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OTOLOGY

Perichondritis of the auricle: bacterial findings and clinical evaluation of different antibiotic regimens

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Abstract

Purpose *Pseudomonas aeruginosa* is commonly found in suppurative perichondritis, but the significant pathogens in non-abscess perichondritis are unclarified. We aimed to explore the bacterial findings and evaluate the effectiveness of different antibiotic regimes in the treatment of patients with perichondritis.

Methods All patients treated for perichondritis at the two Ear–Nose–Throat Departments in Central Denmark Region (covering 20% of the Danish population) from January 1990 to October 2018 were included.

Results In total, 112 patients with ($n=12$) or without ($n=100$) abscess were included in the study. Potential pathogens were found in 40 of 55 cultures. *P. aeruginosa* was recovered in 58% of abscess cases, while Staphylococcus aureus was predominant in non-abscess infections (49%). Eighty-two percent of *S. aureus* recovered were isolated as heavy or moderate growth. In non-abscess cases, no significant differences in clinical progress ($p=0.65$), alteration in antibiotic therapy ($p=0.31$), duration of hospitalization ($p=0.65$), or frequency of relapse of infection ($p=1.00$) or sequelae ($p=0.38$) were found between patients treated with antibiotics covering *S. aureus* vs. *P. aeruginosa*.

Conclusions Our findings suggest that intravenous antibiotic therapy covering *S. aureus* is sufficient and appropriate empirical treatment in the majority of patients with non-abscess perichondritis. Antibiotic coverage should be expanded to include *P. aeruginosa* if the clinical response is disappointing or cultures grow *P. aeruginosa*. The risks and downsides to this approach seems limited as only a minority of patients suffered (minor) cosmetic sequelae and relapse of infection in our cohort of non-abscess perichondritis patients initially treated with antibiotics not covering *P. aeruginosa*.

Keywords Perichondritis · Antibiotics · Bacteria · Pathogens · *Pseudomonas aeruginosa* · *Staphylococcus aureus*

Introduction

Perichondritis of the auricle is a complication of the traumatized ear, which can lead to cosmetic sequelae [1]. Though the incidence may be increasing with the growing popularity of transcartilaginous ear piercing, perichondritis is a relatively rare condition and the literature consists of case reports and only few cohort studies [2–10]. There is a growing body of evidence that *Pseudomonas aeruginosa* is the major pathogen in suppurative (abscess) perichondritis and researchers uniformly recommend antibiotic therapy covering this facultative anaerobe bacterium in these cases [1–5]. The pathogens associated with non-abscess perichondritis is unclarified, but *P. aeruginosa* and *Staphylococcus aureus* have been isolated in a (limited) number of cases [2, 3]. Disregarding a few case reports [6–9], no studies on the clinical outcomes in patients treated with different antibiotic regimens has been published.

Pseudomonas aeruginosa is widespread in nature and thrives on moist surfaces. In immunocompetent persons, it is known to cause otitis externa, keratitis, hot tub folliculitis, post-operative abscesses, and burn infections. Initial treatment with two broad-spectrum antibiotics is generally recommended because of its intrinsically advanced antibiotic resistance and ability to acquire additional resistance. *Staphylococcus aureus* is part of the normal flora of the nose and

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less frequently the skin and pharynx. It is a well-described pathogen in multiple infection entities including wound infections, abscesses, and skin infections. In contrast to *P. aeruginosa*, single treatment with a beta-lactamase antibiotic with extended spectrum (e.g. dicloxacillin, amoxicillin with clavulanate) or a cephalosporin is sufficient. The great difference in antibiotic regimens and their associated side effects and contribution to the antibiotic pressure and resistance development makes it important to gain knowledge on the significant pathogens associated with non-abscess perichondritis and the outcomes of different antibiotic regimens.

We hypothesized that *P. aeruginosa* is not the only pathogen in non-abscess perichondritis and, hence, some patients may be treated sufficiently with less comprehensive antibiotic therapy. The aim of the current study was to explore the significant pathogens in auricular perichondritis and evaluate the clinical outcomes in non-abscess patients treated with different antibiotic regimens.

Materials and methods

All patients with perichondritis of the auricle (ICD10 code H61.0) at the two Ear–Nose–Throat Departments in Central Denmark Region (Aarhus University Hospital and Regional Hospital West Jutland) from January 1990 to October 2018 were included. We excluded patients with necrotizing otitis externa and those thought to have non-infectious inflammation (e.g. relapsing perichondritis, not treated with antibiotics) ($n=22$). Clinical diagnosis of acute perichondritis was based on acute (duration of symptoms < 3 weeks) inflammation of the auricle without involvement of the lobule, with or without secretion of purulence or fluctuant abscess.

The following data were retrospectively obtained from the medical records: age, gender, duration of symptoms, antibiotic treatment prior to admission, bacterial findings, semi-quantification of clinical progress (see below), antibiotic and surgical treatment, duration of hospitalization, complications, and sequelae.

An arbitrary semi-quantification of clinical progress was used to evaluate the clinical outcome of different antibiotic regimens in the current study: worsening, unchanged (no improvement or worsening for a period of 3 days or more), slow progress (regression of symptoms and findings to cure during 7 days or more), moderate progress (regression of symptoms and findings to cure during 3–6 days), fast progress (regression of symptoms and findings to cure during 2 days or less).

Culturing and identification of bacteria were performed as part of the routine diagnostic procedures.

During the 28-year period culturing of the samples and bacterial identification have varied slightly, but the routine procedures have always supported growth and identification of *S. aureus* and *P. aeruginosa*. Briefly, blood agar plates with a streak of *S. aureus* alone or in combination with a chocolate agar plate were used to culture the specimens from skin and secretion swabs. The media were incubated both aerobically in a moist atmosphere and in the presence of 5% carbon dioxide (CO_2) at 35 °C. Pus swabs from abscesses were additionally incubated anaerobically using anaerobic agar plates. All media were incubated for 2 days. Species identification was performed in the early years by phenotypic tests and for the last 10 years been done using matrix-assisted laser desorption/ionization time-of-flight mass spectrometry (MALDI-TOF). Colony-counts of *S. aureus*, *P. aeruginosa,* and hemolytic streptococci were reported semi-quantitatively. Other microbes were only reported when in monoculture and high colony-counts.

In connection with the revision of the local antibiotic guidelines for the treatment of acute perichondritis at the Department of Otorhinolaryngology, Aarhus University Hospital, in late 2017, we noted that empirical treatment with dicloxacillin was unsuitable for patients with suppurative perichondritis, but we were doubtful if *P. aeruginosa* coverage was necessary in all cases of non-abscess perichondritis. The guidelines were altered to ciprofloxacin and piperacillin–tazobactam in all cases.

The study was approved by the Danish Data Protection Agency (# 1-16-02-39-19) and Danish Patient Safety Authority (# 3-3013-2825/1).

Statistical analyses were performed using the Fisher's exact test for categorical variables (number of patients with relapse of infection, sequelae, and antibiotic treatment prior to admission) and the Students *t* test for continuous variables (duration of hospitalization and symptoms) in between-groups comparisons. The Kruskal–Wallis test was used for the comparison of semi-quantitative growth distributions and clinical progress distributions [11]. The Chi-square test was used to calculate monthly and seasonal variation. The normality of the data was assessed using quantile–quantile (QQ) plots. Statistical significance was defined as $p<0.05$.

Results

In total, 112 patients with acute perichondritis were included in the study. Their mean age was 43 years (SD 23) and 43 (38%) were males. Patient symptoms included sore swelling of the auricle (100%), pain (96%), and fever (13%). Incision of an abscess was performed in 12 patients, while 100 patients were treated with antibiotics only. The majority (65/112) of patients were treated with oral antibiotics before admission, most frequently dicloxacillin (36/112) and phenoxymethyl-penicillin (16/112). Apparent etiological factors for infection could be determined in 63% of patients, included piercing ($n=32$), other types of trauma

($n=18$), eczema ($n=11$), otitis externa ($n=6$), and chronic ulcer ($n=4$).

Swabs from the skin (defect) ($n=15$), secretion ($n=28$), and pus ($n=12$) grew potential pathogens in 40 of 55 cultures. *Pseudomonas aeruginosa* was the most prevalent pathogen recovered from abscesses (58%), while *S. aureus* was predominant in non-abscess infections (49%) (Table 1). *Pseudomonas aeruginosa* was recovered from three (7%) cultures in non-abscess cases. Ten of 22 *S. aureus* were isolated as heavy growth (4+), 8 as moderate growth (3+), 1 as sparse growth (2+), and 3 as poor growth (1+). No significant difference in semi-quantitative growth distributions were found between *S. aureus* and *P. aeruginosa* (seven 4+, two 3+, and one 1+) ($p=0.23$, Kruskal–Wallis test).

No significant monthly ($p=0.95$, Chi-square test) or seasonal ($p=0.72$) variation was found.

The following analyses regard the 100 patients without abscess development:

No significant difference in clinical progress (using the five-point semi-quantitative scale) was found between patients treated with antibiotics covering *S. aureus* vs. *P.aeruginosa* ($p=0.65$, Kruskal–Wallis test), or between dicloxacillin versus piperacillin–tazobactam ($p=0.31$) (Table 2).

The antibiotic regimen was altered in 5 of 43 patients treated with antibiotics covering *S. aureus* compared to none of 19 *P. aeruginosa*-covered patients ($p=0.31$, Fisher's exact test). Similarly, the trend towards less frequent altered antibiotics in patients initially treated with dicloxacillin (5/33) versus piperacillin–tazobactam (0/16) did not reach statistical significance ($p=0.16$).

Table 1 Culture results from 55 auricle swabs in 112 patients with acute perichondritis stratified by culture material

	Dry ear	Wet ear		
	Skin	Secretion	Abscess	All
Antibiotics before admission (no. of patients)	7	15	10	32
Number of cultures	15	28	12	55
Normal flora	6	8	1	15
Positive cultures	9	20	11	40
S. Aureus	6	15	1	22
P. Aeruginosa	1	2	7	10
Streptococcus Group A		1		1
Streptococcus Group B	1			1
Streptococcus Group C/G	3	1		4
Non-hemolytic streptococci			2	2
Enterococcus species	2	1		3
Prevotella Buccalus			1	1
Fusobacterium species		1		1
Polymicrobial	3	1	0	4

No significant difference in duration of hospitalization was found between patients treated with antibiotics covering *S. aureus* (mean 4.5 days) and *P. aeruginosa* (mean 4.0 days) ($p=0.65$, Students *t* test).

Ten patients had relapse of infection within 30 days of treatment. In hospitalized patients, no significant difference was found between patients treated with antibiotics covering *S. aureus* (7/32) and *P. aeruginosa* (2/13) ($p=1.00$, Fisher's exact test), or between patients treated with dicloxacillin (4/22) versus piperacillin–tazobactam (0/10) ($p=0.28$). Similarly, no significant difference in sequelae was found between patients treated with antibiotics covering *S. aureus* (3/24) and *P. aeruginosa* (3/12) ($p=0.38$), or between patients treated with dicloxacillin (3/16) versus piperacillin–tazobactam (2/9) ($p=1.00$). In non-hospitalized patients, follow-up information was only obtainable in 14 cases and only 1 patient suffered relapse and sequelae. All sequelae were cosmetic of nature and the majority were minor scars and cartilage enlargements. No patients suffered other complications.

No side effects potentially related to the antibiotic treatment were noted in the medical records.

Discussion

Our bacterial findings confirm that *P. aeruginosa* is the primary pathogen in perichondritis with abscess development. However, only 3 of 43 (7%) cultures from non-abscess cases grew *P. aeruginosa* and *S. aureus* was obtained in 21 (43%) patients. As *S. aureus* is (an infrequent) part of the normal skin flora, it is important to note that 82% of *S. aureus* recovered were isolated as heavy (4+) or moderate (3+) growth and without significant difference in semi-quantitative growth pattern to *P. aeruginosa*. Hence, these findings suggest that *S. aureus* is the major pathogen in non-abscess perichondritis. To our knowledge, no previous studies describe culture results from non-abscess perichondritis cases only. However, two studies included a significant number of non-abscess cases [2, 3]. In a study of 114 patients (8 patients underwent surgical intervention), Davidi et al. found *P. aeruginosa* in 25 of 36 external ear swab cultures [2]. Prasad et al. found *P. aeruginosa* (alone or in mixture) in 40 of 42 cultures from 61 patients (36 with abscess, 19 without abscess, and 6 patients with malignant otitis externa) [3]. Both studies suggest that *P. aeruginosa* play a major role in non-abscess cases. *S. aureus* was recovered in 19% and 12% of patients, respectively [2, 3].

In the evaluation of the clinical outcomes of non-abscess patients treated with antibiotics covering *S. aureus* versus *S. aureus* and *P. aeruginosa*, we were unable to detect statistically significant differences in clinical progress, the number of patients who required altered therapy because

Table 2 Antibiotic treatment and outcomes in 64 hospitalized patients with acute perichondritis of the auricle without abscess development

Coverage	Initial antibiotic(s), intravenous						All
	Streptococci covered	Streptococci and *S. Aureus* covered			Streptococci, *S. Aureus,* and *P.Aeruginosa* covered		
Antibiotics	Penicillin	Dicloxacillin	Cefuroxime	Clindamycin	Piptazo + ciprofloxacin	Cipro + dicloxacillin/cefuroxime	
No. of patients	2	33	9	1	16	3	64
Male gender	0	16	5	0	4	0	25
Age (years), mean	54	46	53	53	40	37	45
Duration of symptoms (days), mean[a]	2.0	4.9	6.4	2.0	3.9	14	5.2
Antibiotics prior to admission (no. of patients)[b]	1	19	7	1	7	2	37
Clinical progress (no. of patients)							
Worsening		1					1
Unchanged	1		1				2
Slow progress		11	1		2	1	15
Moderate progress		15	2	1	12	1	31
Fast progress	1	6	5		2	1	15
Altered antibiotic regimen[c]	1	5	0	0	0	0	6
Hospitalization (days), mean	2.5	4.5	4.4	4.0	3.8	5.3	4.3
Relapse of infection[d]	0/1	4/22	3/9	0/1	0/10	2/3	9/46
Sequelae[d]	0/0	3/16	0/7	0/1	2/9	1/3	6/36

[a]Antibiotics covering S. aureus (mean 5.2 days) versus *P. aeruginosa* (mean 5.6 days): $p = 0.75$, Students t-test.

[b]Antibiotics covering S. aureus (27/43) versus *P. aeruginosa* (9/19): $p = 0.28$, Fisher´s exact test

[c]Because of insufficient progress

[d]No. of patients / patients with follow up

of insufficient progress, duration of hospitalization, and prevalence of relapse or sequelae. There was a slight trend towards less patients with altered antibiotic therapy among *P. aeruginosa*-covered patients (0%), but antibiotics covering *S. aureus* was sufficient in the vast majority of cases in which this coverage was chosen. Our analyses are limited by the low incidence of disease (and resulting number of patients) and the likely selection of patients to different antibiotic regimes according to severity of infection. However, 17 of 21 patient, who were treated with antibiotics covering *P. aeruginosa* were included after the revision of the local antibiotic guidelines (from dicloxacillin to piperacillin–tazobactam) in 2017. Relapse of infection was present in both patients treated with antibiotics covering *S. aureus* (22%) and *P. aeruginosa* (15%). Similarly, 13% and 25% of patients had cosmetic sequelae after treatment with antibiotics covering *S. aureus* and *P. aeruginosa*, respectively. Prasad et al. reported that none of 19 patients with non-abscess perichondritis, who were treated with antibiotics only (differing combinations of intravenous penicillin, gentamicin, and amikacin), developed ear deformity [3].

In addition to the non-randomized design with likely selection of antibiotic therapy according to severity of infection described above, our study is limited by the incomplete follow-up, especially in non-hospitalized patients. However, the study covers all hospitals dealing with relapse of infection and other complications and sequelae in the catchment area, and we expect that the vast majority of patients whom were lost to follow-up, healed without significant morbidity. Though the medical charts were carefully read to include patients with perichondritis only, it is possible that a few patients had erysipelas. Study strengths include the relatively large cohort of patients obtained from all hospitals in Central Denmark Region covering 20% of the Danish population. To our knowledge, the current study is the first to report on the bacterial findings and outcome of different antibiotic regimens in non-abscess perichondritis patients only.

The current study was an attempt to answer the important question, if anti-pseudomonas treatment should be given in all cases of non-abscess perichondritis or empirical treatment directed at *S. aureus* is sufficient? The answer has several implications. *P. aeruginosa* is intrinsically less susceptible to a wide range of antibiotics and is known to acquire resistance easily. Therefore, initial double antibiotic therapy is recommended in severe infections caused by *P.*

aeruginosa. This very broad-spectrum treatment is associated with frequent and occasionally severe side effects, contribute to the antibiotic pressure, and require hospitalization (ciprofloxacin is the only oral anti-pseudomonas drug recommended in Denmark). Ciprofloxacin has some activity against *S. aureus* and shows excellent tissue penetration, but its use is restricted in children (18% of our patients were < 18 years of age) because of the risk of damaging the growing joint cartilage.

Our findings suggest that intravenous antibiotic therapy covering *S. aureus* is sufficient and appropriate empirical treatment in the majority of patients with non-abscess perichondritis. Oral antibiotics covering *S. aureus* may also be sufficient empirical treatment in selected cases (minor infections, not previously treated). However, antibiotic coverage should be expanded to include *P. aeruginosa* if the clinical response is disappointing or cultures grow *P. aeruginosa*. The risks and downsides to this approach seems limited as only a minority of patients suffered cosmetic sequelae and relapse of infection (similarly to patients initially treated with anti-pseudomonas therapy), and no patients developed severe ear deformity or other complications in our cohort of non-abscess perichondritis patients initially treated with antibiotics not covering *P. aeruginosa* ($n = 79$).

Compliance with ethical standards

Conflict of interest None.

Ethical approval According to Danish law, no ethical approval was necessary in this retrospective study.

Informed consent According to Danish law, it is illegal to contact patients to obtain informed consent in retrospective studies, but permission to conduct the study was given by the Danish Patient Safety Authority (# 3-3013-2825/1).

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