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ORIGINAL RESEARCH

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 canalicular 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

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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

Inclusion	Exclusion
Epiphora	Previous DCR to same eye
Evidence of obstruction on probing and irrigation	Congenital NLDO
Fluorescein dye disappearance test	
Obstruction on lacrimal scintigraphy	Age under 16 years

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, fluroscein 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

Success	Failure
Patency on probing and irrigation	Obstruction on probing and irrigation
Resolution of symptoms	Ostial scarring
Improvement of symptoms	No visualization of fluorescein in dye disappearance test
	Persistent symptoms
	Requiring revision or adjuvant intervention

Patient demographic data was collected, including age, gender, date of birth, ethic origin, and language. Refer to Table 3 for baseline characteristics stratified by endonasal endoscopic and external DCR surgery.

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 prednisone 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

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 musoca 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 χ^2-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

Table 3 Demographics of endoscopic endonasal and external dacryocystorhinostomy groups

	Categorized	Total (205)	Endoscopic (105)	External (100)	Overall *P* value
Age, mean (SD)		68.89 (15.022)	66.77 (17.432)	70.34 (12.829)	NS
Female sex (%)		128	68 (64.8)	60 (60)	0.482
Ethnicity (%)	Caucasian	135 (71.4)	58 (59.2)	77 (84.6)	
	Oriental	20 (10.6)	12 (12.2)	8 (8.8)	
	Indian Subcontinent	3 (1.6)	3 (3.1)	0 (0)	
	European	30 (15.9)	24 (24.5)	6 (6.6)	
	African	1 (0.5)	1 (1)	0 (0)	0.001
NESB		29 (14.3)	20 (19.2)	9 (9.1)	0.039
Previous sinus surgery		6 (3)	2 (1.9)	4 (4.2)	0.353
History of ocular trauma with either NLD obstruction or canalicular laceration		7 (3.5)	6 (5.7)	1 (1)	0.069
Comorbidities (yes)		125 (61.6)	66 (62.9)	59 (60.2)	0.698
HT		88 (44)	47 (44.8)	41 (43.2)	0.819
DM		23 (11.5)	17 (16.2)	6 (6.3)	0.029
Smoking	No	170 (85)	88 (83.8)	82 (86.3)	
	Yes	22 (11)	9 (8.6)	13 (13.7)	
	Ex	8 (4)	8 (7.6)	0 (0)	0.140
Ocular history	No	90 (44.3)	48 (46.2)	42 (42.4)	
	Previous cataract surgery	16 (7.9)	9 (8.7)	7 (7.1)	
	Glaucoma	9 (4.4)	1 (1)	8 (8.1)	
	Corneal disease	1 (0.5)	0 (0)	1 (1)	
	Ocular plastic	38 (18.7)	22 (21.2)	16 (16.2)	
	Retinal	9 (4.4)	3 (2.9)	6 (6.1)	
	Other	8 (3.9)	2 (1.9)	6 (6.1)	
	More than two ocular conditions	32 (15.8)	19 (18.3)	13 (13.1)	0.099
Epiphora		204 (100)	104 (100)	100 (100)	Constant
Red eyes		35 (17.2)	14 (13.6)	21 (21)	0.162
Blepharitis		38 (18.7)	21 (20.4)	17 (17)	0.536
Inflammatory eye disease		2 (1)	2 (1.9)	0 (0)	0.161
Itchy eyes		42 (20.7)	17 (16.5)	25 (25)	0.135
Dacrocystitis		35 (17.5)	21 (20.6)	14 (14.3)	0.241
Conjunctivitis history		17 (8.4)	13 (12.6)	4 (4)	
Antibiotic use		57 (27.9)	28 (26.9)	29 (29)	
Use of lubricants greater than 3 months		135 (66.8)	60 (58.3)	75 (75.8)	0.008
Use of chloramphenicol drops		84 (41.4)	39 (37.9)	45 (45)	0.302
Glasses/contacts		143 (74.1)	66 (68)	77 (80.2)	0.054
Anticoagulation					
Past treatment duration months (SD)		32.56 (25.34)	28.2 (24.9)	37.18 (25.03)	NS
Obstruction viewed		199 (100)	204 (100)	95 (100)	Constant

Abbreviations: DM, diabetes mellitus; HT, hypertension; NESB, non-English speaking background; NLD, nasolacrimal duct; NS, not significant; SD, standard deviation.

(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 synechiae 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. There

Table 4 Summary of surgical success

Surgical results	Endonasal	External	Statistical significance
Anatomical patency	96/103 (93.2%)	83/91 (91.2%)	$P = 0.604$
Anatomical patency and symptom relief	84/102 (82.4%)	80/98 (81.6%)	$P = 0.895$

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.[5–7]

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 5 Results of success stratified by DCR surgery endoscopic endonasal and external

Results		Total	Endonasal DCR	External DCR	Overall *P* value
Lacrimal patency		179 (92.3)	96 (93.2)	83 (91.2)	0.604
Symptoms 2 weeks post DCR	Resolution	56 (27.7)	27 (26.2)	29 (29.3)	
	Improved	128 (63.4)	65 (63.1)	63 (63.6)	
	Persistent	15 (7.4)	8 (7.8)	7 (7.1)	
	Symptoms worse	3 (1.5)	3 (2.9)	0 (0)	0.270
Follow up months	Resolution	145 (72.5)	76 (74.5)	69 (70.4)	
	Improved	19 (9.5)	8 (7.8)	11 (11.2)	
	Persistent	15 (7.5)	9 (8.8)	6 (6.1)	
	Revision surgery	21 (10.5)	9 (8.8)	12 (12.2)	0.566
Pooled results of final follow up	Resolution of symptoms or improvement from baseline	164 (82)	84 (82.4)	80 (81.6)	0.895
	Persistent Symptoms and or revision surgery	36 (18)	18 (17.6)	18 (18.4)	0.895
Total number of eye clinic visits (SD)		4.72 (1.602)	5.06 (2.044)	4.38 (0.844)	NS

Abbreviations: DCR, dacryocystorhinostomy; SD, standard deviation.

Table 6 Post operative results and complications stratified by dacryocystorhinostomy surgery, endoscopic endonasal and external

	Total (205) Cases (%)	Endoscopic (105) Cases (%)	External (100) Cases (%)	Overall *P* value Cases (%)
Postoperative results				
Intra-operative complications	8 (4.3)	5 (4.8)	3 (3.7)	0.701
Change in routine treatment	26 (13.2)	11 (10.8)	15 (15.8)	0.300
Lacrimal irrigation no patency	15 (7.7)	7 (6.8)	8 (8.8)	0.604
Tubes fallen out	14 (7.3)	6 (5.9)	8 (8.8)	0.437
Adjunct surgery	17 (8.7)	11 (10.9)	6 (6.3)	0.255
Associated conditions example sinus disease diagnosed	24 (12.2)	20 (19.6)	4 (4.2)	0.001
Referral for other pathology or ocular conditions	30 (15.2)	21 (20.6)	9 (9.5)	0.030
Postoperative complications				
Postoperative hemorrhage	3 (1.5)	2 (2.0)	1 (1.0)	0.597
Punctal erosion	0	0	0	
Canalicular obstruction	6 (3.0)	3 (2.9)	3 (3.2)	0.930

is always available for difficult cases or those with lacrimal sac tumours.[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 to nil 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 herniation[15] 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 sequele 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

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

Study	Number of surgeries	Endonasal success	External success	Complications	Follow up
Leong et al[28]	70 35 external 35 endoscopic	86%	94%	N = 11	30 months
Dolman[5]	354 201 endoscopic 153 external	89.1%	90.2%	Epistaxis n = 11 (endonasal) n = 7 (external) Bruising n = 2 (external) Local infection n = 4 (external) Punctal eversion n = 6 (external) Transient diplopia n = 1 (endonasal)	
Sharma[29]	302 165 endonasal (nonendoscopic) 137 external	88.5% 146	90.5% n = 124	Wound infection n = 4 (endonasal) Nasal mucosal fibrosis n = 8 Nasal hemorrhage n = 2 Canalicular cut by silastic tube n = 24	24 months
Ben Simon et al[15]	176 86 endoscopic 90 external	84%	70%	Sump syndrome n = 2 Postoperative hemorrhage n = 1	7.2 endonasal 6.7 external
Cokkeser et al[21]	130 51 endoscopic 79 external	88.2% n = 45	89.8 n = 71	Intra and postoperative hemorrhage n = 0 (endonasal) n = 14 (external) Wound infection n = 4 (external) Poor wound healing n = 5 (external)	2 months
Agarwal[17]	300 endoscopic	94% n = 282		Lacrimal fisula n = 4 Granulations n = 2	NR
Sonkhya and Mishra[13]	226 endoscopic	92%		Ostium fibrosis 8% Orbital fat prolapse n = 2 Granuloma n = 7 Synechiae (nose) n = 3	6–24 months
Smith et al[23]	9 endoscopic (patients on warfarin)	78% n = 7		Common canaliculi obstruction n = 1 Adhesions (lateral nasal wall and middle turbinate) n = 1 Periorbital bruising n = 2 Postoperative hemorrhage n = 1	6 months
Jin et al[30]	46 endoscopic	96% N = 44		Obstruction secondary to granulation tissue or synechia n = 8	5.9 months
Nussbaumer et al[31]	201 endoscopic	90% n = 181		NR	12 months

Tsirbas and Wormald[19]	104 endoscopic	89% n = 93		Postoperative hemorrhage n = 3	9.7 months
Tsirbas and Wormald[18]	44 endoscopic	91% n = 40		NR	12.9 months
Moore et al[32]	35 endoscopic	83%		New canalicular obstruction n = 1	6 months
Wormald[20]	47 endoscopic	97.5% n = 46		Nil	
Yung and Hardman-Lea[3]	191 endoscopic	89%		NR	6–12 months
Zilelioglu et al[33]	64 endoscopic	79.6% n = 51		Punctal laceration n = 2 Periorbital oedema n = 1 Tube complications n = 18	NR
Fayet et al[34]	300 endoscopic	87% n = 261		Postoperative hemorrhage n = 4 Transient frontal sinusitis n = 1 Nasal mucosa burn n = 1 Cacosmia n = 8 Phlebitis n = 1 Maxillary pain n = 8	13 months
Onerci et al[35]	108 experienced endoscopic surgeon 55 inexperienced endoscopic surgeon	94.5 % experience 58% inexperienced		Granulation tissue around wound n = 6 No hemorrhage	49 months
Watters et al[36]	43 endoscopic	86%			1–46 months
Pandya et al[37]	338 external	77.3% full resolution of symptoms 20.8% partial resolution	NR	NR	11 months
Delaney and Khooshabeh[38]	50 external		70% overall n = 35 80% post sac and 47% presac	NR	36 months
Tarbet and Custer[2]	93 external		95% patency 92% Asymptomatic	Poor scar formation n = 1	
Feretis et al[39]	131 90 external 41 endonasal Glasgow benefit inventory questionnaire	+9.7 IQR (−22.08 to +43.7)	+12.50 (IQR, 0.000 to +38.888)	NA	NA
Leong et al[40]	4800 (review of 73 studies)	84%–94% Laser assisted = 47%–100%	65%–100%	NR	

(*Continued*)

Table 7 (*Continued*)

Study	Number of surgeries	Endonasal success	External success	Complications	Follow up
Maini et al[41]	126 60 endonasal laser 66 endonasal sugery	68% laser group 74% surgical group	N/A	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 = 3, nasal polyps n = 2 Postoperatively: Postoperative bleeding n = 1 Pyocoele 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	12 months

Abbreviations: endoscopic, endoscopic endonasal dacryocystorhinostomy; IQR, interquartile range; NA, not applicable; NR, not recorded; RCT, randomized controlled trial.

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,[1] 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.

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Disclosure

The authors report no conflicts of interest in this work.

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