long-term outcome [3]. Other authors found no difference between wet and dry ears with regards to the

Table III. Univariate analysis of late SSI of patients and intervention characteristics. The statistical association between late SSI and patients or intervention characteristics was studied by Fisher's exact test. P values in bold are statistically significant. (*HR: Hazard Ratio, CI: Confidence interval; CWU: Canal Wall Up, CWD: Canal Wall Down*).

		Total	SSI	No SSI	HR [95%CI]	p =
		n = 98	n = 7	n = 91		
Age	≤ 15	32	1	31	0.34 [0.04; 2.74]	0.42
	> 15	70	6	60		
Gender	M	62	4	55	0.88 [0.21; 3.73]	1.00
	F	40	3	36		
Tobacco use	Yes	28	2	25	1.05 [0.22; 5.1]	1.00
	No	74	5	66		
Number of interventions on same ear	First	54	3	50	0.64 [0.15; 2.7]	0.70
	Second or more	48	4	41		
Otorrhoea during previous six months	Yes	22	4	16	5.2 [1.26; 21.39]	**0.03**
	No	80	3	75		
Infectious episodes during previous 15 days	Yes	5	0	5	0 [+∞; -∞]	1.00
	No	97	7	86		
Pre-operative antibiotic therapy	Yes	10	0	8	0 [+∞; -∞]	1.00
	No	92	7	83		
Pre-operative ear examination	Wet	12	2	7	3.96 [0.89; 17.55]	0.124
	Dry	90	5	84		
Day off surgery	Yes	31	3	28	1.62 [0.39; 6.81]	0.68
	No	71	4	63		
Surgery duration (min)	≤ 60	46	6	38	7.36 [0.92; 58.93]	**0.043**
	> 60	56	1	53		
Surgical wound classification	III	19	2	13	2.21 [0.47; 10.38]	0.29
	II	83	5	78		
NNIS score	>1	17	1	12	1.09 [0.14; 8.34]	1.00
	≤1	85	6	79		
Cholesteatoma	Yes	62	3	57	0.48 [0.11; 2.01]	0.43
	No	40	4	34		
Drilling	Yes	45	4	39	1.71 [0.4; 7.22]	0.70
	No	57	3	52		
Technique	CWU	96	5	88	0.13 [0.03; 0.53]	**0.04**
	CWD	6	2	3		
Autologous graft	Yes	97	7	87	0.77 [0.04; 15.75]	1.00
	No	5	0	4		
Foreign material	Yes	48	4	43	1.45 [0.34; 6.13]	0.71
	No	54	3	48		
Fibrin glue	Yes	5	2	2	9.4 [2.56; 34.47]	**0.025**
	No	97	5	89		
Non-resorbable foreign material	Yes	10	0	10	0 [+∞; -∞]	1.00
	No	92	7	81		
Resorbable suture	Yes	33	2	31	0.79 [0.16; 3.84]	1.00
	No	69	5	60		
Intravenous intra-operative antibiotic administration	Yes	16	2	13	2.21 [0.47; 10.38]	0.29
	No	86	5	78		
Oral post-operative antibiotic administration	Yes	18	2	13	2.21 [0.47; 10.38]	0.29
	No	84	5	78		
Ear packing duration (d)	≤ 7	56	5	49	2.04 [0.41; 10]	0.45
	> 7	46	2	42		

outcome of tympanoplasty and affirmed that ear discharge was not a reason to postpone surgery [12]. However, no indication was given in that study concerning the causes of failure, including the rates of SSI. Functional outcome (auditory status, tympanic closure) was not collected during our study and the occurrence of SSI ended the follow-up. Data concerning the effects of SSI on functional outcome could have helped in the decision to postpone surgery in the event of a wet ear. This was especially true in the event of minor SSI such as delayed purulent ear discharge accessible to local antibiotic therapy without the need for surgery or rehospitalisation. Ears with active COM are usually treated medically before surgery to stop the discharge and lower mucosal inflammation [12]. The only active COM ears that we operate are those that are resistant to medical treatment and where surgery may help in controlling the inflammatory process by removing any infective tissues and re-establishing normal middle ear cavity ventilation. Concerning antibiotic prophylaxis, a recent meta-analysis showed that there was no significant evidence that antibiotic prophylaxis is helpful in reducing SSIs after ear surgery [14]. The same authors also found a bias in some studies where surgical wound class was determined pre-operatively according to the type of surgery without taking intra-operative findings into account [14].

The late SSI diagnosed in this study were not due to nosocomial infection in view of their time to onset. Unlike early SSI, late SSI mechanisms seem to involve anatomical modifications of middle ear cavities due to surgery and chronic inflammatory activity of COM before surgery. Otorrhoea during the 6 months before surgery could be a marker of this chronic inflammation and is associated with late SSI onset, while wet ear at the time of surgery seems only to predict early SSI.

The anatomical goals of COM surgery to avoid recurrence are the removal of all inflammatory tissue and the readjustment of the V/S ratio where V is for ventilation (the volume of air circulating in the middle ear) and S is for surface (the area of the walls of the middle ear cavities) [21]. In some cases of common tympanoplasty, tympanic membrane repair may impair ventilation of the middle ear and decrease the elimination of inflammatory secretions. This can lead to SSI even if the normal anatomy has been restored. Massive cholesteatoma or recurrent COM need a wide opening of the antromastoid cavities using the CWD method, and perfect ventilation is difficult to achieve in such cases, leading to recurrent infections. This kind of surgery, especially in multi-operated ears, might be more rapid than simple tympanoplasty in ears with fewer extended lesions. This might partly explain the paradoxical correlation between late SSI and shorter duration of surgery. Long duration of surgery is usually associated with SSI, a parameter that is included in the NNIS score [11 22]. However, duration of surgery does not seem to influence retroauricular wound infection rates at 3 weeks after tympanomastoid surgery [4]. The association between fibrin glue usage and late SSI remains unclear and has not been reported to date either in either ear surgery or in interventions involving other areas of the body. The small number of patients in our study in whom fibrin glue was used could have introduced a bias. The number of cases with fibrin glue use may also have been biased. Fibrin glue is often used with bone powder or hydroxyapatite to fill mastoid cavities, but these materials are to be avoided in the event of active inflammation. Further studies are needed to confirm this association.

A limitation in of the present study was the absence of exhaustive bacteriological analysis. Only a few sterile bacteriological analyses were performed for every case of wet ear and for each case of SSI. The data obtained were not sufficient to draw conclusions about important questions such as the difference between pre- and post-operative bacteriological flora or the pre-operative identification of germs significantly implicated in SSI.

Conclusions

The abovementioned data highlight the need for specific SSI surveillance procedures and for risk indices in otologic surgery [22]. Larger studies would help to confirm our results and the use of long-term functional parameters and bacteriological analysis would help aid in guiding the clinician when confronted by the different kinds of COM that may be encountered.

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