

Original Research Article

Endonasal dacryocystorhinostomy: evaluation of the anatomical and functional results

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ABSTRACT

Background: Dacryocystorhinostomy is a novel surgical technique for NLD obstruction performed by external and endonasal approach. Both procedures have variable success rates and advantages or disadvantages. The objectives were to study functional and anatomic outcomes of endoscopic DCR and to assess degree of ostium shrinkage in postoperative period.

Methods: Prospective study comprising 68 patients of NLD obstruction with 70 procedures performed during the period of October 2014 to October 2016. Various dimensions of bony neo-ostium were recorded intraoperatively and during 1st and 3rd month follow up. Mitomycin C was applied in 37 cases. Degree of ostium shrinkage and its correlation with surgical success was studied. Outcome of study was measured as functional and anatomical success.

Results: 68 patients in age range of 7 to 71 years. Mean intraoperative height and width were 12.0 ± 2.08 mm and 5.17 ± 0.82 mm respectively and intraoperative surface area of ostium was 62.77 ± 17.27 mm². The study showed strong positive correlation between initial and final ostium size. The final ostium irrespective of its size, if patent does not result in recurrence of symptoms and can be considered as success. In the present study, functional and anatomical success was 97.14% and failure rate was 2.86%.

Conclusions: Both functional and anatomical success require creation of patent neo-ostium, although the intraoperative size of ostium is not the deciding factor for final outcome. Complete exposure of lacrimal sac, adequate mucosal preservation, good marsupialization and mucosal apposition are the some of the crucial factors responsible for stable ostium patency and hence the surgical success.

Keywords: Nasolacrimal duct obstruction, Endoscopic dacryocystorhinostomy, Neo-ostium

INTRODUCTION

Nasolacrimal drainage system obstruction, a commonest cause of epiphora, is encountered in clinical practice by both otolaryngologist and ophthalmologist. It can be congenital or acquired. Congenital causes include nasolacrimal duct atresia or fistula whereas acquired conditions include acute and chronic inflammation, maxillofacial trauma, post-surgery, irradiation etc.

Dacryocystorhinostomy (DCR), a rhinostomy at the level of lacrimal sac to bypass the nasolacrimal duct (NLD) obstruction, is the treatment of choice. External dacryocystorhinostomy was the treatment of choice for the post canalicular stenosis in the 20th century. The advent of endoscopes has opened a new panorama in the management of NLD obstruction. Endonasal DCR have various advantages over external DCR approach including excellent visibility, surgically less invasive,

absence of a visible scar, preservation of the orbicularis oculi lacrimal pump mechanism, shorter operative time and faster postoperative recovery which in turns improve patient's quality of life.^{1,2} Steeper learning curve and higher equipment cost are the only disadvantages with endonasal approach. External and endonasal DCR are described in the literature with variable success rates and surgical limitations. The reported success rates of endonasal DCR vary between 63% and 93.5%, whereas external DCR has success rates of 70% to 95.8%.³⁻⁷ However, surgical failure for endonasal DCR ranges from 4% to 13%.⁸⁻¹⁰

Literature have documented various factors responsible for surgical failure of endonasal DCR which includes inadequate sac exposure, small sized sac opening, fibrosis of the sac prior to surgery and ostium related factors like inappropriate location of the ostium, poor apposition of mucosal flaps, granulations over stoma site, synechia and sump syndrome. Among all, cicatricial closure of the osteotomy site is the most common factor reported.⁹⁻¹¹ However there are limited studies in literature demonstrating sequence of post-operative ostium shrinkage as well as a definite correlation between ostium size and surgical success.¹²⁻¹⁴ Controversy still revolves around the progression of lacrimal ostium shrinkage after surgery.

The current study was designed to evaluate the functional and anatomical success of endonasal DCR, to demonstrate the course of ostium shrinkage in post-operative period and to establish the correlation between ostium size and surgical success.

METHODS

This prospective study, comprised of 68 patients referred to Otolaryngology Department with symptoms of epiphora, having obstruction at the level of nasolacrimal duct. The study was conducted from October 2014 to October 2016 in Otorhinolaryngology Department of Indira Gandhi Government Medical College and Hospital, Nagpur (Maharashtra, India). The research protocol was approved by the institutional ethics committee. Patients were in the age range of 7 to 71 years. All patients were subjected to detailed history, clinical, haematological and radiological examination. Lacrimal Sac syringing was done in all cases, for bilateral lacrimal system, irrespective of the disease site. Patients with obstruction at the level of nasolacrimal duct either acquired or congenital, were included in the study. However, those having canalicular or punctum block and having history of prior lacrimal system surgery (DCR or DCT) were excluded from the study. Dacryocystography was done when indicated to rule out canalicular obstruction (Figure 1). Nasal endoscopy was done to look for any associated sino-nasal pathology. Detail ophthalmic evaluation was done by ophthalmologist. Patients were counselled for surgery and subjected to endonasal endoscopic dacryocystorhinostomy under

necessary anaesthesia. 70 DCR procedures were performed on 68 patients of which 66 (97.06%) were unilateral and 2 (2.94%) were bilateral cases.

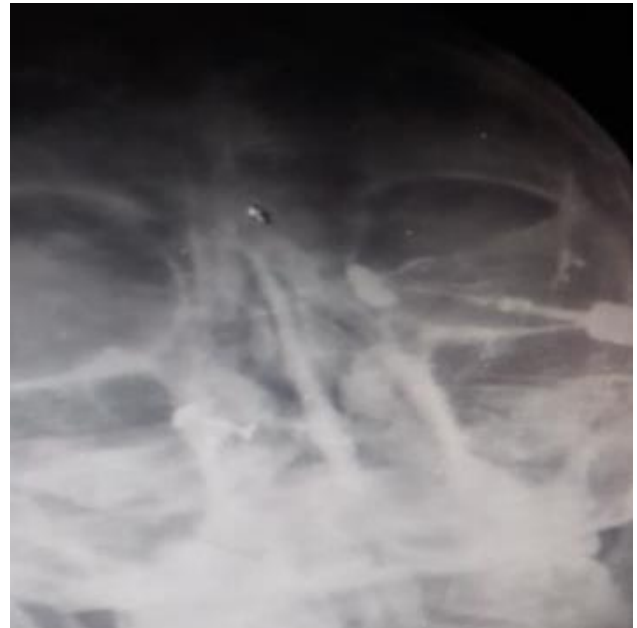


Figure 1: Dacryocystography showing collection of radio-opaque dye in lacrimal sac region suggestive of nasolacrimal duct obstruction.



Figure 2: Measurement of sac opening with Castajevo calliper.

Standard surgical steps of endoscopic DCR were followed. Adequate bone removal was done till the whole lacrimal sac stands out prominently over lateral nasal

wall. After opening the sac, sac contents (mucoid, mucopurulent, clear fluid) and condition of the sac wall (oedematous, fibrosed, inflamed, normal) was noted. The vertical and horizontal diameters of the neo-ostium were measured using castajevic callipers and Schirmer's strips (Figure 2) and surface area was calculated. Adequate mucosal preservation with flap refashioning and approximation was done in order to achieve shallow based circular fashioned and wide ostium. Mitomycin-C (MMC) was randomly applied to the neo-ostium in 37 cases. Gelfoam soaked in 0.2 mg/ml MMC was kept over the ostium for 1 minute and removed. Lacrimal stenting was not done in any of the cases. Follow up was done at 1 week, 1 month and 3 months post-operatively. At each visit patients symptoms were assessed and lacrimal syringing was done. Nasal endoscopy was done at 1 month and 3 month post-operatively. On endoscopy, the neo-ostium was examined for its anatomical patency and its horizontal, vertical diameter and surface area were measured (Figure 3). Any associated pathologies like synechia or granulations were noted and addressed.



Figure 3: Neo-ostium at 3rd month of follow up.

Statistical analysis

Continuous variables were presented as mean SD. Categorical variables were expressed in frequency and percentages. Intra operative height, width and area were compared at different follow-up period by performing one way repeated measure ANOVA. Bonferroni multiple comparison test was used for post operative comparison. Effect of MMC on area of ostium was assessed by performing independent t-test for different follow-up period. $P < 0.05$ was considered as statistical significant. Logistic regression was used to predict the effect of ostium size on surgical success. Statistical software STATA version 14.0 was used for data analysis.

In present study, we defined success as per Pittore et al as functional success (subjective) which means resolution of lacrimal symptoms (epiphora, swelling etc) and

anatomical success (objective) which means endoscopic evidence of patent neo-ostium and free flow of saline on lacrimal sac syringing.¹⁵

RESULTS

70 endoscopic DCR procedures were performed in 68 patients, of which 66 (97.06%) were unilateral and 2 (2.94%) were bilateral. Left side was affected in 51.47% patients whereas in 45.59% cases right side was involved. Patients were in the age range of 7 to 71 years with maximum patients in the age group of 40 to 50 years (36.76%) and mean age of 41.29 years. Male to female ratio was 1:4.67. All cases presented with epiphora (100%), 10.29% (7) had lacrimal swelling (mucocele) while 1 patient had lacrimal fistula. The etiology of NLD obstruction was idiopathic in 97% (66) cases whereas in 1.47% it was iatrogenic following intra- nasal surgery. Congenital NLD obstruction was identified in 1.43% patients. Nasal endoscopy showed deviation of nasal septum in 25 (25%) cases, 1 case of concha bullosa and ethmoidal polyposis each. In 72% patients, nasal endoscopy did not reveal any abnormality. On lacrimal sac syringing, 62 (88.57%) patients had complete block with mucoid, mucopurulent and clear regurgitations from opposite punctum in 23 (32.86%), 31 (44.28%) and 8 (11.43%) patients respectively.

Intraoperatively, we observed and documented the condition of lacrimal sac after adequate bone clearance, condition of sac wall and contents of the sac after opening it. Lacrimal sac was distended in 7 (10%), collapsed in 4 (5.72%) and normal in 59 (84.28%) cases. Lacrimal sac wall was inflamed in 27 (38.57%) cases whereas oedematous in 20 (28.57%), fibrosed in 4 (5.72%) and normal in 19 (27.14%) cases. After opening the sac, discharge was mucopurulent in 31 (44.28%), mucoid in 24 (34.28%) and clear in 15 (21.44%) cases.

Measurements of neo-ostium dimensions, intra-operatively and at follow up

In the present study, the intraoperative height of ostium ranged from 7 mm to 18mm, with maximum number of cases i.e. 50 (71.43%) in the range 10.1-15.0 mm. At 1st and 3rd month follow up, we noticed reduction in the height of ostium in all cases. Maximum cases were observed in the range 0 to 5 mm, with 65 (92.86%) and 68 (97.14%) cases at 1st and 3rd month respectively.

The intraoperative width of the ostium ranged from 4 mm to 7 mm, with 52 (74.29%) cases in the range of 4.1 to 6.0 mm. Reduction of width was noticed in all cases during follow up with maximum patients observed in range of 2.1 to 4.0 mm. At 1 month, 62 (88.57%) and at 3rd month 54 (77.14%) cases were observed in 2.1 to 4.0mm range.

The intraoperative surface area of ostium ranged from 28 to 108 mm². The maximum number of cases 19 (27.14%)

were in 50.1 to 60 mm² range. At 1 month the surface area ranged between 0 to 32.5 mm² and the maximum number of cases 55 (78.17%) were in the 10.1 to 20 mm² range. At 3 months the surface area ranged from 0 to 24

mm² with maximum number of cases 41 (58.57%) being in the 10.1-20 mm² range. Figure 4 demonstrating comparison of surface area, intraoperatively and postoperatively at 1st and 3rd month follow up.

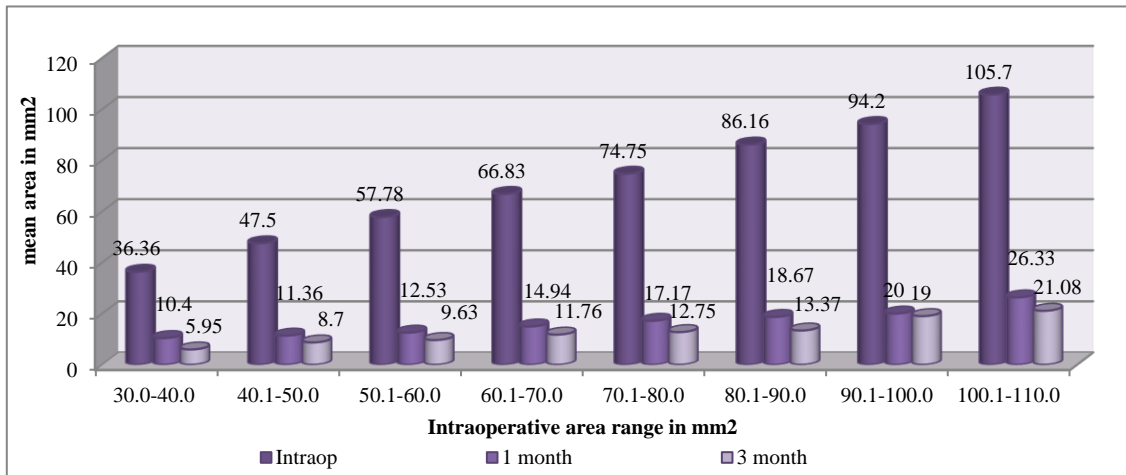


Figure 4: Comparison of surface area intraoperative and postoperative 1st and 3rd month.

Table 1: Measurement of dimensions of ostium intraoperatively and during follow up.

Ostium evaluation	Intraoperative		1 st month		3 rd month	
Height (mm)	Number	Percentage	Number	Percentage	Number	Percentage
0-5.0	0	0	65	92.86	68	97.14
6-10.0	18	25.71	5	7.14	2	2.86
10.1-15.0	50	71.43	0	0	0	0
15.1-20.0	2	2.86	0	0	0	0
Width (mm)						
0-2.0	0	0	6	8.57	16	22.86
2.1-4.0	13	18.57	62	88.57	54	77.14
4.1-6.0	52	74.29	2	2.86	0	0
6.1-8.0	5	7.14	0	0	0	0
Surface Area (mm²)						
0-10.0	0	0	10	14.28	28	40
10.1-20.0	0	0	55	78.57	41	58.57
20.1-30.0	1	1.43	4	5.71	1	1.43
30.1-40.0	6	8.57	1	1.43	0	0
40.1-50.0	11	15.17	0	0	0	0
50.1-60.0	19	27.24	0	0	0	0
60.1-70.0	18	25.71	0	0	0	0
70.1-80.0	4	5.71	0	0	0	0
80.1-90.0	6	8.57	0	0	0	0
90.1-100.0	2	2.86	0	0	0	0
100.1-110.0	3	4.28	0	0	0	0

Table 2: Comparison of mean ostium dimensions.

Dimensions	Intraoperative	1 st month	3 rd month
Vertical (Height) mm	12.0±2.08	4.30±0.86	3.82±0.89
Horizontal (Width)mm	5.17±0.82	3.38±0.65	2.91±0.73
Surface area mm ²	62.77±17.27	14.20±5.33	10.83±4.94
Degree of reduction in area%		77.56%	82.75%

Table 3: Mean ostium area in MMC applied and not applied group.

Mitomycin	Mean ostium surface area mm ²			P value
	Intra op	1 month	3 months	
Applied	63.15±16.79	15.81±4.88	12.88±4.07	<0.0001, HS
Not applied	61.95±18.01	12.34±5.30	8.53±4.87	<0.0001, HS
P value	0.7091, HS	0.0060, HS	0.0001, HS	

Table 1 showing measurement of dimensions of ostium intraoperatively and during follow up. Mean ostium dimensions (vertical, horizontal and surface area) showed statistically significant reduction during follow up when compared to intraoperative dimensions ($p < 0.0001$). Table 2 showing comparison of mean ostium dimensions.

MMC was randomly applied to the neo-ostium in 37 (52.86%) cases. After 3rd month, mean ostium surface area in MMC applied group was more as compared to the not applied group. However, the difference was not statistically significant. Table 3 showing mean ostium area in MMC applied and not applied group.

Outcome

At 3rd month follow up, 68 (97.14%) cases had complete resolution of symptoms with wide, patent ostium. 2 (2.86%) patients returned with epiphora (functional failure) whose lacrimal sac syringing showed complete block with regurgitation from opposite punctum and complete closure of neo-ostium on nasal endoscopy (anatomical failure).

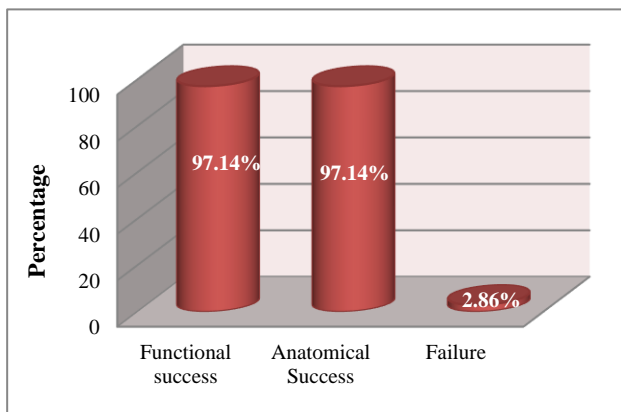


Figure 5: Functional, anatomical success and failure rate of endonasal dacryocystorhinostomy.

In the present series of endonasal DCR, the overall anatomical and functional success rate was 97.14% each and the failure rate was 2.86%.

Complications

No major complications were encountered intraoperatively and during postoperative period. Minor complications like synechiae and granulations were seen

in 10% and 2.86% patients respectively. However, these were not obstructing the neo-ostium and were addressed accordingly.

DISCUSSION

Historically, dacryocystorhinostomy (DCR) has been performed externally with very good outcomes. Since last two decades, interest in endoscopic approach has increased markedly but limited by the inferior clinical outcomes. Advances in endoscopic visualization, development of new instrumentation, and growing clinical experience have addressed many of the concerns initially associated with endoscopic approach. Currently, literature has validated the comparable success rate and advantages of endoscopic approach to DCR with external techniques.^{4,6,16,17}

Endoscopic DCR is creating a stoma to bypass the nasolacrimal duct obstruction. Obstruction can be congenital or acquired. Congenital causes include nasolacrimal duct atresia or fistula whereas acquired conditions include idiopathic, acute and chronic inflammation, maxillofacial trauma, post-surgery, irradiation etc. Long standing obstruction of the NLD often leads to infection and inflammation of the lacrimal sac known as dacryocystitis. Chronic dacryocystitis is more common and presents as epiphora, discharge, regurgitation of mucoid or mucopurulent material on applying pressure over the sac area, cystic swelling or mucocele in the region of sac and chronic inflammation of caruncle and neighbouring parts of the conjunctiva. However, Hartikainen et al observed that many patients tolerate lacrimal duct obstruction with epiphora for many years without clinical infection, representing simple stenosis of lacrimal duct (SSLD).²² They diagnosed cases as SSLD clinically when there was clear fluid regurgitation from the lacrimal sac and cases of chronic dacryocystitis when there was mucoid or mucopurulent discharge. We came across clear regurgitation on lacrimal sac syringing in 22.86% cases. Thus, as per Hartikainen et al, these 22.86% cases belonged to simple stenosis of lacrimal duct and rest of 77.14% were labelled as chronic dacryocystitis.²² Various studies in literature had documented idiopathic or primary acquired obstruction as most common cause of NLD obstruction.^{18,21,23} We also had similar finding documented in 68 (97.14%) cases.

68 patients of NLD obstruction in the age range of 7 to 71 years were studied, with mean age of 41.29 years and maximum patients in age group of 40 to 50 years

(36.76%). Dacryocystitis can occur at any age group, but is more frequently seen in middle age individuals. This finding was supported by various authors where they showed that the frequency of dacryocystitis increased after 40 years of age.^{8,18,19} Female preponderance as seen in the present and other studies can be attributed to narrower lumen of bony lacrimal canal and probable hormonal effects in female gender.^{8,18,20,21}

Lacrimal syringing and probing was performed to identify the level of obstruction in the lacrimal drainage pathway. On probing either a soft or hard stop was noted. Dacryocystography was performed to rule out canalicular obstruction in doubtful cases. Only those cases with nasolacrimal duct obstruction were selected. According to Beigi et al lacrimal syringing alone has a high false positive rate for nasolacrimal duct obstruction and many cases with nasolacrimal duct obstruction also had concomitant canalicular obstruction.²⁴ As dacryocystography was done when there was a suspicion of canalicular block, canalicular obstruction was not encountered in any of the selected cases.

Concomitant nasal procedures

It is not surprising to find overlap of concomitant nasal diseases in patients presenting with nasolacrimal duct obstruction. Crowded nasal passage and limited exposure of lacrimal sac limits the outcome of endonasal DCR. Deviated nasal septum and concha bullosa on diseased side need to be addressed in order to improve access, for making the procedure technically easier and prevent adhesion formation and hence improve the surgical success. Endoscopic sinus surgery for chronic rhinosinusitis and removal of nasal mass should be done simultaneously to reduce overall nasal inflammation and to avoid multiple exposure to anaesthesia. Figueira et al in their study of 576 cases of endoscopic DCR, found that 14.1% of their patients required simultaneous endonasal procedures.²⁵ They reported performing septoplasty in 11.9%, middle turbinate surgery in 1.5% and polypectomy in 0.34%. Nussbaumer et al performed 256 endoscopic DCR's and reported septoplasty was performed in 16.4%, partial middle turbinectomy in 3.9%, uncinectomy in 0.8% and polypectomy in 0.4%.²⁶ Ali et al performed 269 powered endoscopic DCR, among them additional nasal procedures were done in 53.4% patients, with septoplasty in 47% and middle turbinoplasty in 5.9% patients.²⁷ In the present study, septoplasty was done in 20% cases and revision FESS and conchoplasty in 1.48% each.

Evolution of ostium

The mean intraoperative height and width were 12.0 ± 2.08 mm and 5.17 ± 0.82 mm respectively and the mean intraoperative surface area of ostium was 62.77 ± 17.27 mm². Ostium dimensions were recorded during each follow up and noteworthy was that maximum reduction in the size of the ostium occurred at 1 month

postoperatively where the ostium shrinkage occurred by 77.56% and at 3 months there was an additional reduction by 5.17% i.e. 82.73%. In 2.86% patients who had recurrence of epiphora had complete closure of ostium at 3 months. These cases also had smaller intraoperative dimensions. It was observed that in cases where the intraoperative dimensions of ostium were higher, the corresponding post-operative dimensions at 1 month and 3 months were also higher which was statistically significant ($p < 0.0001$). Though smaller intra operative ostium has greater risk of smaller post-operative ostium and closure, the failure usually results from a completely closed ostium and not a small post operative ostium. Thus, a strong positive correlation was observed between the initial and final ostium size. With regards to the rate and degree of ostium contraction, these findings were supported by various instigators.^{11,13,14} Chan et al and Ben Simon et al in their respective analysis showed strong positive correlation between intraoperative and postoperative ostium dimensions.^{14,28} Mann and Wormald described a surgical technique where in the nasal and lacrimal mucosa was approximated which results in a first intention healing with minimal ostium granulations or stenosis and minimal shrinkage of the postoperative DCR ostium.¹³ Standard surgical steps of endonasal DCR were followed with bony clearance exposing lacrimal sac from fundus till proximal NLD. Adequate mucosal preservation, approximation and flap refashioning was done in order to achieve shallow based circular fashioned ostium. The degree to which an ostium constricts from its initial intra-operative size is variable, with wide reported ranges of 20% to 98%. This variability may not only be influenced by surgical and patient factors but may also reflect different methods employed to create and measure the ostium. Individual variations in the anatomy invariably lead to variations in ostium sizes. Instead of making efforts to achieve a standard size in all cases, the primary aim should be a complete exposure, adequate marsupialisation and good mucosal apposition. This fact was supported by various authors in their respective studies on surgical outcomes of endonasal DCR.²⁹⁻³¹

Cheng et al conducted a meta-analysis, including 11 studies, on the efficacy of MMC in endoscopic DCR.³² The size of the osteotomy was bigger in the MMC group compared to the control group at 3 and 6 months after surgery. However, there was no statistically significant difference in the osteotomy surface area between the two groups at 12 months after surgery. MMC, an antifibrotic agent, may be useful in halting the healing process in initial stages, where the shrinkage is the greatest and potentially help to reduce early anatomic failure. Although the final ostium size achieved in MMC applied was larger than not applied group, it didn't consistently correlate with higher success.³³⁻³⁵ Similar finding was observed in present case series where MMC was applied in 52.86% cases.

Major complications associated with Endonasal DCR like CSF leak, orbital prolapse are relatively rare and majority

of the complications seen are usually minor like synechiae, granulations, problems related to intubation. Nuehas and Baylis reported two presumptive cases of CSF leakage associated with DCR.³⁶ They found that the fracture of anterior skull base could be due to applying a rotational force to the Kerrison Rongeur while enlarging the posterior nasal window. Fayet et al reported a case of CSF leak following endonasal DCR in an 80 year old patient.³⁷ Zuercher et al reported minor intraoperative complications in 7.14% cases which included trauma to vestibule during drilling, diffuse bleeding and injury to inferior canaliculi.¹⁸ Early postoperative complications included periorbital oedema, subconjunctival hematoma and bicanalicular silicone tube migration and excess fixation resulting injury to lacrimal canaliculi in 15.48% cases. Late post operative complications included infection of lacrimal drainage system, synechiae formation and granulation related to lacrimal intubation in 30.95% cases. Lacrimal stenting was not done in any of the cases of present series.

The reported success rates of endonasal DCR vary between 63% and 96%. Functional and anatomical success of 97.14% was achieved with failure rate of 2.86%. In the study by Zuercher et al complete success was 85.7%, anatomic success was 4.8%, functional success was 1.2% and failure was 8.3% for both primary and salvage cases.¹⁸ In the study done by Tsirbas et al anatomical patency was achieved in 95%, anatomic patency and symptom relief was seen in 89% cases, excluding canalicular obstruction anatomical patency was seen in 97% and anatomic and symptom relief was in 91%.⁴ Yung et al had complete cure in 89% cases, partial cure in 6% and no cure in 5% cases.³⁸ Excluding canalicular obstruction, 93% had complete cure, 3% had partial cure and 3% had none. Pittore et al, reported the functional (subjective) and anatomical success rate of 94.3%.¹⁵ In the study by Sinha et al, the reported success rate was 96%.³⁹ The risk factors for failure can be attributed to smaller size of intraoperative ostium, improper selection of cases and poor apposition of nasal mucosal and lacrimal sac wall flaps which may result in closure of ostium.

CONCLUSION

Endonasal DCR offers an effective surgical treatment for NLD obstruction with high success rate and lesser complications when performed with utmost precision. The maximum shrinkage of the ostium occurs within first month after surgery, remaining relatively stable thereafter. The ultimate success depends upon the creation of a patent neo-ostium, although the intraoperative size of ostium is not the deciding factor for final outcome. Complete exposure of lacrimal sac, adequate mucosal preservation, good marsupialisation of lacrimal sac and mucosa to mucosa apposition are some of the factors responsible for stable ostium patency and hence the surgical success. Associated sino-nasal pathologies and anatomical variations should be

addressed simultaneously to improve surgical access and success.

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Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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