A comparison of external and endoscopic endonasal dacryocystorhinostomy for acquired nasolacrimal duct obstruction

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Purpose: To compare success rates of external dacryocystorhinostomy (DCR) and endoscopic endonasal DCR for acquired nasolacrimal duct obstruction (NLDO).

Design: Historical cohort study.

Participants: 100 patients who underwent external DCR and 105 patients who underwent endoscopic endonasal DCR.

Methods: A retrospective review of medical records of patients with acquired NLDO who underwent DCR from 2004–2010 was performed. Data regarding the lacrimal drainage system, eye examination, surgical outcomes, patient symptom control, and postoperative care were analyzed.

Main outcome measures: Surgical success was defined by patient’s resolution of symptoms with patency on irrigation. Surgical failure was defined as no symptomatic reduction in epiphora and/or an inability to irrigate the lacrimal system postoperatively.

Results: A total of 205 patients underwent surgeries for acquired NLDO. The average age was 69 years, and 62.4% of subjects were female. Pooled results showed that both surgical approaches had similar success rates (endoscopic endonasal DCR 82.4% versus external DCR 81.6%; \( P = 0.895 \)). Complication rates were low in both types of surgery. This included three patients with postoperative hemorrhage (two who had endonasal DCR surgery and one having external DCR surgery). This resolved with conservative treatment. Postoperative problems with lacrimal patency (including canaliculor obstruction) occurred to 6.8% of endoscopic patients and 9% of those with the external DCR surgery. Of the 14 patients who had their silicone tubes fall out before the 2-month assessment, 10 were classified as failures (71%), in contrast to only a failure rate of 13.9% of those whose tubes were present for the recommended time. This difference was statistically significant (\( P < 0.01 \)).

Conclusion: The success rate of DCR for acquired NLDO in our group of patients was high overall with a low complication rate between the two types of surgery. There was no statistically significant difference between endoscopic and external DCR. Endoscopic surgery may have a benefit of preserving the lacrimal pump system and leaving no surgical scar. Patient preference and availability of each service should direct management. Hence endoscopic endonasal DCR surgery should be considered for primary treatment of nasolacrimal duct obstruction.

Keywords: lacrimal sac, postoperative, irrigation, epiphora

Introduction

Standard treatment for nasolacrimal duct obstruction has been dacryocystorhinostomy (DCR) surgery. The external approach is performed through a cutaneous incision to access the lacrimal sac. The procedure gained popularity due to its efficacy and relatively low complication rates. Endoscopic endonasal DCR has gathered momentum...
with direct visualization under endoscopic guidance. Caldwell first introduced the endonasal approach for lacrimal surgery in 1893. However endoscopic endonasal DCR has only become recently employed with new endoscopy instruments and technique.\(^1\) This approach avoids an external scar and neurovascular disruption along the tract exposing the lacrimal sac.

The reported success rates of both procedures range from 63% to 97%.\(^2\)\(^-\)\(^4\) The wide range of success is likely due to surgical variability, patient demographics, and lack of standardized outcome measures in the medical literature. The purpose of the current study was to evaluate both the functional/anatomic success as well as symptom control for endoscopic endonasal and external DCR surgeries performed at two specialized centers.

### Methods

Medical records were reviewed in all patients who underwent surgery for acquired nasolacrimal duct obstruction (NLDO) from January 2004 to May 2010. The study was carried out in accordance with the ethical guidelines of the Declaration of Helsinki with institutional ethical approval. Data was collected in a spreadsheet with a standard collection template used for both types of operations.

A diagnosis of NLDO was made from ophthalmic examination and/or radiological findings. All patients included had symptoms of epiphora. Documented obstruction on syringing and probing or obstruction on lacrimal scintigraphy were used in the diagnosis of NLDO.

Patients with previous DCR surgery to the same eye were excluded from the study. Refer to Table 1 for selection criteria for nasolacrimal duct obstruction.

Surgery choice of external or endoscopic endonasal DCR was based on hospital or day surgery attended. All operations at the two eye centers were performed by one of the authors (RG). All patients who had the external DCR surgery held private health insurance. The endonasal endoscopic DCRs were performed at a public hospital. This is a weakness of the study.

### Table 1 Selection criteria for cases with NLDO

<table>
<thead>
<tr>
<th>Inclusion</th>
<th>Exclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epiphora</td>
<td>Previous DCR to same eye</td>
</tr>
<tr>
<td>Evidence of obstruction on probing and irrigation</td>
<td>Congenital NLDO</td>
</tr>
<tr>
<td>Fluorescein dye disappearance test</td>
<td>Age under 16 years</td>
</tr>
<tr>
<td>Obstruction on lacrimal scintigraphy</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: DCR, dacryocystorhinostomy; NLDO, nasolacrimal duct obstruction.

Patients underwent ophthalmic examinations including irrigation of the nasolacrimal drainage systems, fluorescein dye disappearance test, and intranasal examination. All patients had tubes inserted intra-operatively.

Standard external approach was used. Endoscopic endonasal DCR surgery consisted of adequate lacrimal sac exposure and creation of a large marsupialized lacrimal sac, covering the exposed bone with preserved nasal mucosal flaps.

Postoperatively, the silicone tube was removed after 1–2 months. In 14 patients, the tubes fell out early, and four patients had their tubes in situ for more than 4 months. Irrigation of the nasolacrimal systems and fluorescein dye disappearance test was performed at postoperative follow-up appointments in all patients.

Postoperatively, all patients were assessed within 1 month of surgery. Patient follow-up included 2 months follow-up for tube assessment and subsequent 4–12-month follow-up for progress and symptom surveillance. During postoperative visits, patients were asked about symptomatic resolution of epiphora and assessed with patency on irrigation, fluorescein dye disappearance test, and intranasal examination. Postoperative complications were also noted at each visit. All patients were followed up for at least 6 months (range 6–24 months).

Results were defined by patient’s resolution of symptoms with patency on irrigation and a positive fluorescein dye disappearance test. Patients’ resolution of symptoms were stratified into four categories during data collection. These were: 1) no epiphora and complete resolution of symptoms; 2) improved epiphora with associated patient satisfaction, with no further follow-up required; 3) continued epiphora with no improvement; and 4) revision DCR surgery required with or without Jones tubes. Only patients with patency on irrigation of the lacrimal system and a negative fluorescein dye disappearance test postoperatively could be classified into categories 1 and 2.

Outcome measures were pooled in order to determine success or failure. Patients who were categorized 1 and 2 with patency on irrigation were defined as a successful outcome. Patients were also categorized as surgical failure if they experienced any postoperative episode of dacryocystitis. Inability to irrigate the lacrimal system postoperatively, nasal endoscopy with scarring at the intranasal osteotomy, and/or no visualization of fluorescein dye was also classified as a surgical failure. It can be noted that patients with improved or resolved symptoms but with postoperative obstruction on irrigation were still classified as surgical failure. Refer to Table 2 for outcome measures.
Table 2 Outcome measures for cases post dacryocystorhinostomy surgery

<table>
<thead>
<tr>
<th>Success</th>
<th>Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patency on probing and irrigation</td>
<td>Obstruction on probing and irrigation</td>
</tr>
<tr>
<td>Resolution of symptoms</td>
<td>Ostial scarring</td>
</tr>
<tr>
<td>Improvement of symptoms</td>
<td>No visualization of fluorescein in dye disappearance test</td>
</tr>
<tr>
<td></td>
<td>Persistent symptoms</td>
</tr>
<tr>
<td></td>
<td>Requiring revision or adjuvant intervention</td>
</tr>
</tbody>
</table>

Patency on probing and irrigation was achieved in 96 (93.2%) of 103 patients. Resolution of symptoms was achieved in 84 (82.4%) of 102 patients postoperatively. The tubes were kept in situ for a minimum duration of 2 months before removal.

Surgical technique

Endoscopic endonasal DCR

Endoscopic endonasal DCR was performed under general anesthesia. After vasoconstriction of the nasal cavity by neurosurgical pledges soaked in cocaine, the head of the middle turbinate and the mucosa surrounding the lacrimal sac are infiltrated with a (lignocaine and lidocaine combination) local anesthetic. The dose of local anesthetic was not recorded in the data template. A surgical incision is made at the lateral nasal wall, anterior superior to the insertion of the middle turbinate. The posterior mucosal flap is elevated off the maxillary bone and incision made until the sac is exposed. Metallic lacrimal probes are passed medially through both canaliculi so as to tent the sac lumen. By preserving the nasal submucosal injection in the presumed lacrimal fossa during opening of the sac, marsupialization can occur to appose the nasal mucosa. A silicone bicanalicular tube is then positioned and tied. All patients were given postoperative chloramphenicol and prednisolone drops to the affected eye four times a day for a month as well as oral cephalosporin. Medication variation was only considered if the patient had a known allergy. Patients are encouraged to wash using nasal rinse or sprays to prevent crust formation.

External DCR

External DCR was performed under local anesthetic. Some patients were sedated for the duration of the procedure. A straight incision is made medially to the angular vein at the level of the medial canthal ligament. The wound is opened with traction sutures for adequate exposure of the anterior lacrimal crest. An osteotomy is created and lacrimal sac and mucosa opened to form anterior and posterior flaps. Probing ensures site of obstruction is localized, then flaps sutured with 6/0 vicryls sutures. A silicon tube is inserted and tied. The wound is closed and skin is sutured using fine sutures for cosmetic effect. All patients were given chloramphenical and prednisilone eye drops four times a day for a month postoperatively. The tubes were kept in situ for a minimum duration of 2 months before removal.

Statistical analysis

Independent-samples t-test and χ²-nonparametric analysis were used to compare numerical variables and proportions, respectively, between successful and failed cases and between endoscopic and external DCRs. Significance testing was carried out on patient demographics, ocular history, comorbidities and symptoms, peri and postoperative outcomes and follow up. Outcomes measures were pooled with assessment of statistical significance. SPSS program was used for the statistical analysis.

Results

A total of 205 patients were included in the study (128 females and 77 males), with a mean age of 69 years. Demographics between the two surgical groups were similar. There was no statistically significant difference in comorbidities, previous sinus disease or surgery, ocular history, or presenting symptoms. There was a statistically significant difference in the ethnic origin, with more Caucasians in the external DCR group than the endoscopic endonasal group (see Table 3).

Multivariate analysis was not performed, as the majority of the groups’ characteristics were statistically similar apart from intervention.

The operation was classified as successful by the objective demonstration of a patent nasolacrimal system through irrigation. Patency was achieved in 96 (93.2%) of 103 patients for the endonasal DCR and 83 (91.2%) of 91 patients for external DCR surgery (refer to Table 4). The difference was not statistically significant (P = 0.604).

Anatomical patency and symptom relief (6–24 months postoperatively) was achieved in 84 (82.4%) of 102 patients in the endonasal DCR group and 80 (81.6%) of 98 patients in the external DCR group (Table 4). This difference was not statistically significant (P = 0.895). Refer to Table 5 for results of success stratified by DCR surgery, endonasal and external.

The complication incidence was low and similar in both operations. Three patients had postoperative hemorrhage...
(two who had endonasal DCR surgery and one having external DCR surgery). Postoperative hemorrhage was either wound hemorrhage or epistaxis. All of these patients were treated conservatively, including nasal spray and/or packing. Hemostasis was achieved with no secondary hemorrhage resulting in surgical intervention. Canalicular obstruction was documented in six cases, with three in each of the surgical groups. There was no documented orbital and subcutaneous emphysema, conjunctival fistula formation, retrobulbar hemorrhage, medical rectus paresis, orbital fat herniation, or nasal mucosal synchiae formation. See Table 6 for postoperative results and complications stratified by DCR surgery, endoscopic endonasal and external.

Fourteen patients who underwent DCR surgery had tubes that fell out before the 2-month assessment, of which six were in the endonasal group and eight in the external group.

### Table 3 Demographics of endoscopic endonasal and external dacryocystorhinostomy groups

<table>
<thead>
<tr>
<th>Categorized</th>
<th>Total (205)</th>
<th>Endoscopic (105)</th>
<th>External (100)</th>
<th>Overall P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean (SD)</td>
<td>68.89 (15.022)</td>
<td>66.77 (17.432)</td>
<td>70.34 (12.829)</td>
<td>0.698</td>
</tr>
<tr>
<td>Female sex (%)</td>
<td>128</td>
<td>68 (64.8)</td>
<td>60 (60)</td>
<td>0.012</td>
</tr>
<tr>
<td>Ethnicity (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caucasian</td>
<td>135 (71.4)</td>
<td>58 (55.6)</td>
<td>77 (77)</td>
<td>0.001</td>
</tr>
<tr>
<td>Oriental</td>
<td>20 (10.6)</td>
<td>12 (11.5)</td>
<td>8 (8.0)</td>
<td>0.353</td>
</tr>
<tr>
<td>Indian</td>
<td>3 (1.6)</td>
<td>3 (3.0)</td>
<td>0 (0)</td>
<td>0.069</td>
</tr>
<tr>
<td>Subcontinent</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>European</td>
<td>30 (15.9)</td>
<td>24 (22.8)</td>
<td>6 (6.0)</td>
<td>0.008</td>
</tr>
<tr>
<td>African</td>
<td>1 (0.5)</td>
<td>1 (1.0)</td>
<td>0 (0)</td>
<td>0.000</td>
</tr>
<tr>
<td>NESB</td>
<td>29 (14.3)</td>
<td>20 (19.2)</td>
<td>9 (9.1)</td>
<td>0.039</td>
</tr>
<tr>
<td>Previous sinus surgery</td>
<td>6 (3)</td>
<td>2 (1.9)</td>
<td>4 (4.2)</td>
<td>0.353</td>
</tr>
<tr>
<td>History of ocular trauma</td>
<td>7 (3.5)</td>
<td>6 (5.7)</td>
<td>1 (1.0)</td>
<td>0.069</td>
</tr>
<tr>
<td>with either NLD obstruction or canalicular laceration</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comorbidities (yes)</td>
<td>125 (61.6)</td>
<td>66 (62.9)</td>
<td>59 (60.2)</td>
<td>0.698</td>
</tr>
<tr>
<td>HT</td>
<td>88 (44)</td>
<td>47 (44.8)</td>
<td>41 (43.2)</td>
<td>0.819</td>
</tr>
<tr>
<td>DM</td>
<td>23 (11.5)</td>
<td>17 (16.2)</td>
<td>6 (6.3)</td>
<td>0.029</td>
</tr>
<tr>
<td>Smoking</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>170 (85)</td>
<td>88 (83.8)</td>
<td>82 (86.3)</td>
<td>0.029</td>
</tr>
<tr>
<td>Yes</td>
<td>22 (11)</td>
<td>9 (8.6)</td>
<td>13 (13.7)</td>
<td>0.140</td>
</tr>
<tr>
<td>Ex</td>
<td>8 (4)</td>
<td>8 (7.6)</td>
<td>0 (0)</td>
<td>0.140</td>
</tr>
<tr>
<td>Ocular history</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>90 (44.3)</td>
<td>48 (46.2)</td>
<td>42 (42.4)</td>
<td>0.099</td>
</tr>
<tr>
<td>Previous cataract surgery</td>
<td>16 (7.9)</td>
<td>9 (8.7)</td>
<td>7 (7.1)</td>
<td>0.099</td>
</tr>
<tr>
<td>Glaucoma</td>
<td>9 (4.4)</td>
<td>1 (1.0)</td>
<td>8 (8.1)</td>
<td>0.162</td>
</tr>
<tr>
<td>Corneal disease</td>
<td>1 (0.5)</td>
<td>0 (0)</td>
<td>1 (1)</td>
<td>0.162</td>
</tr>
<tr>
<td>Ocular plastic</td>
<td>38 (18.7)</td>
<td>22 (21.2)</td>
<td>16 (16.2)</td>
<td>0.241</td>
</tr>
<tr>
<td>Retinal</td>
<td>9 (4.4)</td>
<td>3 (2.9)</td>
<td>6 (6.1)</td>
<td>0.241</td>
</tr>
<tr>
<td>Other</td>
<td>8 (3.9)</td>
<td>2 (1.9)</td>
<td>6 (6.1)</td>
<td>0.241</td>
</tr>
<tr>
<td>More than two ocular conditions</td>
<td>32 (15.8)</td>
<td>19 (18.3)</td>
<td>13 (13.1)</td>
<td>0.099</td>
</tr>
<tr>
<td>Epiphora</td>
<td>204 (100)</td>
<td>104 (100)</td>
<td>100 (100)</td>
<td>Constant</td>
</tr>
<tr>
<td>Red eyes</td>
<td>35 (17.2)</td>
<td>14 (13.6)</td>
<td>21 (21)</td>
<td>0.162</td>
</tr>
<tr>
<td>Blepharitis</td>
<td>38 (18.7)</td>
<td>21 (20.4)</td>
<td>17 (17)</td>
<td>0.536</td>
</tr>
<tr>
<td>Inflammatory eye disease</td>
<td>2 (1)</td>
<td>2 (1.9)</td>
<td>0 (0)</td>
<td>0.161</td>
</tr>
<tr>
<td>Itchy eyes</td>
<td>42 (20.7)</td>
<td>17 (16.5)</td>
<td>25 (25)</td>
<td>0.135</td>
</tr>
<tr>
<td>Dacrocystitis</td>
<td>35 (17.5)</td>
<td>21 (20.6)</td>
<td>14 (14.3)</td>
<td>0.241</td>
</tr>
<tr>
<td>Conjunctivitis history</td>
<td>17 (8.4)</td>
<td>13 (12.6)</td>
<td>4 (4)</td>
<td>0.241</td>
</tr>
<tr>
<td>Antibiotic use</td>
<td>57 (27.9)</td>
<td>28 (26.9)</td>
<td>29 (29)</td>
<td>0.302</td>
</tr>
<tr>
<td>Use of lubricants greater than 3 months</td>
<td>135 (66.8)</td>
<td>60 (58.3)</td>
<td>75 (75.8)</td>
<td>0.038</td>
</tr>
<tr>
<td>Use of chloramphenicol drops</td>
<td>84 (41.4)</td>
<td>39 (37.9)</td>
<td>45 (45)</td>
<td>0.135</td>
</tr>
<tr>
<td>Glasses/contacts</td>
<td>143 (74.1)</td>
<td>66 (68)</td>
<td>77 (80.2)</td>
<td>0.054</td>
</tr>
<tr>
<td>Anticoagulation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Past treatment duration months (SD)</td>
<td>32.56 (25.34)</td>
<td>28.2 (24.9)</td>
<td>37.18 (25.03)</td>
<td>0.008</td>
</tr>
<tr>
<td>Obstruction viewed</td>
<td>199 (100)</td>
<td>204 (100)</td>
<td>95 (100)</td>
<td>Constant</td>
</tr>
</tbody>
</table>

Abbreviations: DM, diabetes mellitus; HT, hypertension; NESB, non-English speaking background; NLD, nasolacrimal duct; NS, not significant; SD, standard deviation.
was no statistical significance between the external DCR group and the endoscopic endonasal group ($P = 0.44$). Of these patients, 10 had persistent symptoms or surgical failure (71%). Of the 186 patients who had their tubes in situ for the recommended time (2 months), 26 had persistent symptoms or surgical failure (13.9%). This difference was statistically significant ($P < 0.01$).

No endonasal DCR operations needed conversion to external DCR surgery. A biopsy was required for four endonasal surgeries due to detection of polyps or suspicious lesions. One patient was found to have a nasal polyp, with three other biopsy results reporting inflammatory or keratotic lesion. The exact anatomical location of the biopsies were unknown.

Twenty-one patients were candidates for revision surgery: 9 (8.8%) of 104 patients in the endonasal group, and 12 (12.2%) of 98 patients in the external group. This difference was not statistically significant. The main reasons for revision surgery were persistent or worse symptoms. Endoscopic revision surgery was undertaken instead of a revision external DCR, due to surgeon and patient preference. Seven patients with previous external DCR underwent revision endonasal DCR. Patency and symptom resolution was achieved in four cases. Two patients had patency on probing and irrigation, but persistent symptoms. One patient had repeat DCR surgery, with a total of three external and endonasal DCR to the same eye with continued persisting symptoms. Five patients who had previous initial endonasal DCR underwent revision endonasal DCR. Four out of five of these patients had patency on irrigation, but only two patients had resolution of symptoms, with three patients experiencing persistent epiphora. The discrepancy between anatomical patency and resolution of symptoms may be due to the lacrimal paradox outlined in the discussion.\(^5\)\(^\text{-}^7\)

**Discussion**

External DCR surgery at the turn of the century was regarded as the gold standard in treatment for nasolacrimal duct obstruction. The case for this procedure lies in its predictability of success and direct visualization of the anatomy compared with a nasoendoscope. However, the procedure leaves a cutaneous scar and the potential for injury to medial canthal structures, cerebrospinal fluid rhinorrhea, and functional interference with the physiological action of the lacrimal pump.\(^8\)

Over the last decade, however, endoscopic DCR has shown equally promising results for long-term success in nasolacrimal duct obstruction with the benefits of minimal invasive surgery. Endoscopic DCR allows direct inspection of the lacrimal sac for underlying pathology. With an understanding of the intranasal anatomy, assessment and treatment of obstruction can be a routine procedure. The assessment of failures can also be viewed endoscopically. This allows recognised mistakes to be immediately revised at the time of surgery. Intranasal biopsy of suspicious mucosa can be taken for further assessment. The option of converting an endoscopic DCR to external approach during initial surgery

<table>
<thead>
<tr>
<th>Table 4 Summary of surgical success</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Surgical results</strong></td>
</tr>
<tr>
<td>-----------------------------------</td>
</tr>
<tr>
<td>Anatomical patency</td>
</tr>
<tr>
<td>Anatomical patency and symptom relief</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 5 Results of success stratified by DCR surgery endoscopic endonasal and external</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Results</strong></td>
</tr>
<tr>
<td>-----------------------------------</td>
</tr>
<tr>
<td>Lacrimal patency</td>
</tr>
<tr>
<td>Symptoms 2 weeks post DCR</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Follow up months</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Pooled results of final follow up</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Total number of eye clinic visits (SD)</td>
</tr>
</tbody>
</table>

**Abbreviations:** DCR, dacryocystorhinostomy; SD, standard deviation.

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is always available for difficult cases or those with lacrimal sac tumors.9

The endoscopic approach has a reduced risk of interfering with the medial canthal tendon and physiology of the lacrimal pump mechanism. There is the advantage of no external scar, providing a desired cosmetic effect for patients.4 More importantly endoscopic endonasal DCR surgery has been shown to have earlier postoperative recovery time.10,11 Additionally, the Watters et al paper on long-term results for endoscopic DCR surgery showed lower rates of air regurgitation while nose blowing.12

Both surgical procedures have minimal rates of hemorrhage, but there is a lower risk of cerebrospinal fluid rhinorrhea in endoscopic endonasal surgery.6,13 Dacryocystitis is not a direct contraindication to the endoscopic surgery, and patients with chronic dacryocystitis can be treated with the endoscopic technique.13

The endoscopic approach allows diagnosis and management of associated conditions. In our series, 20 patients who had endoscopic endonasal surgery were identified or treated with an associated condition, including septal deviation, sinus disease, and dacryocystitis. Only four patients were identified with an associated condition in the external DCR group. This difference was statistically significant (P = 0.001). Hence, patients with a concomitant nasal and paranasal disorder that may contribute to the nasolacrimal obstruction can be diagnosed and treated simultaneously if the endoscopic endonasal procedure is performed.14

Complications of endoscopic endonasal DCR are low but can include re-stenosis of the opening, bleeding from the nasal cavity, orbital injury and corneal abrasion, or canaliculi erosion.15–17 A lacrimal sump syndrome and associated recurrent infections can occur if the lower portion of the bone surrounding the sac is removed inadequately. This can be avoided with a marsupialization technique used in our surgeries. Opening the sac inferior to the proximal nasolacrimal duct after bone removal can prevent this syndrome.13

Tsirbas and Wormald used a similar technique in endoscopic DCR to fully expose the lacrimal sac and marsupialize it into the lateral nasal wall with the nasal and lacrimal mucosa in apposition. They achieved high long-term success rates with this approach at 89%.18–20

Serious complications including orbital and subcutaneous emphysema, retrobulbar hemorrhage, medial rectus paresis, and orbital fat herniation15 are rare in the medical literature for both forms of DCR surgery. Of the 226 patients who underwent endoscopic endonasal DCR in the Sonkhya retrospective case series, only two patients had complications of orbital fat prolapse and lamina papyracea damage. Both had no sequelae from this complication.13 We found no serious complications in our study, with only three patients with postoperative hemorrhage requiring conservative treatment. In a case series of 79 external DCRs, 14 patients had postoperative hemorrhage compared with 0 out of 51 patients in the endoscopic endonasal group.21 The latter group all had a general anesthetic where hypotension could be achieved, hence most likely resulting in the lower rates of bleeding.

Endoscopic DCRs in our case series were performed with general anesthetic. Local anesthetic techniques have been reported with safe results for patients. A prospective study of 26 endoscopic DCRs showed no anesthetic complications under local anesthetic.22 Both surgical procedures can be performed as day only cases. A case series of warfarinized patients undergoing endoscopic endonasal DCR found the

| Postoperative results | Total (205) Cases (%) | Endoscopic (105) Cases (%) | External (100) Cases (%) | Overall P value
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Intra-operative complications</td>
<td>8 (4.3)</td>
<td>5 (4.8)</td>
<td>3 (3.7)</td>
<td>0.701</td>
</tr>
<tr>
<td>Change in routine treatment</td>
<td>26 (13.2)</td>
<td>11 (10.8)</td>
<td>15 (15.8)</td>
<td>0.300</td>
</tr>
<tr>
<td>Lacrimal irrigation no patency</td>
<td>15 (7.7)</td>
<td>7 (6.8)</td>
<td>8 (8.8)</td>
<td>0.604</td>
</tr>
<tr>
<td>Tubes fallen out</td>
<td>14 (7.3)</td>
<td>6 (5.9)</td>
<td>8 (8.8)</td>
<td>0.437</td>
</tr>
<tr>
<td>Adjunct surgery</td>
<td>17 (8.7)</td>
<td>11 (10.9)</td>
<td>6 (6.3)</td>
<td>0.255</td>
</tr>
<tr>
<td>Associated conditions example</td>
<td>24 (12.2)</td>
<td>20 (19.6)</td>
<td>4 (4.2)</td>
<td>0.001</td>
</tr>
<tr>
<td>sinus disease diagnosed</td>
<td>30 (15.2)</td>
<td>21 (20.6)</td>
<td>9 (9.5)</td>
<td>0.030</td>
</tr>
<tr>
<td>Referral for other pathology or ocular conditions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Postoperative complications</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Postoperative hemorrhage</td>
<td>3 (1.5)</td>
<td>2 (2.0)</td>
<td>1 (1.0)</td>
<td>0.597</td>
</tr>
<tr>
<td>Punctal erosion</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Canalicular obstruction</td>
<td>6 (3.0)</td>
<td>3 (2.9)</td>
<td>3 (3.2)</td>
<td>0.930</td>
</tr>
</tbody>
</table>
treatment to be safe and efficacious for treatment of distal nasolacrimal obstruction. The anticoagulated patients were not required to stop their warfarin preoperatively. This increases the generalizability of the procedure to a broader patient pool.23 All nine surgeries were performed under local anesthetic. In this study, a statistically significant difference in the ethnic origin was noted, where there were more Caucasians in the external DCR group than the endoscopic endonasal group. This difference may be due to the external group having private health insurance and the endonasal procedure carried out on patients in a public hospital.

Surgical success was defined as both anatomical patency and symptom relief in our study, giving more conservative results. Anatomical patency and symptom control have varying results in both external and endoscopic surgery throughout the medical literature.

Geoff Rose describes the lacrimal paradox, where anatomical success may not correlate to success in control of symptoms and vice versa. He describes the signs and symptoms of drainage disorders to be either volume related or flow related. Volume-related backwash from the lacrimal sac in most cases can be treated with appropriate surgery. However, flow-related characteristics are largely due to limitation or tear conductance from the lateral canthus to the nose. Symptom relief of flow-related symptoms is not achievable in every patient, especially if there is hydraulic resistance of the canaliculi and nasolacrimal duct.6,7

A small lacrimal punctum can cause tearing and may require patients to undertake a 3-snip punctoplasty. This, as well as ligament laxity of the eyelid and hypersecretion of the lacrimal gland, can also cause epiphora in patients with a patent functional nasolacrimal apparatus.

Endoscopic endonasal DCR has an established role in revision DCR surgery. Boush reported five successes in endoscopic revision in six primary endoscopic failures.24 In our study, five patients underwent revision endoscopic endonasal DCR, with four patients having patency on irrigation, and of those, two patients with complete resolution of symptoms. Seven patients with previous external DCR underwent revision endonasal DCR. Patency and symptom resolution was achieved in four cases. Ben Simons’ case series of 22 revisions found similar results, with success in nine patients who failed the first procedure.15

It is difficult to compare success rate for primary surgery between external DCR and the endoscopic endonasal procedures as there are few comparative studies. Few studies have standard outcome measures, with some studies defining success as patency to irrigation with others concentrating on symptom resolution. Our study included both objective patency results and subjective patient symptom measurements. Evidence for endoscopic dacryocystorhinostomy appears to be comparable to the “gold standard” external approach, with success rates ranging from 78% to 97%. Refer to Table 7. A weakness in our study was that one group of surgical patients held private insurance, whilst the other procedure patients were performed in the public hospital. The difference in demographics may have confounded the outcomes, although baseline characteristic data was gathered for both groups.

Our findings showed a high success rate of both endoscopic and external approach, with 92.3% of patients showing patency to irrigation and 82% showing improved or resolution of symptoms. There was no statistically significant difference between the two surgical approaches. The high predictability of external DCR in previous case series may in fact have been operator dependant rather than due to the surgery itself.

Endoscopic DCR are more expensive to run initially, with high equipment costs compared with general ophthalmology used in external DCR.2 However, with shorter surgical times and use of local anesthetic in a day-surgery setting, these costs can be absorbed over time.2,25 The procedure is technically involved and can initially be difficult to learn. Experience with persons highly skilled with endonasal surgery and endoscopic techniques is imperative, and this can incur higher training costs only in the short-term.10

A learning curve of the endoscopic procedure was demonstrated in several studies. Onerci stratified according to experience of the surgeon and found high success rates of up to 94% with experienced surgeons, compared with inexperienced surgeons with success rates of only 58%.26 This highlights the emphasis of DCR surgery to be performed by ophthalmologists with an understanding of intranasal anatomy, perhaps with initial training together with an ENT (ear, nose, and throat) surgeon.

Boush and Unlu found a strong relationship between silicone tube retention and success, which was mirrored in our study.24,27 Fourteen patients who underwent DCR surgery had tubes that fell out before the 2-month assessment. Of these patients, 10 had persistent symptoms or surgical failure, giving a failure rate of 71%. This difference was statistically significant with patients whose tubes were in at the 2-month assessment, having a failure rate of 13.9% (P < 0.01). For both external and endoscopic endonasal DCR surgery having the silicone tube in situ for the recommended time period is important to achieve surgical success.
Table 7  Studies (1995–2010) reporting results of primary dacryocystorhinostomy, endoscopic endonasal and external

<table>
<thead>
<tr>
<th>Study</th>
<th>Number of surgeries</th>
<th>Endonasal success</th>
<th>External success</th>
<th>Complications</th>
<th>Follow up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leong et al²⁸</td>
<td>70</td>
<td>86%</td>
<td>94%</td>
<td>N = 11</td>
<td>30 months</td>
</tr>
<tr>
<td></td>
<td>35 external</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>35 endoscopic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dolman²</td>
<td>354</td>
<td>89.1%</td>
<td>90.2%</td>
<td>Epistaxis</td>
<td></td>
</tr>
<tr>
<td></td>
<td>201 endoscopic</td>
<td></td>
<td></td>
<td>n = 11 (endonasal)</td>
<td>24 months</td>
</tr>
<tr>
<td></td>
<td>153 external</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Bruising n = 2 (external)</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Local infection n = 4 (external)</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td>Punctal eversion n = 6 (external)</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Transient diplopia n = 1 (endonasal)</td>
<td></td>
</tr>
<tr>
<td>Sharma²⁹</td>
<td>302</td>
<td>88.5%</td>
<td>90.5%</td>
<td>Wound infection n = 4 (endonasal)</td>
<td>7.2 endonasal</td>
</tr>
<tr>
<td></td>
<td>165 endonasal</td>
<td></td>
<td></td>
<td>n = 124</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(nonendoscopic)</td>
<td></td>
<td></td>
<td>Nasal mucosal fibrosis n = 8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>137 external</td>
<td></td>
<td></td>
<td>Nasal hemorrhage n = 2</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Canalicul cut by silastic tube n = 24</td>
<td></td>
</tr>
<tr>
<td>Ben Simon et al¹¹</td>
<td>176</td>
<td>84%</td>
<td>70%</td>
<td>Sump syndrome n = 2</td>
<td>6.7 external</td>
</tr>
<tr>
<td></td>
<td>86 endoscopic</td>
<td></td>
<td></td>
<td>Postoperative hemorrhage n = 1</td>
<td></td>
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<tr>
<td></td>
<td>90 external</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cokkeser et al¹¹</td>
<td>130</td>
<td>88.2%</td>
<td>89.8</td>
<td>Intra and postoperative hemorrhage</td>
<td>2 months</td>
</tr>
<tr>
<td></td>
<td>51 endoscopic</td>
<td></td>
<td></td>
<td>n = 0 (endonasal)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>79 external</td>
<td></td>
<td></td>
<td>n = 14 (external)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Wound infection n = 4 (external)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Poor wound healing n = 5 (external)</td>
<td></td>
</tr>
<tr>
<td>Agarwal¹⁷</td>
<td>300 endoscopic</td>
<td>94%</td>
<td></td>
<td>Lacrimal fisula n = 4</td>
<td>NR</td>
</tr>
<tr>
<td></td>
<td>n = 282</td>
<td></td>
<td></td>
<td>Granulations n = 2</td>
<td></td>
</tr>
<tr>
<td>Sonkhya and Mishra¹³</td>
<td>226 endoscopic</td>
<td>92%</td>
<td></td>
<td>Ostium fibrosis 8%</td>
<td>6–24 months</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Orbital fat prolapse n = 2</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>Granuloma n = 7</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Synechiae (nose) n = 3</td>
<td></td>
</tr>
<tr>
<td>Smith et al²³</td>
<td>9 endoscopic (patients on warfarin)</td>
<td>78%</td>
<td></td>
<td>Common canalicul obstruction n = 1</td>
<td>6 months</td>
</tr>
<tr>
<td></td>
<td>n = 7</td>
<td></td>
<td></td>
<td>Adhesions (lateral nasal wall and middle turbinate) n = 1</td>
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<td></td>
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<td></td>
<td>Periorbital bruising n = 2</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Postoperative hemorrhage n = 1</td>
<td></td>
</tr>
<tr>
<td>Jin et al³⁰</td>
<td>46 endoscopic</td>
<td>96%</td>
<td></td>
<td>Obstruction secondary to granulation tissue or synechia</td>
<td>5.9 months</td>
</tr>
<tr>
<td></td>
<td>N = 44</td>
<td></td>
<td></td>
<td>n = 8</td>
<td></td>
</tr>
<tr>
<td>Nussbaumer et al³¹</td>
<td>201 endoscopic</td>
<td>90%</td>
<td></td>
<td>NR</td>
<td>12 months</td>
</tr>
<tr>
<td></td>
<td>n = 181</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Study</td>
<td>Procedure</td>
<td>Success Rate</td>
<td>Methodology</td>
<td>Complications</td>
<td></td>
</tr>
<tr>
<td>-------------------------------</td>
<td>----------------------</td>
<td>--------------</td>
<td>-------------</td>
<td>-------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Tsirbas and Wormald</td>
<td>Endoscopic</td>
<td>89%</td>
<td>n = 93</td>
<td>Postoperative hemorrhage n = 3</td>
<td></td>
</tr>
<tr>
<td>Moore et al</td>
<td>Endoscopic</td>
<td>83%</td>
<td>n = 40</td>
<td>New canalicular obstruction n = 1</td>
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<tr>
<td>Wormald</td>
<td>Endoscopic</td>
<td>97.3%</td>
<td>n = 46</td>
<td>Nil</td>
<td></td>
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<tr>
<td>Yung and Hardman-Lea</td>
<td>Endoscopic</td>
<td>89%</td>
<td>n = 51</td>
<td>Nil</td>
<td></td>
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<tr>
<td>Zilelioglu et al</td>
<td>Endoscopic</td>
<td>79.6%</td>
<td>n = 51</td>
<td>Transient frontal sinusitis n = 1</td>
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<tr>
<td>Fayet et al</td>
<td>Endoscopic</td>
<td>87%</td>
<td>n = 261</td>
<td>Cacosmia n = 8</td>
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<tr>
<td></td>
<td></td>
<td></td>
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<td>Punctal laceration n = 2</td>
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<td></td>
<td></td>
<td></td>
<td>Periorbital oedema n = 1</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Tube complications n = 18</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>Postoperative hemorrhage n = 4</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Transient frontal sinusitis n = 1</td>
<td></td>
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<td></td>
<td></td>
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<td></td>
<td>Nasal mucosa burn n = 1</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Phlebitis n = 1</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Maxillary pain n = 8</td>
<td></td>
</tr>
<tr>
<td>Onerci et al</td>
<td>Endoscopic surgery</td>
<td>94.5%</td>
<td></td>
<td>Granulation tissue around wound n = 6</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>58%</td>
<td></td>
<td>No hemorrhage</td>
<td></td>
</tr>
<tr>
<td>Watters et al</td>
<td>Endoscopic surgery</td>
<td>86%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pandya et al</td>
<td>External</td>
<td>77.3%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Full resolution of symptoms</td>
<td>20.8% partial resolution</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delaney and Khooshabeh</td>
<td>External</td>
<td>70% overall</td>
<td>n = 35</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>80% post sac and 47% presac</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tarbet and Custer</td>
<td>External</td>
<td>95% patency</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feretis et al</td>
<td>External/Endonasal</td>
<td>+9.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>IQR (−22.08 to +43.7)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leong et al</td>
<td>(Review of 73 studies)</td>
<td>84%−94%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Laser assisted = 47%−100%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(Continued)
Karim et al

Table 7

<table>
<thead>
<tr>
<th>Study</th>
<th>Number of surgeries</th>
<th>Endonasal success</th>
<th>Follow up</th>
<th>Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maini et al41</td>
<td>126</td>
<td>60 endonasal laser</td>
<td>12 months</td>
<td>Intra-operative: Obstruction caused by prominent agger nasi cells n = 2, concha bullosa or large middle turbinate requiring incision n = 5, adhesions from previous surgery n = 2, deviated nasal septum requiring septoplasty n = 1, osteomyelitic sinus n = 1, and prominent agger nasi n = 2. Postoperative bleeding n = 1, peri-orbital ecchymosis post local anesthetic n = 5, vestibular abrasions n = 2. Three patients randomized to laser converted to surgical treatment due to technical difficulties. Five patients randomized to laser underwent combined laser and dissection technique.</td>
</tr>
</tbody>
</table>

**Conclusion**

DCR is the treatment of choice for the treatment of nasolacrimal duct obstruction. All studies show similar results in regards to external versus endoscopic surgery.

Both operations have low complication rates. The advantage of endoscopic surgery is that it leaves no scar and preserves the lacrimal pump system, unlike external DCR. An understanding of intranasal anatomy, however, is required for endoscopic surgery, with appropriate endoscopic training.

Choice in regards to surgical techniques should depend on patient preference, with consideration given on the availability of resources amongst health care systems. The endoscopic endonasal approach was introduced in 1893 by Caldwell, but only over the last decade have we seen the predictable high success rates like that of external DCR.

Endoscopic DCR surgery with its discussed benefits warrants a place in the 21st century as a contender for primary treatment of nasolacrimal duct obstruction.

**Acknowledgment**

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**Disclosure**

The authors report no conflicts of interest in this work.

**References**

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