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Review Article

Bacterial infections in patients with nipple piercings: a qualitative systematic review of case reports and case series

Abstract

The main objective of this review is to identify the most frequently isolated bacteria in patients with infections related to nipple piercings in case reports and case series. In addition, the aim is to describe clinical manifestations and antecedents. There is a protocol of this review. The terms "bacterial infections", "nipple piercing" and their synonyms were considered. Pubmed/Medline, Scopus, Embase, Web of Science core collection and Ovid/Medline databases were searched until November 15, 2021 without date or language restrictions. Two authors extracted the articles and three other authors performed the selection, first by title and abstract, and second by full-text revision. Discrepancies were resolved with yet two other authors. Quality was assessed using the Joanna Briggs checklists. Finally, data extraction was realized. A total of 1,531 articles were extracted, of which 20 articles were included, and one article was added by hand-searching. The final number of articles included was 21, all of them with acceptable quality of evidence. Twenty-seven patients were considered (23 women and 4 men), aged between 15–60 years old. The most frequent bacterial genus in case reports and case series was *Staphylococcus* (n=10), and the most frequent species was *M. fortuitum* (n=6), although etiology seems to be diverse. The breast was the main affected organ, and the most frequent findings were fluid collection, pain, erythema, granulation tissue and swelling. The suspicion of infection by this bacterial species could be taken into account when it is associated with nipple piercings; however, larger studies are required to give a conclusion based on the evidence.

Keywords: bacterial infections, breast abscess, nipple piercing, MeSH-NLM

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Introduction

Piercing is a type of body modification performed by inserting a large gauge needle through skin or cartilage, creating a fistula-like opening, usually adorned [1]. A survey in the United States reported that 35% of participants claimed to have had piercings, and 14% in places other than the earlobe [2]. Additionally, a survey conducted in France showed that people aged 25 to 34 had the highest prevalence of having a piercing, with greater frequency in women [3]. The most common visible locations for those perforations are the face, nose and ears; the semi-visible areas are the navel and tongue; and not-visible, such as nipples and perineum, have become common types of body art in both genders [4].

Nipple piercings (NP) can cause both non-infectious and infectious complications. Non-infectious complications include injuries when playing contact sports, galactorrhea when nipples are stimulated, etc. [5]. On the other hand, NP could favor the access of pathogens that lead to local infections at the area of perforation that could spread to surrounding tissues, causing mastitis or abscesses [6]. The isolation of the specific type of bacteria could be essential to choose the most appropriate treatment. In general, the therapeutic approach for breast abscess recommends accompanying the drainage with antibiotics focused on the suspicion of *S. aureus* [7]. However, the presence of NP may predispose to infections caused by other types of pathogens. There are systematic reviews about etiology and complications from ear cartilage [8], tongue [9] and lip [9] piercings. However, to date there is no systematic review about the complications or etiology of NP, the incidence of which appeared to be 21% [10]. Additionally, the presence of NP is significantly associated to the development of breast abscess [11], a clinical manifestation of bacterial breast infections. Therefore, in order to answer a specific question with evidence-based methodology, this systematic review focuses on bacterial infections in patients with nipple piercings. Nowadays, the main source of information about bacterial infections associated with NP are case reports

and case series. Consequently, in order to determine which are the most commonly isolated bacteria in these patients, these types of publications have been critically reviewed in this article. In addition, clinical manifestations and antecedents are described.

Materials and methods

Case reports and case series about bacterial infections in the mammary region, heart, skin or blood in patients with an antecedent of NP were searched. In this review, "case series" are defined as those studies in which more than 5 cases are reported [12]. There is a pre-published protocol of this systematic review registered in PROSPERO, CRD42021236900 (https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42021236900). This review was conducted in accordance with PRISMA [13] (Attachment 1, Supplementary Material 1).

Data sources and search

PubMed, Scopus, Embase, Web of Science core collection and Ovid/Medline databases were searched until November 15, 2021. The terms "bacterial infections", "nipple piercing" and their synonyms were considered; however, terms referring to piercings in other body locations were excluded. There were no date or language restrictions. The PubMed search strategy was modified for use in other databases (Attachment 1, Supplementary Material 2). Additionally, a hand-search was performed in the same databases to identify other potentially relevant articles.

Selection criteria

The inclusion criteria were: 1) having an NP; 2) bacterial infection in the mammary region, associated skin, heart or blood; and 3) isolation and identification of the bacterial genus and species. The following exclusion criteria were considered: 1) incorrect population: patients infected by other types of microorganisms (viruses, fungi, parasites) or patients without NP; 2) incorrect publication type: revisions, misprints, etc.; 3) not having access to full-text; and 4) reports that did not specify causative agent. In addition, not all patients from every selected article were included; in contrast, just those patients in which the infection-causing bacteria was identified were included, defined as "eligible cases".

Selection of studies

Two authors (GAAV, MMAS) exported the articles from the databases to Rayyan software (https://www.rayyan.ai/). Then, duplicates were removed to continue with the selection, carried out independently by three authors (LMAC, KAZA, CAAM), first by title and abstract, and second by full-text revision. Discrepancies were resolved with two other authors (CAAA and AAAC).

Data extraction

Data were extracted and verified by all the authors. The following data were extracted: 1) author; 2) age and sex of the patient; 3) compromised nipple; 4) the length of time the patient had the NP; 5) clinical presentation and antecedents; and 6) isolated bacteria and treatment in each case.

Quality assessment

The quality was assessed using the Joanna Briggs Institute checklist for case reports [14] and for case series [15]. Acceptable quality was considered for cases that satisfied 5 appraisal items [16].

Results

Selected studies

A total of 1,531 articles were extracted from PubMed (n=175), Scopus (n=444), Embase (n=486), Web of Science core collection (n=137) and Ovid/Medline (n=288). Additionally, one article was added by hand-searching in the five electronic databases mentioned [17]. Removal of duplicate articles resulted in a total of 488. In the selection by title and abstract, 431 articles were eliminated. With the remaining 57, a full-text review was carried out, in which 36 articles were excluded for the reasons given in Figure 1, where the flowchart of the selection process according to PRISMA is shown [13]. Finally, 21 articles were considered in this review [17], [18], [19], [20], [21], [22], [23], [24], [25], [26], [27], [28], [29], [30], [31], [32], [33], [34], [35], [36], [37].

Characteristics of the selected studies

Twenty-one articles were included for qualitative synthesis, all of them with acceptable quality of evidence (Attachment 1 , Supplementary Material 3). Four out of 21 articles were case series, and the rest were case reports. Regarding the case reports, one of them presented three eligible cases [19]; on the other hand, three of the case series presented more than one eligible case: one of them presented three [27] and the other, four [30]. All other articles only presented one eligible case, such that 27 patients were considered in total. The following data is summarized for each eligible case: 1) patient characteristics; 2) clinical presentation and antecedents; and 3) isolated bacteria. Additional information can be found in Table 1.

Patient characteristics

Of the 27 patients, 23 were women [17], [19], [20], [23], [24], [25], [27], [28], [29], [30], [31], [32], [33], [34], [35], [36], [37] and 4 were men [18], [21], [22], [26], with an age range between 15–60 years old. With regard

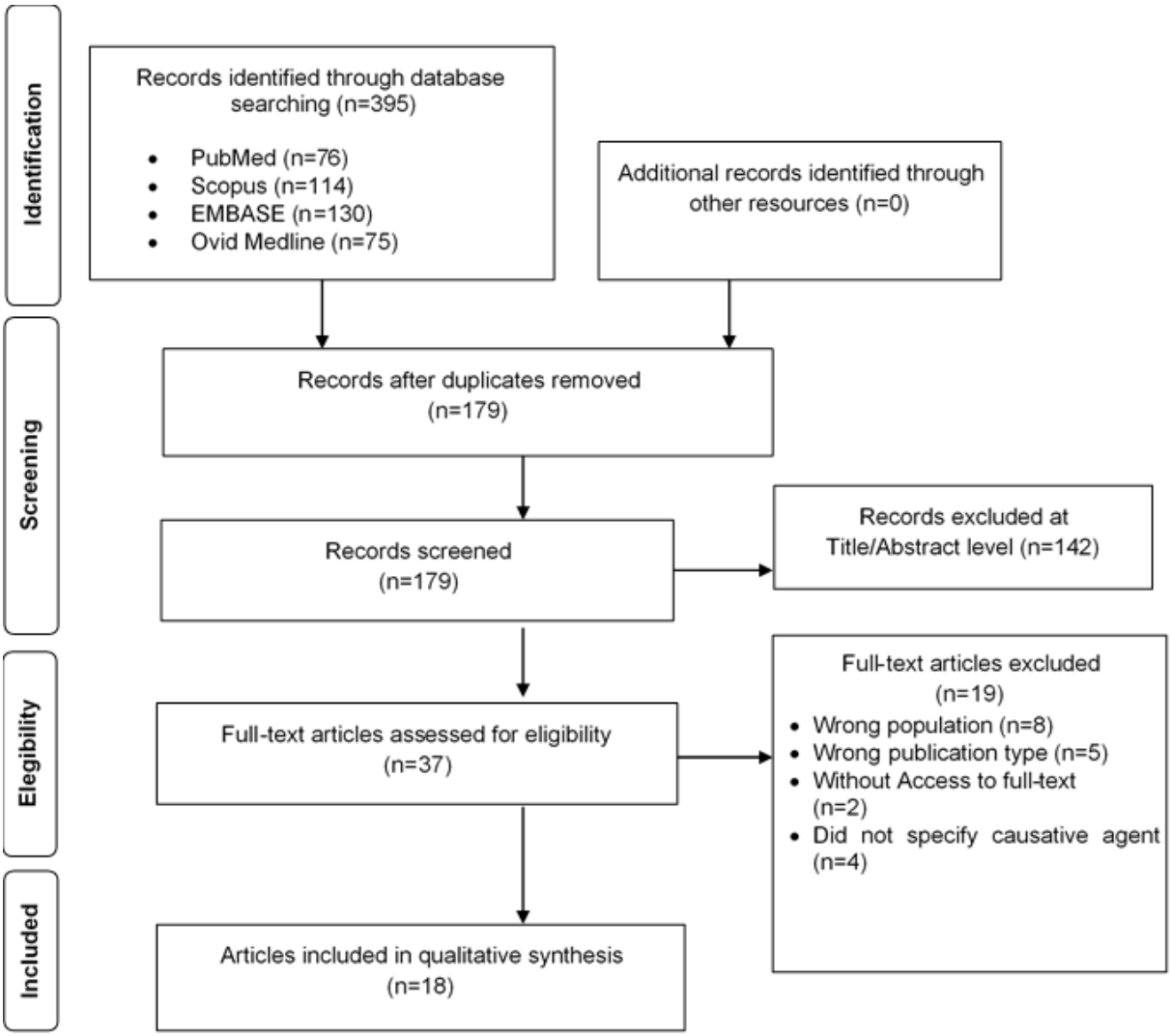

Figure 1: PRISMA flowchart

to the piercing location, 15 patients had the piercing in the right nipple [17], [18], [20], [21], [23], [25], [27], [28], [29], [31], [34], [35], [36], 7 in the left nipple [19], [22], [24], [26], [32], [33], and 1 in both nipples [37]; however, in four patients this information was not described [30]. The time between the placement of the piercing and the infection was not specified in nine cases [18], [24], [28], [30], [33]; on the other hand, regarding those that were specific: 3 patients had NP for a period less than 1 month [17], [23], [27]; 7 patients had NP for a period greater than 1 month but less than 6 months [19], [22], [25], [26], [29], [34], [37]; 6 patients had NP for a period greater than or equal to 6 months but less than or equal to 1 year [19], [20], [21], [27], [32], [36]; and only 3 patients had NP for more than 1 year [27], [31], [35].

Clinical presentation and antecedents

The breast was the main affected organ in the clinical presentation. Breast fluid collection was found in 22 patients [17], [18], [19], [20], [21], [23], [24], [25], [26], [27], [28], [29], [31], [32], [33], [34], [35], [36], breast pain or tenderness in 10 patients [18], [19], [23], [25], [27], [28], [32], [34], [35], [36], breast enlarging or swelling in 9 patients [17], [18], [19], [21], [25], [26], [27], [34], breast erythema in 8 patients [17], [18], [19], [25], [26], [31], [32], [34], and granulomatous tissue in 5 patients [19], [24], [28], [36], [37]. The following findings were not reported in more than one patient: chest wall cellulitis [22], retroareolar cellulitis [21], dyspnea and productive cough with bloody sputum [22], hyperpigmentation [24], breast induration [17] and endocarditis [22].

Some antecedents were reported, as follows: sexual contact with possible exposure of the pierced nipple [21], [31], smoking [19], [29], [35], breast implants [19], [32], pectoral and calf implants [18], exposure or swimming in dirty water [33], or in the ocean [24], [26], touching the nipple with objects [35] and the presence of prosthetic aortic valve [22]. Clinical presentation and antecedents of the patients are summarized individually in Table 2.

Table 1: Characteristics of the included studies

Author	Age	Sex	Country	Year	Study design
Brook I [17]	15	F	USA	2001	Case report
De Kleer N [18]	60	M	Canada	2001	Case report
Siddique N [29]	30	F	USA	2020	Case report
Ceniceros A [31]	32	F	USA	2019	Case report
Cornelissen A [32]	45	F	Netherlands	2017	Case report
Drifmeyer E [26]	29	M	USA	2007	Case report
Abbas K [33]	21	F	Netherlands	2014	Case report
Pearlman M [34]	19	F	USA	1995	Case report
Abdulrahman G [35]	22	F	UK	2015	Case report
Trupiano J [36]	17	F	USA	2001	Case report
Lewis C [37]	29	F	USA	2004	Case report
Jacobs V [19]	35	F	Germany	2002	Case series
Jacobs V [19][a]	28	F			
Zardawi I [20]	29	F	Australia	2004	Case report
Pendle S [21]	38	M	Australia	2016	Case report
Ochsenfahrt C [22]	24	M	Germany	2001	Case report
Bader M [23]	17	F	Canada	2007	Case report
Maroun E [24]	42	F	USA	2012	Case report
Bengualid V [25]	17	F	USA	2008	Case report
Shoyele O [28]	28	F	USA	2018	Case series
Leibman A [27]	30	F	USA	2011	Case series
Leibman A [27][a]	28	F			
Leibman A [27][b]	44	F			
Baker G [30]	30[d]	F	USA	2019	Case series[e]
Baker G [30][a]	30[d]	F			
Baker G [30][b]	30[d]	F			
Baker G [30][c]	30[d]	F			

M: male, F: female, [a]second eligible case from the same article, [b]third eligible case from the same article, [c]fourth eligible case from the same article, [d]mean age in the studied patients, [e]published as conference abstract

Isolated bacteria

The most frequently isolated bacterial genera were *Staphylococcus* (n=10) and *Mycobacterium* (n=9), all in different patients except for two of them [19], [34]. All isolated *mycobacteria* were non-tuberculous *mycobacteria* (NTM). In total, there were 6 cases of infection due to *M. fortuitum* [24], [25], [26], [29], [33], [37]; 8 cases due to coagulase-negative *Staphylococcus* [19], [22], [32], [34], [35], 4 of them confirmed as *S. epidermidis* [22], [32], [34], [35]; 2 due to *N. gonorrhoeae* [21], [31]; 2 due to *S. aureus* [23], [27]; 2 due to *S. agalactiae* [19], [27]; and 2 due to *P. acnes* [28], [30]. In addition, the following bacteria were identified in one patient only: *A. turicensis* [35], *G. terrae* [20], *P. melanogenica* [25], *P. intermedia* [17], *P. anaerobius* [17], *Nocardia* sp. [33], *M. chelonei* [34], *P. harei* [35], *M. abscessus* [36], *M. holsaticum* [19], *M. agri* [19], *M. brumae* [19], *Actinomyces* [27], *P. acnes* [30], *C. amycolatum* [30], *H. parainfluenzae* [30], group A beta-hemolytic *Streptococcus* [18], a "green microaerophilic *Streptococcus*" [19], and a rare gram-positive coccus not otherwise specified [30]. On the other hand, some cases corresponded to co-infections, for example: *M. fortuitum* was reported as coinfection in two cases, in one of them with *P. melanogenica* [25] and in the other case with *Nocardia* sp. [33]; *S. epidermidis* was also reported as coinfection in two cases, in one of them with *M. chelonei* [34] and in the other case with *Actinomyces* and *P. harei* [33]; also, one of the *S. agalactiae* cases was actually a co-infection with coagulase-negative *Staphylococcus* [19]; moreover, *P. intermedia* was reported with *P. anaerobius* [17]; finally, there was a co-infection of *C. amycolatum*, *P. acnes* and *H. parainfluenzae* [30]. Isolated bacteria, as well as treatments for each patient are summarized in Table 3.

Table 2: Antecedents and clinical presentation

Author	Clinical presentation
Brook I [17]	A: – CP: Collection of fluid, erythema, swelling and induration in the mammary region
De Kleer N [18]	A: Bilateral pectoral and calf implants CP: Collection of fluid, fever, headache, swelling, erythema and tenderness in the pectoral region
Siddique N [29]	A: Smoker CP: Collection of fluid in the mammary region
Ceniceros A [31]	A: Sexual encounters with mouth-nipple contact CP: Collection of fluid and erythema in the mammary region
Cornelissen A [32]	A: Breast implants before NP CP: Collection of fluid, pain and erythema in the mammary region
Drifmeyer E [26]	A: Sailor CP: Collection of fluid, pain and erythema in the mammary region
Abbas K [33]	A: Swimming in “dirty waters with algae” after placement of the NP CP: Collection of fluid in the mammary region
Pearlman M [34]	A: – CP: Collection of fluid, pain, erythema, and swelling in the breast region
Abdulrahman G [35]	A: Smoker; occasionally rubs the compromised nipple with objects CP: Collection of fluid and pain in the mammary region
Trupiano J [36]	A: – CP: Collection of fluid, granulomatous tissue and pain in the mammary region
Lewis C [37]	A: – CP: Granulomatous mass-shaped tissue in the mammary region
Jacobs V [19]	A: Obesity; nicotine abuse; tongue piercing CP: Collection of fluid and granulomatous tissue in the mammary region
Jacobs V [19][a]	A: Nicotine abuse; the patient removed the piercing CP: Collection of fluid and pain in the mammary region
Zardawi I [20]	A: – CP: Collection of fluid in the mammary region
Pendle S [21]	A: Sexual encounter with mouth-mouth and mouth-nipple contact CP: Retroareolar cellulitis, collection of fluid and swelling in the mammary region
Ochsenfahrt C [22]	A: Congenital bicuspid aortic valve and aortic coarctation, the latter undergoing surgery at 9 years of age CP: Endocarditis, cellulitis of the chest wall, dyspnea, productive cough with bloody sputum
Bader M [23]	A: – CP: Collection of fluid and pain in the mammary region
Maroun E [24]	A: Smoker; uterine fibroids and iodine allergy; hot tub use and ocean swim CP: Collection of fluid, granulomatous tissue and hyperpigmentation of the mammary region
Bengualid V [25]	A: – CP: Collection of fluid, pain, erythema and swelling of the mammary region
Shoyele O [28]	A: – CP: Collection of fluid, cystic neutrophilic granulomatous mastitis, and pain from the mammary region
Leibman A [27]	A: – CP: Collection of fluid, swelling of the mammary region
Leibman A [27][a]	A: – CP: Collection of fluid, enlargement of the mammary region
Leibman A [27][b]	A: – CP: Collection of fluid and pain from the mammary region
Baker G [30]	A: – CP: –
Baker G [30][a]	A: – CP: –
Baker G [30][b]	A: – CP: –
Baker G [30][c]	A: – CP: –

A: antecedents, CP: clinical presentation, [a]second eligible case from the same article, [b]third eligible case from the same article, [c]fourth eligible case from the same article, –: not reported

Table 3: Isolated bacteria and treatment

Author	Isolated bacteria	Antibiotics	Surgical intervention
Brook I [17]	*Prevotella intermedia, Peptostreptococcus anaerobius*	Yes • Post-isolation: Clindamycin	Yes
De Kleer N [18]	Group A beta hemolytic *Streptococcus*	Yes Antibiotic type was NS	Yes
Siddique N [29]	*Mycobacterium fortuitum*	Yes Post-isolation: • TMP-SMX • Linezolid, Levofloxacin, TMP-SMX • Linezolid, TMP-SMX	Yes
Ceniceros A [31]	*Neisseria gonorrhoeae*	Yes Pre-isolation: • Clindamycin • Ceftriaxone, azithromycin Post-isolation: • Ciprofloxacin	Yes
Cornelissen A [32]	*Staphylococcus epidermidis*	Yes Antibiotic type was NS	Yes
Drifmeyer E [26]	*Mycobacterium fortuitum*	Yes Pre-isolation: • Cephalexin • Clindamycin Post-isolation: • Amikacin, Cefoxitin, Clarithromycin • Amikacin, Meropenem • Clarithromycin	Yes
Abbas K [33]	*Mycobacterium fortuitum, Nocardia*	Yes Pre-isolation: • TMP-SMX Post-isolation: • TMP-SMX, Levofloxacin • TMP-SMX, Azithromycin	Yes
Pearlman M [34]	*Staphylococcus epidermidis, Mycobacterium chelonei*	Yes Pre-isolation: • Cephalexin Post-isolation: • Amoxicillin, Clavulanic acid • Ciprofloxacin • Clarithromycin	Yes
Abdulrahman G [35]	*Staphylococcus epidermidis, Actinomyces turicensis, Peptoniphilus harei*	Yes Pre-isolation: • Flucloxacillin • Amoxicillin, Clavulanic acid	Yes
Trupiano J [36]	*Mycobacterium abscessus*	NP	Yes
Lewis C [37]	*Mycobacterium fortuitum*	Yes Post-isolation: • Amikacin, Cefoxitin • TMP-SMX, Clarithromycin	Yes
Jacobs V [19]	*Mycobacterium holsaticum, Mycobacterium agri, Mycobacterium brumae,* Coagulase-negative *Staphylococcus*	Yes Post-isolation: • Cefuroxime	Yes
Jacobs V [19][a]	Coagulase-negative *Staphylococcus, Streptococcus agalactiae*	Yes Post-isolation: • Sultamicillin • Cefuroxime, Flucloxacillin	Yes
Zardawi I [20]	*Gordonia terrae*	Yes Post-isolation: • Tetracycline	Yes

(Continued)

Table 3: Isolated bacteria and treatment

Pendle S [21]	*Neisseria gonorrhoeae*	Yes Post-isolation: • Ceftriaxone, Azithromycin	NP
Ochsenfahrt C [22]	*Staphylococcus epidermidis*	Yes Post-isolation: • Azithromycin, Gentamicin • Gentamicin, Vancomycin, Ofloxacine • Flucloxacillin	Yes
Bader M [23]	*Staphylococcus aureus*	Yes Pre-isolation: • Cefoxitin, Doxycycline, Clindamycin • Cefazolin, Clindamycin*	Yes
Maroun E [24]	*Mycobacterium fortuitum*	Yes Pre-isolation: • Cephalexin Post-isolation: • Levofloxacin, Azithromycin	Yes
Bengualid V [25]	*Mycobacterium fortuitum, Prevotella melanogenica*	Yes Pre-isolation: • Cefazolin • Amoxicillin, Clavulanic acid Post-isolation: • Amoxicillin, Clavulanic acid, Metronidazole, Ciprofloxacin, Clarithromycin	Yes
Shoyele O [28]	*Propionibacterium acnes*	Yes Pre-isolation: • Cefazolin • Amoxicillin, Clavulanic acid Post-isolation: • Amoxicillin, Clavulanic acid, Metronidazole, Ciprofloxacin, Clarithromycin	Yes
Leibman A [27]	*Streptococcus agalactiae*	NP	Yes
Leibman A [27][a]	*Actinomyces*	NP	Yes
Leibman A [27][b]	*Staphylococcus aureus*	NP	Yes
Baker G [30]	Coagulase-negative *Staphylococci*	NS	NS
Baker G [30][a]	Coagulase-negative *Staphylococci*	NS	NS
Baker G [30][b]	*Corynebacterium amycolatum, Propionibacterium acnes, Haemophilus parainfluenzae*	NS	NS
Baker G [30][c]	A rare gram-positive cocci not otherwise specified	NS	NS

TMP-SMX: Trimethoprim-sulfamethoxazole, NS: not specified, NP: not performed, *the patient also received intravenous immunoglobulins, [a]second eligible case from the same article, [b]third eligible case from the same article, [c]fourth eligible case from the same article

Discussion

Cases of breast abscess in non-lactating patients usually present a combined flora of *S. aureus*, *Streptococcus*, and anaerobic bacteria [38]. In this review, the most frequent bacterial genus was *Staphylococcus* (n=10); followed by *Mycobacterium* (n=9), specifically coagulase-negative *Staphylococcus* and NTMs, respectively; and the most commonly identified species were *M. fortuitum* (n=6) and *S. epidermidis* (n=4).

The fast-growing mycobacteria, or Runyon's group IV, are the most common cause of soft tissue Mycobacterium infection and they are often related to trauma [39]. According to the literature, infections by *M. fortuitum* (a fast-growing type of mycobacterium) appear to be unusual [40]. *M. fortuitum* usually causes skin and soft tissue infections after direct inoculation, such as in trauma, sur-

gery or cosmetic procedures; although, according to literature, it seems to be less frequent in the latter [41]. However, *M. fortuitum* was the most frequently isolated bacterial species in this review. In addition, *M. fortuitum* has also been isolated in infections related to other cosmetic procedures besides piercings, such as pedicures [42], [43], tattooing [44], and mesotherapy [45]. Five of the six cases of infection by *M. fortuitum* reported fluid collection. This fact is corroborated in the literature, since in most cases this type of bacteria causes pustules, nodules with or without suppuration, granulomas with the presence of a central or necrotic caseous area and a sporotrichoid pattern, with susceptibility to certain antibiotics, such as amikacin, clarithromycin, azithromycin, erythromycin, cefoxitin, and doxycycline [46].

Staphylococcus was the most frequent bacterial genus found in this review. *S. aureus* can cause localized inflammation, cellulitis, or even the formation of abscesses, which begin as a localized acute inflammatory response [47]. In fact, according to literature, most primary breast abscesses are associated with *S. aureus* infection, therefore empirical antibiotics are usually based on suspicion of this bacterium [7]. However, in this review, *S. aureus* was reported less frequently than *S. epidermidis*, which was isolated in 4 patients (although coagulase-negative *staphylococcus* was reported in 8 patients). Nevertheless, it should be noted that *S. epidermidis* was not the main cause of breast infection in two of these patients [34], [35]. *S. epidermidis* is a harmless commensal of the skin and mucous membranes; however, this pathogen can also cause infection from exogenous sources, such as endocarditis from native and prosthetic valves [48], catheter surfaces [49], and medical implants [50]. The latter has been reported in this review. One of the included articles reports a case of *S. epidermidis* infection in a patient with history of bilateral augmentation with silicone implants two years before placing the NP in both nipples [32]. In addition, there was a similar case with pectoral and calf implants; however, in this patient group, A beta-hemolytic *streptococcus* was isolated [18]. Additionally, another of the reviewed cases reports a native valve endocarditis due to the spread of *S. epidermidis* from a previous mastitis [22]. Since *S. epidermidis* is a human commensal, all of the case reports suggest a contamination by the normal flora of the skin in which the access point is the hole created by the NP.

Two cases of *N. gonorrhoeae* infection were also identified. These two patients reported recent sexual contact involving the NP, one with the partner's penis [31], and the other with the mouth [21]. *N. gonorrhoeae* can be easily transmitted from men to their sexual partners, since it can adhere to sperm, causing high bacterial concentrations in this fluid [51]. In one of these patients [31], penis-nipple contact was doubtful, but mouth-nipple contact was reported; in the same way in the other one [21], in which all types of contact with ejaculatory fluid were denied, but vigorous contact of mouth-mouth and mouth-nipple type was confirmed. Although the main transmission mechanism is through direct penile-vaginal contact or vice versa, representing approximately 70% of the cases according to literature [52], saliva could represent the transmission path in the cases presented in this review, since the presence of *N. gonorrhoeae* in saliva and pharyngeal secretions has been previously demonstrated [53].

A large number of patients were women. This seems to be related to the fact that the use of NP is more common in women, but actually literature suggests that NP is more common in men [2], [54]. However, NP could cause more problems in women than in men, since women have more adjacent subcutaneous tissue in the breast region, which represents an entry route for pathogenic organisms [40]. Obesity [19] and smoking [29], [35] were the main antecedents reported in this review. In fact, these two variables were previously identified as risk factors for the development of breast abscess [11], [55]. Moreover, it is advisable to ask the patient about the history of NP, even when this is not evident in the clinical presentation, since the patient could have removed it before [36].

It is suggested to start antibiotic treatment as soon as a bacterial skin infection is suspected, after taking a culture, then maintaining or changing the antibiotic according to the results of the antibiogram, depending on the individual case. Additionally, if the case corresponds to a breast abscess, it will be necessary to drain or aspirate the fluid. On the other hand, culture results sometimes could be negative, but because of clinical features and the casuistry found in this review, the clinician will have to assess whether to continue or suspend the antibiotic treatment. Most of the patients – 22 out of 27 total to be precise – presented fluid collection in the mammary region. The therapeutic approach guides for breast abscesses recommend accompanying the drainage with targeted antibiotics for the suspicion of *S. aureus* [7]. Although etiology in patients with NP seems to be diverse, the suspicion of infection by *M. fortuitum* could be taken into account. However, we suggest larger studies (i.e., case control studies) to confirm, based on evidence, a possible association between NP and *M. fortuitum* infection. Despite having considered thorough exclusion criteria and a critical appraisal checklist, the results of the case reports and case series by their nature are not representative for the entire population. However, as it constitutes the only evidence available about the etiology of bacterial infections in patients with NP, this systematic review provides an important first step in determining the etiology of infections among different bacterial species in patients with nipple piercings, especially if the infection persists despite the initial treatment.

Conclusions

- The bacterial species with the highest frequency in the case reports and case series of patients with infections and NP was *M. fortuitum*.
- Despite the limitations of this review, the suspicion of infection by *M. fortuitum* could be taken into account, especially if the infection persists despite the initial treatment.
- Larger studies are needed to determine an association between NP and *M. fortuitum* infection.

Notes

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Competing interests

The authors declare that they have no competing interests.

Attachments

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1. Attachment1_id000080.pdf (121 KB)
   Supplementary Material

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