Inferior Meatus Surgery for Distal Nasolacrimal Duct Obstructions
Long-term Outcomes and Treatment Paradigm

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**IMPORTANCE** Epiphora is a symptom resulting from obstruction of the nasolacrimal system. Classically, dacryocystorhinostomy has been performed to relieve epiphora. However, this does not address distal obstruction. Inferior meatus (IM) surgery at or near Hasner’s valve has been shown to have a 92.8% short-term success rate in treating distal nasolacrimal duct (NLD) obstruction. In addition, IM surgery for proximal obstruction has shown poor success rates. Differentiation between distal and proximal obstruction would allow for more appropriate treatment and improved patient outcomes. To date, no study has addressed long-term outcomes or the workup for distal and proximal NLD obstructions.

**OBJECTIVE** To report long-term outcomes in a subset of patients with epiphora due to distal NLD obstruction who underwent IM surgery and to present a treatment paradigm to differentiate distal from proximal NLD obstruction.

**DESIGN, SETTING, AND PARTICIPANTS** This retrospective medical record review with follow-up telephone survey was conducted at a tertiary referral center. Participants were patients surgically treated for epiphora from July 2006 to March 2010.

**INTERVENTION** Inferior meatus surgery was performed to relieve epiphora in patients with distal NLD obstruction.

**MAIN OUTCOMES AND MEASURES** Improvement or resolution of epiphora.

**RESULTS** Seventeen patients were contacted for follow-up; 13 patients responded, representing 18 nasolacrimal systems. One patient (2 sides) was excluded owing to the surgical specimen showing leukemic infiltrates. Mean time of follow-up was 6.2 years. Ten sides had distal NLD obstruction. Of the nasolacrimal systems with distal obstruction, 9 had long-term subjective improvement of symptoms (90%). No patient had nasal complications.

**CONCLUSIONS AND RELEVANCE** Directed IM endoscopic surgery resulted in long-term improvement of epiphora in 90% of nasolacrimal systems when performed for distal NLD obstruction. A treatment paradigm was developed and is detailed herein.
Epiphora is a symptom encountered in otolaryngology and ophthalmology clinics. Excessive tearing can be caused by obstruction of the upper or lower nasolacrimal (NL) system. Classically, epiphora has been treated with a dacryocystorhinostomy (DCR) to bypass the lower NL system. However, this does not address correctable obstruction within the lower, or more distal, system. Inferior meatus (IM) endoscopy allows for visualization of lower NL system obstruction and directed treatment, offering a minimally invasive alternative treatment option for epiphora.

Congenital NL duct (NLD) obstruction is a common cause of epiphora, found in 6% to 20% of newborns. Fortunately, greater than 95% of cases resolve spontaneously by age 1 year. More concerning is the congenital dacryocystocele, where the NL system is obstructed distally at the valve of Hasner. Nasolacrimal duct orifice cysts have also been described in the adult population and, with correct management, are an easily reversible cause of epiphora.

The most common cause of epiphora is acquired NLD obstruction and is most frequently seen in the fifth to sixth decades of life, more commonly in women. Obstruction of the NLD is often due to infection, trauma, or nasal inflammatory disease. Neoplastic processes can obstruct tear flow by invading the NL system or adjacent structures. Nasal tumors such as inverted papillomas have been shown to cause epiphora by obstructing the NL system and are a rare cause of epiphora. Although most neoplastic obstruction is caused by local disease, obstruction can also be caused by systemic neoplastic processes. Iatrogenic injury to the NL system from nasal, sinus, or orbital surgery can also lead to epiphora.

Workup of epiphora begins with saline irrigation. A syringe is used to cannulate the punctum and canaliculus, usually in the outpatient ophthalmology setting. Partial obstructions can be relieved by irrigation of the NL system. Unfortunately, relief by saline irrigation is often temporary, and further intervention is needed.

The gold standard for treatment of epiphora has been DCR, which completely bypasses the IM and creates an outflow tract for tears from the lacrimal sac to the nasal cavity. The procedure can be accomplished externally or endoscopically. Some studies have shown a higher rate of success for endoscopic DCR compared with external DCR.

More recently, our research group published early experiences with endoscopy of the IM with directed treatment beginning at the orifice of the NLD. Directed IM treatment is a minimally invasive alternative to DCR and has been shown to be very effective. Rogers et al. also detailed short-term outcomes in patients who underwent directed IM surgery. Fourteen sides with distal NL obstruction were operated on, and 13 (93%) sides demonstrated cure or significant improvement after a median follow-up of 9 months. Poor success rates were seen in patients with proximal NLD obstruction: only 1 of 4 sides had short-term improvement of symptoms at 9 months. In the present study, all but 1 patient with epiphora who underwent IM endoscopy was found to have some abnormality or obstruction in the IM at Hasner’s valve, including patients who were found at surgery to have disease extending proximally in the NLD or lacrimal sac.

To our knowledge, no study has evaluated the long-term effectiveness of directed endoscopic IM surgery for distal NLD obstruction in patients with epiphora, nor has anyone systematically determined the workup necessary to differentiate distal from proximal NL system obstructions. We aim to address long-term outcomes of directed endoscopic IM surgery and present a diagnosis and management algorithm for patients with epiphora.

Methods

Our retrospective study was approved by the Emory institutional review board. All included patients had undergone endoscopy of the IM and subsequent directed treatment to relieve the epiphora at the Emory University Department of Otolaryngology–Head and Neck Surgery from July 2006 to March 2010. Exclusion criteria included previous surgical intervention for epiphora.

All participants were treated by the senior author (J.M.D.), and many had been referred after undergoing preliminary ophthalmologic workup for epiphora consisting of NL examination and irrigation. After referral to the Department of Otolaryngology–Head and Neck Surgery, patients underwent an initial history and physical examination. Computed tomography scans were performed on the first few patients, and those with chronic rhinosinusitis (CRS) but not as part of the workup for epiphora. If IM abnormalities were identified, the patient was scheduled for IM surgery to treat epiphora.

Patients underwent surgical intervention in the operating room under general anesthesia. The surgical technique has been described previously. Briefly, irrigation of the NL system was first performed using a 21-gauge catheter. The NL orifice was endoscopically visualized where there was distention of the lateral nasal wall during irrigation. Lacrimal probes were used only in the first few patients early in the surgeon’s experience. Resection of the distal obstruction was then performed using small through-cutting instruments and a microdebrider. Marsupialization of cystic structures was performed if necessary. Resection of redundant, hypertrophic, or pathologic tissue was continued proximally until free flow of irrigation fluid was achieved. The lateral wall mucosa of the IM was avoided to prevent circumferential scarring. Stents were not used. Postoperative dexamethasone ophthalmic drops were used for all patients for 10 to 14 days; all patients also used nasal saline spray.

To assess long-term results, we contacted each patient by telephone to evaluate symptoms of epiphora and nasal breathing. Degree of improvement was assessed using the following scale: 0, no tearing; 1, intermittent mild tearing; 2, frequent mild tearing; 3, frequent moderate tearing; 4, severe constant tearing. Patients were also asked if and when their tearing improved and if their nasal breathing was affected after surgical intervention. Demographic data as well as operative findings were recorded.

Results

From July 2006 to March 2010, 17 patients underwent directed IM surgery for epiphora. Thirteen patients had previ-
ously been described by Rogers et al.\textsuperscript{12} and 4 additional patients who subsequently underwent IM surgery during this period were identified. All 17 patients were contacted for long-term follow-up by telephone, and 13 patients responded. \textbf{Figure 1} summarizes the patient findings.

Eighteen NL systems were represented in the 13 patients who responded. The mean age at the time of therapeutic intervention was 58.8 years. The mean time of telephone follow-up was 6.2 years (range, 2.7-7.5 years). Five patients had bilateral epiphora before intervention; 7 patients had only left-sided epiphora; and 1 patient had only right-sided epiphora. No patient had undergone previous invasive surgery of the NL system.

There were 4 patients, representing 4 NL systems, who did not respond to our inquiries. Of these patients, 2 were men and 2 were women. The mean age of these 4 patients at the time of the intervention was 35.2 years. Of these 4 NL systems, 2 were proximal, and 2 were distal. The 2 distal obstructions were early successes but could not be included in the long-term data.

Each patient was either seen first in the clinic at the Emory University Department of Otolaryngology–Head and Neck Surgery or referred from the Department of Ophthalmology. Office endoscopic examination of the IM was performed on all patients, totaling 18 NL systems. Inferior meatus endoscopy identified abnormality of the IM in all patients (Figure 2). All patients underwent IM surgery in the operating room to address the NLD orifice obstruction. At the time of surgery, findings included 11 NL systems with hypertrophic mucosa, edema, or scar of Hasner’s valve, and 5 had cysts. Some patients were found to have obstruction extending proximally in the NLD and lacrimal sac. We refer to this as \textit{proximal obstruction} or \textit{proximal disease}. One patient (2 NL systems) had suspect surgical findings, and pathologic examination of the excised tissue revealed chronic lymphocytic leukemia (CLL). This patient was excluded from our study owing to the comorbidity: surgery restricted to the IM would never be curative because the disease had infiltrated the entire NL system.

Of the remaining 16 NL systems, 10 were found to have disease involving only the distal portion of the NLD, at or near Hasner’s valve. The remaining 6 patients were found during IM surgery to have disease extending proximally. Long-term follow-up of patients with distal-only obstruction of the NL system revealed that 9 (90%) experienced sustained improvement of epiphora after IM endoscopy and directed treatment. Seven (70%) NL systems had complete resolution of symptoms. Two patients (20%) had significant subjective improvement but not complete resolution of symptoms (Table). One NL system did not show improvement of symptoms despite follow-up endoscopy revealing a patent NLD orifice, suggesting proximal mucosal disease and/or mucosal dysfunction. The patient later required DCR for definitive treatment. Of the 6 patients with proximal disease, the success rate of IM surgery was only 17% (n=1) (Table).

No patient experienced complications from anesthesia. One patient had a fracture of the attachment of the inferior turbinate during surgery. This was in a patient with proximal disease who otherwise tolerated the procedure well. However, the surgical treatment ultimately failed for this patient, and DCR was required.

\textbf{Figure 1. Study Enrollment Diagram}

\begin{center}
\begin{tikzpicture}
\node (start) at (0,0) {17 Patients surveyed (23 NL systems)};
\node (mid) at (0,-1.5) {13 Patients responded (18 NL systems)};
\node (end) at (0,-3) {16 Total NL systems};
\node (distal) at (0,-4.5) {10 Distal NL obstructions};
\node (proximal) at (0,-6) {6 Proximal NL obstructions};
\node (successes) at (0,-7.5) {9 Long-term successes};
\node (failure) at (0,-8.5) {1 Failure};
\draw (start) -- (mid) node [midway, left] {1 Patient excluded (2 NL systems)};
\draw (mid) -- (end) node [midway, left] {10 Distal NL obstructions} node [midway, right] {6 Proximal NL obstructions};
\draw (end) -- (distal) node [midway, right] {9 Long-term successes} node [midway, left] {1 Failure};
\end{tikzpicture}
\end{center}

NL indicates nasolacrimal.

\textbf{Figure 2. Endoscopic Views of Nasolacrimal Duct (NLD) Obstruction}

\begin{center}
\begin{tabular}{ll}
\textbf{A}, Preoperative distal obstruction of the NLD orifice. The asterisk marks the central area, and the blue arrowheads mark boundaries of soft tissue. & \textbf{B}, Postoperative patent NLD orifice (yellow arrowhead). \\
\end{tabular}
\end{center}
Discussion

Inferior meatus endoscopy with directed treatment is a minimally invasive alternative to DCR. Although DCR has long been considered the definitive method for treatment of epiphora due to NL system obstruction, it is not without risks. It is an invasive procedure, performed endoscopically or externally, and it nonspecifically bypasses the distal NL system. Furthermore, DCR performed by an inexperienced surgeon can result in a failure rate of nearly 50% at 4 years’ follow-up. Nasal endoscopy allows for visualization of the IM and NL orifice and gives the otorhinolaryngologist the unique opportunity to evaluate IM disease. If distal disease is recognized, it can be addressed using endoscopy in the operating room and directed IM treatment to resolve the obstruction. The incidence of distal NL obstruction causing epiphora is unknown but is likely underestimated owing to the infrequent evaluation of the IM.

Evaluation of a patient presenting with epiphora is critical to appropriate diagnosis and early, effective treatment. The patient may first present to either the ophthalmologist or the otorhinolaryngologist, although they more commonly present to the ophthalmologist. However, appropriate evaluation by both specialists will improve the ability to correctly identify and appropriately address the condition. The paradigm presented below encompasses a multidisciplinary approach, including ophthalmology and otolaryngology, for patients presenting with epiphora.

Treatment Paradigm

Evaluation should begin with examination of the NLD orifice. If obstruction is noted, IM surgery should be considered. If the NLD orifice is normal on examination, the patient should be referred to ophthalmology for in-office irrigation. If the NL system freely irrigates, no IM treatment is necessary, and the ophthalmologist should focus the differential diagnosis on lid or punctal disease. If irrigation is unsuccessful or requires high pressure, the patient should be referred to an otolaryngologist for surgical evaluation of the IM.

In the operating room, the first step is NL system irrigation under endoscopic visualization. If irrigation in the operating room does not reach the IM, proximal obstruction is likely, and DCR should be considered. However, if irrigation does reach the IM, or if the NLD orifice mucosa balloons, then IM surgery should be performed. This treatment paradigm is presented in Figure 3.

Additional Benefits of IM Evaluation

Endoscopic evaluation of the nose in the workup for epiphora has an added advantage of identifying otherwise undiagnosed systemic disease. Such was the case in our patient who underwent IM endoscopy with directed treatment for suspect distal disease who was determined to have CLL, which had not been previously diagnosed.

Inferior meatus endoscopy and directed treatment was previously shown to be effective in 93% of patients with distal NL disease after a follow-up of 9 months. In the pres-

Table. Characteristics and Outcomes of Obstructions

<table>
<thead>
<tr>
<th>Patient/Sex/Age, y</th>
<th>Side</th>
<th>Procedure/Finding</th>
<th>Follow-up, y</th>
<th>Outcome (Rating Scale*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distal Obstructions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/F/67</td>
<td>Left</td>
<td>Resection of cyst at NLD orifice</td>
<td>6.90</td>
<td>Cure (0)</td>
</tr>
<tr>
<td>2/F/56</td>
<td>Right</td>
<td>Resection of cyst at NLD orifice</td>
<td>6.83</td>
<td>Cure (0)</td>
</tr>
<tr>
<td>3/M/72</td>
<td>Left</td>
<td>Resection of mucosal hypertrophy at NLD orifice</td>
<td>6.61</td>
<td>Improvement (1)</td>
</tr>
<tr>
<td>4/F/65</td>
<td>Left</td>
<td>Resection of mucosal hypertrophy at NLD orifice</td>
<td>6.55</td>
<td>Improvement (2)</td>
</tr>
<tr>
<td>5/F/57</td>
<td>Right</td>
<td>Resection of right cyst at NLD orifice</td>
<td>6.39</td>
<td>Cure (0)</td>
</tr>
<tr>
<td>6/F/81</td>
<td>Left</td>
<td>Resection of cyst at NLD orifice</td>
<td>6.13</td>
<td>Failure, required DCR</td>
</tr>
<tr>
<td>7/F/62</td>
<td>Bilateral</td>
<td>Resection of mucosal hypertrophy at NLD orifices</td>
<td>3.66</td>
<td>Bilateral cure (0)</td>
</tr>
<tr>
<td>8/F/39</td>
<td>Bilateral</td>
<td>Resection of mucosal hypertrophy at NLD orifices</td>
<td>3.30</td>
<td>Bilateral cure (0)</td>
</tr>
<tr>
<td>Proximal Obstructions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5/F/57</td>
<td>Left</td>
<td>Resection of left mucosal hypertrophy at NLD orifice and proximal duct</td>
<td>6.39</td>
<td>Failure required DCR,</td>
</tr>
<tr>
<td>9/M/50</td>
<td>Left</td>
<td>Resection of mucosal hypertrophy at NLD orifice and proximal duct</td>
<td>6.16</td>
<td>Failure, required DCR</td>
</tr>
<tr>
<td>10/F/71</td>
<td>Left</td>
<td>Resection of mucosal hypertrophy at NLD orifice and proximal duct</td>
<td>6.00</td>
<td>Failure, required DCR</td>
</tr>
<tr>
<td>11/F/59</td>
<td>Bilateral</td>
<td>Resection of mucosal hypertrophy at NLD orifices and proximal ducts</td>
<td>5.88</td>
<td>Left cure (0), Right failure required DCR</td>
</tr>
<tr>
<td>12/F/77</td>
<td>Left</td>
<td>Resection of cyst with disease extending proximal to NLD orifice</td>
<td>5.63</td>
<td>Failure, required DCR</td>
</tr>
<tr>
<td>13/F/73</td>
<td>Bilateral</td>
<td>Bilateral obstruction extending proximally determined to be CLL</td>
<td>2.07</td>
<td>Failure bilaterally, required DCRs</td>
</tr>
</tbody>
</table>

Abbreviations: CLL, chronic lymphocytic leukemia; DCR, dacryocystorhinostomy; NL, nasolacrimal duct.

* Degree of epiphora improvement was assessed using the following scale: 0, no tearing; 1, intermittent mild tearing; 2, frequent mild tearing; 3, frequent moderate tearing; 4, severe constant tearing.
ent study, 90% of individuals with distal obstruction of the NL system who underwent IM treatment (n=9) had sustained, long-term improvement of symptoms at a mean follow-up of 6.2 years.

Procedure and Study Limitations
Although patients were initially evaluated for epiphora using endoscopy, it is impossible to determine the extent of proximal disease purely with IM endoscopy. Inferior meatus endoscopy with directed treatment is most effective for distal disease of the NL system. For this reason, it is critical to differentiate distal from proximal obstruction because of the poor success rates for IM surgery in proximal NLD obstructions. Rogers et al.12 showed a 25% short-term success of IM surgery for NLD disease extending proximally. Unfortunately, primary proximal NL disease can extend distally and cause abnormal appearance of the NLD orifice in the IM. This needs to be differentiated from primary distal disease obstructing the NLD orifice. More accurate evaluation of the NL system using a multidisciplinary approach with otolaryngology and ophthalmology will locate the site of obstruction and ultimately benefit the patient. It is important to identify extension of mucosal disease in the NLD because symptoms can persist from mucosal dysfunction despite patency of the distal NLD. Dacryocystogram can be of use in identifying the site of obstruction, but findings from this test might be negative if the abnormality is primarily a mucosal dysfunction without complete obstruction.

A limitation of this study is the small number of patients who responded to the survey. Although the patient population and number of NL systems evaluated are comparable to those of a previous study performed by our research group12 on short-term outcome after IM endoscopy with directed treatment, analysis using more patients would increase the power of our study.

Conclusions
Epiphora can be an irritating and debilitating symptom indicating NL system disease. This study evaluated 12 patients with obstruction of the NL system totaling 16 sides, 10 of which were due to distal obstruction. Long-term resolution of symptoms was achieved in 90% of patients with distal NL system obstruction (n=9).

Given our results, we conclude that IM endoscopy with treatment directed at distal structures of the NL system is an effective technique for management of epiphora in patients with distal NLD obstruction, with sustained long-term improvement. Differentiating distal from proximal obstruction is difficult but necessary for a successful outcome. We recommend that patients presenting with epiphora be evaluated in a multidisciplinary setting to maximize results.
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Study concept and design: Daraei, DelGaudio.
Acquisition, analysis, or interpretation of data: Daraei, DelGaudio.
Drafting of the manuscript: Daraei, DelGaudio.
Critical revision of the manuscript for important intellectual content: Daraei, DelGaudio.
Statistical analysis: Daraei.
Administrative, technical, or material support: DelGaudio.
Study supervision: DelGaudio.

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REFERENCES