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Original Article

Value of microbiology study in congenital nasolacrimal duct obstruction

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Abstract

Purpose: Evaluation of the effect of different microorganisms on congenital nasolacrimal duct obstruction (CNLDO) tightness and whether probing or silastic intubation is likely to fail in a particular microorganism infection.
Methods: The culture and sensitivity results of lacrimal drainage system (LDS) discharge samples from patients with CNLDO were reviewed. Different microorganisms were correlated with the severity of nasolacrimal duct (NLD) obstruction observed during surgical intervention. The success rates of probing and silastic intubation as a primary procedure for each identifiable microorganism were documented. Statistical analysis was conducted to correlate the type of microorganism with the tightness of CNLDO and treatment failure.
Results: Out of 181 specimens, 22 had no growth (12.1%). LDS with positive culture had 76.6% successful probing ($n = 49$) and 82.1% successful silastic intubation ($n = 78$). Gram-positive and Gram-negative species were almost equally detected. The most prevalent organisms were *Streptococcus pneumoniae* and *Hemophilus influenzae* (48.1% and 39.2%, respectively). Tight CNLDO was more prevalent in *Serratia marcescens* ($n = 2$; 100%) and *Staphylococcus aureus* ($n = 4$; 33.3%) infections with a 7.75 Odds ratio [95% confidence interval (CI), 1.67–34.63]. *Staphylococcus aureus* had 37.5% successful probing; however, success was achieved in all cases with silastic intubation. *Serratia marcescens* infections had 100% successful silastic intubation.
Conclusion: Microbiology study can predict tight CNLDO and helps in choosing the most successful treatment option. CNLDO with *Staphylococcus* infection and *Serratia marcescens* were likely to have tight NLD obstruction and silastic intubation had better outcomes.

Keywords: Microbiology, Congenital, Nasolacrimal duct, Obstruction

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Introduction

Congenital nasolacrimal duct obstruction (CNLDO) has been reported in up to 6% of newborn infants with various recommended treatment modalities to resolve the obstruction.[1] Frequent lacrimal sac (LS) massage and topical antibiotics are considered a conservative method of treatment that is most effective during the first year of life.[2] Otherwise, surgical probing or silastic intubation is performed to overcome the unresolved obstruction.[3,4]

Nasolacrimal duct (NLD) obstruction, whether congenital or acquired, predisposes lacrimal drainage system (LDS) to secondary bacterial infection due to stagnation of the tear within LS.[5] Moreover, different microorganism species have variable abilities to induce different degrees of host tissue reaction through the release of different inflammatory mediators, hence variable degrees of fibrosis that aggravate the already present obstruction.

Microbiological studies to identify the type of species involved in LS infection secondary to CNLDO have been

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extensively reported.[6–11] Nevertheless, the effect of different species on the degree of tightness of CNLDO and the treatment outcome has not been studied before. The aim of this study is to evaluate the capability of different species to induce variable degrees of fibrosis, observed as degree of tightness, and to predict which procedure is likely to fail based on microbiology results.

Patients and methods

A retrospective cohort study included patients with CNLDO who had been swabbed from LS regurge for culture and sensitivity to identify the offending microorganisms. The swabs were taken during initial clinical evaluation before the commencement of any treatment. We included patients diagnosed with simple CNLDO, obstruction at the level of Hasner's valve, who were treated with probing or silastic intubation as a primary procedure at the Ophthalmology Department, College of Medicine, King Saud University, Riyadh, Saudi Arabia, between January 1998 and December 2008. Patients with punctal or canalicular abnormalities were excluded as well as previous operative intervention. Approval for this study was obtained from the University Institutional Review Board (IRB).

A chart review collecting the age, microbiology culture results, severity of NLD obstruction, type of surgical intervention and success rates was completed. Culture results, whether they revealed growth of microorganisms or not, were reviewed and divided into groups according to the identified species. Tight obstruction was considered when the surgeon described difficulty passing probe #1 to achieve patency of LDS or the use of smaller probe size to bypass the obstruction. Surgical intervention, either probing or silastic intubation as a primary procedure, was recorded. The procedure was considered successful when all preoperative symptoms (epiphora, discharge and increased tear lake) had disappeared with a normal dye disappearance test (DDT) and a patent Jones primary dye test.

The collected data were statistically analysed using SPSS version 17.0 (SPSS Inc., Chicago, IL, USA) and Medcalc 9.0 (MedCalc Software, Mariakerke, Belgium). Descriptive analysis was conducted to describe different variables, while Odds ratios for success were calculated for each microorganism in general as well as for tight obstruction in particular. The significance level was set as $p < 0.05$; in addition, 95% corresponding confidence intervals were calculated.

Results

Specimens were obtained from 181 LDS in 141 patients with CNLDO with a mean (SD) age of 29.9 (±19.4) months, range (1 month–9 years). Twenty-two cultures showed no growth (12.1%). LDS with no growth had 95.5% total success rate with 100% successful probing ($n = 13$) and 88.9% successful silastic intubation ($n = 8$). Culture positive LDS had 79.9% total success rate with 76.6% successful probing ($n = 49$) and 82.1% successful silastic intubation ($n = 78$). When comparing CNLDO that had positive-culture results to those with no growth, the odds ratio was 5.33; however, it did not reach up to significant level ($p = 0.153$; 95% CI [4.37–25.63]).

The total number of identified microorganisms was 210, with single microorganisms in 113 cultures, two species in 41 cultures and three species in five cultures. Gram-negative and Gram-positive species were almost equally detected ($n = 107$; 50.9% and $n = 103$; 49.1%, respectively).

Streptococcus pneumoniae and *Hemophilus* influenzae were the most prevalent microorganisms ($n = 87$; 48.1% and $n = 71$; 39.2%, respectively), followed by *Moraxella* catarrhalis ($n = 23$; 12.7%), *Staphylococcus* aureus ($n = 12$; 6.6%) and *Pseudomonas* aeruginosa ($n = 7$; 3.9%). The most effective local antibiotics for Gram-positive and Gram-negative organisms were Bacitracin and Polymyxin B, respectively.

Table 1 summarizes the prevalence of different microorganism species, whether single growth or associated with other species, as well as their corresponding success rates of probing and silastic intubation. The calculated odds ratio and the corresponding confidence intervals per single and total specific microorganism infection (mixed species) showed similar values with insignificant changes.

No growth group had 9.1% ($n = 2$) tight obstruction. The tight obstruction was more prevalent in *Staphylococcus* aureus infections ($n = 4$; 33.3%) than in *Streptococcus* pneumonia or *H.* influenzae infections ($n = 4$; 4.6% and $n = 6$; 8.5%, respectively). The Odds ratio of having tight obstruction with staphylococcus aureus infection was 7.75 (95% CI: [1.67–34.63]), which was statistically significant ($p = 0.0005$). All reported LDS with *Serratia* marcescens infection ($n = 2$) had tight obstruction, which made statistical analysis of the limited value. Tight obstruction was not reported in *M. catarrhalis*, *P. aeruginosa*, *Hemophilus parainfluenzae*, *Streptococcus pyogenes*, *Streptococcus* milleri or *Staphylococcus* epidermidis infections.

Both LDS with *Serratia* marcescens had successful silastic intubation. LDS infected with *Staphylococcus* aureus had a 58.3% total success rate ($n = 7$) with 37.5% successful probing ($n = 3$) and 100% successful silastic intubation ($n = 4$). Success rates in the other prevalent species varied between 73.6% and 85.7% with generally more successful silastic intubation than probing, except for *M. catarrhalis*, which had 100% successful probing (Table 1). *H. parainfluenzae*, *Streptococcus pyogenes*, *Streptococcus* milleri and *Staphylococcus* epidermidis had 100% successful treatment whether probing or silastic intubation. None of them had tight obstruction.

Most bilateral cases showed the same culture results with the exception of two patients. One patient showed *H.* influenzae on one side and *M.* catarrhalis on the other side, with simple NLD obstruction on both sides. The other patient showed *Streptococcus* pneumoniae on one side, with simple NLD obstruction, and *Staphylococcus* aureus with tight NLD obstruction on the other side. Table 2 shows the prevalence of tight NLD obstruction and the total success rate of each microorganism with related statistical analysis.

Discussion

CNLDO causes stagnation of fluid within LS, which predisposes to secondary bacterial infection.[12] The source of bacteria can be the normal inhabitants of the conjunctiva, the upper respiratory tract, the birth canal in the neonatal period or a pathogenic organism that is absent under normal circumstances.[13,14] This report looks at the value of identifying

Table 1. The prevalence of different microorganism species whether single growth or associated with other species as well as the success rates of both probing and silastic intubation. Bold numbers to highlight the total numbers of species or procedure.

Type	Total			Single			Mixed		
	No.	Success No. (%)		No.	Success No. (%)			Success No.	Total No.
		Probing	Intubation		Probing	Intubation			
Streptococcus pneumoniae	**87**	**27** (75.0)	**37** (72.5)	**49**	**20** (80.0)	**21** (87.5)	5 cultures revealed 3 species	**23**	**38**
							Hemophilus influenzae	17	30
							Moraxella catarrhalis	4	6
							Staphylococcus aureus	1	3
							Hemophilus parainfluenzae	2	2
							Pseudomonas aeruginosa	2	2
Hemophilus influenzae	**71**	**17** (70.8)	**36** (76.6)	**37**	**11** (78.6)	**21** (91.3)	3 cultures revealed 3 species	**21**	**34**
							Streptococcus pneumoniae	17	30
							Staphylococcus aureus	1	3
							Moraxella catarrhalis	2	2
							Hemophilus parainfluenzae	2	2
Moraxella catarrhalis	**23**	**10** (100)	**10** (76.9)	**14**	**6** (100)	**7** (87.5)		**7**	**9**
							Streptococcus pneumoniae	4	6
							Hemophilus influenzae	2	2
							Staphylococcus aureus	1	1
Staphylococcus aureus	**12**	**3** (37.5)	**4** (100)	**6**	**0** (0.0)	**4** (100)	3 cultures revealed 3 species	**3**	**6**
							Streptococcus pneumoniae	1	3
							Hemophilus influenzae	1	3
							Pseudomonas aeruginosa	1	2
							Moraxella catarrhalis	1	1
Pseudomonas aeruginosa	**7**	**1** (50.0)	**5** (100)	**2**	N/A	**2** (100)	2 cultures revealed 3 species	**4**	**5**
							Streptococcus pneumoniae	2	2
							Hemophilus influenzae	2	2
							Staphylococcus aureus	1	2
							Streptococcus pyogenes	1	1
Hemophilus parainfluenzae	**4**	N/A	**4** (100)	**0**	N/A	N/A	2 cultures revealed 3 species	4	4
							Hemophilus influenzae	2	2
							Streptococcus pneumoniae	2	2
							Pseudomonas aeruginosa	2	2
Others									
Streptococcus pyogenes	**2**	N/A	**2** (100)	**1**	N/A	**1** (100)	*Pseudomonas aeruginosa*	1	1
Serratia marcescens	**2**	N/A	**2** (100)	**2**	N/A	**1** (100)			
Streptococcus milleri	**1**	**1** (100)	N/A	**1**	1 (100)	N/A			
Staphylococcus epidermidis	**1**	**1** (100)	N/A	**1**	1 (100)	N/A			

Table 2. Statistical analysis of specific microorganism success rate and tight obstruction of NLD. The underlined numbers are the statistically significant values.

Type	Total No.	Total				Tight obstruction			
		Success No. (%)	*P* value	Odds ratio	CI	No. (%)	*P* value	Odds ratio	CI
Streptococcus pneumoniae	**87**	**64** (73.6)	0.205	**1.5**	[0.76–2.95]	**4** (4.6)	0.166	**0.45**	[0.12–1.56]
Hemophilus influenzae	**71**	**53** (74.6)	0.411	**1.32**	[0.65–2.67]	**6** (8.5)	0.746	**1.19**	[0.37–3.76]
Moraxella catarrhalis	**23**	**20** (86.9)	**0.049**	**0.3**	[0.07–1.13]	**0** (0)	N/A	N/A	N/A
Staphylococcus aureus	**12**	**7** (58.3)	0.091	**2.7**	[0.71–10.07]	**4** (33.3)	**0.0005**	**7.75**	[1.67–34.63]
Pseudomonas aeruginosa	**7**	**6** (85.7)	0.618	**0.58**	[0.03–5.07]	**0** (0)	N/A	N/A	N/A
Hemophilus parainfluenzae	**4**	**4** (100)	N/A	N/A	N/A	**0** (0)	N/A	N/A	N/A
Others									
Streptococcus pyogenes	**2**	**2** (100)	0.1210	N/A	N/A	**0** (0)	N/A	N/A	N/A
Serratia marcescens	**2**	**2** (100)	0.1210	N/A	N/A	**2** (100)	N/A	N/A	N/A
Streptococcus milleri	**1**	**1** (100)	0.1210	N/A	N/A	**0** (0)	N/A	N/A	N/A
Staphylococcus epidermidis	**1**	**1** (100)	0.1210	N/A	N/A	**0** (0)	N/A	N/A	N/A

particular bacterial species as a risk factor for failure through a possible correlation with the severity of obstruction. Previous reports looked generally at the bacteriology profile in CNLDO with possible impact on the success rate if the culture was positive (Table 3) without specific microorganism effect.

Our series showed *Streptococcus* pneumoniae and *H.* influenzae as the most common isolates in CNLDO (48.1% and 39.2%, respectively). This is similar to the results of Kuchar et al. (35.4% and 19.6%) and Usha et al. (32.7% and 31.3%), despite higher prevalence in our study and is different from other studies that have been summarized in Table 3.[6–11]

Microbial infection initiates an immune-system response and tissue reaction caused by the elaboration of different mediators that end up with fibrosis. This was confirmed by histopathologic study of chronic dacryocystitis.[15,16] However, the degree of tightness of obstruction in CNLDO is more complicated as inflammatory fibrosis is not the only etiological factor and the degree of congenital anomaly itself can play a role in the tightness of NLD obstruction.

Having mentioned that, to highlight the added effect of specific microorganism on the tightness of obstruction, we looked at LDS with no growth as a control group as well as different species in a comparative manner. The prevalence of tight obstructions in LDS with no growth (9.1%) reflects the sole effect of the congenital anomaly on the degree of tightness. Moreover, *Streptococcus* pneumoniae and *H.* influenzae had 4.6% and 8.5% tight obstructions, which were even less than the control group and none of

Table 3. Comparison of different studies dealing with microbiological profile of CNLDO.

Study	Number of LDS	No growth (%)	Gram+ve (%)	Gram −ve (%)	Common pathogens	Risk for failure	Pathogen specific risk for failure	Success rate	Antibiotic sensitivity
Kuchar et al.	50	30	49.3	50.7	*Streptococcus pneumoniae* (35.4%) *Hemophilus influenzae* (19.6%)	N/A	N/A	N/A	Yes (Bacitracin & Neomycin)
Usha et al.	238	17	57	43	*Streptococcus pneumoniae* (32.7%) *Hemophilus influenzae* (31.3%)	N/A	N/A	N/A	Yes (Ofloxacin)
Gerkowicz et al.	81	25	70	28.8	*Staphylococcus epidermidis* (28%) *Staphylococcus aureus* (22%).	N/A	N/A	N/A	N/A
MacEwen et al.	151	79	35	65	*Hemophilus influenzae* (55%) *Staphylococcus aureus* (35%)	No	N/A	N/A	N/A
Bareja and Ghose	114	32.5	85.7	14.3	*Streptococcus pneumoniae* (28.9%) *Staphylococcus aureus* (13.2%)	N/A	N/A	N/A	Yes (Cloxacillin)
Kim et al.	50	36	56.2	43.8	Staphylococcus aureus (25%) *Pseudomonas aeruginosa* (15.6%)	No	N/A	Irrigation (96%) Probing (84.6%)	Yes (Ciprofloxacin)
Al-Faky et al.	181	12.1	49.1	50.9	*Streptococcus pneumoniae* (48.1%) *Hemophilus influenzae* (39.2%)	No	Yes	Probing (76.6%) Intubation (82.1%)	Yes (Bacitracin & Neomycin)

Moraxella catarrhalis, *P. aeruginosa*, *H. parainfluenzae*, *Streptococcus pyogenes*, *Streptococcus* milleri or *Staphylococcus* epidermidis had tight obstruction. On the other hand, staphylococcus aureus had 33.3% tight obstructions, which was higher than the control group and other microorganism infections. It had almost eight times the Odds ratio of having tight obstruction which possibly reflects the direct effect of staphylococcus aureus on the degree of tightness. We had only two LDS with *Serratia* marcescens infection with 100% tight obstruction that made statistical analysis of limited value.

The increased incidences of tight obstruction with *Staphylococcus* aureus and *Serratia* marcescens infections could be attributed to their pathogenic features. *Staphylococcus aureus* is associated with severe form of infections due to rapid tissue destruction and soft-tissue necrosis.[17–19] Its deleterious effect is attributable to wide varieties of elaborated extracellular cytotoxins and virulence factors that destroy polymorph leucocytes and induce tissue destruction. These factors stimulate the release of tumor necrosis factor-α (TNF-α), resulting in transforming growth factor-β (TGF-β) induction and initiation of profibrotic signalling.[20]

Moreover, the highly expressed *Staphylococcus* aureus surface component protein A can mimic TNF-α.[21] In view of this, it is important not only to kill *Staphylococcus* aureus with topical antibiotics – as the released toxins are still active and capable of inducing more fibrosis, especially with recurrent infections – but rapid surgical intervention is recommended to alleviate the predisposing obstruction and enhance normal lacrimal outflow.

Serratia marcescens was thought to be non-pathogenic bacteria and was used as a biological marker till the 1960s, when it was identified as an opportunistic organism. It infects mainly respiratory and urinary tracts and is also responsible for 2% of nosocomial infections.[22] Its virulence is related to the production of proteases, hemolysins and adherence properties.[23] Animal studies have revealed marked fibrous-tissue proliferation of cow's mammary parenchyma infected with *Serratia* marcescens due to a failure in maintaining a high level of interleukin 10 (IL-10), which down regulates proinflammatory cytokines.[24] *Serratia marcescens*, as a Gram-negative organism, also has lipid A as a component of lipopolysaccharide, which promotes apoptosis and TGF-β activation, which in turn initiates fibrosis.[25]

Despite the remarkable differences between the success rates of groups with no growth and with bacterial growth (95.5% and 73.6%, respectively), it was statistically insignificant ($p = 0.153$). This could be due to a very low number of failures among no growth group. The effect of mixed infection did not affect the statistical analysis as we had similar values with a single concerned microorganism. LDS infected with *Staphylococcus* aureus had the lowest success rate ($n = 7$; 58.3%) with the most frequent tight obstruction (33.3%) except for *Serratia marcescens*.

Silastic intubation was a successful primary procedure in treating CNLDO infected with *Serratia marcescens*, despite having tight obstruction. On the other hand, all failed cases with *Staphylococcus* aureus had probing only ($n = 5$); however, success was achieved in all cases with *Staphylococcus aureus*, which underwent silastic intubation as a first procedure ($n = 4$). Probing and silastic intubation were performed in similar age groups in LDS-infected cases with *Staphylococcus aureus*, which eliminates the effect of age as a risk factor.

In view of this, the microbiology study of CNLDO may have a value in predicting the tightness of obstruction. Identification of *Staphylococcus* aureus infection is an encouraging factor for early intervention, and silastic intubation might be recommended for both *Staphylococcus* aureus and *Serratia* marcescens infections.

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