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Microbiology of breast abscesses[☆]

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ABSTRACT

Introduction: Treatment of breast abscesses is based on drainage and antibiotic therapy directed at the bacteria causing the infection. The aim of this study was to know the etiological agents of breast abscesses. **Methods:** Patients who had a culture-positive breast abscess between September 2015 and January 2020 were included in the study. Culture results were consulted in the laboratory database. It was collected from medical records if the patients presented the following risk factors: breastfeeding, diabetes or smoking. Abscesses secondary to surgical wound infection were excluded.

Results: Sixty patients were included, 58 women and 2 men. *Staphylococcus aureus* was the most frequent agent in lactating women. Anaerobic bacteria were isolated in 28 (61%) of 46 abscesses in non-lactating patients. In non-lactating patients, the frequency of anaerobes in abscesses was lower in diabetics than in the rest (0/5 vs 26/38; $P = .013$). In non-lactating and non-diabetic patients, the proportion of abscesses with anaerobes was higher in smokers than in non-smokers (21/24 vs 5/14; $P = .003$). Aerobic gram-positive cocci were the most frequent agents in diabetics.

Conclusion: Anaerobes were the most frequent agents, followed by *S. aureus*. The etiology of breast abscesses varied with the risk factors studied.

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Microbiología de los abscesos mamarios

RESUMEN

Introducción: El tratamiento de los abscesos mamarios se basa en el drenaje y la antibioticoterapia dirigida a las bacterias causantes de la infección. El objetivo de este estudio fue conocer los agentes etiológicos de los abscesos mamarios.

Métodos: Se incluyó en el estudio a los pacientes que, entre septiembre de 2015 y enero de 2020, tuvieron un absceso mamario con cultivo positivo. Se consultaron los resultados de los cultivos en la base de datos del laboratorio. Se recogió de las historias clínicas si los pacientes presentaban los siguientes factores de riesgo: lactancia, diabetes o hábito fumador. Se excluyeron los abscesos secundarios a una infección de herida quirúrgica.

Resultados: Se incluyeron 60 pacientes, 58 mujeres y 2 varones. *Staphylococcus aureus* fue el agente más frecuente en mujeres lactantes. Se aislaron bacterias anaerobias en 28 (61%) de los 46 abscesos en pacientes no lactantes. En los no lactantes, la frecuencia de anaerobios en los abscesos fue menor en diabéticos que en el resto (0/5 frente a 26/38; $P = .013$). En los no lactantes y no diabéticos, la proporción de abscesos con anaerobios fue mayor en fumadores que en no fumadores (21/24 frente a 5/14; $P = .003$). Los cocos grampositivos aerobios fueron los agentes más frecuentes en los diabéticos.

Conclusión: Los anaerobios fueron los agentes más frecuentes, seguidos por *S. aureus*. La etiología de los abscesos mamarios varió con los factores de riesgo estudiados.

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Introduction

Breast abscesses lead to considerable morbidity. They have a tendency to recur and can cause permanent sequelae, such as deformities of the breast or loss of ability to produce milk¹. Breast-feeding women, smokers and diabetic patients are at increased risk for breast abscess^{1–3}. Treatment is based on drainage and administration of antibiotics¹. The selection of empirical antibiotic therapy for breast abscesses should target the bacteria that most commonly cause these infections.

Studies on the microbiology of breast abscesses published to date indicate that there are a variety of bacterial species that can cause these infections, and demonstrate mixed results in terms of the relative contribution of different species or groups of bacteria^{2,4–20}. These disparities in the results of published studies may be due, at least in part, to differences in the screening criteria of the subjects and in the methodology adopted to carry out the cultures and interpret their results. The factors that make it difficult to compare different studies include: a) the fact that some studies include post-surgical infections along with primary breast abscesses, or puerperal and nonpuerperal abscesses, and do not provide disaggregated results^{2,10,11,16,17,19,20}; b) the fact that most publications, especially the most recent ones, do not describe the methodology used to carry out the cultures, and in particular whether or not the culture has been carried out for anaerobic bacteria^{2,8–10,12,14,15,17–20}; c) the fact that almost all of the published papers lack a description of the criteria used to interpret the cultures, which is especially important when it comes to attributing relevance to skin commensal bacterial species and common contaminants of cultures. This article studies the aetiology of primary breast abscesses using strict and explicit criteria to screen subjects, perform microbiological studies and interpret culture results. The objective of this study was to discover the aetiological agents of breast abscesses in our setting.

Materials and methods

Patients who had a breast abscess with a positive culture between September 2015 and January 2020 were retrospectively studied. The source of information for patient screening was the Microbiology Laboratory database. Direct microscopic examination of all breast abscess samples received in the laboratory was performed, and those with one or more epithelial cells per low-power field (100×) were excluded from the study. The following culture media were spiked with samples: blood agar, chocolate agar, blood agar with colistin and nalidixic acid (incubated at 35 °C in air with 5% CO₂ for at least three days), MacConkey agar (incubated one day in air at 35 °C), Schaedler agar and Schaedler agar with vancomycin and kanamycin (incubated at 35 °C in anaerobiosis for at least five days). A thioglycolate broth was also spiked and incubated at 35 °C for at least five days. Becton Dickinson (BD, Sparks, MD, USA) supplied the culture media until January 2019. Thereafter, BD supplied the Schaedler agar, the Schaedler agar with vancomycin and kanamycin and the thioglycolate broth, while bioMérieux (Marcy l'Étoile, France) supplied the rest of the culture media. Isolated microorganisms were identified by mass spectrometry (MALDI-TOF MS, bioMérieux), and species-level identifications with a 99.9% confidence level were considered valid. Limited growth of bacteria typical of the skin flora (coagulase-negative *Staphylococcus*, *Corynebacterium* and *Cutibacterium*) was deemed insignificant and ignored, except in the following cases: 1) the isolation in pure culture of *Staphylococcus lugdunensis* was always deemed significant, because its capacity to cause breast abscesses is understood²¹; 2) the isolation of other coagulase-negative *Staphylococcus* was deemed significant if direct

microscopic examination of the sample showed staphylococcal-compatible intraleukocytic Gram-positive cocci and no other Gram-positive cocci were isolated from the culture (own criterion); 3) the isolation of *Corynebacterium kroppenstedtii* was always deemed significant²²; 4) following previously published criteria²³, the isolation of other Gram-positive diphtheria-producing bacilli was deemed significant if the following four conditions were met: pure or predominant diphtheria-producing culture; b) direct microscopic examination of the sample with Gram-positive bacilli or >1 neutrophil per 100× field; c) presence in the patient of an erythematous or purulent lesion with clinical suspicion of infection; and d) the clinician agreed that the isolate was the cause of the infection, or moderate or abundant growth of the isolate was observed in the culture, and the clinical picture was highly suggestive of a role in infection²³. The presence of anaerobic bacteria in the culture was confirmed by the aerotolerance test (simultaneous subculture of chocolate agar, incubating it for 48 h at 37 °C in aerobiosis with 5% CO₂, and Schaedler agar, incubating it for 48 h at 37 °C in anaerobiosis). If more than two morphotypes of anaerobic bacteria were observed in the culture without predominance of any of them, it was reported as mixed anaerobic flora. If there were one or two predominant anaerobic morphotypes, they were identified. Strains of *Actinomyces* were counted among anaerobes, even if they showed growth in aerobiosis. A polymicrobial infection was identified if more than one significant microorganism was isolated. The results of the cultures were obtained from the laboratory database. Medical histories were reviewed and information was collected regarding the status of diabetic, smoker or breast-feeding mother, as well as the method of obtaining the culture sample. Abscesses secondary to a surgical wound infection were excluded. If a patient had more than one episode of breast abscess in the study period, only the first was considered, regardless of the microorganism that was isolated in subsequent episodes. The reason for this is that if all episodes were included, the microorganisms that most often caused recurrences would be overrepresented. Fisher's exact test was used to compare proportions.

Results

Sixty patients met the inclusion criteria for the study: 58 women and two men, with a mean age of 40 years (standard deviation [SD] = 12 years). Of these, 55 had a medical history containing sufficient information on all risk factors considered (breastfeeding, diabetes, smoking). Abscess samples for culture were obtained in 44 cases by percutaneous needle aspiration, in 15 cases by incision and surgical drainage, and in one patient the spontaneous drainage material was collected with a swab with anaerobic transport medium. Table 1 shows the culture results of the 60 abscess samples. All microorganisms were isolated from the primary plates. Anaerobic bacteria were the most common agents, followed by *Staphylococcus aureus*. Table 2 shows the species of anaerobic bacteria that were isolated as predominant morphotypes or as pure culture. *Fingoldia magna* was the most common anaerobic species. All strains of *S. aureus* were methicillin-susceptible. All strains of *Corynebacterium* and coagulase-negative *Staphylococcus* (including *S. lugdunensis*) were isolated from samples obtained by needle aspiration or surgical drainage.

Abscesses in breast-feeding women

Twelve patients were breast-feeding mothers, with a mean age of 34 years (SD = 5.3 years), nine of whom were primiparous. *S. aureus* was the most common agent in breast-feeding patients (Table 1).

Table 1
Culture results for the 60 abscess samples.

Culture result	Number of patients ^a				
	Total (n = 60)	Breast-feeding (n = 12)	Not breast-feeding		
			Total (n = 46)	Diabetic (n = 5)	Not diabetic (n = 38)
Pure culture					
<i>S. aureus</i>	16	10	6	2	3
Coag.-neg. <i>Staph.</i> ^b	3	—	3	1	2
Aerobic GNB [Gram-negative bacilli] ^c	5	1	4	1	3
<i>Corynebacterium</i> ^d	4	—	3	—	3
<i>Streptococcus agalactiae</i>	1	—	1	1	—
Anaerobes ^e	1	—	1	—	1
Polymicrobial infection					
Only anaerobes	25	—	24	—	23
Aerobes ^f /anaerobes	4	1	3	—	2
Only aerobes ^g	1	—	1	—	1

^a In 2 of the 60 patients it was not possible to rule out the possibility that they were breast-feeding mothers, and in 3 of the 46 patients who were not breast-feeding it was not possible to rule out the possibility that they were diabetic. Therefore, in the table the sum of patients who were breast-feeding and patients who were not breast-feeding does not equal the total (60), and the sum of diabetics and non-diabetics does not equal the total of patients who were not breast-feeding (46).

^b Coagulase-negative *Staphylococcus*: *S. epidermidis*: 2, *S. lugdunensis*: 1.

^c *Escherichia coli*: 2, *Proteus mirabilis*: 2, *Pseudomonas aeruginosa*: 1.

^d *C. kroppenstedtii*: 3, *C. tuberculoearicum*: 1.

^e Unidentified diphtheria-producing Gram-positive bacillus: 1.

^f Aerobes: *S. aureus*: 1, *S. lugdunensis*: 1, *S. epidermidis*: 1, *Streptococcus anginosus*: 1.

^g *Streptococcus intermedius* and *S. anginosus*: 1.

Table 2
Distribution by species of anaerobic bacteria isolated in pure or predominant culture.

	Samples, n
Gram-positive	
<i>Finegoldia magna</i>	7
<i>Cutibacterium avidum</i>	2
<i>Peptostreptococcus anaerobius</i>	1
<i>Peptoniphilus asaccharolyticus</i>	1
<i>Actinomyces neuui</i>	1
<i>Actinomyces europaeus</i>	1
Unidentified diphtheria-producing GPB [Gram-positive bacilli] ^a	1
Gram-negative	
<i>Campylobacter ureolyticus</i>	1
<i>Prevotella timonensis</i>	1
<i>Prevotella bivia</i>	1
<i>Fusobacterium necrophorum</i>	1
Unidentified Gram-negative bacilli ^a	3
Unidentified Gram-negative cocci ^a	1

^a The MALDI-TOF MS system software did not provide identification.

Abscesses not associated with breastfeeding

The mean age of patients who were not breast-feeding was 42 years (SD = 12 years). Anaerobic bacteria were isolated in 28 (61%) of the 46 abscesses, and 25 (54%) were found to be purely anaerobic (Table 1). The proportion of abscesses in which anaerobic bacteria were isolated was lower in diabetics than in the rest of the patients (0 out of 5 versus 26 out of 38, respectively; $P = .013$). In non-diabetics, the proportion of anaerobic abscesses was higher in smokers than in non-smokers (21 out of 24 versus 5 out of 14, respectively; $P = .003$). In four of the five diabetic patients, the infection was caused by an aerobic Gram-positive coccus (Table 1).

C. kroppenstedtii was isolated in three women with subareolar abscesses. All three women were treated with drainage (surgical in two cases and needle aspiration in the third) and antibiotic therapy. One of the patients subsequently had several recurrences in both breasts with repeated positive cultures (two from each breast) for *C. kroppenstedtii*, despite being treated with several cycles of antibiotics to which the bacterium was susceptible *in vitro*. The second patient received three cycles of treatment with antibiotics active *in vitro* over five months due to the persistence of the abscess, which

finally resolved. The third patient did not return for a consultation and there are no follow-up data. She had had a breast abscess nine months earlier at the same location, which was drained without a microbiological study.

In three patients, aged 55, 63 and 73 years, there was significant isolation of *Staphylococcus epidermidis*; pure culture in two cases (Table 1). Microscopic examination of the samples revealed moderate (one case) or abundant (two cases) leukocytes and intraleukocytic Gram-positive cocci. The growth in culture of *S. epidermidis* was moderate in two cases and abundant in one. In one case, moderate growth of an unidentified anaerobic Gram-negative bacillus was also obtained. All three patients were treated with needle aspiration drainage and antibiotic therapy to which the isolated strains were susceptible *in vitro*. The abscesses resolved in two cases (including polymicrobial infection). The third patient underwent further drainage a month later (without microbiological study) because the lesion persisted, and subsequently did not attend a consultation, so there are no more follow-up data.

Discussion

In this retrospective study, methicillin-susceptible *S. aureus* was the most common agent in breast abscesses in breast-feeding women. A greater variety of aetiological agents was found in breast abscesses in women who were not breast-feeding, with a predominance of anaerobic bacteria.

There are only two studies that have been carried out in Spain on the microbiology of nonpuerperal breast abscesses, both by the same group of researchers and both published in 1995^{10,11}. These studies, which partially overlap, include patients with surgical infections and primary breast abscesses without disaggregating the results, so it is difficult to compare their results with those of our study. The lower proportion of anaerobes found in these studies may be due to the studies' inclusion of patients with abscesses secondary to surgery^{10,11}.

Our study has demonstrated the importance of anaerobic bacteria in abscesses not associated with breast-feeding, particularly in smokers, who represented a significant proportion of patients in our series (24 of the 38 patients who were non-diabetic and not breast-feeding were smokers). Previous studies have also found

an association between smoking and the presence of anaerobes in breast abscesses^{9,14}. In our study, we found anaerobes in 61% of abscesses in patients who were not breast-feeding. Examination of the literature reveals that the proportion of primary breast abscesses with anaerobes ranges from 44% to 93% in publications that state that anaerobic culture has been performed^{4–7}. In contrast, the percentage of abscesses with anaerobes varies between 25% and 42% in studies that do not claim to have performed anaerobic culture of all samples^{9,12,15,18,20}. This difference underscores the importance of adequate microbiological documentation in studies on the aetiology of these infections. With regards to the most relevant anaerobic species, the significance of *Finnegoldia magna* and the absence of *Bacteroides* striking, which is consistent with previously published results²⁴.

Although our study does not include many diabetic patients, the results suggest that breast abscesses in these patients have a differentiated microbiology, with a lower presence of anaerobes. Confirmation of these findings is needed in studies with more patients.

Two cases of breast abscess due to *S. epidermidis* and one case of polymicrobial abscess involving *S. epidermidis* were documented in this study. There is no description in the literature of a primary breast abscess due to coagulase-negative *Staphylococcus*, other than *S. lugdunensis*, for which case the criteria used to give it clinical significance are explained. Coagulase-negative *Staphylococcus* appear in many publications in the list of isolated microorganisms and are among the most common in some studies^{7,8,13,19,20}, but without an explanation of the criteria that have been followed to give them clinical significance. In a proven case of primary breast abscess due to coagulase-negative *Staphylococcus*, the species was not determined²⁵. Our results indicate that *S. epidermidis* can cause primary breast abscesses, although this is not common. It is also worth noting the older age of patients with significant isolation of *S. epidermidis*.

In conclusion, the aetiology of breast abscesses varied with the patient's risk factors. *S. aureus* predominated in breast-feeding mothers, anaerobes in smokers, and aerobic Gram-positive cocci in diabetics. These risk factors should be considered in future studies on the aetiology and antibiotic therapy of breast abscesses.

Conflicts of interest

None.

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