

## Endoscopic dacryocystorhinostomy with nasal mucosal flaps: A comparative study

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## **Endoscopic dacryocystorhinostomy with nasal mucosal flaps: A comparative study**

### **Cover Page Footnote**

All authors have reviewed the manuscript. All authors have read and approved the final manuscript for submission. The study was conducted at Zagazig University Hospital, which is a tertiary care hospital and a referral center in Zagazig, Al-Sharkia, Egypt.

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## ORIGINAL STUDY

# Endoscopic Dacryocystorhinostomy with Nasal Mucosal Flaps: A Comparative Study

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### Abstract

**Introduction:** Endoscopic dacryocystorhinostomy (DCR) is a procedure employed to treat epiphora caused by anatomical obstruction of the nasolacrimal pathway. Its principle is to create a connection between the lacrimal sac and the nasal cavity to bypass the obstruction and restore the tear flow. Diverse modifications to conventional endoscopic DCR have been developed to improve its success rate. The present study aims to compare the results and assess the outcome of endoscopic DCR using a novel flap technique, inferiorly based nasal mucosal flap, versus the posteriorly based flap in cases of epiphora due to primary acquired nasolacrimal duct obstruction.

**Patients and methods:** Under general anesthesia, 30 patients, who were divided randomly into two groups, underwent endoscopic DCR using either a posteriorly or an inferiorly based nasal mucosal flap.

**Results:** The overall success rate was 93.3%, with no statistically significant difference between the two groups. In the posterior flap group, epiphora resolved completely in 10 patients and improved in three patients, whereas in the inferior flap group, it resolved completely in 13 patients and improved in two patients. The overall complication rate was 33.3%, with no statistically significant difference between both groups. The neo-ostium was obliterated and closed by a fibrous membrane in two (13.3%) patients in the posterior flap group. No major complications occurred in either group.

**Conclusion:** The inferiorly based nasal mucosal flap has a high success rate and low complication rate similar to the known posteriorly based nasal mucosal flap. Thus, we can recommend it as a new adjuvant technique for endoscopic DCR with good results.

**Keywords:** Epiphora, Endoscopic dacryocystorhinostomy, Nasal mucosal flaps

## 1. Introduction

Epiphora is a relatively common condition that affects the patient's life and causes social embarrassment. It can be due to either functional or anatomical abnormality of the lacrimal excretory system. An anatomical obstruction could be either congenital or acquired. It may occur at any site along the nasolacrimal pathway. The etiology and the pathogenesis of primary acquired nasolacrimal duct obstruction are still unclear. It is supposed to occur as a result of a chronic inflammatory process ending in fibrosis, stenosis, and closure of the duct ostium [1–3].

Patients with primary acquired nasolacrimal duct obstruction may have persistent epiphora, acute or

chronic dacryocystitis, conjunctivitis, or chronic conjunctival injection. Dacryocystorhinostomy (DCR) is a surgical procedure employed to re-establish the tear flow from the lacrimal system to the nose. Its concept is to create a fistula between the lacrimal sac and the nasal cavity to bypass the obstruction. It can be conducted via either an external or endoscopic approach. External DCR remained the standard treatment of acquired nasolacrimal duct obstruction. However, facial scarring, dysfunction of the lacrimal pump resulting from the interruption of the medial canthus anatomy and orbicularis oculi muscle, and limitations in patients with acute dacryocystitis with abscess formation have been reported as significant disadvantages [4–6].

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In 1989, McDonogh and Meiring [7] published the first clinical study of endoscopic DCR. The advent of rigid nasal endoscopes, surgeons' experience in the endoscopic nasal anatomy, and familiarity with the endonasal treatment have made the endoscopic approach increasingly popular as an appropriate treatment for patients having obstruction of the lacrimal system at the level of the sac (saccul obstruction) or below it (postsaccul obstruction) [8,9].

Endoscopic DCR offers several distinct advantages such as no external incision, maintaining the lacrimal pumping mechanism, shorter recovery time, lower postoperative morbidity, and the ability to simultaneously address, diagnose, and manage an intranasal pathology [6,10]. However, endoscopic DCR carries several challenges, mainly the need to precisely identify the lacrimal sac's location and prevent restenosis of the neo-ostium. Hence, it is important to understand the anatomy of the lateral nasal wall to allow accurate and complete exposure of the lacrimal sac intranasally. Moreover, the formation of a mucosa-lined fistula is a fundamental principle for a successful outcome [11,12].

Different modulations to the original procedure have been developed to ameliorate the operative technique and its success rate. Free nasal mucosal graft and variant nasal mucosal flaps have been developed for reconstruction of the neo-ostium, as well as preservation of the lacrimal sac mucosa has been described. Such modifications aim to decrease stomal stenosis and improve the procedure outcome. Furthermore, preserving the nasal mucosal flaps can help to reduce the granulation and synechiae formation rate with a substantial decrease in the failure rate [12–17].

The present study aims to compare the results and assess the outcome of endoscopic DCR using a novel flap technique, inferiorly based nasal mucosal flap, versus the posteriorly based flap in cases of epiphora due to primary acquired nasolacrimal duct obstruction.

## 2. Patients and methods

A randomized-controlled study was conducted in the Oto-Rhino-Laryngology Department, Faculty of Medicine, Zagazig University, Zagazig, Egypt, during the period from July 2019 to July 2022. The study was approved by the Institutional Review Board (IRB) of Zagazig University.

Inclusion criteria were patients having primary acquired nasolacrimal duct obstruction.

### 2.1. Exclusion criteria

The following were the exclusion criteria:

- (1) Patients younger than 14 years old or unfit for surgery.
- (2) Patients having functional epiphora or congenital nasolacrimal duct obstruction.
- (3) Patients having superior, inferior, or common canaliculus obstruction.
- (4) Past history of DCR whether external or endoscopic, trauma to the lacrimal excretory system, or irradiation covering the nasal or periorbital region.

All the patients underwent the following diagnostic protocol:

- (1) A detailed history of epiphora, including recurrent dacryocystitis, dacryocystocele, history of trauma, and previous nasal and sinus surgery.
- (2) Full ophthalmological examination by the ophthalmology team, including fluorescein dye disappearance test, lacrimal irrigation, and diagnostic probing.
- (3) Complete ENT examination, including rigid nasal endoscopy, under local anesthesia to assess for septal deviation, turbinate hypertrophy, polyp, granuloma, or tumor.
- (4) Computed tomography scanning of the nose and paranasal sinuses without contrast to outline the anatomy of the bony structures relevant to the lacrimal sac, for example, the ascending process of maxilla, the lacrimal bone, agar nasi cell, and the uncinat process and rule out a concomitant sinus disease or a suspicion of a tumor within the paranasal sinuses or the nasolacrimal system (Fig. 1).
- (5) Computed tomography dacryocystography using Omnipaque (300 mg iodine/ml) to assess the lacrimal system anatomy and help to identify the location and extent of obstruction, lacrimal sac masses, dacryoliths, and diverticula (Fig. 2a and b).
- (6) The necessary routine preoperative laboratory workup.

Fully informed written consent was obtained from all the patients. The patients underwent endoscopic DCR using either a posteriorly or an inferiorly based nasal mucosal flap.

### 2.2. The operative technique

- (1) Under controlled hypotensive general anesthesia with oral endotracheal intubation, the patient is placed supine and the head is flexed to 15° and slightly rotated toward the surgeon.
- (2) Under the guidance of 4-mm nasal endoscopes 0° and 30°, 5 ml of 1% lidocaine with 1 :100 000 epinephrine is used to infiltrate the axilla of the middle turbinate and the frontal process of the

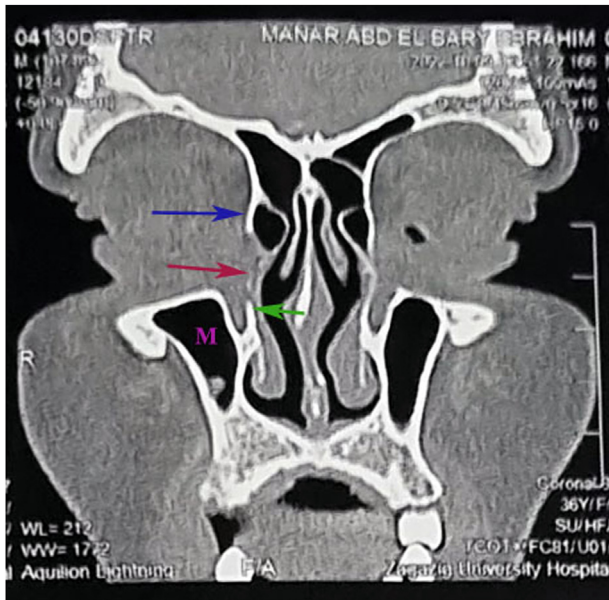


Fig. 1. Computed tomography scanning of the lacrimal sac region: coronal view, bone window. Green arrow: frontal process of maxilla, blue arrow: agar nasi cell, red arrow: the lacrimal sac, M: the maxillary sinus.

maxilla. Cottonoids soaked in 1:1000 adrenaline are placed in the middle meatus, along the frontal process of the maxilla, and adjacent to the septum (Fig. 3).

- (3) Then, a posterior or an inferiorly based nasal mucosal flap is created.

**2.2.1. Creation of a posteriorly based nasal mucosal flap:** With scalpel no. 15, a horizontal incision is made on the lateral nasal wall 10 mm above the axilla of the middle turbinate, extending from 2 to 3 mm posterior to the axilla and 10 mm onto the frontal process of the maxilla. Then, a vertical incision is made from the anterior end of the superior horizontal incision to the midpoint of the middle turbinate. Another horizontal incision is made inferiorly from the insertion of the uncinat process to join the vertical incision. Thus, the mucosal flap can be folded around the anterior end of the middle turbinate to keep it out of the operative field (Fig. 4).

**2.2.2. Creation of an inferiorly based mucosal flap:** With scalpel no. 15, the first vertical incision is made on the lateral nasal wall starting 10 mm above the axilla of the middle turbinate and is brought down to the level of the insertion of the inferior turbinate. A second vertical incision is made ~8 mm anterior to the first vertical incision. A superior horizontal incision is made 10 mm above the axilla of the middle turbinate connecting the two vertical

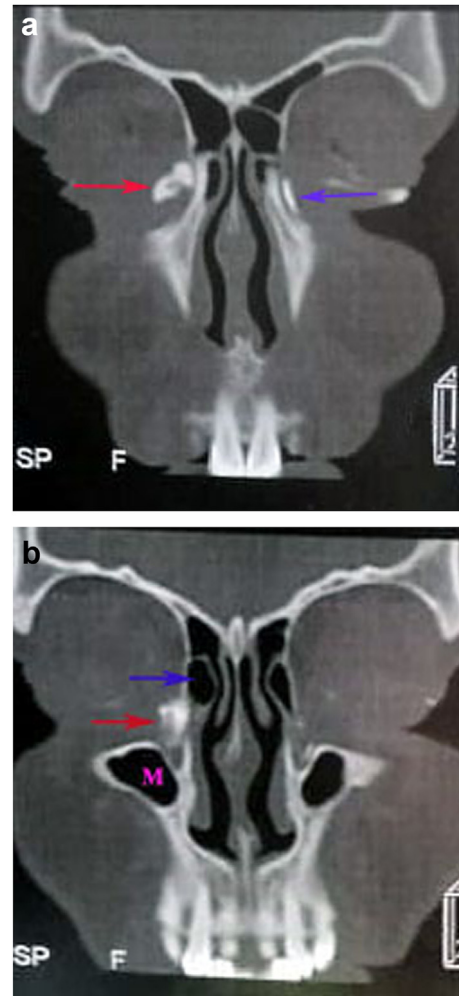


Fig. 2. Computed tomography dacryocystography: coronal view, bone window. (a) Red arrow: right distended lacrimal sac (dacryocystocele), blue arrow: normal left lacrimal sac. (b) Red arrow: right distended lacrimal sac (dacryocystocele), blue arrow: right agar nasi cell, M: right maxillary sinus.

incisions (Fig. 5). Thus, the mucosal flap can be reflected over the inferior turbinate keeping it out of the operative field.

- (4) A Freer elevator or Cottle dissector is used to elevate the mucosal flap, keeping under the mucoperiosteum on the bone. The flap is elevated from the bone and over the maxillary line exposing the hard frontal process of the maxilla and the thin lacrimal bone.
- (5) An up-biting Kerrison Rongeur is used to remove the hard bone of the frontal process of the maxilla overlying the lacrimal sac. Bone removal is continued superiorly up to a level of 8 mm above the axilla of the middle turbinate to ensure complete exposure of the lacrimal sac up to the level of the fundus. A 2-mm diamond

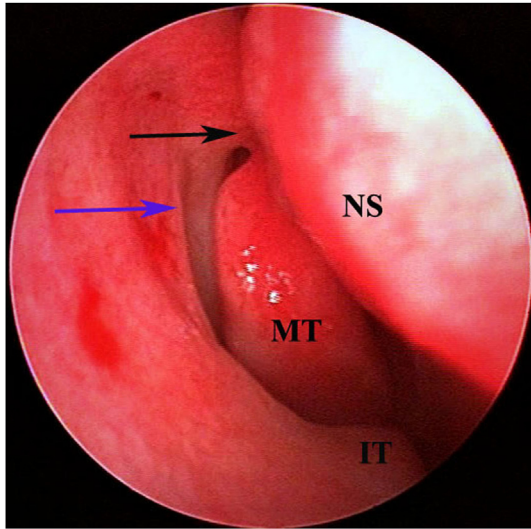


Fig. 3. Endoscopic anatomy of the lateral nasal wall in the lacrimal sac region. Blue arrow: the maxillary line, black arrow: the axilla of the middle turbinate. IT, inferior turbinate; MT, middle turbinate; NS, nasal septum.

endonasal drill may be used to complete removing the thick bone above the insertion of the middle turbinate. The lacrimal bone is removed up to the insertion of the uncinata without disturbing the uncinata itself.

- (6) When the lacrimal sac is fully exposed, it bulges into the nasal cavity (Fig. 6a and b). A lacrimal probe is used to tent the medial wall of the lacrimal sac to guide the incision of the sac with clear visualization of the probe to prevent injury to the common canaliculus. The lacrimal probe should be passed from the punctum through to the nasal cavity without any obstruction.

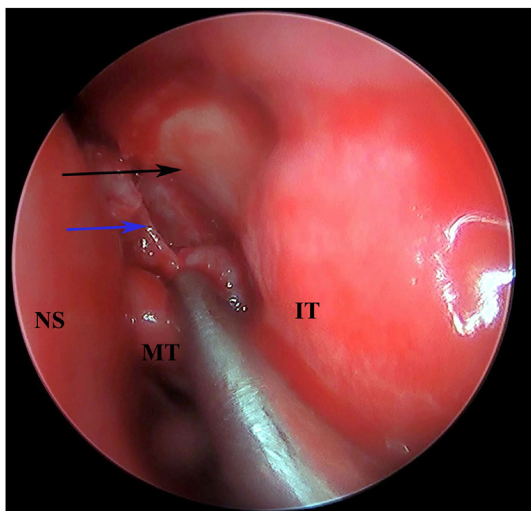


Fig. 4. The posteriorly based nasal mucosal flap. Blue arrow: the posteriorly based nasal mucosal flap, black arrow: the frontal process of the maxilla. IT, inferior turbinate; MT, middle turbinate; NS, nasal septum.

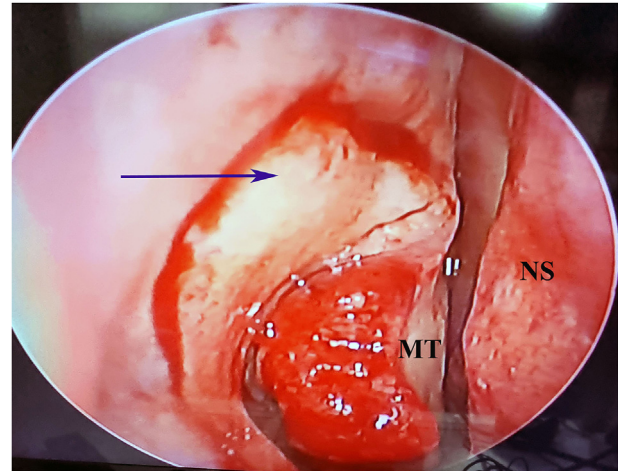


Fig. 5. The inferiorly based nasal mucosal flap. Blue arrow: the inferiorly based nasal mucosal flap. MT, middle turbinate; NS, nasal septum.

Bowman probe (size 00) is passed from either the inferior or superior lacrimal punctum into the lacrimal sac. An ENT sickle knife or a keratome knife is used to incise the lacrimal sac vertically along its entire length. This incision is made as far posteriorly as possible to create a wide anterior flap. Bellucci micro-ear scissors is used to create an upper and lower incision in the anterior and posterior flaps. Thus, the flaps can be reflected anteriorly and posteriorly correspondingly lying flat on the lateral nasal wall.

- (7) A Crawford bicanalicular silicone stent is inserted into the nasal cavity via the superior and inferior puncta, and the tubes were secured by tying the ends together and making the knot on the nasal side.
- (8) With the posteriorly based nasal mucosal flap, the mucosal flap is trimmed to a superior and an inferior limb, and they are repositioned to overlap each sac flap. With the inferiorly based nasal mucosal flap, the mucosal flap is repositioned back to overlap the anterior sac flap.
- (9) This will maintain a mucosa-lined nasolacrimal drainage pathway as well as it will minimize bone exposure to encourage healing. Then, small gelfoam pieces are placed to hold the mucosal flaps in place and the nose is packed with one Sofra-Tulle (a gauze dressing impregnated with an antibiotic).

### 2.3. Postoperative care

- (1) The Sofra-Tulle nasal pack was removed the next day and the patient was discharged home thereafter. An oral antibiotic for 10 days, decongestant nasal spray for 5 days, antibiotic eye drops for 2

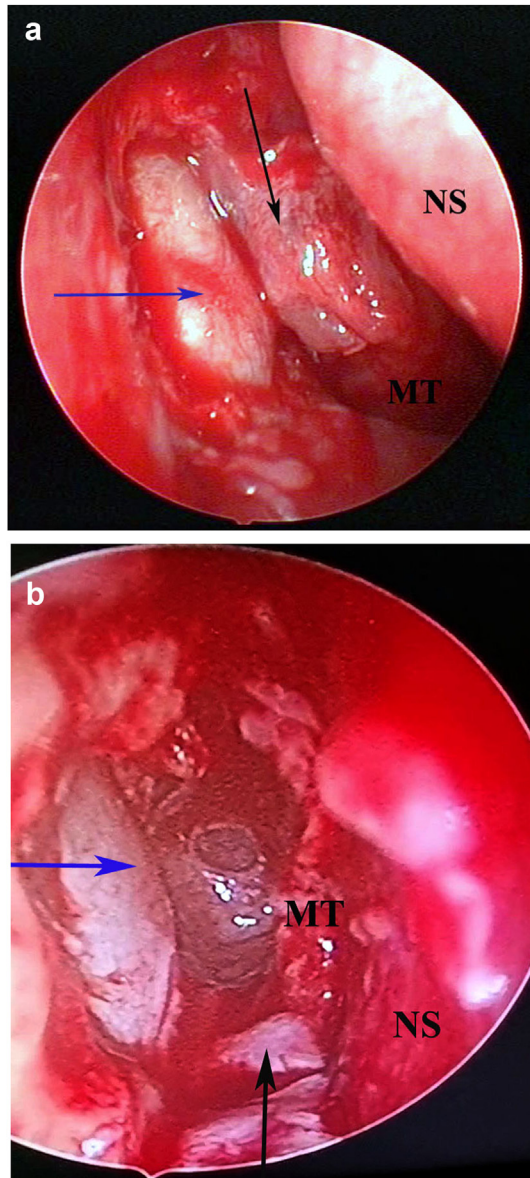


Fig. 6. (a): Exposure of the lacrimal sac. Black arrow: the posteriorly based nasal mucosal flap, blue arrow: the lacrimal sac. (b) Exposure of the lacrimal sac. Black arrow: the inferiorly based nasal mucosal flap, blue arrow: the lacrimal sac. MT, middle turbinate; NS, nasal septum.

weeks, and normal saline nasal spray to prevent crust formation were prescribed.

- (2) The patients were followed up after 1 week, then every 2 weeks during the first 3 months. At the follow-up visits, rigid nasal endoscopy was performed to clean the nose and remove crusts if present, assess the patency of the neo-ostium, and report any sequelae like adhesion, granuloma, or polyp.
- (3) Three months postoperatively, the Crawford bicanalicular silicone stent was removed in the outpatient clinic and the patient was followed up

monthly. At the follow-up visits, the lacrimal system was irrigated to check for patency, fluorescein dye was instilled into the patient's conjunctival sac, and the neo-ostium was inspected with nasal endoscope 0° or 30°.

- (4) The functional outcome was classified as no improvement, improvement after surgery, and complete resolution of epiphora. Objectively, the outcome was evaluated by endoscopic visualization of patent neo-ostium, positive lacrimal syringing, and endoscopic documentation of the presence of fluorescein dye in the nasal cavity after a few blinks.

#### 2.4. Statistical analysis

The collected data were checked, entered, and analyzed using SPSS, version 22 software for data processing (SPSS Inc., Chicago, Illinois, USA). Data were expressed as the number and percentage for qualitative variables, whereas mean  $\pm$  SD and range for quantitative ones. The non-numerical data were tabulated and compared using the  $\chi^2$  test or Fisher exact test (if the number of cells  $<5$ ). Quantitative data were tested for normality using the Kolmogorov–Smirnov test, assuming normality at  $P$  value more than 0.05, using Student  $t$  if normally distributed. The accepted level of significance in this study was stated at 0.05. The smaller the  $P$  value obtained, the more significant the results. A  $P$  value of more than 0.05 indicates a non significant result, a  $P$  value of less than 0.05 indicates a significant result, and a  $P$  value less than 0.001 indicates a highly significant result.

### 3. Results

This study included 30 patients complaining of epiphora owing to primary acquired nasolacrimal duct obstruction. All patients had a positive fluorescein dye disappearance test (grade  $>1$ ) and a hard stop on lacrimal probing. A total of 29 (96.7%) patients were female and one (3.3%) patient was male, with a mean age of  $34.5 \pm 10.1$  years (Tables 1 and 2). Moreover, 25 patients had unilateral epiphora, whereas five patients had bilateral epiphora. In patients having bilateral epiphora, only one side was previously operated by external DCR in three patients and endoscopic DCR in the other two patients. In addition, 20 patients had right-sided epiphora, whereas 10 patients had left-sided epiphora.

According to the type of the created nasal mucosal flap, the patients were divided randomly into two groups (Table 3). Intraoperatively, three patients had a high septal deviation that was managed by

Table 1. General characteristics of the studied group.

Variables	N = 30
Age:	
Mean $\pm$ SD	34.5 $\pm$ 10.1
Range	20–65
Sex [n (%)]	
Male	1 (3.3)
Female	29 (96.7)

septoplasty in two patients, whereas the septal deviation was not obscuring the nasal endoscopic view in the third patient. One patient had a polypoidal middle turbinate on the same side of the epiphora, and it was managed using a Stryker microdebrider. In 26 (86.7%) patients, a Kerrison rongeur was only used to remove the bone to completely expose the sac, whereas in four (13.3%) patients, a diamond endonasal drill was needed, with a statistically significant difference ( $P = 0.013$ ) (Table 4). With elevating either the posteriorly or inferiorly based nasal mucosal flap, the frontal process of the maxilla and the lacrimal bone were well exposed and were removed adequately, thereby allowing excellent exposure of the lacrimal sac. Five patients had dacryocystopyoceles as pus came out on incising the lacrimal sac. Moreover, both posteriorly and inferiorly based nasal mucosal flaps were easily repositioned back, minimizing bone exposure. The mean operative time of the posterior flap group was 104.3 min, compared with 101.3 min for the inferior flap group, with no statistically significant difference ( $P = 0.4585$ ) (Table 4).

The patients were followed up for 6 months. The Crawford bicanalicular silicone stent was removed 12 weeks postoperatively in both groups. Then, the patients were followed up monthly for 3 months, and none of the patients were lost to follow-up. The overall success rate was 93.3%, with no statistically significant difference between the two groups ( $P = 0.27$ ). In the posterior flap group, epiphora resolved completely in 10 patients and improved in three patients, whereas in the inferior flap group, it resolved completely in 13 patients and improved in

Table 3. Type of the nasal mucosal flap.

Nasal mucosal flap	N = 30 [n (%)]
Posteriorly based flap	15 (50)
Inferiorly based flap	15 (50)

two patients (Table 5). On nasal endoscopic assessment, the site of the neo-ostium was in front of the axilla of the middle turbinate and patent in 28 (93.3%) patients, with no statistically significant difference between the two groups. Fluorescein dye cannot be detected intranasally in two (13.3%) patients within the posterior flap group, who had an obliterated neo-ostium with a negative fluorescein test result (Table 6).

The overall complication rate was 33.3%, with no statistically significant difference between both groups ( $P = 0.45$ ) (Table 7). No major complications occurred, such as epistaxis, orbital complications, or cerebrospinal fluid leak. The neo-ostium was obliterated and closed by a fibrous membrane in two (13.3%) patients in the posterior flap group. On nasal endoscopy, this membrane was moving inward with external pressure on the inner canthus area. Intranasal adhesions between the septum and the lateral nasal wall developed in three (10%) patients: one in the posterior flap group and two in the inferior flap group. Such adhesions were divided under local anesthesia in the outpatient clinic. Granuloma developed at the site of the neo-ostium in three (10%) patients 1–2 months postoperatively, one patient in the posterior flap group, and two patients in the inferior flap group. They were treated efficiently with steroid nasal spray twice daily for 1 month. In two patients, one patient in each group, a part of the silicone stent in the nose was difficult to remove after being divided at the medial canthus as a part of the stent was impacted under the mucosa of the lateral nasal wall. However, both patients were asymptomatic and had patent neo-ostium with no epiphora. Hence, they were managed expectantly. No other complications related to the silicone stent have been reported.

Table 2. The relation between the demographic data and type of the nasal mucosal flap.

	Operation		Test	P value
	Posterior flap (N = 15)	Inferior flap (N = 15)		
Sex [n (%)]				
Male	1 (6.7)	0	Fisher	0.13 NS
Female	14 (93.3)	15 (100)		
Age				
Mean $\pm$ SD	30.6 $\pm$ 11.7	28.3 $\pm$ 5.53	$t$ test = 0.69	0.45 NS

P value more than 0.05 = not significant (NS).



Table 4. The operative data among the studied groups.

	Operation		Test	P value
	Posterior flap (N = 15)	Inferior flap (N = 15)		
Duration of surgery (min)	104.3 ± 10.99	101.3 ± 10.77	t test = 0.7551	0.4585 NS
Technique [n (%)]				
Powered: drill	4 (26.7)	0	$\chi^2 = 4.615$	0.013 S
Non-powered	11 (73.3)	15 (100)		

P value more than 0.05 = not significant (NS).

P value of less than 0.05 = significant (S).

Table 5. The postoperative functional outcome.

The outcome	Operation [n (%)]		Test	P value
	Posterior flap (N = 15)	Inferior flap (N = 15)		
Epiphora	2 (13.3)	0	$\chi^2 = 2.591$	0.27 NS
Improvement of epiphora	3 (20)	2 (13.3)		
Complete resolution of epiphora	10 (66.7)	13 (86.7)		

P value more than 0.05 = not significant (NS).

Table 6. The postoperative outcome.

	Operation [n (%)]		Test	P value
	Posterior flap (N = 15)	Inferior flap (N = 15)		
Nasal endoscopic detection of fluorescein dye				
Negative	2 (13.3)	0	$\chi^2 = 2.143$	0.14 NS
Positive	13 (86.7)	15 (100)		
Site of neo-ostium				
In front of the axilla of the middle turbinate	13 (86.7)	15 (100)	$\chi^2 = 2.143$	0.143 NS

P value more than 0.05 = not significant (NS).

Table 7. The postoperative complications.

	Operation [n (%)]		Test	P value
	Posterior flap (N = 15)	Inferior flap (N = 15)		
Complications	5 (33.3)	5 (33.3)		
Type of complication				
Intranasal adhesion	1 (6.7)	2 (13.3)	$\chi^2 = 2.667$	0.45 NS
Obliterated neo-ostium	2 (13.3)	0		
Granuloma at the site of the neo-ostium	1 (6.7)	2 (13.3)		
Difficulty in stent removal	1 (6.7)	1 (6.7)		

P value more than 0.05 = not significant (NS).

#### 4. Discussion

The endonasal approach was first described by Caldwell in 1893 [18]. Nevertheless, only in the 1990s the endoscopic approach became feasible owing to the evolution of rigid fiberoptic nasal endoscopes that greatly advanced viewing of the surgical details and facilitated intranasal access to the lacrimal sac. Consequently, endoscopic DCR became increasingly popular owing to its eminent advantages compared with external DCR [5,19].

Endoscopic DCR basically includes either sacrificing or raising a nasal mucoperiosteal flap,

creating a bony window in the lacrimal fossa, and opening the medial wall of the lacrimal sac with or without bicanalicular intubation with a silicone stent [20].

To get access to the lacrimal sac, the mucosa and bone over a part of the nasolacrimal duct and the lacrimal sac must be removed. Hence, a part of the bone remains exposed at the completion of the surgery. The presence of bare bone can lead to granulation and scar tissue formation around the bony window [21]. Mahendran et al. [22] used a free nasal mucosal graft to cover the bare bone in patients undergoing endoscopic DCR. Subsequently,

the design of nasal mucosal flaps has been developed in flap-preservation techniques over the years. The concept of raising a nasal mucosal flap before creating the osteotomy is to place it over the osteotomy at the end of the procedure to avoid areas of bare bone as much as possible aiming to decrease the rate of adhesion and granulation formation, thus reducing the failure rate [17]. Hence, variant nasal mucosal flaps have been described such as U-shaped, L-shaped, H-shaped, and bipediced interlacing [11,12,14,15].

In the present study, we preserved the nasal mucosal flap, and the patients were divided into two groups: the known posteriorly based flap and a novel inferiorly based flap. A Kerrison rongeur and a diamond endonasal drill (in four patients only) were used to remove all the bone covering the lacrimal sac to create a large osteotomy. The novel inferiorly based flap as well as the posteriorly based flap allows adequate exposure and removal of the frontal process of the maxilla and the lacrimal bone, thereby facilitating exposure of the lacrimal sac. The creation of such a large osteotomy allows wide exposure of the lacrimal sac and the development of the sac flaps. Then, we used the posteriorly or the inferiorly based nasal mucosal flap with the lacrimal sac flaps aiming for healing with the primary intention to have a mucosa-lined wide neo-ostium with no statistically significant difference between the two groups regarding the mean operative time. This is similar to nasal and lacrimal sac mucosal apposition seen with external DCR. The meticulous apposition of the mucosa and a wide rhinostomy ensure fistulization. Moreover, the presence of a large area of functioning mucosa helps the healing process and prevents the granulation tissue and closure of the neo-ostium. The success rate was 86.7% in the posteriorly based flap group and 100% in the inferiorly based flap group, whereas the overall success rate was 93.3%, with no statistically significant difference between the two groups.

The current study's results were in agreement with that of Tsirbas and Wormald [12], who reported a success rate of 93% on using a U-shaped posteriorly based nasal mucosal flap and lacrimal sac flaps, whereas Trimarchi et al. [14] reported a success rate of 91.3% on using L-shaped posteriorly based nasal mucoperiosteal flap with lacrimal sac flaps. Moreover, Mueller et al. [11] reported a 96.4% success rate with the use of the bipediced interlacing nasal mucosal flap technique, whereas Mueller et al. [23] used a superiorly based nasal mucosal flap in revision endoscopic DCR with a 100% success rate as the mucosal flap has been replaced to minimize bone exposure and optimize patency.

Massegur et al. [24] compared two groups of patients who underwent endoscopic DCR with and without preserving the nasal mucosa, and they found that the mucosa-preserving technique was more functional and slightly more successful. In addition, Kansu et al. [25] mentioned that the result of endoscopic DCR with preservation of the mucosal flaps was as good as the best result achieved with external DCR.

The use of silicone stents and the optimal duration of stenting are still controversial. The reported duration of stenting ranges from 4 weeks to 4 months [26,27]. In the present study, the Crawford bicanalicular silicone stent was used in all the patients of both groups, and the stent was removed after 3 months. Bicanalicular intubation with a silicone stent is still performed by many ophthalmologists and rhinologists during both external and endoscopic DCR as it is believed that stent placement may improve the patency of the canaliculi and the neo-ostium, especially in the first postoperative period, when the reparative process can clog the breach [28].

The present study's overall complication rate was 33.3%, with no statistically significant difference between both groups. No orbital complication was reported as we kept the dissection anterior to the uncinat process. No epistaxis or other major event occurred. All complications were minor. Granulomas developed only in three (10%) patients in both groups and were treated effectively with steroid nasal spray. Thus, in the current study, using either a posteriorly or an inferiorly based nasal mucosal flap with the lacrimal sac flaps minimizes the granulation and crusting over the exposed bone and decreases the need for endoscopic cleaning postoperatively. The difficulty in removal of part of the stent could be owing to the knot of silicone stent being close to the mucosal flaps. Thus, it may get impacted under the mucosa during the healing process. Therefore, the knot of the stent should remain inferiorly in the nasal cavity away from the mucosal flaps to avoid such complications or granulation tissue formation.

Preserving the nasal mucosa and using the lacrimal sac flaps enable primary healing along the edges of the lacrimal sac and nasal mucosa, hence marsupializing the lacrimal sac into the lateral nasal wall. Covering the edges of the rhinostomy site with the flaps minimizes granulation tissue and adhesion formation and prevents the restenosis of the neo-ostium, which is the most common cause of failure in endoscopic DCR. In the present study, the neo-ostium was obliterated and closed by a fibrous membrane only in two (13.3%) patients in the posterior flap group. Hence, the results of our study

suggest that using either a posteriorly or an inferiorly based nasal mucosal flap with the lacrimal sac flaps allows the creation of a stable lacrimal neo-ostium by healing with primary intention.

However, the present work has limitations as the follow-up period was relatively short and there was difficulty in measuring the size of the neo-ostium by a standard method. Hence, longer follow-up is advised to prevent adhesions and obstruction of rhinostoma and ensure its efficiency in providing long-lasting symptom improvement. Further studies are also needed to assess the effect of the neo-ostium size on the outcome of endoscopic DCR.

In conclusion, endoscopic DCR with a large bony ostium and nasal mucosal and lacrimal sac flaps has been considered an acceptable technique for treating distal lacrimal system obstructions. The endoscopic approach requires knowledge of the endoscopic nasal anatomy and appropriate endonasal surgical skills. The present study highlights that the novel inferiorly based nasal mucosal flap provides adequate access and exposure to the lacrimal sac and has a high success rate and low complication rate similar to the known posteriorly based nasal mucosal flap. Thus, we can address and recommend it as a new adjunct technique for endoscopic DCR with good results.

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## Conflicts of interest

The authors declare that they have no competing interests.

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## References

- [1] Önerci M. Dacryocystorhinostomy. Diagnosis and treatment of nasolacrimal canal obstructions. *Rhinology* 2002;40:49–65.
- [2] Cavada MN, Grayson JW, Sacks R. Endoscopic dacryocystorhinostomy. *Curr Otorhinolaryngol Rep* 2019;7:141–6.
- [3] Bartley GB. Acquired lacrimal drainage obstruction: an etiologic classification system, case reports, and a review of the literature. Part 3. *Ophthalmic Plast Reconstr Surg* 1993;9:11–26.
- [4] Peng W, Tan B, Wang Y, Wang H, Wang Z, Liang X. A modified preserved nasal and lacrimal flap technique in endoscopic dacryocystorhinostomy. *Sci Rep* 2017;7:6809.
- [5] Watkins LM, Janfaza P, Rubin PA. The evolution of endonasal dacryocystorhinostomy. *Surv Ophthalmol* 2003;48:73–84.
- [6] Savino G, Battendieri R, Traina S, Corbo G, D'Amico G, Gari M, et al. External vs. endonasal dacryocystorhinostomy: has the current view changed? *Acta Otorhinolaryngol Ital* 2014;34:29–35.
- [7] McDonogh M, Meiring JH. Endoscopic transnasal dacryocystorhinostomy. *J Laryngol Otol* 1989;103:585–7.
- [8] Sinha V, Gupta D, Prajapati B, More Y, Khandelwal P, Singh SN, Himanshu B. Endoscopic dacryocystorhinostomy with conventional instruments: results and advantages over external dacryocystorhinostomy. *Indian J Otolaryngol Head Neck Surg* 2008;60:207–9.
- [9] Eloy P, Bertrand B, Martinez M, Hoebeke M, Watelet JB, Jamart J. Endonasal dacryocystorhinostomy: indications, technique and results. *Rhinology* 1995;33:229–33.
- [10] Gurler B, San I. Long-term follow-up outcomes of nonlaser intranasal endoscopic dacryocystorhinostomy: how suitable and useful are conventional surgical instruments? *Eur J Ophthalmol* 2004;14:453–60.
- [11] Mueller SK, Freitag SK, Lefebvre DR, Bleier BS. Endoscopic DCR using bipediced interlacing mucosal flaps. *Laryngoscope* 2018;128:794–7.
- [12] Tsirbas A, Wormald PJ. Endonasal dacryocystorhinostomy with mucosal flaps. *Am J Ophthalmol* 2003;135:76–83.
- [13] Ben Simon GJ, Joseph J, Lee S, Schwarcz RM, McCann JD, Goldberg RA. External versus endoscopic dacryocystorhinostomy for acquired nasolacrimal duct obstruction in a tertiary referral center. *Ophthalmology* 2005;112:1463–8.
- [14] Trimarchi M, Giordano Resti A, Bellini C, Forti M, Bussi M. Anastomosis of nasal mucosal and lacrimal sac flaps in endoscopic dacryocystorhinostomy. *Eur Arch Oto-Rhino-Laryngol* 2009;266:1747–52.
- [15] Ferguson ASJ, White PS, Sharpe GDM. Endoscopic dacryocystorhinostomy. *ENT Audiol News* 2018;27:5.
- [16] Codère F, Denton P, Corona J. Endonasal dacryocystorhinostomy: a modified technique with preservation of the nasal and lacrimal mucosa. *Ophthalmic Plast Reconstr Surg* 2010;26:161–4.
- [17] Cokkeser Y, Evereklioglu C, Er H. Comparative external versus endoscopic dacryocystorhinostomy: results in 115 patients (130 eyes). *Otolaryngol Head Neck Surg* 2000;123:488–91.
- [18] Caldwell GW. Two new operations for obstruction of the nasal duct, with preservation of the canaliculi. *Am J Ophthalmol* 1893;10:189–92.
- [19] Marcet MM, Kuk AK, Phelps PO. Evidence-based review of surgical practices in endoscopic endonasal dacryocystorhinostomy for primary acquired nasolacrimal duct obstruction and other new indications. *Curr Opin Ophthalmol* 2014;25:443–8.
- [20] Kumar S, Mishra AK, Sethi A, Mallick A, Maggon N, Sharma H, Gupta A. Comparing outcomes of the standard technique of endoscopic dcr with its modifications: a retrospective analysis. *Otolaryngol Head Neck Surg* 2019;160:347–54.
- [21] Durvasula VS, Gatland DJ. Endoscopic dacryocystorhinostomy: long-term results and evolution of surgical technique. *J Laryngol Otol* 2004;118:628–32.
- [22] Mahendran S, Stevens-King A, Yung MW. How we do it: the viability of free mucosal grafts on exposed bone in lacrimal surgery – a prospective study. *Clin Otolaryngol* 2006;31:324–7.
- [23] Mueller SK, Freitag SK, Lefebvre DR, Lee NG, Bleier BS. Revision eDCR using a superior pedicled mucosal flap. *Orbit* 2019;38:1–6.
- [24] Masegur H, Trias E, Ademà JM. Endoscopic dacryocystorhinostomy: modified technique. *Otolaryngol Head Neck Surg* 2004;130:39–46.
- [25] Kansu L, Aydın E, Avci S, Kal A, Gedik S. Comparison of surgical outcomes of endonasal dacryocystorhinostomy with or without mucosal flaps. *Auris Nasus Larynx* 2009;36:555–9.

- [26] Al-Qahtani AS. Primary endoscopic dacryocystorhinostomy with or without silicone tubing: a prospective randomized study. *Am J Rhinol Allergy* 2012;26:332–4.
- [27] Yeon JY, Shim WS. Endoscopic dacryocystorhinostomy without silicone stent. *Acta Otolaryngol* 2012;132(Suppl 1):S77–81.
- [28] Longari F, Dehgani Mobaraki P, Ricci AL, Lapenna R, Cugini C, Ricci G. Endoscopic dacryocystorhinostomy with and without silicone intubation: 4 years retrospective study. *Eur Arch Oto-Rhino-Laryngol* 2016;273:2079–84.