Dacryocystitis: Systematic Approach to Diagnosis and Therapy
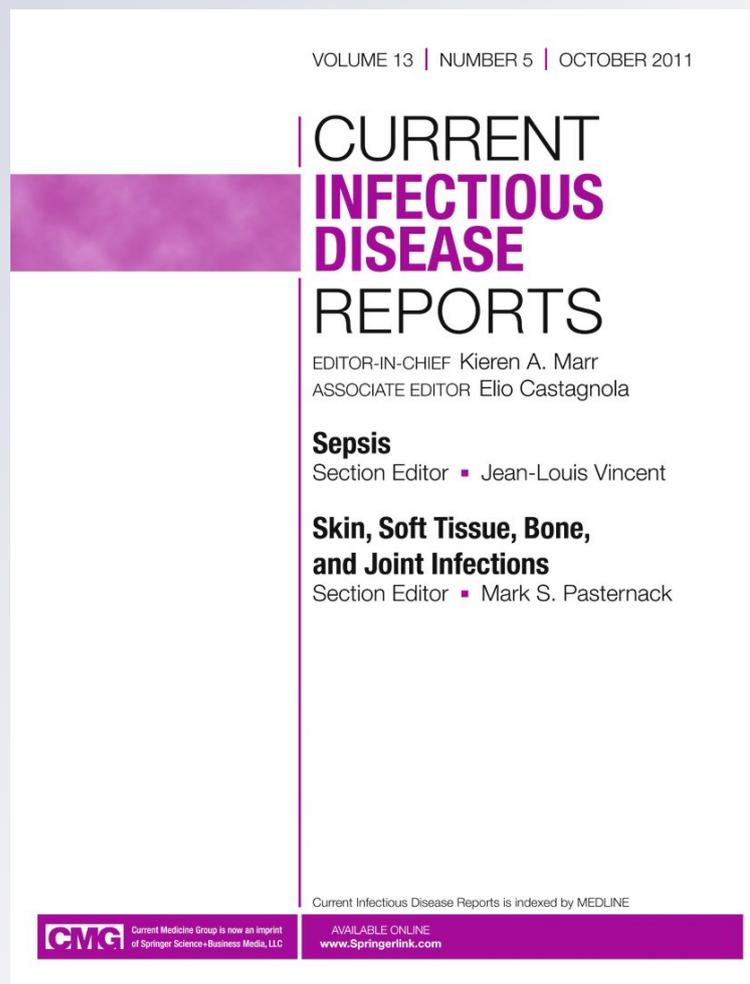
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UPPER RESPIRATORY, HEAD, AND NECK INFECTIONS (I BROOK, SECTION EDITOR)

Dacryocystitis: Systematic Approach to Diagnosis and Therapy

Sergio Pinar-Sueiro · Mercedes Sota · Telmo-Xabier Lerchundi · Ane Gibelalde · Bárbara Berasategui · Begoña Vilar · Jose Luis Hernandez

Abstract The objective of this paper is to review the main findings of the largest studies on the etiopathogenesis and microbiology of the development of dacryocystitis and to formulate clinical and surgical guidelines based on said studies and on our experience at Cruces Hospital, the Basque Country, Spain. The most common sign of this entity is the distal nasolacrimal duct obstruction, and this should be treated to prevent clinical relapse. The time when surgery should be indicated mainly depends on the clinical signs and symptoms, age and general status of a patient. Given the germs isolated in cases of dacryocystitis, antibiotic therapy against Gram positive (*S. aureus, S. pneumoniae, S. epidermidis)* and Gram negative bacteria (*H. influenzae, P. aeruginosa)* should be administered, orally in adults and intravenously in pediatric patients, prior to surgery. Gentamicin and amoxicillin-clavulanic acid have been found to be effective against the bacteria commonly implicated in the etiopathogenesis of this entity.

Introduction

The term dacryocystitis refers to a series of clinical entities characterized by inflammation of the lacrimal sac. Signs and symptoms may differ according to the etiology of the clinical picture.

On the basis of clinical diagnosis, many studies have aimed to improve our understanding of the etiopathogenic mechanisms leading to dacryocystitis and, thereby, propose a suitable, effective treatment for patients. In our review, bringing together the main studies carried out in this field, we aim to shed more light on this clinical entity, clarifying our knowledge thereof and making recommendations for improving the way it is treated.

Dacryocystitis

Clinical Signs and Symptoms and Etiopathogenesis

Dacryocystitis is a common condition, with characteristic symptoms and signs, which help in its diagnosis, but its progression is sometimes slow and it has a tendency to recur. Moreover, it is associated with sequelae such as the

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formation of draining fistulae, recurrent conjunctivitis, and even abscesses, orbital cellulitis and endophthalmitis in patients who undergo intercurrent intraocular surgery.

Under normal conditions, the mucosa of the lacrimal sac is highly resistant to infection. However, infections of the tear duct may develop, triggered by functional problems. Although there are several causes, the main mechanism for the occurrence of dacryocystitis is distal obstruction of the nasolacrimal duct, which leads to the retention of tears and detritus at the bottom of the conjunctival sac at the level of the lacrimal sac [1]. A "critical mass" of bacteria may be reached, overwhelming the anti-infection response of the lacrimal sac mucosa, leading to an acute or chronic infection.

Acute Dacryocystitis

Acute dacryocystitis consists of inflammation of the lacrimal sac, in general caused by infection. This pathology is predominantly found in adult women, while it is also relatively common in young infants.

The most notable common signs and symptoms are reddening, oedema and the presence of a painful area of induration overlying the nasolacrimal sac, specifically just below the anatomical boundary of the medial canthal ligament. Epiphora and discharge may also be observed. In particular, when pressure is applied to the inflamed tear duct, purulent material may be expressed through the lacrimal punctum. Frequently, patients may present conjunctivitis and preseptal cellulitis. Rarely, the infection extends beyond the septum, and causes orbital cellulitis.

Chronic Dacryocystitis

This is more common than acute dacryocystitis and there are several stages of presentation:

- Catarrhal: there is intermittent conjunctival hyperaemia and epiphora, with mucoid discharge that is normally sterile.
- Lacrimal sac mucocele: stagnant tears collect and there is dilation of the lacrimal sac, with mucoid content.
- Chronic suppurative: epiphora and chronic conjunctivitis are observed, with erythema of the lacrimal sac. There is reflux of purulent material with pressure, and microorganisms are often isolated.

Predisposing Factors

Various risk factors have been described for the development of acute/chronic dacryocystitis. The highest risk factor is the obstruction of the nasolacrimal duct [1]. Age has also been described as a predisposing factor, the occurrence of acute dacryocystitis being more prevalent with increasing age among patients with nasolacrimal duct obstruction. In line with this, several studies have indicated that the peak prevalence of this disease occurs in the fifties and sixties [1, 2••]. Being female is also a known risk factor for the development of this infectious condition. Indeed, clearly higher rates of both acute and chronic dacryocystitis have been reported among women (73%, 63.3%, respectively) [3, 4]. Additionally, nasal pathologies seem to have a crucial role in the risk of developing dacryocystitis. In an interesting study, Bale et al. demonstrated that in 41 out of 143 cases of dacryocystitis analysed (28.6%), there was an underlying nasal abnormality, the most common findings being nasal septum deviation, rhinitis and inferior turbinate hypertrophy on the same side as the infection. Moreover, in 48.78% of the cases, cultures obtained from nasal flora and lacrimal sac flora on the infected side were similar [1]. Lastly, the presence of dacryoliths at various levels of the lacrimal drainage system is a known risk factor for the development of dacryocystitis [5]. In the scientific literature, various studies have reported the presence of dacryoliths in 6% to 18% of patients with nasolacrimal duct obstruction undergoing external dacryocystorhinostomy [5–10]. Dacryoliths are seen in patients with earlier presentation of clinical signs and symptoms (≤55 years) [5, 10]. Although there is not a consensus on this, Yazici found a higher proportion of men than women with dacryoliths among those undergoing external dacryocystorhinostomy [10]. Patients with dacryoliths have also been found to be more predisposed to distension of the lacrimal sac without infection [5, 10, 11]. The use of make-up seems to be involved in the formation of dacryoliths. Hyphae, especially of Candida, have also been isolated involved in the formation of these dacryoliths [10, 12, 13].

Dacryocystitis in Children

Dacryocystitis is a disease that rarely occurs before 30 years of age (with the exception of congenital dacryocystitis and cases associated with head injury involving the lacrimal drainage system) [1, 2••]. Overall, it is relatively rare in children and, when it occurs, it is almost always associated with congenital nasolacrimal duct obstruction. It has been reported that up to 6% of healthy newborns have this type of obstruction [14–16] but, of these, only 2.9% develop acute dacryocystitis [17]. The rate is around 60% in those with congenital dacryocoele [18]. The diagnosis is clinical and must be differentiated from preseptal cellulitis and mucocele, mainly by the presence of hardening, inflammation and/or hyperaemia at the level of the medial canthal

ligament, associated with the presence of mucopurulent material that drains through the lacrimal punctum and epiphora. A high temperature and leukocytosis help the confirmation of the diagnosis, although these are not required for the diagnosis.

Diagnostic Management

The Role of the Culture

It is important to perform cultures from samples taken from the infected area, and sometimes also blood cultures, the latter being indicated in pediatric patients and adults who require admission due to immunosuppression, fever (>38.5°C), or signs of progression of the infection.

How a sample should be obtained for culture is a controversial issue. It can be taken either from the mucopurulent material found at the bottom of the conjunctival sac or from the secretion obtained by squeezing the lacrimal sac at the level of the lacrimal punctum, which, in our opinion, both entail an unacceptably high risk of contamination of the sample, and, finally, puncture and aspiration of the lacrimal sac. We believe puncture and aspiration of the lacrimal sac should be considered as the technique of choice. In order to properly perform this technique, an antiseptic should first be applied to the area of puncture, and then, with a 20 G needle, orienting the needle slightly below the horizontal, the lacrimal sac is punctured in the area below the medial canthal ligament.

The sample collected in the syringe should be sent to the laboratory straight away for immediately processing, or, when this is not possible, kept in an anaerobic transport medium. In any case, samples must be stored at 4 to 8°C until processing and arrive at the laboratory within 24 h of collection [2••]. If direct inoculation is to be carried out, the following culture media are recommended: blood agar, chocolate agar, Sabouraud, a medium for anaerobic microorganisms (for example, Schaedler) and thioglycolate broth. The inoculated media must also be sent immediately to the laboratory for further processing [19].

Etiologic Agents

Despite the indication for culture by puncture and aspiration and, in some cases, blood culture, in our experience many patients are referred with previously established infections refractory to oral antibiotic treatments, and very often positive cultures will not be obtained or those obtained will not help identify the primary aetiological agent.

With regards to adults, in recent years, a range of studies have been conducted in order to identify the flora of the lacrimal sac (Table 1). These studies have obtained the samples by different techniques in patients with chronic and acute dacryocystitis, either by collection of discharge expressed from the lacrimal punctum by pressure on the lacrimal sac [20–23, 24••], irrigating the lacrimal drainage system [20, 22], direct puncture and aspiration of the lacrimal sac [23, 24••], or by taking the samples directly from lacrimal sac during dacryocystorhinostomy [2••, 25•, 26, 27]. Results have varied widely, the rate of positive cultures ranging from 8.3% [2••] up to 100% of the samples in some series [25•]. Although in most studies Gram-positive bacteria are more commonly isolated, some variability has been observed across studies with regards to the percentage of Gram-positive and Gram-negative isolates, the percentages ranging from 90%:2.5% in favour of Gram-positive [25•], to 61%:39% in favour of Gram-negative bacteria [27]. There does, however, seem to be a higher level of agreement across the various studies with regards to the most commonly isolated germs: *Staphylococcus aureus* and *Streptococcus pneumoniae* being the most common among Gram-positive and *Haemophilus influenzae*, *Serratia marcescens* and *Pseudomonas aeruginosa* among Gram-negative bacteria [2••]. Anaerobic microorganisms have been isolated in as many as 15.7% of the positive cultures, in some studies, the most common genus being *Bacteroides* (5.7%) [22]. In other studies, however, the most frequently recovered anaerobes were *Peptostreptococcus* species, *Propionibacterium* species, *Prevotella* species and *Fusobacterium* species [28, 29]. As for fungi, they have been reported to be present in 4% to 7% of cases, the most commonly isolated genus being *Candida,* although *Aspergillus* and *Mucor* may also be found [2••, 22]. We should highlight a paper by Badhu et al., in which they observe that the microbiological pattern of chronic dacryocystitis varies according to the geographical region, probably due to environmental factors [30]. In their study in Nepal, the most common microorganism was *S. pneumoniae* [30]. In contrast, some other authors report the most common species to be Gram negative, for example, in Israel (61%), in particular, *Pseudomonas aeruginosa* (22%) [27]; while in other geographical regions the most commonly found species are *Staphylococcus epidermidis* and *Staphylococcus aureus,* namely in Saudi Arabia [21], China [22], Austria [31] and Australia [32]. Like these latter countries, in our hospital (Province of Bizkaia, the Basque Country, Spain), the main aetiological agent was found to be *S. aureus* (26.3%) [2••]; however, in our case, the second most prevalent microorganism was *Haemophilus influenzae* (15.8%) (Tables 1) [2••].

For pediatric patients, there are differences in clinical management with respect to that of adults, given the greater risks in the case of spread and progression of the infection. In particular, a more careful tailoring of the empirical antibiotic treatment should enable us to keep the patient's condition under tighter control. In an interesting study of 47 children, Kuchar et al., observed that Gram positive were

Table 1 Summary of the main articles related to etiologic agents associated to acute and chronic dacryocystitis

Study	Age	n	Technique	% positive	Gram +	Antibiotic (sensitivity)	Gram -	Antibiotic (sensitivity)	Other microorganisms
Pinar-Sueiro et al., 2011 [2]	Adults	697	Direct culture of the lacrimal sac content	8.3%	*49.1% S. aureus 26.3% S. pneumoniae (5.2%)*	Rifampicin (100%) Gentamicin (91.7%)	*43.9% Haemophilus influenzae (15.8%) Serratia marcescens (7.0%)*	Ceftriaxone (100%) Gentamicin (100%)	Fungi (7%)
Razavi et al., 2010 [47]	Children and adults (12–85 years of age)	61 (12 acute and 49 chronic)/ 66 eyes	Routine microbiological analysis	92.4%	*71.2% S. epidermidis*	Ceftriaxone Ampicillin	*21.2%*	Ciprofloxacin Cephalexin	7.5% polymicrobial
Kebede et al., 2010 [48]	Adults	114		79.8%	*62.6% S. pneumoniae (23%) S. pyogenes (14.3%) S. aureus (12.1%) S. viridans (9.9%)*	Chloramphenicol (82.4%) Erythromycin (68.1%) Tetracycline (61.5%)	*37.4% Haemophilus influenzae (9.9%)*	Gentamicin (79.1%)	
Owji et al., 2009 [25]	Adults	40	Intrasaccular sample during DCR	100%	*90% S. aureus*		*2.5%*		
Bharathi et al., 2008 [24]	Adults	1891	Reflux after squeezing the sac/needle aspiration	80.3%	*70.9% S. aureus*		*29.1% P. aeruginosa*		
Delia et al., 2008 [26]	Adults	421	Intrasaccular sample during DCR	90.97%	*75% S. epidermidis*		*25% P. aeruginosa*		
Mandal et al., 2008 [45]	Adults	56	Intrasaccular sample during DCR	53.6%	*S. aureus 40% S. epidermidis 10% S.pneumoniae*	Chloramphenicol against S. epidermidis; tobramycin	*P. aeruginosa 16.6% K. pneumoniae 6.6% H. influenzae 6.6%*	fluoroquinolones: ciprofloxacin and ofloxacin	
Martins et al., 2008 [46]	Adults (39–71 years of age)	14	Intrasaccular sample during DCR	92.8%	*53.8% S. aureus 28.6%*	Oxacillin i.v. Ceftriaxone i.v.	*15.4%*	Ceftriaxone i.v.	30.8% polymicrobial
Darrell et al., 2008 [49]	Young infants (6 weeks of age)	22	Blood culture	27.3%	*Coagulase-negative staphylococci (22%) Non pneumococcal and non enterococcal streptococci (5%)*	Broad spectrum ab. iv.			
		16	Ocular discharge	94%	*68.8% S. aureus*		*28.7% P. aeruginosa*		
Mills et al., 2007 [23]		89	Reflux after squeezing the sac/needle aspiration/ Intrasaccular sample during DCR	89.88%					
Sun et al., 2005 [22]	Adults	91	Reflux on pressure the sac/sac irrigation	85%	*64.4% S. epidermidis*		*18.9% Stenotrophomonas. maltophilia 26% H. influenzae*		
Chaudhry et al., 2005 [21]	Adults	188	Reflux on pressure in the sac/intrasaccular sample during DCR	97.4%	*53.7% S. epidermidis*				
Hartikainen et al., 1997 [20]	Adults	118	Reflux on pressure/sac irrigation	84%	*62% S. epidermidis*		*20% H. influenzae*		
Mahajan et al., 1983 [50]	Total	75	Sterile cotton-wool swabs	68%	*S. aureus (14.6%)*		*P. aeruginosa (4%) Acinetobacter (1.3%) Coliforms (2.6%)*		
					S. epidermidis (12%) S. pneumoniae (33.3%)				
	Children	61		41%	*S. pneumoniae*				
	Adults	14		7%	*S. pneumoniae*				

more frequently isolated in the samples obtained, being the *S. pneumoniae* the predominant microorganism in 36.4% of cases, followed by *H. influenzae* (19.6%) [33].

The Role of Antibiogram

Data obtained from antibiogram analysis in some of the most relevant studies of microbiology of the lacrimal sac in adults show interesting and quite practical results. Based on sensitivity analysis using antibiograms, Sun et al. reported that the antibiotics most active against the Gram-positive bacteria isolated in the cultures of their 100 samples were, in the following order: levofloxacin, amikacin, ofloxacin and ciprofloxacin. With regards to the Gram-negative isolates, the most active antibiotics were: gentamicin, levofloxacin, and tobramycin. Accordingly, for both Gram-positive and negative bacteria, the most active antibiotic was found to be levofloxacin [22]. In our experience, Gram-positive and Gram-negative bacteria were most sensitive to rifampicin and ceftriaxone respectively. Overall, gentamicin was found to have the best spectrum of activity for both, without taking into account the streptococci that tend not to be sensitive [2••]. On the other hand, and reinforcing the initial empirical treatment used in our centre for the treatment of adult patients with acute dacryocystitis, amoxicillin-clavulanic acid was active in 80% of cases of *S.aureus* and in 100% of the cases of *H. influenzae* isolated. That is, with this initial treatment, the activity and selectivity are both relatively high for most of the germs involved, since a high percentage of the most commonly found Gram-positive and negative bacteria are sensitive to this antibiotic.

We must also recall the greater frequency of methicillin-resistant *S. aureus* (MRSA), specially in those patients with acute dacryocystitis [23]. MRSA is a major pathogen in skin and soft tissue in head and neck infections, and it should be considered when selecting empiric antibiotic therapy, specially in patients with aggressive, atypical acute dacryocystitis.

In pediatric patients, sensitivity and resistance analysis of antibiotics demonstrated that *S. pneumoniae* was sensitive to bacitracin in 100% and to chloramphenicol and tetracycline in 84% of cases. On the other hand, *H. influenzae* was found to be sensitive to norfloxacin, chloramphenicol, tetracycline, norfloxacin and ofloxacin in all cases (100%). In conclusion, the authors recommended initial empirical antibiotic treatment with bacitracin and neomycin, and in the case of lack of effectiveness or as an alternative in the event of intolerance or allergies, ofloxacin, administered topically [33]. Prokosch et al. add to these results with a study on patients between 6 and 16 months of age undergoing lacrimal drainage system surgery. They obtained positive cultures in 97% of cases, with more than 5 organisms being isolated in 87% of cases, a reflection of the technique used to collect the samples (irrigation and taking a swab for culture), and *S. pneumoniae* (31%) was the most common species. Their sensitivity analysis found that chloramphenicol, fusidic acid and ciprofloxacin/levofloxacin were very active against all the microorganisms isolated, while erythromycin and gentamicin proved to be insufficiently effective [34]. The aforementioned results differ somewhat from those obtained 10 years earlier by Huber-Spitzy et al., who found *S. aureus* (45%) to be the predominant microorganism, followed by *S. epidermidis* (20%), *S. pneumoniae* only being isolated in 15% of the samples [31]. Indeed, there seems to have been a progressive increase in Gram-negative organisms over the years.

It has been observed that the topical antibiotic that has the highest activity against *S. pneumoniae* in vitro is bacitracin [33], followed by chloramphenicol and the tetracyclines (Tables 1 and 2).

Table 2 Most frequently isolated microorganisms in acute or chronic dacryocystitis in adults or pediatric patients

Patient	Type	Gram +	Gram -	Anaerobes	Fungi
Adults	AD	*S. aureus* [23, 24] MRSA [23]* *S. epidermidis* [26]	*P. aeruginosa* [23], *H. Influenzae* [2]	*Bacteroides*[22], *Peptostreptococcus, Propionibacterium, Prevotella, Fusobacterium*[28]	*Candida, aspergillus, mucor* [2]
	CD	*S. aureus* [2, 25] *S. epidermidis* [26] *S. pneumoniae* [2]	*H. influenzae* [2, 50], *S. marcescens* [2], *P. aeruginosa* [24]	*Bacteroides* [22], *Peptostreptococcus, Propionibacterium, Prevotella, Fusobacterium* [28]	*Candida, aspergillus, mucor* [2]
Pediatrics	AD	*S. epidermidis* [49]	*H. influenzae* [49]	*Peptostreptococcus, Propionibacterium, Prevotella, Fusobacterium* [29]	*C. albicans*, [29]
	CD	*S. epidermidis* [49]	*H. influenzae* [49]	*Peptostreptococcus, Propionibacterium, Prevotella, Fusobacterium* [29]	*C. albicans* [29], *Aspergillus*

AD acute dacryocystitis; *CD* chronic dacryocystitis; *MRSA* methicillin-resistant *Staphylococcus aureus*. *MRSAs have been isolated more frequently as etiologic agents in acute dacryocystitis than in chronic dacryocystitis

Usefulness of Blood Culture

Evidence-based databases question the utility of blood culture in the microbiological diagnosis in patients with dacryocystitis. As for the blood cultures, again there is wide variation in the reported rates of positive results. In an interesting study by Baskin et al., in 25 infants younger than 6 months of age with acute dacryocystitis, the rate of positive blood cultures was reported to be 88%, of which 22.7% turned out to be coagulase-negative staphylococci. Usually the isolation of these microorganisms is associated with contamination of the sample, both in blood culture and other types of samples that can be contaminated by skin flora [35••]. According to these data, blood culture does not have high sensitivity in dacryocystitis. However, it should be practiced in pediatric patients, adult patients with immunosuppression that require hospital admission, and those with fever higher than 38.5°C.

Treatment

Management of Acute Dacryocystitis

In adults, the most widely recommended treatment for the management of people with acute dacryocystitis consists of the application of heat with massage, systemic antibiotics (oral or intravenous administration, as appropriate) and percutaneous abscess drainage [36]. On the other hand, for cases that course with a clear abscess, drainage by puncture and aspiration of the lacrimal sac seems to be the technique of choice for treatment, as well as for the diagnostic information it provides. However, apart from being an uncomfortable, potentially painful, technique for the patient, it is sometimes not possible to drain sufficient mucopurulent material from the sac, leading to recurrent and prolonged inflammation, the formation of lacrimal cutaneous fistulae adjacent to the medial canthal ligament, and of fibrous and granulation tissue in the lacrimal sac, as well as adverse effects due to systemic antibiotics [35••] (Fig. 1, Table 3).

Classically, surgical intervention has not been considered an option for the treatment of purulent acute dacryocystitis due to the risk of clinical worsening and spread of the infection. However, there is a growing interest in the role of transcanalicular endoscopic laser-assisted dacryocystorhinostomy and nasal endoscopic surgery for the management of this type of infection [37•], enabling the abscess to be drained with minimal surgery time and decreasing the rate of postoperative infectious complications. Moreover, these techniques with nasal endoscopic control, sometimes allow simultaneous diagnosis and treatment of the nasal abnormality underlying the infection (nasal septum deviation, middle turbinate hypertrophy, or chronic ethmoid
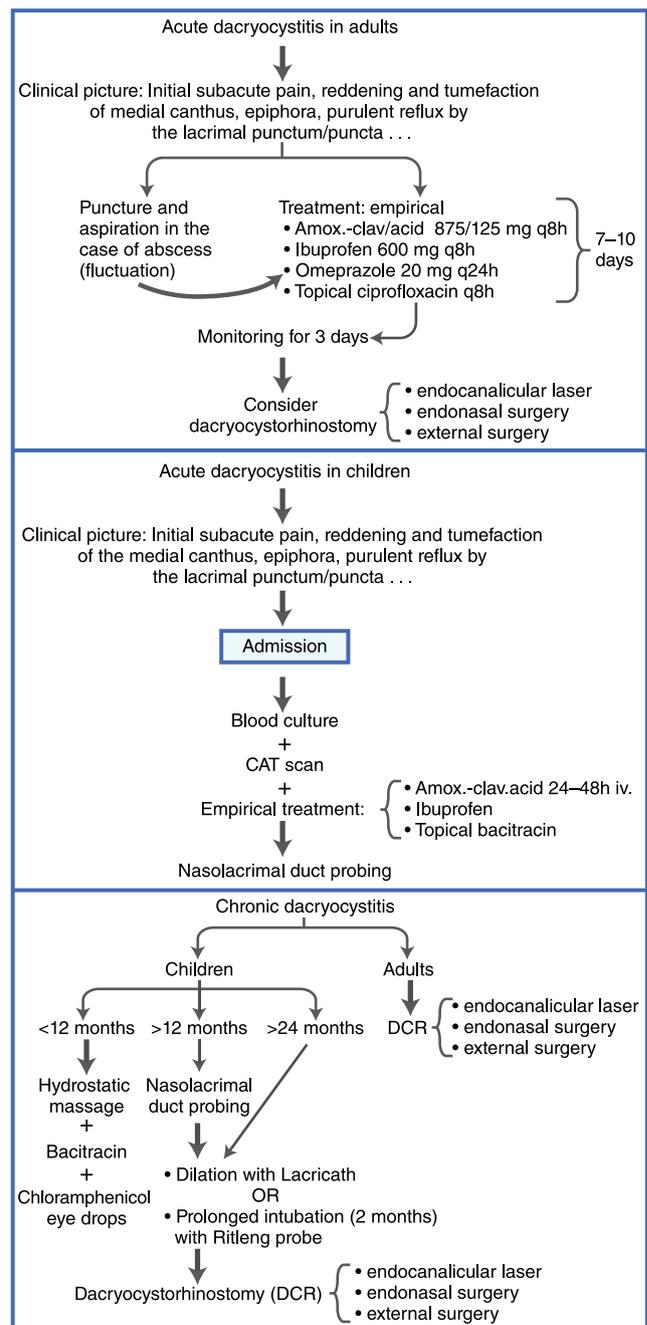

Fig. 1 Diagnosis and treatment algorithm for patients with dacryocystitis according to age and clinical entity

sinusitis). In fact, some recent publications indicate that nasal endoscopic dacryocystorhinostomy has begun to be considered the treatment of choice from the start, since it is more effective than conservative treatment and achieves earlier resolution of the condition than with external dacryocystorhinostomy (3.4±1 and 8.3±1.3 days, respectively) [36, 37•]. Nasal endoscopic surgery also achieves higher rates of opening of the nasolacrimal ostium than using classical surgery with external dacryocystorhinostomy

Table 3 Proposed antibiotic therapy for patients with infectious dacryocystitis, according to age of patient and type of etiologic microorganism

Type of AD	Preop Prophylaxis	Intraop Prophylaxis	Treatment		Eyedrop
			Oral	IV	
Pediatrics	≥24 h before surgery intravenous Amox/clav (500 mg/50 mg) • ≤3 months (≤5 kg): 100–150 mg/kg/day in 3 doses • >3 months (5–40 kg): 100 mg/kg/day in 4 doses	Amox/clav (2 g/200 mg) 1 g/100 mg iv (1 dose)	None	Amox/clav (500 mg/50 mg) • ≤3 months (≤5 kg): 100–150 mg/kg/day in 3 doses • >3 months (5–40 kg): 100 mg/kg/day in 4 doses	Bacitracin/neomycin 1/8 h or Chloramphen icol 1/8 h [51–53]
Adults	None	*Cefazoline (1–2 gr iv) (1 dose) or Amox/clav (2 g/200 mg) 1 g/100 mg iv (1 dose) or Gentamicin (0.5 mg/ml) 1 mg/kg iv (1 dose)	Amox/clav 600/125 mg/ 12 h or Cloxacylin 500 mg/6 h	Amox/clav (2 g/200 mg) 1 g/100 mg/ 8 h iv or Gentamicin (0.5 mg/ml) 1 mg/kg/8 h iv	Tobramycin 1/8 h [2]
MRSA	Vancomycin 1 g iv/12 h or linezolid 600 mg/12 h (oral) + rifampin 300 mg/12 h (oral)	Vancomycin 1 g iv (1 dose) or linezolid 600 mg iv (1 dose)	Linezolid 600 mg/12 h+ Rifampin 300 mg/12 h	Vancomycin 1 g/12 h+ Linezolid 600 mg/12 h	Chloramphenicol 1/8 h [53]
Anaerobes	Metronidazole 500 mg iv (1 dose) or Clindamycin 600 mg iv (1 dose) or Amox/clav (2 g/200 mg) 1 g/ mg/ 8 h iv or 600/125 mg/12 h oral	Metronidazole 500 mg iv (1 dose) or Clindamycin 600 mg (1 dose) or Amox/clav (2 g/200 mg) 1 g/ 100 mg iv (1 dose)	Metronidazole 500 mg/8 h or Clindamycin 300 mg/ 8 h or Amox/clav 600/ 125 mg/12 h	Metronidazole 500 mg/8 h or Clindamycin 600 mg/8 h or Amox/clav (2 g/200 mg) 1 g/100 mg/ 8 h iv	Chloramphenicol 1/8 h
Fungi	Amphotericin B 60 mg/24 h iv or Itraconazole 100 mg/24 h iv or 200 mg/24 h oral or Fluconazole 200 mg/12 h oral	Amphotericin B 60 mg iv (1 dose) or Itraconazole 100 mg iv (1 dose)	Itraconazole 200 mg/24 h oral or Fluconazole 200 mg/12 h oral	Amphotericin B 60 mg/24 h iv or Itraconazole 100 mg/24 h iv	Amphotericin B 0.1% 1/4 h or Fluconazole (0.2%) 1/4 h

AD acute dacryocystitis; iv intravenous; preop preoperative; intraop intraoperative, MRSA methicillin-resistant; Staphylococcus aureus, Amox/clav Amoxiciline/clavulanic acid. *Antibiotic intraoperative prophylaxis in adults is only indicated for patients who have had prior episodes of mucocele, mucopyocele, or acute dacryocystitis. Please, note that doses of medications are given per day for treatments and preoperative prophylaxis. The timing of antibiotic administration in the management of dacryocystitis depends on clinical evolution. Intraoperative prophylaxis consists of a single dose

[37•]. Additionally, this surgery avoids excessive manipulation of the inflamed ducts, in the context of an active infection, and therefore is associated with a lower rate of stenosis (Fig. 1).

In the particular case of pediatric patients with acute dacryocystitis, there is an association with a higher rate of intranasal mucocele, preseptal cellulitis and retrobulbar abscesses [38]. Accordingly, given that the etiopathogenesis is generally similar and the usual progression of the condition in these patients, the treatment tends to differ with respect to that offered to adult patients. Intubation of the nasolacrimal duct [14, 18, 38] hospital admission and the use of intravenous antibiotics have been recommended. In any case, follow-up of such cases must be supervised by pediatricians with experience in neonatal infections, due to the high risk of sepsis associated with the immature immune system of these patients [14, 17, 38–42]. Given this risk, assessments have been made of the prevalence of the spread of the infection systemically associated with the surgical procedure of choice (namely, nasolacrimal duct probing), and it has been found to occur in up to 17.5% of patients who undergo this procedure [43], although the prevalence varies between series [44]. Thus, prior administration of systemic antibiotics has been proposed by several authors, to prevent this spread, especially in patients at risk of infectious endocarditis [38, 44]. Another finding that supports our recommendation of the administration of antibiotics, prior to probing patients with acute dacryocystitis, is its statistically significant association with a higher rate of success of the procedure: specifically, it is less often necessary to repeat the procedure when the antibiotic treatment is administered at least 24 h before the surgery [35••], although we recognise that there is no consensus on this (Fig. 1, Table 3).

Management of Chronic Dacryocystitis

Management of chronic dacryocystitis varies according to the age of patients. Generally, in adults, it has been proposed that patients with lacrimal sac swelling and suspicion of obstruction of the lacrimal drainage system associated with tear stones should be treated conservatively; using lacrimal sac massage and lacrimal irrigation until symptoms improve, reserving surgery for cases refractory to these techniques [45].

On the other hand, some authors have proposed the use of surgery as the treatment of choice for chronic dacryocystitis. These same authors, however, observed a higher risk of soft-tissue infection after dacryocystorhinostomy when there was no antibiotic prophylaxis in this type of patient [46]. We believe postoperative infection after surgery of the lacrimal drainage system increases the likelihood of failure and, accordingly, that it is a good idea for topical or systemic antibiotic therapy to be given during surgery for chronic dacryocystitis in certain cases. We recommend the use of prophylactic antibiotics for dacryocystorhinostomy in patients who have had prior episodes of mucocele, mucopyocele, or acute dacryocystitis. Various studies have published concerning the microbiology of chronic dacryocystitis. In the nineteen-thirties, Traquair et al. found that the microorganism most commonly isolated was *S. pneumoniae* [47]. Later, other authors have found *S. aureus* to be the most prevalent microorganism [48]. In 2005, Sun et al. isolated *S. epidermidis* as the most common microorganism in a sample of 91 patients, although it should be taken into account that the isolation of this species tends to be caused by contamination by the commensal microbiota as mentioned earlier [22] (Table 1). In our experience, we use intravenous cefazolin (1 or 2 gr.), showing high sensitivity for the microorganisms above mentioned.

Pediatric patients must be followed before indicating surgery. If clinical signs are suggestive of congenital nasolacrimal duct obstruction, being the patient less than 12 months of age, conservative treatment is recommended, as more than 90% of these patients experience spontaneous resolution. Conservative treatment consists, mainly in hydrostatic massage and bacitracin eyedrops (twice daily), if there is important mucopurulent secretion in the conjunctival sac. Early surgery (nasolacrimal intubation) should be indicated if the patient associates a dacryocele or episodes of acute dacryocystitis. Having our patient symptoms above described, and being between 12 and 18 months of age, we recommend, directly, nasolacrimal probing. Patients between 18 and 36 months could benefit of nasolacrimal dilation or intubation. Finally, in pediatric patients older than 3 years of age, dacryocystorhinostomy is indicated. Antibiotic prophylaxis during or after surgery is not essential, unless the patient has important mucopurulent collection in conjunctival sac after expression of the lacrimal sac.

Conclusions

While, according to various studies, there is some variability, there is a certain degree of balance between the Gram-positive and negative bacteria isolated, the former being somewhat more common, in particular *S. aureus* and *H. influenzae*. The analysis of antibiograms of isolates has confirmed that gentamicin, ciprofloxacin and chloramphenicol have excellent properties with respect to the characteristic sensitivities of the aforementioned Gram-positive and negative bacteria. Nevertheless, the sensitivity to amoxicillin-clavulanic acid, widely used in our health system for the treatment of these processes, is also high (80%) for *S. aureus* and reaches 100% for *H. influenzae*, these being the species most commonly isolated from each group.

These figures, as well as the easy management of this antibiotic, tolerance and clinical effectiveness, encourage us to continue to recommend it for initial treatment.

As for the management of adult patients with acute episodes of dacryocystitis, the initial approach should consist in the taking of lacrimal drainage culture samples by puncture and aspiration of the lacrimal sac, followed by empirical treatment with oral antibiotics and anti-inflammatories. Depending on their progression, patients may require endonasal or external laser dacryocystorhinostomy, with the initiation of the oral antibiotics as much as 7 days prior to the procedure, but always taking into consideration the general health of the patient. In pediatric patients, we recommend admission to hospital for observation, in coordination with pediatricians, performing blood cultures and early use of a lacrimal probe in patients under the age of two, or dilation, intubation or dacryocystorhinostomy in older children. These procedures should be preceded by at least 24 h of intravenous antibiotic therapy, given the relatively high risks of sepsis, meningitis and endocarditis.

Finally, in patients with chronic dacryocystitis, the treatment should be surgery, the timing of which and the type of technique being chosen as a function of the age of the patient, their etiology and signs and symptoms (Fig. 1).

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