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Clinical and microbiological evaluation of the culture results of the patients with chronic dacryocystitis at a tertiary care hospital

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Abstract

Objective: In this study, we aimed to evaluate the isolated strains from the patients with chronic dacryocystitis and the relationship between different anatomical areas and their antibiotic susceptibilities.

Methods: Fifty patients diagnosed with chronic dacryocystitis were included. Fifty patients underwent endoscopic endonasal dacryocystorhinostomy from March 2013 to April 2014. Swab samples were obtained from conjunctiva and inferior nasal meatus before surgery, obtained from lacrimal sac during surgery. Identification and antibiotic susceptibility of the isolated strains were performed by automated Vitek version 2.0 systems (BioMeriuex Inc., Marcy-l'Étoile, France).

Results: A total of 39 (78%) female and 11 (22%) male patients were operated and 150 swab samples were evaluated. Bacterial growth was detected in 136 (90.6%) culture samples. A single (n=125; 91.9%) or two different (n=11; 9.1%) microorganisms were grown on culture media. The distribution of gram-positive strains (n=91) and gram-negative strains (n=56) were 61.90% and (38.10%), respectively. The most frequently isolated gram-positive isolate was *Staphylococcus*. Gram-negative isolates were susceptible to third-generation cephalosporins, cefepime and carbapenems while gram-positive isolates were susceptible to vancomycin, teicoplanin and linezolide.

Conclusion: For methicillin-sensitive coagulase-negative *Staphylococci* and methicillin-resistance coagulase-negative *Staphylococci*, bacterial growth demonstrated similarities among three different compartments (conjunctiva, lacrimal sac and inferior meatus). In other words, growth of these microorganisms in one location points to their proliferation in the other location or vice versa. This data can be used to guide antimicrobial therapy for these cases; but further studies are required.

Keywords: Chronic dacryocystitis, conjunctival flora, lacrimal sac, culture.

Özet: Bir üçüncü basamak hastanesindeki kronik dakriyosistit hastalarının kültür sonuçlarının klinik ve mikrobiyolojik değerlendirmesi

Amaç: Bu çalışmada, kronik dakriyosistitli hastalardan izole edilen örnekler yardımıyla farklı anatomik bölgeler ile bunların antibiyotik duyarlılığı arasındaki ilişkinin incelenmesi amaçlanmıştır.

Yöntem: Kronik dakriyosistit tanısı konmuş ve Mart 2013 ile Mayıs 2014 arasında endoskopik endonazal dakriyosistorinostomi ameliyatı geçiren 50 hasta çalışma kapsamına alındı. Swab örnekleri konjunktiva ve alt nazal meatustan ameliyat öncesi, lakrimal kese örnekleri ise ameliyat sırasında alındı. İzole edilmiş örneklerin tanımlanmasında ve antibiyotik duyarlılığının belirlenmesinde Vitek version 2.0 sistemleri kullanıldı (BioMeriuex Inc., Marcy-l'Étoile, Fransa).

Bulgular: Otuz dokuzu kadın (%78), 11'i erkek (%22) toplam 150 hasta ameliyat edildi ve kendilerinden swab örnekleri alındı. Kültür örneklerinin 136'sında (%90.6) bakteri gelişimi saptanmıştır. Kültür ortamında tek (n=125; %91.9) veya iki farklı (n=11; %9.1) mikroorganizma ekimi yapıldı. Gram-pozitif ve gram-negatif örneklerin dağılımı sırasıyla %61.9 (n=91) ve %38.1 (n=56) oldu. En çok rastlanan gram-pozitif örnek *Staphylococcus* idi. Gram-negatif izolatlar 3. nesil sefalosporinlere, sefepime ve karbapenemlere duyarlılık gösterirken gram-pozitif izolatlar vankomisin, teikoplana ve linezolide duyarlılık gösterdi.

Sonuç: Metisilin duyarlı koagülaz-negatif *Staphylococci* ve metisilin dirençli koagülaz-negatif *Staphylococci* için bakteri büyümesi, konjonktiva, lakrimal kese ve alt meatus olmak üzere üç bölgede benzerlik göstermiştir. Başka bir deyişle bu mikro-organizmaların bir lokasyonda büyümesi başka bir lokasyonda da hızla büyüyebileceklerini göstermektedir.

Anahtar sözcükler: Kronik dakriyosistit, konjonktiva florası, lakrimal kese, kültür.

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Chronic dacryocystitis is an inflammatory process of the lacrimal sac associated with total or partial occlusion of the lacrimal duct. Obstruction of the lacrimal system can emerge secondary to idiopathic, traumatic, mechanical obstruction and/or infection. Microorganisms colonized within the occluded lacrimal system can presumably cause inflammation.[1–3] In studies where bacterial colonization in conjunctiva, lacrimal duct and sac in patients with chronic dacryocystitis were analyzed, various outcomes have been encountered within years. Mixed bacteria, *Staphylococci spp*. or *Streptococci spp*. are frequently isolated bacteria.[1–4] In the pathology of chronic dacryocystitis, surgical fistula constructed to establish a communication between occluded lacrimal duct and nasal passage through external or endonasal approach is called dacryocystorhinostomy. This procedure is the gold standard in the surgery of chronic dacryocystitis. Dacryocystostomy enables patency of the occluded lacrimal duct and lacrimal fluid flow is maintained thanks to mechanical communication between lacrimal sac and nasal passage. This mechanical communication ensures lacrimal drainage and eradication of the causative colonized bacteria, which gained pathogenicity. However, this assumption has not been proved conclusively.[5–7] In this study, we aimed to evaluate the isolated strains from the patients with chronic dacryocystitis and the relationship between different anatomical areas and their antibiotic susceptibilities.

Materials and Methods

Study design

Tepecik Training and Research Hospital is a tertiary care center with 1200 beds. This prospective study was approved by the Ethics Committee of this hospital (2013/02). Patients were monitored and surveyed in accordance with the Helsinki Declaration of 1975, as revised in 1983. All patients provided written informed consent before being enrolled in the study. Volunteer participants between from March 2013 to April 2014 were included in this study. Signed enlightened consent forms, which explained details of the study. Our patients who consulted to our outpatient clinic with complaints of epiphora were jointly evaluated by ENT and Ophthalmology Departments. Lacrimal duct and lacrimal sac obstruction were examined preoperatively using lacrimal irrigation, Schirmer's test and dacryocystography. Patients with diagnosis of chronic dacryocystitis who experienced acute episodes or individuals who used antibiotics or underwent revision surgery within 3 weeks were excluded from the study.

Outcome parameters

Swab samples were obtained from conjunctiva and inferior nasal meatus before surgery, obtained from lacrimal sac during surgery. By this method, we aimed to compare the culture results of conjunctiva (anatomic part before the occlusion), lacrimal sac (occlusion part), and inferior meatus (anatomic part after the occlusion).

Surgical technique

Fifty patients with the diagnosis of chronic dacryocystitis underwent endoscopic endonasal dacryocystorhinostomy (EDCR) or intubation of silicon tubes under local anaesthesia in the operating room on a day care basis. All cases were operated under local anesthesia in our clinic's outpatient surgery unit. Patients were administered 1 mg/kg pethidine HCl IM, mg atropine IM, and 5 mg diazepam PO 45 min before the surgery. Local anesthesia was achieved by topical 2% pontocaine and injection of 2% lidocaine with 25/1000 epinephrine intranasally. 0.4% Oxybuprocaine was applied topically to the eye. 0° and 30° 4.0-mm endoscopic Hopkins telescopes manufactured by Storz company (Karl Storz GmbH & Co., Tuttlingen, Germany) were used with mounted camera.

Bacterial isolates

In patients with the diagnosis of chronic dacryocystitis who underwent EDCR and silicone tube intubation, swab samples were retrieved preoperatively from conjunctiva and inferior nasal meatus and from lacrimal sac directly under sterile condition. Swab samples were obtained from conjunctiva and inferior nasal meatus before local application of eye drops and nasal tampons. Swab samples were especially taken from purulent drainage within lacrimal sac. Impact of environmental factors (nasal packing, regional bleeding, surgical instruments and endoscopes) and contamination of middle meatus were particularly avoided. Swab samples of conjunctiva, lacrimal sac and inferior nasal meatus were incubated on thioglycollate broth for 24–48 hours. The incubated broth medium has been cultivated on blood agar, chocolate agar and eosin-methylene blue agar. The identification and the antimicrobial susceptibility of the isolated strains were studied by automated Vitek version 2.0 systems (BioMeriuex, Marcy-l'Étoile, France).

Statistical analysis

Data were analyzed using the Statistical Package for Social Sciences 15.0 for Windows (SPSS Inc., Chicago, IL, USA). Parametric tests were applied to data of normal distribution and non-parametric tests (Mc Nemar) were applied to data of questionably normal distribution. $p<0.05$ was considered as statistically significant.

Results

Mean age of 50 patients who were included in the study with the diagnosis of chronic dacryocystitis and planned to undergo EDCR was 42.8±7.2 (range: 28 to 62) years. Study population consisted of 39 (78%) female and 11 (22%) male patients. Twenty-eight left and 22 right eyes were operated and 150 swab samples retrieved from conjunctiva, lacrimal sac and inferior nasal meatus were evaluated.

Among 150 swab samples, bacterial growth was detected in 136 (90.6%) and not detected in 14 (9.4%) culture samples. A total of 147 isolates were proliferated. A single (n=125; 91.9%) or two different (n=11; 9.1%) microorganisms were grown on culture media. The distribution of gram-positive strains and gram-negative strains were (n=91; 61.90%) and (n=56; 38.10%), respectively. The distribution of the strains isolated in patients with chronic dacryocystitis is shown in Table 1.

Distribution of isolates grown in total of 150 samples retrieved before and after the operation was as follows:

- Conjunctiva (44/8): total bacterial growth in 44 samples (gram-positive 33 samples, gram-negative 11 samples) and no bacterial growth in 8 samples.

Table 1. Distribution of the strains isolated in patients with chronic dacryocystitis.

		Conjunctiva	Lacrimal sac	Inferior nasal meatus	Total (%)
Gram-positive	MSSA	9	7	13	29 (19.72%)
	MSCNS	9	9	8	26 (17.68%)
	MRCNS	6	8	7	21 (14.28%)
	MRSA	1	1	1	3 (2.04%)
	GBS	1	1	1	3 (2.04%)
	Difteroid bacilli	3	-	-	3 (2.04%)
	S. pneumoniae	2	-		2 (1.36%)
	S. oralis	1	-	1	2 (1.36%)
	S. mitis	1	-	1	2 (1.36%)
Total gram-positive		33	26	32	91 (61.9%)
Gram-negative	*P. aeruginosa*	1	11	4	16 (10.88%)
	K. pneumoniae	3	4	4	11 (7.48%)
	E. coli	1	1	7	9 (6.12%)
	S. maltophilia	2	1	-	3 (2.04%)
	P. vulgaris	-	2	-	2 (1.36%)
	C. freundii	-	1	1	2 (1.36%)
	E. aerogenes	-	1	1	2 (1.36%)
	A. baumanii	-	-	2	2 (1.36%)
	E. cloacae	-	2	-	2 (1.36%)
	C. koseri	-	1	-	1 (0.68%)
	E. faecalis	-	-	1	1 (0.68%)
	P. stutzeri	1	-	-	1 (0.68%)
	S. marcescens	1	-	-	1 (0.68%)
	P. mirabilis	-	1	-	1 (0.68%)
	K. oxytoca	1	-	-	1 (0.68%)
	A. iwolfii	1	-	-	1 (0.68%)
Total gram-negative		11	25	20	56 (38.10%)
Total isolates		44 (29.9%)	51 (34.7%)	52 (35.4%)	147 (100%)

GBS: Group B *Streptococcus;* **MRCNS:** methicillin-resistant coagulase-negative *Staphylococcus;* **MRSA:** methicillin-resistant *Staphylococcus aureus;* **MSCNS:** methicillin-sensitive coagulase-negative *Staphylococcus;* **MSSA:** methicillin-sensitive *Staphylococcus aureus*

- Lacrimal sac (51/2): total bacterial growth in 51 samples (gram-positive 26 samples, gram-negative 25 samples) and no bacterial growth in 2 samples.
- Inferior nasal meatus (52/4): total bacterial growth in 52 samples (gram-positive 32 samples, gram-negative 20 samples) and no bacterial growth (n=4).

Most frequently isolated gram-positive bacteria were methicillin-sensitive *Staphylococcus aureus* (MSSA) (n=29; 19.72%), methicillin-sensitive coagulase-negative *Staphylococci* (MSCNS) (n=26; 17.68%) and methicillin-resistant coagulase-negative *Staphylococci* (MRCNS) (n=21; 14.28 %) (Table 1). Most frequently isolated Gram-negative strains were *Pseudomonas aeruginosa* (n=16; 10.88%), *Klebsiella pneumoniae* (n=11; 7.48%) and *Escherichia coli* (n=3; 2.04%) (Table 1).

In our study, in various regions of different compartments (conjunctiva, lacrimal sac and inferior nasal meatus) the number of microorganisms (MSSA, MSCNS and MRCNS) grown, rates of bacterial proliferation in pairwise comparisons (conjunctiva - lacrimal sac, conjunctiva - inferior meatus or lacrimal sac - inferior meatus), probabilities of concurrent bacterial proliferation and correlations among them are shown in Table 2. Number of individual microorganisms grown in cultures prepared from two different regions, both separately and in combination and distribution of each microorganism as expressed statistically as percentages are shown in Table 2.

The number of a certain microorganism grown in different compartments both individually or concurrently was also recorded (i.e. MSSA was grown in nine swab samples retrieved from conjunctiva, seven from lacrimal sac, however simultaneous proliferation of MSSA was observed in six swab samples of conjunctiva and lacrimal sac). Starting from this observation, a correlation was seen between conjunctiva and lacrimal sac as for bacterial growth.

For MSCNS and MRCNS, bacterial growth demonstrated similarities among three regions. This similarity can be explained by the correlation between growth rates of both compartments. In other words, growth of MSSA in conjunctiva was also seen in the lacrimal sac and inferior meatus; however, proliferation of MSSA in inferior meatus was not observed concurrently in the lacrimal sac (growth of MSSA was seen in the inferior meatus in 13 cases and in only seven of them lacrimal sac was infected with the same microorganism at the same time). Therefore, simultaneous growth of MSSA in these two locations was not a consistent finding.

Results were evaluated statistically using McNemar test (Table 3). In pairwise comparisons between all locations, growth of MSCNS and MRCNS demonstrated similarities. In other words, growth of these microorganisms

Table 2. Concurrent bacterial growth of different compartments (conjunctiva, lacrimal sac and inferior nasal meatus) and correlations among them.

	Regions of isolated strains					
Gram positive	**Conj.**	**L. sac**	**Conj. + L. sac**	**Conj. + L. sac / Conj.; %**	**Conj. + L. sac / L. sac; %**	**p-value**
MSSA	9	7	6	6/9x100 = 66.6%	6/7x100 = 85.7%	p=0.002
MSCNS	9	9	6	6/9x100 = 66.6%	6/9x100 = 66.6%	p=0.003
MRCNS	6	8	5	5/6x100 = 83.3%	5/8x100 = 62.5%	p=0.003
	Conj.	**Inf. nm**	**Conj. + Inf. nm**	**Conj. + Inf. nm / Conj.; %**	**Conj. + Inf. nm / Inf. nm; %**	**p-value**
MSSA	9	13	7	7/9x100 = 77.7%	7/13x100 = 53.8%	p=0.004
MSCNS	9	8	5	5/9x100 = 55.5%	5/8x100 = 62.5%	p=0.003
MRCNS	6	7	6	6/6x100 = 100%	6/7x100 = 85.7%	p=0.002
	L. sac	**Inf. nm**	**L. sac + Inf. nm**	**L. sac + Inf. nm / L. Sac; %**	**L. sac + Inf. nm / Inf. nm; %**	**p-value**
MSSA	7	13	6	6/7x100 = 85.7%	6/13x100 = 46.1%	p=0.006
MSCNS	9	8	5	5/9x100 = 55.5%	5/8x100 = 62.5%	p=0.003
MRCNS	8	7	5	5/8x100 = 62.5%	5/7x100 = 71.4%	p=0.002

Conj.: conjunctiva bacterial proliferation; **L. sac:** lacrimal sac bacterial proliferation; **Inf. nm:** inferior nasal meatus bacterial proliferation; **Conj. + L. sac:** conjunctiva bacterial proliferation and lacrimal sac bacterial proliferation in both regions; **Conj. + Inf. nm:** conjunctiva bacterial proliferation and inferior nasal meatus bacterial proliferation in both regions; **L. sac + Inf. nm:** lacrimal sac bacterial proliferation and inferior nasal meatus bacterial proliferation in both regions; **MRCNS:** methicillin-resistant coagulase-negative *Staphylococcus;* **MSCNS:** methicillin-sensitive coagulase-negative *Staphylococcus;* **MSSA:** methicillin-sensitive *Staphylococcus aureus*

in one location points to their proliferation in the other location or vice versa.

Simultaneous growth of MSSA was observed in pairwise comparisons between conjunctiva - lacrimal sac and conjunctiva - inferior meatus; however, metachronous growth of MSSA was noted between lacrimal sac and inferior meatus. MSSA was localized concurrently in conjunctivas and lacrimal sacs of our patients, while such a correlation was not detected between lacrimal sac and inferior meatus as for growth of MSSA. This observation suggests us that MSSA may proliferate only in the lacrimal sac but not in the inferior meatus or vice versa.

Complications of chronic dacryocystitis such as conjunctivitis, corneal ulcer, acute on chronic dacryocystitis, lacrimal abscess and fistula were seen in 17 (34%) of these patients; 76 (51.7%) of the culture samples were positive for bacterial growth.

Antimicrobial susceptibility test results for gram-positive and gram-negative isolates are shown in Tables 4 and 5, respectively.

All gram-positive isolates were susceptible to vancomycin, teicoplanin and linezolide. Among gram-negative isolates, strains of *Enterobacteriacea spp.* were susceptible to carbapenems, third-generation cephalosporins and cefepime. *Pseudomonas aeruginosa* strains were susceptible to meropenem (86.4%), imipenem (54.5%), aminoglycosides (90.9%).

Discussion

Microbial flora of the ocular surface consists primarily of gram-positive microorganisms namely *Staphylococci* and diphteroids. *S. aureus*, is the most frequently isolated bacteria in eye infections. Microorganisms found in conjunctival flora can be transformed into pathogens and become a source of infection in the presence of predisposing conditions including ophthalmic surgery, immunosuppression, malnourishment and lacrimal duct obstruction.[1–4]

Coden et al.[3] analyzed purulent discharge coming from lacrimal sac during dacryocystorhinostomy operations performed on the patients diagnosed as dacryocystitis and detected bacterial growth in 52.5% of the cases. Based on culture results, growth of a single or mixed bacteria was detected in 71 and 29% the cases, respectively. Growth of gram-positive (64.5%) and gram-negative

Table 3. Individual strains grown in cultures prepared from two different regions.

Gram-positive	Localizations	p-value*
MSSA	Conjunctiva and lacrimal sac	p=0.002
	Conjunctiva and inferior nasal meatus	p=0.004
	Lacrimal sac and inferior nasal meatus	p=0.06
MSCNS	Conjunctiva and lacrimal sac	p=0.003
	Conjunctiva and inferior nasal meatus	p=0.003
	Lacrimal sac and inferior nasal meatus	p=.003
MRCNS	Conjunctiva and lacrimal sac	p=0.003
	Conjunctiva and inferior nasal meatus	p=0.002
	Lacrimal sac and inferior nasal meatus	p=0.002

*McNemar test: p<0.005 significant. **MRCNS:** methicillin-resistant coagulase-negative *Staphylococcus;* **MSCNS:** methicillin-sensitive coagulase-negative *Staphylococcus;* **MSSA:** methicillin-sensitive *Staphylococcus aureus*

Table 4. Antibiotic susceptibility of gram-positive isolates.

Isolates	Antibiotic susceptibility									
Gram-positive	**PEN**	**VA**	**TEIKO**	**LZD**	**E**	**DA**	**LEV**	**SXT**	**FA**	**GN**
MSSA (n=29)	9.1%	100%	100%	100%	100%	100%	100%	100%	100%	100%
MSCNS (n=26)	24.1%	100%	100%	100%	55.1%	55.1%	96.5%	82.7%	27.5%	96.5%
MRCNS (n=21)	0%	100%	100%	100%	17.8%	17.8%	32.1%	60.7%	10.7%	32.1%
MRSA (n=5)	0%	100%	100%	100%	20%	20%	100%	100%	100%	100%
GBS (n=4)	100%	100%	100%	100%	100%	100%	100%	100%	0%	0%
S. mitis/oralis (n=2)	0%	100%	100%	100%	0%	0%	100%	0%	0%	0%
S. pneumoniae (n=2)	0%	100%	100%	100%	0%	0%	100%	0%	0%	0%

DA: clindamycin; **E:** erythromycin; **FA:** fusidic acid; **GBS:** Group B *Streptococcus*; **GN:** gentamycin; **LEV:** levofloxacin; **LZD:** linezolid; **MRCNS:** methicillin-resistant coagulase-negative *Staphylococcus*; **MRSA:** methicillin-resistant *Staphylococcus aureus;* **MSCNS:** methicillin-sensitive coagulase-negative *Staphylococcus;* **MSSA:** methicillin-sensitive *Staphylococcus aureus;* **PEN:** penicillin; **SXT:** trimethoprim-sulfamethoxazole; **TEC:** teicoplanin; **VA:** vancomycin.

Table 5. Antibiotic susceptibility results of gram-negative microorganisms.

Isolates	Antibiotic susceptibility											
Gram-negative	**AMP**	**AMC**	**CAZ**	**CRO**	**TZP**	**SCF**	**AK**	**GN**	**FEP**	**IMP**	**MEM**	**SXT**
E. coli (n=14)	57.1%	92.8%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
K. pneumoniae (n=15)	33.3%	91.6%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
P. vulgaris (n=1)	0%	0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
ESBL (+) *P. vulgaris* (n=2)	0%	0%	0%	0%	100%	100%	100%	100%	0%	100%	100%	100%
	CAZ	**FEP**	**TZP**	**SCF**	**AK**	**GN**	**IMP**	**MEM**	**CIP**			
A baumannii (n=3)	33.3%	66.7%	33.3%	66.7%	66.7%	66.7%	66.7%	66.7%	66.7%			
P. aeruginosa (n=22)	90.9%	81.6%	77.2%	86.4%	90.9%	90.9%	54.5%	86. %4	51%			
P. stuttzeri (n= 1)	100%	100%	100%	100%	100%	100%	100%	100%	100%			
C. koserii (n=2)	0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
E. aerogenes (n=3)	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
S. maltohilia (n=3)	100%	0%	100%	100%								
	AMP	**AMC**	**CAZ**	**CRO**	**TZP**	**SCF**	**AK**	**GN**	**FEP**	**IMP**	**MEM**	**SXT**
S. marsecens (n=1)	0%	0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
K. oxytoca (n=2)	0%	0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
E. cloacae (n=2)	0%	0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
A. iwolfii (n=1)	100%	100%	100%	100%	100%	100%	100%	100%	100%			
C. freundii (n=3)	0%	0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
P. mirabilis (n=1)	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

AK: amikacin; **AMC:** amoxicillin-clavulanic acid; **AMP:** ampicillin; **CAZ:** ceftazidime; **CIP:** ciprofloxacin; **CRO:** ceftriaxone; **FEP:** cefepime; **GN:** gentamycin; **IMP:** imipenem; **MEM:** meropenem; **SCF:** sulbactam/cefoperazone; **SXT:** trimethoprim-sulfamethoxazole; **TZP:** tazobactam/piperacillin.

(27.3%) was also observed. The most prevalent gram-positive bacteria were *Staphylococcus epidermidis* (27.3%) and *Staphylococcus aureus* (22.1%) while *Pseudomonas aeruginosa* (8.7%) was observed most commonly among gram-negative bacteria. Microbiological results of culture samples retrieved from conjunctivas or lacrimal sacs of the patients diagnosed as chronic dacryocystitis and frequently observed pathogenic agents during the last decade are shown in Table 6.[4,8–14] In the studies included in Table 6, microbiology reports of culture samples retrieved from conjunctival irrigation fluid or lacrimal sac discharge, indicated predominancy of gram-positive bacteria in 53.7 and 77.4% of the cases, respectively. Among gram-positive microorganisms, *Staphylococci spp.* were grown most frequently (in order of decreasing frequency, *S. aureus* [24.6–53.8%] and *S. epidermidis* ([26.1–45.3%]). Besides, in various publications, culture samples were harvested using various methods including conjunctival or punctal irrigation, aspiration or from lacrimal sac as a direct swab sample during operation.[4,8–14] In our study, a total number of 150 swab samples were retrieved from conjunctiva, inferior nasal meatus and intraoperatively from lacrimal sac all under sterile conditions. In 136 (90.6%) samples, bacterial growth was detected and in 14 (9.4%) samples, any bacterial growth was not observed. In 125 (91.9%) locations growth of a single microorganism and in 11 (9.1%) regions mixed bacterial growth (two different bacteria) were observed and a total of 147 isolates were grown. Bacterial isolates consisted mostly of gram-positive (n=91 samples; 61.90%) and gram-negative (n=56 samples; 38.10%) microorganisms which was in compliance with the literature results. Culture results of the samples retrieved from conjunctiva, inferior meatus of the nasal cavity and intraoperatively from lacrimal sac demonstrated similarities with the results of the comparable literature studies. However, our results differed from the outcomes of the studies which evaluated all of these locations in combination. Culture results of the patients operated with the diagnosis of chronic dacryocystitis demonstrated that among gram-positive group, *Staphylococci* took the first place (53.72%). Among subgroups of *Staphylococci spp.*, growth of *S. aureus* (21.76%) was mostly observed.

Table 6. Microbiological results of culture samples retrieved from conjunctivas or lacrimal sacs of the patients diagnosed as chronic dacryocystitis during the last ten years.

	Patients	Sample region	Microbiological results
Kubo et al.[8]	1 AD 3 CD	Conjunctival fornix irrigation, nasal cavity lacrimal sac.	MRSA
Sun et al.[9]	91 CD	Conjunctival, lacrimal sac refluxing material	**Gr+ (64.4%); Gr- (18.9%)** Most common: *Staphylococcus epidermidis* (26.1%)
Chaudhry et al.[10]	188 CD	Conjunctival fornix irrigation, or EDCR lacrimal sac culture	**Gr+ (53.7%); Gr- (25.8%)** **Most common:** *Staphylococcus epidermidis* (33.5%)
Mills et al.[4]	21 AD 68 CD	Lacrimal sac, intraoperative or needle aspiration/stab incision sac reflux.	Chronic dacryocystitis **Gr+ (68.8%); Gr- (28.7%)** **Most common:** *Staphylococcus aureus* (24.6%)
Das et al.[11]	421 CD	External DCR lacrimal sac	**Gr+ (75%); Gr- (25%)** **Most common:** *Staphylococcus epidermidis* (40. 6%)
Bharathi et al.[12]	566 AD 1325 CD	Conjunctival , DCR lacrimal sac culture	Chronic dacryocystitis **Gr+ (70.9%); Gr- (29.1%)** **Most common:** *Staphylococcus aureus* (44.2%)
Razavi et al.[13]	12 AD 49 CD	Positive regurgitation	Chronic dacryocystitis **Gr+ (77.4%); Gr- (18.9%)** **Most common:** *Staphylococcus epidermis* (45.3%)
Kim et al.[14]	33CD	External or endoscopic DCR surgery silicone tube	**Gr+ (73.1%); Gr- (23.1%)** **Most common:** *Staphylococcus aureus* (53.8%)

AD: acute dacryocystitis; **CD:** chronic dacryocystitis; **DCR:** dacryocystorhinostomy; **MRSA:** methicillin-resistant *Staphylococcus aureus*

Mills et al.[4] reported a multi-centered study in 6 different centers and collected 80 culture samples from 21 (23.6 %) patients with acute and chronic (n=68; 76.4%) infections in a study population of 89 patients and gram-positive and gram-negative isolates were grown in 55 (68.8%) and 23 (28.7%) culture samples, respectively. In the group of chronic dacryocystitis, gram-positive (64.9%; 37/57) and gram-negative (31.6%; 18/57) microorganisms were grown and in the gram-positive group, *Staphylococcus aureus* (24.6%), MSSA (22.8%), MRSA (1.8%) and coagulase-negative *Staphylococci* (17.5%) were identified most frequently. Kim et al.[14] implanted silicone tubes in 89 patients using external method (n=34) or EDCR (n=5) procedure and obtained culture samples from all of these 89 cases. They had identified a total of 52 isolates from 37 (94.9%) cases with significant culture results. These isolates consisted of gram-positive (73.1%) and gram-negative (23.1%) bacteria. Most frequently, *Staphylococci* (53.8%) were grown in cultures. Among gram-positive microorganisms, 28 strains of *S. aureus*, MRSA and CNS were identified in 78.6% (n=22) and 7.7% of the cases, respectively.

Relevant with results of the literature, bacterial colonization which took place following partial or total occlusion of the lacrimal drainage system in cases diagnosed as chronic dacryocystitis led to chronic infection and growth of gram-positive bacteria with a dominancy of *S. aureus*. In our study, distribution of gram-positive microorganisms in order of decreasing frequency was as follows: MSSA - 19.72%, MSCNS - 17.68%, MRCNS - 14.28%, and MRSA - 2.04%

Culture results of the samples harvested regionally from conjunctiva, lacrimal sac and inferior meatus, synchronicity and concordance between growth of MSSA, MSCNS and MRCNS in pairwise comparisons (conjunctiva - lacrimal sac, conjunctiva - inferior meatus and lacrimal sac - inferior meatus) were analyzed and based on the results of the statistical analysis, growth of MSCNS and MRCNS demonstrated similarities in all three regions of growth with statistically significant outcomes (i.e. growth of MSSA was seen in inferior meatus in 13 cases and in seven of these cases, MSSA was also detected concurrently in culture samples retrieved from lacrimal sac). Therefore, a metachronism between these two locations as for growth of MSSA is the point in question. According to

McNemar test, synchronous growth of MSCNS and MRCNS was observed in pairwise comparisons of all locations. In other words, this result indicates simultaneous growth of these bacteria in both locations or vice versa. However, growth of MSSA demonstrated synchronicity between conjunctiva and lacrimal sac and also between conjunctiva and inferior meatus, while metachronous growth of MSSA was observed between lacrimal sac and inferior meatus. In other words, MSSA may proliferate in the lacrimal sac, but not in the inferior meatus or vice versa. In conclusion, based on the gram-positive culture results of the samples retrieved from patients who underwent EDCR operations with the indication of chronic dacryocystitis, distribution of frequencies of MSSA, MSCNS and MRCNS among compartments were compared, and growth of MSCNS and MRCNS showed synchronicity in all three regions while growth of MSSA was in concordance only between conjunctiva and lacrimal sac or inferior meatus but not between lacrimal sac and inferior meatus.

Diseases of the nasolacrimal system are generally chronic in nature and recurrent episodes of conjunctivitis and dacryocystitis occur in almost all patients. Antimicrobial prophylaxis is needed in lacrimal surgery. During the postoperative period of EDCR surgery, broad-spectrum antibiotics are used for 5–7 days. As an oral antibiotic, generally 3rd generation fluoroquinolons or extended-spectrum penicillin derivatives (cephalosporins, amoxicillin/clavulanic acid) are preferred.[15–18] In our study, all gram-positive isolates were susceptible to vancomycin, teicoplanin and linezolide. Besides, 96–100% of the microorganisms –excluding MRCNS– are susceptible to levofloxacin. Among gram-negative isolates, strains of *Enterobacteriacea spp.* were susceptible to carbapenems. *Pseudomonas aeruginosa* strains were susceptible to meropeneme (86.4%), imipenem (54.5%), and aminoglycosides (90.9%).

Conclusion

Obstruction of the nasolacrimal system is generally a chronic condition and in all of these patients recurrent attacks of conjunctivitis and dacryocystitis occur. In lacrimal surgery, antimicrobial prophylaxis is frequently required. In our study, culture results of the samples retrieved from conjunctiva, inferior meatus of the nasal cavity and intraoperatively from lacrimal sac demonstrated similarities with the results of the comparable literature studies. However, our results differed from the outcomes of the studies which evaluated all of these locations in combination. Culture results of the patients operated with the diagnosis of chronic dacryocystitis demonstrated that *Staphylococci* took the first place (53.72%) among gram-positive group. Among subgroups of *Staphylococci spp.*, the growth of *S. aureus* (21.76%) was observed most commonly. With the results obtained, we have offered guiding alternatives for the selection of appropriate antibiotics to the clinicians who are caring for cases monitored with the diagnosis of chronic dacryocystitis.

Conflict of Interest: No conflicts declared.

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