

# Recent Developments in the Evaluation and Management of Adult Lacrimal Obstruction

a report by

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Obstruction of the lacrimal drainage system can lead to various symptoms. These commonly include intermittent or constant epiphora, which is defined as tearing due to interference with tear drainage (as opposed to lacrimation, which reflects hypersecretion of tears). Acute or chronic dacryocystitis (lacrimal sac infection) may also develop. Obstruction may occur anywhere along the lacrimal drainage pathway from the punctum to the intranasal ostium of the nasolacrimal duct. Obstruction may be secondary to congenital, infectious, inflammatory, traumatic, or neoplastic processes. A thorough clinical history, physical examination, and, in some cases, radiological evaluation can assist in determining the etiology and appropriate therapy.<sup>1</sup>

## Anatomy and Pathophysiology

A thorough understanding of the anatomy of the lacrimal drainage system is vital in the evaluation and management of lacrimal obstruction. There is a close relationship among the orbit, intracranial space, and nose. At the most proximal end of the system are the puncta, which are located in the medial aspect of the upper and lower eyelids. The punctal opening is about 0.2–0.3mm in diameter. Distal to this is an approximately 2mm vertical component of the canaliculus. The canaliculus then travels horizontally for 8–10mm to join a common canaliculus. Roughly 6% of individuals do not have a common canaliculus.<sup>2</sup> Yazici et al. examined 341 lacrimal systems of patients with epiphora and identified by a dacryocystography (DCG) a common canaliculus in 94%; upper and lower canalicular systems met at the lacrimal sac in 3.8%; and canaliculi entered the sac separately in 2%. At the junction between the canaliculus and the lacrimal sac is a fold of mucosa known as the valve of Rosenmüller. This valve prevents retrograde flow from the lacrimal sac, which sits in a bony fossa comprising the lacrimal bone and the nasal process of the maxilla. Fayet et al. performed a prospective study of the surgical anatomy of the lacrimal fossa.<sup>3</sup> Adult candidates for endonasal dacryocystorhinostomy (DCR) underwent a pre-operative computed tomography DCG (CT-DCG) and the relationship of the lacrimal apparatus to the adjacent structures was analyzed. The uncinat process (UP) was found to be adjacent to the lacrimal fossa in 94.8% of cases. They concluded that, because of this proximity to the lacrimal fossa, at least the anterior portion of the UP should be resected when forming the osteotomy during an endoscopic DCR.<sup>3</sup> The lacrimal sac extends approximately 10–15mm vertically from the medial canthal tendon inferiorly where the start of the nasolacrimal duct begins. The nasolacrimal duct represents the interosseous portion of the system and enters into the inferior meatus through a mucosal fold known as the valve of Hasner.

Janssen et al. performed axial CT studies of the bony lacrimal canal in patients with primary acquired nasolacrimal duct obstruction (NLDO) and

revealed a statistically smaller diameter compared with controls.<sup>4</sup> Women were also found to have a smaller canal diameter than men.

Tears are actively pumped through the lacrimal drainage system with the help of gravity. This pump mechanism is thought to occur through the positive pressure created by the contraction of the orbicularis oculi muscle during eyelid closure. With eyelid opening, a negative pressure is created in the lacrimal sac, drawing the tears toward it.<sup>5</sup> Pavlidis et al. used sonography to visualize the movement of the lacrimal sac and medial canthal tendon (MCT) during blinking.<sup>6</sup> They found that the MCT with the orbicularis compressed the lacrimal sac by 50% in control subjects during blinking, but by only 15.5% in those with NLDO.<sup>6</sup>

## Evaluation

Lacrimal pump disorders should be differentiated from obstructive disorders. Clinical examination through inspection and lacrimal irrigation, as well as documented evidence, may suggest a pump disorder. Equivocal irrigation of the system may represent a functional obstructive etiology and may benefit from radiographic studies. Recent radiological investigations have helped in identifying the anatomical location of an obstruction and assisting in preparation for possible surgery.<sup>7</sup> Radiographic tests include dacryoscintigraphy (DS), DCG, CT-DCG, and magnetic resonance DCG (MR-DCG).

Developed in the 1970s, DS allows for a functional assessment of the lacrimal drainage system.<sup>8</sup> Radionuclide solution is instilled in each eye and images are sequentially taken to allow an analysis of physiological tear drainage. The limited resolution achievable with DS is a relative

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drawback of this diagnostic modality. DCG and CT-DCG both use a radiopaque contrast medium for more precise anatomical imaging of the drainage system. The latter allows the extrapolation of additional detailed information including soft tissue and bony anatomy via axial and coronal scans. The use of CT-DCG for recurrent or persistent epiphora after surgery has also recently been studied; however, the results have not been consistent. A large study of 72 cases by Amin et al. found an identifiable cause for epiphora in 42% of failed cases, but a more recent study by Gökçek et al. detected a cause in 83% of cases. However, this latter study included only 18 cases.<sup>9,10</sup>

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Recently, Lüchtenberg et al. described the use of 3D rotational angiography as an adjunct to conventional CT-DCG.<sup>11</sup> This new technology may yield additional information not available with current CT-DCG; however, further clinical studies are needed. Other new technologies include MR-DCG. This may offer advantages over conventional DCG by avoiding ionizing radiation and viscous contrast media while still offering high-resolution images to identify sites of obstruction. Takehara et al. and Karagülle et al. have shown that its use is safe and effective in identifying the site of obstruction; however, cost and availability may be limiting factors to its widespread acceptance.<sup>12,13</sup>

### Dacryocystorhinostomy

Surgical management of nasolacrimal duct obstruction involves the creation of a new pathway for tear flow from the lacrimal sac directly into the nose, bypassing the nasolacrimal duct. Traditionally, with a normal canalicular system external dacryocystorhinostomy has been performed. This involves a skin incision to expose the lacrimal sac and to obtain access to the lacrimal bone. The lacrimal bone is removed and the lacrimal sac mucosa is anastomosed to the nasal mucosa. Variations in technique include size of the surgical ostium, creation of anterior or posterior mucosal flaps, use of antimetabolites, and use of silicone stents. Success rates with this approach are generally over 90%; however, there is an external scar that may be cosmetically unacceptable for some.

### Endoscopic Dacryocystorhinostomy

The development and popularization of the rigid endonasal endoscope in the 1980s and 1990s led to increased endoscopic approaches to DCR. Several potential advantages over external DCR include lack of an external scar, better maintenance of lacrimal pump function through preservation of the orbicularis muscle (which is sectioned in the external approach), decreased bleeding, and an ability to simultaneously treat nasal pathologies that may lead to a failure of the DCR (i.e. septal deformities or sinusitis).<sup>14,15</sup> Disadvantages of endoscopic surgery may include its initial learning curve with increased operating time and increased cost.<sup>16,17</sup>

Hartikainen et al. performed a prospective randomized trial with 60 patients comparing external and endoscopic techniques.<sup>18</sup> They found a higher success rate with external DCR, although this was not statistically significant. However, mean surgery time was statistically significant between the two groups: 38 minutes for endoscopic DCR and 78 minutes for external DCR ( $p < 0.001$ ).<sup>18</sup>

Another recent, non-randomized, prospective trial by Ben Simon et al. comparing the two procedures at a tertiary referral center showed a success rate of 70% for external and 84% for endoscopic DCR ( $p = 0.03$ ).<sup>19</sup> The authors suggest that their strict guidelines for defining success may have contributed to their relatively low success rate compared with previous published reports. In addition, all etiologies of NLDO were included in the trial and those with a history of facial trauma were more likely to have undergone external DCR.<sup>19</sup>

DCR surgery failure is usually due to the closure of the surgical osteotomy, which may be due to exuberant fibrosis or granulation tissue formation. In an attempt to maintain a patent anastomosis, the use of the antimetabolite mitomycin C has been previously studied in external DCR surgery and found to increase the number of symptom-free cases.<sup>22,23</sup> Recently, Deka et al. performed a prospective controlled study involving 60 cases undergoing external DCR. There were three groups—a control and two mitomycin C groups—and the drug was administered at either 0.05mg/ml or 0.4mg/ml. Nasal endoscopic evaluation was performed on the first post-operative day, at two weeks, and six months after surgery. The ostium size in group 3 was found to be significantly larger in comparison with the control group and with group 2. The success rate in group 1 was 90%, and 95% for groups 2 and 3. There were no complications related to the use of mitomycin C in these cases. The dose and application times have been variable in the recent studies.<sup>22,23</sup>

There are few reports regarding the use of mitomycin C and endoscopic dacryocystorhinostomy surgery, and the results to date are mixed.

There are few reports regarding the use of mitomycin C and endoscopic DCR surgery, and the results to date are mixed.<sup>24</sup> Alañón Fernandez et al. carried out a randomized, prospective study in 200 patients to study the effects and possible secondary adverse effects of mitomycin C. The average follow-up was 15 months. Excessive scarring was seen in 21% of the control group and 8% of the mitomycin C group. This difference was statistically significant ( $p = 0.02$ ) and the control group had an increased relative risk for excessive scarring (2.71) compared with the treatment group. There were no adverse secondary effects due to application of mitomycin.<sup>25</sup> The authors did not report their success rate in terms of symptom resolution; rather, they based success on subjective scarring observed on post-operative endonasal evaluation. In another recent prospective randomized trial, Dolman found no difference in

success rates between the groups that were and were not treated with mitomycin C (93 and 94% of 58 and 118 patients, respectively).<sup>26</sup>

### Transcanalicular Dacryocystorhinostomy

A recent surgical approach for the treatment of NLDO is transcanalicular (or endocanalicular) laser DCR.<sup>27</sup> Canalization of the upper lacrimal system is performed and a laser probe is inserted through the upper canaliculi and advanced along the nasolacrimal duct to the lateral wall of nasal fossa. Under endonasal visualization, the laser is used to create a transcanalicular nasolacrimal ostium.<sup>27</sup> Various lasers have been used, including the potassium titanyl phosphate (KTP) laser, erbium (Er):yttrium aluminium garnet (YAG), neodymium (Nd):YAG, holmium (Ho):YAG, and diode.<sup>28-31</sup> Success rates have been variable with the initial small series and different lasers. Two large series have been performed with Nd:YAG or Ho:YAG, and diode.<sup>30,32</sup> Piaton et al. used the Nd:YAG or Ho:YAG laser in their series of 317 patients and found an overall success rate of 63%, with no difference between the use of either laser. There was no difference with the use of antimetabolites in this series.<sup>30</sup>

In a study using the diode laser, Maeso et al. carried out an observational, prospective, non-randomized interventional study on 150 consecutive eyes. They divided the patients into two groups of 75 eyes. Group I did not have silicone intubation or mitomycin C, while in group II mitomycin C and bicanalicular intubation were used. The mean follow-up period was 16 months. There was no statistical difference between the two groups. Complete resolution of symptoms occurred in 91% of cases, partial improvement in 4%, and no change in symptoms in 5%.<sup>32</sup> Additional randomized, controlled studies may be helpful in further defining the role of this new technique.

### Conjunctivodacryocystorhinostomy

In some cases, including obstruction or agenesis of the proximal portion of the canalicular system, lacrimal pump dysfunction, trauma, or lid-globe deformity, a conjunctivodacryocystorhinostomy may need to be performed. This entails the creation of a drainage route from the medial portion of the conjunctival fornix to the nose. Nasal endoscopy at the time of surgery may be helpful during this procedure as it facilitates tube placement and ensures appropriate tube length. In addition, simultaneous management of any possible nasal pathology that may otherwise interfere with proper tube function may also be performed. The fistula created remains stented open with a Jones' tube, but often requires long-term maintenance to ensure patency; also, intermittent extrusion of the tube may occur requiring additional treatment.

Dailey and Tower described the use of a new frosted Jones' tube to improve tube stability.<sup>33</sup> The authors contend that it preserves the ease of manual removal for the clinician while providing some friction to reduce the incidence of spontaneous extrusion. In their initial report they had eight months of follow-up without any extrusion. The use of a Medpor-coated tube has recently been investigated by Fan et al.<sup>34</sup> There were no tube extrusions or displacements in their cohort after six to 28 months of follow-up, and complete or significant resolution of epiphora was achieved in 88.5% of cases.<sup>34</sup>

### Lacrimal Intubation

In the pediatric population, nasolacrimal probing with silicone intubation is highly effective; however, in adults their use has been limited. Inatani et al.

described the use of a specially designed tube that has thick segments for the nasolacrimal sac and duct, and a thin segment for the canaliculi.<sup>35</sup> In their series, they achieved a success rate of 68% for those with nasolacrimal duct obstruction and 76% with common canalicular obstruction.<sup>35</sup> This is consistent with previous studies that have shown higher success with patients with canalicular obstruction than in those with NLDO.<sup>36</sup> Kashkouli et al. recently compared the success rates of monocalicular versus bicanalicular silicone intubation of incomplete nasolacrimal duct obstruction in adults.<sup>37</sup> Complete success was achieved in 59.09% of eyes with bicanalicular intubation and in 61.53% of eyes with monocalicular intubation; however, the monocalicular tubes had a higher partial success rate and a lower failure rate than the bicanalicular tubes. The reason for this difference may be related to more severe pre-operative obstruction or more manipulation and injury during bicanalicular intubation.<sup>37</sup>

With improved understanding of the surgical anatomy, there has been a trend toward endoscopically assisted, minimally invasive lacrimal surgery.

### Lacrimal Stenting

The use of a polyurethane stent to maintain the patency across an obstruction in the lacrimal system was developed by Song and is the most commonly used stent.<sup>38</sup> Placement of the stent often requires the assistance of an interventional radiologist using fluoroscopic guidance.<sup>39</sup> Lee et al. described the use of guidewires for stent placement with 93% success without the use of fluoroscopy.<sup>40</sup> The Song lacrimal stent was found to initially relieve epiphora in 93-97% of patients.<sup>41</sup> However, long-term results of stent placement in the nasolacrimal system have not been encouraging.<sup>42</sup> Patency rates after stent placement decrease progressively with time: the five-year primary and secondary patency rates after stent placement in 609 lacrimal systems of 530 patients with epiphora were 19 and 34%, respectively.<sup>43</sup> The main cause of decreasing stent patency appears to be obstruction of the stent by granulation tissue or mucoid materials.<sup>43,44</sup> Some stents have had to be removed because of decreased patency. Long-term results of lacrimal stent placement were reported by Kim et al. After stent removal, the immediate patency rate was 77%; however, the rate of maintained patency decreased progressively with time.<sup>45</sup> The major factor negatively affecting patency after stent removal was contraction of the lacrimal sac at the time of stent removal.<sup>45</sup>

### Balloon Dacryocystoplasty

The use of balloon dacryocystoplasty to dilate an obstruction in the lacrimal system has been studied in both the pediatric and adult population; however, it is generally more successful in the former group, with success rates approaching 90%. In adults, success rates have ranged from 10 to 75%.<sup>46-48</sup> There are two approaches for balloon introduction: via the punctum (anterograde) or through the nose (retrograde). The antegrade approach is most commonly used by ophthalmologists because it does not require fluoroscopy or the assistance of a radiologist. Kashkouli et al. retrospectively reviewed 62 eyes of 55 patients and compared the

success rate of endoscopically assisted balloon dacryocystoplasty and silicone intubation with silicone intubation alone in adults with incomplete NLDO.<sup>48</sup> There was no statistically significant difference between the two groups (53.8% in the silicone intubation group and 60.8% in the balloon dacryocystoplasty group). In a similar study, Kuchar and Steinkogler found that at one year the success rate was 73%.<sup>49</sup> Several studies have reviewed the short- and long-term outcomes of retrograde dacryocystoplasty in adults.<sup>50-52</sup> Fenton et al. reported an overall re-obstruction rate of 29% at one year, but 69% of those with initially complete obstruction failed by one year.<sup>50</sup> Lee et al. reported their five-year results and found only a 36.9% success rate. Long-term patency was affected by the site of the obstruction ( $p < 0.001$ ) and the balloon inflation time ( $p < 0.001$ ). Those with proximal obstruction (lacrimal sac and canaliculus) fared worse than those with obstruction at the level of the

nasolacrimal duct, and those with shorter inflation times (two minutes) did better than longer times (five minutes).<sup>51</sup>

## Conclusions

In recent years, there have been several advances in the evaluation and management of lacrimal obstruction. Evidence-based assessments of new lacrimal surgical techniques are limited by the fact that the majority of published studies are non-controlled case series. In addition, studies may not define success equally and 'standard' surgical techniques may likewise vary. With improved understanding of the surgical anatomy, there has been a trend toward endoscopically assisted, minimally invasive lacrimal surgery. Additional studies (ideally randomized with appropriate control populations) may help to further define the role of new approaches to the diagnosis and management of lacrimal obstruction. ■

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