

Comparison of endonasal endoscopic dacryocystorhinostomy over external dacryocystorhinostomy

Mohit Goel¹, Manish Sharma^{2,*}, Deepak Kotwal³, Divya Gupta⁴, Padam Singh Jamwal⁵

¹Senior Resident, Maharishi Markandeshwar Medical College, Haryana, ²Senior Resident, ⁵Professor, Dept. of ENT, Govt. Medical College, Jammu, ³Senior Resident, BLK Superspeciality Hospital, New Delhi, ⁴Medical Officer, Dept. of Health & Medical Education, Jammu

***Corresponding Author:**

Email: maddys654@gmail.com

Abstract

Dacryocystorhinostomy (DCR) is an operation indicated for nasolacrimal duct obstruction. It creates a lacrimal drainage pathway into the nasal cavity to facilitate drainage of the previously obstructed excreting system. DCR can be performed either through external or endoscopic approach. We undertook this study to compare the results and advantages of endonasal endoscopic DCR with external DCR with respect to intraoperative and postoperative complications, duration of surgery, functional and cosmetic outcome. Out of 40 patients taken up for DCR, 20 underwent unilateral external DCR, 18 had unilateral endoscopic DCR and 2 had bilateral endoscopic DCR. Thus, a total of 22 eyes underwent endoscopic DCR and it was concluded that endoscopic dacryocystorhinostomy is a less time consuming, almost equally effective and aesthetically better than external approach and is an acceptable and functional alternative to external dacryocystorhinostomy.

Keywords: Endoscopic, Nasolacrimal duct.

Introduction

Lacrimal gland with upper and lower lacrimal pathways secretes tears and drains them into the nasal cavity. Puncta and lacrimal canaliculi constitutes upper lacrimal pathway, while lacrimal sac and nasolacrimal duct constitutes lower lacrimal pathway. Lacrimal pathway obstruction leads to infection, epiphora, blurry eye-sight with pain around face and ocular region.⁽¹⁾ Symptoms and signs of a lacrimal obstruction include tears and frequent conjunctival discharge. Nasolacrimal duct obstruction is the common form of acquired lacrimal obstruction, especially in middle-aged females.⁽²⁾ It is subdivided into primary and secondary. Primary acquired nasolacrimal duct obstruction is caused by inflammation or fibrosis barring any precipitating cause.⁽³⁾ Secondary acquired lacrimal drainage obstruction is caused by infection, inflammation and trauma. Infection is caused by bacteria, viruses, fungi and parasites.⁽⁴⁾ Dacryocystorhinostomy (DCR) is an operation indicated for nasolacrimal duct obstruction. It creates a lacrimal drainage pathway into the nasal cavity to facilitate drainage of the previously obstructed excreting system.⁽⁵⁾ DCR can be performed either through external or endoscopic approach. External DCR is regarded as a gold standard with a success rate of 80 to 100%.⁽⁶⁾ With advancement in technology accompanied by improved visualization, endoscopic DCR has gained much fame. It has advantages over external DCR like low morbidity, short recovery time, no need of external incision along with maintaining lacrimal pumping mechanism.⁽⁷⁾ We undertook this study to compare the results and advantages of endonasal endoscopic DCR with external DCR with

respect to intraoperative and postoperative complications, duration of surgery, functional and cosmetic outcome.

Materials and Methods

This prospective study was conducted in the Department of Otorhinolaryngology and Head and Neck Surgery, SMGS Hospital in collaboration with the Upgraded Department of Ophthalmology, Government Medical College, Jammu for a period of one year. The study was conducted after taking approval of Institutional Ethics Committee. All symptomatic cases of epiphora which were diagnosed for primary acquired nasolacrimal duct obstruction or chronic dacryocystitis in the age group of 15-60 years and those who were willing to undergo surgery were included in the study. Patients having active dacryocystitis, cases with canalicular and punctal obstruction, ectropion or entropion, noticeable lower lid laxity, malignancy of lacrimal sac, fibrotic sac, nasal pathology and cases with bleeding diathesis were excluded from the study. Forty patients attending the ophthalmology and the ENT outpatient departments with diagnosis for primary acquired nasolacrimal duct obstruction or chronic dacryocystitis were enrolled in the study. The patients were randomized into two groups, after taking informed written consent from them. Group I included patients who agreed to undergo external dacryocystorhinostomy and Group II included patients who agreed to undergo endoscopic endonasal dacryocystorhinostomy. A detailed history of the enrolled patients was taken. A thorough anterior rhinoscopy was done and any abnormalities like a deviated nasal septum, polyposis and hypertrophied turbinates were looked for. The

ophthalmic examination was done by an ophthalmologist. The eyelids were examined for entropion, ectropion and lid laxity. The puncta were examined for their normal location and size. Any medial canthal swelling was noted. Nasolacrimal duct obstruction was diagnosed by the regurgitation of fluid into the conjunctival sac by applying pressure over the lacrimal sac area. Lacrimal sac syringing was done to confirm the diagnosis. Routine blood investigations were done. Patency of the stoma was checked by sac syringing and endoscopic inspection of the stoma for external and endoscopic DCR. All conventional and endoscopic Dacryocystorhinostomy operations were performed under local anaesthesia and general anaesthesia respectively.

For external dacryocystorhinostomy operations, the nasal cavity was packed with roller gauze soaked in 4% xylocaine with adrenaline 1:1,00,000. All patients were given local anaesthesia for the sac region, consisting of an equal mixture of 2% lignocaine and 0.5% bupivacaine, with 1:100000 adrenaline; 2ml was injected on the flat side of the nose in anterior ethmoidal and dorsal nasal nerve region, 2ml in the infratrochlear region and 2ml in the infraorbital region consisting of 2% xylocaine with adrenaline 1:1,00,000. A straight vertical incision was made 10 mm medial to the inner canthus avoiding the angular vein. The anterior lacrimal crest was exposed by blunt dissection and the superficial portion of the medial palpebral ligament divided. The periosteum was elevated from the spine on the anterior lacrimal crest to the fundus of sac and reflected forwards. The sac was reflected laterally from the lacrimal fossa. The anterior lacrimal crest and the bone from lacrimal fossa were removed. A probe was introduced into the lacrimal sac through the lower canaliculus and the sac was incised in H-shaped manner to create two flaps. A vertical incision was made in the nasal mucosa to create anterior and posterior flaps. The posterior and anterior flaps were sutured. The medial canthal tendon was resutured to the periosteum and the skin incision closed with interrupted sutures. The duration of surgery was measured from the making of the incision on the skin to the closure of the skin incision by suturing.

For endonasal dacryocystorhinostomy surgery, nasal cavity was packed with gauze soaked in 4% xylocaine with 1:100,000 adrenaline, 15 minutes before the procedure. The mucosa anterior to uncinat process was infiltrated with 2% xylocaine with 1:100,000 adrenaline. 0° and 30° 4mm rigid endoscopes were used for the procedure. Using the sickle knife a rectangular cuff of mucosa of 10mm × 5mm just anterior to superior half of the uncinat process was incised. The mucosal cuff was then elevated with a periosteal elevator and removed using a pair of cutting forceps. The frontal process of maxilla and the very thin lacrimal bone was identified. A 2 mm Kerrison punch was used to nibble away the thick bone at the frontal

process of the maxilla. The bone removal was then continued nasally to expose the lacrimal sac. Lacrimal probing with Bowman's probe was used to tent the medial wall of sac after dilating the punctum with punctum dilator. The sac was then slit open with an angled knife. The medial wall of sac was removed with a tissue punch. Syringing was done with saline to confirm the free flow and patency, which was confirmed endoscopically. A threaded piece of merocel nasal pack was placed in the operative field. Duration of surgery was measured from incision till merocel pack was kept. Nasal pack in external DCR was removed after 48 hours. Clots and crusts were cleared from nasal cavity in the follow up period. Syringing of lacrimal passage was done at 1 week, 1 month, 2 months and 3 months for patency. New ostium status was checked endoscopically during follow up visits. Patients were not allowed to blow nose during first week after surgery. One week course of post-operative oral cephalosporins was prescribed to the patients. Eye drops were prescribed twice daily for 3 weeks after surgery. Topical nasal decongestants were prescribed to the patient thrice daily for 1 week. The patients were asked to report weekly for endoscopic removal of crusts around the lacrimal window. All patients of both the groups were followed weekly for 2 weeks and then after 1 month, 2 months and 3 months. Patient's subjective improvement in epiphora was noted and a record of any complication / complaint was made.

The outcome of external and endoscopic DCR was categorized into full success, partial success and failure. Subjective evaluation was made in terms of complete, partial or no relief from symptoms. Objective assessment was made by syringing. Full success was defined as no symptom of epiphora and no resistance to flow of fluid from sac to nasopharynx on syringing. Partial success was defined as less watering than before surgery and some regurgitation of fluid through the upper punctum and some passing into nasopharynx. Failure was defined as no symptomatic reduction of epiphora, inability to irrigate the lacrimal system postoperatively and/or postoperative nasal endoscopy with scarring in the intranasal osteotomy.

Results

Out of 40 patients taken up for DCR, 20 underwent unilateral external DCR, 18 had unilateral endoscopic DCR and 2 had bilateral endoscopic DCR. Thus, a total of 22 eyes underwent endoscopic DCR. All the patients operated were in the age group of 15-60 years. Average age was 38.2 years and 39.75 years for external DCR and endoscopic DCR respectively.

Maximum patients were observed in the age group of 30-40 years (42.5%). Maximum patients that underwent external DCR were in the second and third decade of life (70%). Maximum patients that underwent endoscopic DCR were in the third and fourth decade of life (75%). The number of female patients were 18

(90%) and 14 (70%) in external DCR and endoscopic DCR respectively, whereas number of male patients were 2 (10%) and 6 (30%) in external DCR and endoscopic DCR respectively. Epiphora was the most common complaint in both groups *i.e.*, 16 (80%) and 17 (77.3%) eyes were having epiphora in external DCR and endoscopic DCR groups respectively. Remaining patients had other associated features of chronic dacryocystitis like mucopurulent discharge, mucocele and lacrimal fistula.

The operative duration of external DCR ranged from 23 to 50 minutes with a mean of 36.05 minutes and for endoscopic DCR, 15 to 45 minutes with a mean

of 26.82 minutes. The difference was found to be statistically significant using chi-square test ($p=.021$).

Patients were evaluated and surgical outcome was assessed by history and irrigation. Full success meant that patient's symptoms of epiphora had resolved and on syringing from lower punctum there was no regurgitation of fluid from upper punctum; partial success meant that the patient had less watering than before surgery and that irrigation passed partially or completely through the ostium into the nose; and surgical failure meant that ostium had sealed and the patient had persistent epiphora. Endoscopic examination of every patient was done to assess the postoperative status of ostium (Table 1).

Table 1: Surgical outcome in both the groups

| Postoperative syringing with endoscopic status of ostium | External DCR | Endoscopic DCR | Satisfaction level | Outcome |
|--|--------------|----------------|-------------------------------------|-----------------|
| Patent | 19 (95%) | 20 (90.9%) | Fully Satisfied | Full Success |
| Partial block with clear fluid regurgitation from upper punctum, ostium stenosed | – | 1 (4.55%) | Symptoms improved but not satisfied | Partial success |
| Complete Block with Obliterative scarring of ostium | 1(5%) | 1(4.55%) | Not satisfied | Failure |

Subjective and Objective outcome were same. Full success was achieved in 95% cases of external DCR (19/20 eyes) and in 90.9% cases of endoscopic DCR (20/22 eyes). Partial success was recorded in 1 eye (4.55%) of endoscopic DCR group. There was a surgical failure in 1 eye in both the groups. The difference of surgical outcomes in the two groups was statically not significant with chi-square ($p=.62$). Endoscopic evaluation of the patients of partial success and failure were done to determine the underlying causes. Cause of partial success in endoscopic DCR group was inadequate removal of bone (1 eye, 4.55%) and granulation tissue at the ostium leading to stenosis of ostium. Failure seen in 1 eye in each group was due to obliterative scarring of the newly created ostium.

Complication rate was almost similar in both the groups with chi-square ($p=.813$) which was not significant. The most common intraoperative complication was moderate bleeding which was seen in 2 (10%) cases of external DCR and 3 (13.6%) cases of endoscopic DCR. Bleeding occurred from cutaneous vessels, branches from angular vessels, branches of ethmoidal vessels and from nasal mucosal vessels. Intraoperative haemostasis was optimised by a properly placed skin incision in External DCR group and by using vasoconstrictive anaesthetic agent in both groups. The most common postoperative complication was periorbital oedema seen in 3 (15%) cases of external DCR and 1 (4.5%) case of endoscopic DCR (Table 2).

Table 2: Complications observed in both the groups

| Complications | External DCR | | Endoscopic DCR | |
|--|--------------|----|----------------|------|
| | No. | % | No. | % |
| Intraoperative | | | | |
| Intraoperative Haemorrhage | 2 | 10 | 3 | 13.6 |
| Laceration of Punctum | - | - | - | - |
| Accidental entry into Anterior Ethmoidal air cells | - | - | - | - |
| Trauma to Middle Turbinate | - | - | - | - |
| CSF Leak | | | | |
| Postoperative | | | | |
| Epistaxis | - | - | - | - |
| Acute Dacryocystis | - | - | - | - |

| | | | | |
|---------------------------------|---|----|---|-----|
| Periorbital Oedema | 3 | 15 | 1 | 4.5 |
| Wound Complication | - | - | - | - |
| Periorbital Emphysema | - | - | - | - |
| Abnormal Skin Scar | - | - | - | - |
| Conjunctivitis | - | - | - | - |
| Obstruction of Rhinostomy site | 1 | 5 | 1 | 4.5 |
| Synechiae of Rhinostomy site | 1 | 5 | 1 | 4.5 |
| Granulations of Rhinostomy site | - | - | 1 | 4.5 |

All the cases of external DCR had an external scar which was absent in endoscopic DCR group. Additional procedures of septoplasty and uncinectomy were done in one case each in endoscopic DCR group.

Discussion

External DCR surgery, a gold standard in treatment of nasolacrimal duct obstruction, has advantage of direct visualization of the anatomical structures surrounding the lacrimal sac. However, cutaneous scar, injury to medical canthal structures, along with cerebrospinal fluid rhinorrhoea and functional interference with the natural mechanism of lacrimal pump are its disadvantages.^(8,9) Endoscopic DCR outcores external DCR in area of cosmetic outcome and direct inspection of lacrimal sac for pathology involved, as well as for immediate correcting mistakes during surgery.⁽¹⁰⁾

In the present study, the patients operated were of mean age of 38.2 years and 39.75 years for external DCR and endoscopic DCR respectively. Maximum patients who underwent external DCR were in the age groups of 20-30 and 30-40 years. Maximum patients who underwent endoscopic DCR were in the age group of 30-40 years. This indicates that acquired nasolacrimal duct obstruction is more common in middle age group. Similar findings were reported by Gupta *et al.*⁽¹¹⁾ Moras *et al.* in his study reported maximum incidence in third and fourth decade of life, which is comparable to our study.⁽¹²⁾

In our study, females constituted 90% and 70% of patients of external DCR and endoscopic DCR with a combined percentage of 80% of total patients. This shows that the nasolacrimal duct obstruction is more common in females than males. This finding is in corroboration with other authors that primary nasolacrimal duct obstruction is a condition primarily affecting females.^(5,11,12,13,14) The striking predilection for females can be explained by the narrower lumen of the bony nasolacrimal canal. It is also possible that endocrine factors may be playing a role in the aetiology of chronic dacryocystitis.⁽¹²⁾ Persistent epiphora was the most common presentation seen in our study with rest of the patients presenting with other features of chronic dacryocystitis like mucopurulent discharge, mucocele, and lacrimal fistula. Similar trend was seen in the study of Sarkar *et al.*,⁽¹⁴⁾ however study conducted by Gupta *et al.*⁽¹¹⁾ had most of the patients with clinical features of mucopurulent discharge.

In the present study, all endonasal DCR surgeries were performed under general anaesthesia. All external DCR surgeries were performed under local anaesthesia. In both groups, patients stayed overnight in the hospital. Mean duration of surgery was 36.05 minutes and 26.82 minutes for external DCR and endoscopic DCR respectively. The difference was found statistically significant ($p=0.021$). Longer operative time in external DCR was reported by many authors and is in accordance with our study.^(5,12,15) The shorter operative time recorded for endoscopic DCR was probably due to direct access of rhinostomy site endoscopically. In our study, there was a significant decline in operative duration with increasing experience of surgical team. We also found that surgical duration is closely related to intraoperative bleeding. In the present study, the success rate was defined by an anatomically patent nasolacrimal system ascertained by sac syringing and nasal endoscopy and patient satisfaction in post operative follow-up visits. Objective and subjective success were same. Full success rate of the present study was 95% and 90.9% for external DCR and endoscopic DCR respectively with no statistically significant difference, whereas partial success rate was 4.55% for endonasal DCR. Present success rates were similar to the previously reported success rates like Gupta *et al.*,⁽¹¹⁾ who reported success rate of endonasal DCR as 90% after a single procedure and 95% after revision procedure which was equal to Ex-DCR (95%). Sinha *et al.* reported a success rate of 96% in endoscopic DCR.⁽¹⁶⁾ Although Karim *et al.* showed that both surgical approaches had similar success rates (endoscopic endonasal DCR 82.4% versus external DCR 81.6%)⁽¹⁷⁾ but Duwal and Saiju reported the success rate of endoscopic endonasal DCR to be 90.3% and external DCR to be 94.1% which is comparable to our study.⁽¹⁸⁾

Failure in the present study was reported in 1 (5%) case of external DCR and 1 (4.55%) case of endoscopic DCR which were due to oblitative scarring of the ostium. Partial success was seen in 1 (4.55%) case of external DCR which was due to inadequate bone removal. This was comparable to Dolman who reported partial success in 2% of external DCR and 4% of endonasal DCR.⁽¹⁹⁾

In present study, concomitant procedures were combined with endoscopic DCR in 2 cases. In one case septoplasty was done and in one case uncinectomy was combined with endoscopic DCR. The concomitant

surgery is in accordance with the study of Deviprasad *et al.* in which 25 endoscopic DCRs were performed.⁽²⁰⁾ Six patients (25%) had associated sinonasal diseases. They underwent 8 concomitant intranasal surgeries, 4 septoplasties and 4 functional endoscopic sinus surgeries. Similarly, in the study of Chougule *et al.*, endoscopic DCR was done in 90 cases and 26 (28.8%) patients had septoplasty.⁽²¹⁾ Pathak *et al.* also concluded that endoscopic DCR have comparable results *vis-a-vis* external DCR, with added advantages of aesthetic results with no external scar, correction of associated nasal pathology, preservation of lacrimal pump and reduced operating time.⁽²²⁾ Thus these studies advocate a single procedure for concomitant nasal procedures similar to the present study.

In our study, both groups had almost similar rate of complications which was statistically not significant. In present study only intraoperative complication seen was haemorrhage which was seen in 10% cases of external DCR and 13.6% cases of endoscopic DCR. Similar intraoperative complication rate was seen in the study conducted by Cokkeser *et al.* in which intraoperative haemorrhage occurred in 15% eyes during external DCR and 15.69% eyes during endonasal DCR.⁽²³⁾ Duwal and Saiju in their study reported intraoperative bleeding in 5.88% patients of endoscopic DCR and 6.45% patients of endoscopic DCR.⁽¹⁸⁾ Our results are comparable to Gauba who reported 18% cases of intraoperative haemorrhage in external DCR and 13% cases of intraoperative haemorrhage in endonasal DCR.⁽²⁴⁾ The bleeding was managed with local vasoconstrictive agents. The bleeding in case of external DCR can be from cutaneous vessels, branches of angular vessels, branches of ethmoidal vessels and from nasal mucosal vessels. The haemorrhage in endoscopic DCR can occur from branches or ethmoidal vessels and from nasal mucosal vessels and if nasal mucosa is inflamed bleeding is increased.

No postoperative case of epistaxis was seen in endoscopic DCR group. This corresponds to the study of Moras *et al.*⁽¹²⁾ However, in the study conducted by Cokkeser *et al.*, out of 79 external DCRs, 14 patients had postoperative hemorrhage compared with zero out of 51 patients in the endoscopic endonasal group.⁽²³⁾

In the present study, postoperative periorbital oedema was more in external DCR (15%) than in endoscopic DCR (5%) which may be due to dissection required near the medial canthus in external DCR group. It was managed with NSAIDs. Synechia formation at rhinostomy site was seen in 1 case in each group and was managed on OPD basis. Synechia formation between middle turbinate and septum in endoscopic DCR group occurs in the patient who undergoes septoplasty and endoscopic DCR in a single procedure. This can be due to the injury caused on the opposing surface of middle turbinate and septum. Obliterative scarring and obstruction of rhinostomy site leading to failure of surgery was seen in 1 case in each

group. Granulation tissue at rhinostomy site was seen in 1 case of endoscopic DCR which led to stenosis. The decreased incidence of postoperative epistaxis and synechia formation in endoscopic DCR in our study can be attributed to the use of merocel nasal pack which acts as a haemostatic pack. All the cases of external DCR had an external scar which was not the case with endoscopic DCR group, so endoscopic DCR can be offered as an option to the young patients who do not want a facial scar.

Conclusion

The conclusion drawn from this study is that endoscopic dacryocystorhinostomy is a less time consuming, almost equally effective and aesthetically better than external approach and is an acceptable and functional alternative to external dacryocystorhinostomy.

References

1. Penttila E, Smirnov G, Tuomilehto H, Kaarniranta K, Seppa J. Endoscopic dacryocystorhinostomy as treatment for lower lacrimal pathway obstructions in adults: review article. *Allergy Rhinol (Providence)* 2015;6(1):e12-9.
2. Woog JJ. The incidence of symptomatic acquired lacrimal outflow obstruction among residents of Olmsted County, Minnesota, 1976–2000 (an American Ophthalmological Society thesis). *Trans Am Ophthalmol Soc* 2007;105:649-66.
3. Lindberg JV, McCormick SA. Primary acquired nasolacrimal duct obstruction. A clinicopathologic report and biopsy technique. *Ophthalmology* 1986;93(8):1055-63.
4. Bartley GB. Acquired lacrimal drainage obstruction: an etiologic classification system, case reports and a review of the literature. Part 3. *Ophthalm Plast Reconstr Surg* 1993;9(1):11-26.
5. Saha R, Sinha A, Phukan JP. Endoscopic versus external approach dacryocystorhinostomy: A comparative analysis. *Niger Med J* 2013;54:165-9.
6. 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(8):1463-8.
7. Gurler B, San I. Long-term follow-up outcomes of non-laser intranasal endoscopic dacryocystorhinostomy: how suitable and useful are conventional surgical instruments? *Eur J Ophthalmol* 2004;14(6):453-60.
8. Khan MK, Hossain MA, Hossain MJ, Al-Masud A, Rahman MZ. Comparative study of external and endoscopic endonasal dacryocystorhinostomy for the treatment of chronic dacryocystitis. *JAFMC Bangladesh* 2011;7:15-7.
9. Shun-Shin GA, Thurairajan G. External dacryocystorhinostomy-an end of an era? *Br J Ophthalmol* 1997;81:716-7.
10. Zhou W, Zhou M, Li Z, Wang T. Endoscopic intranasal dacryocystorhinostomy in forty five patients. *Chin Med J (Engl)* 1996;109:747-8.
11. Gupta S, Goyal R, Thakur AS, Singh H. Conventional dacryocystorhinostomy versus endonasal dacryocystorhinostomy – a comparative study. *People's J Scientific Res* 2008;1:1-4.

12. Moras K, Bhat M, Shreyas CS, Mendonca N, Pinto G. External dacryocystorhinostomy versus endoscopic dacryocystorhinostomy: a comparison. *J Clin Diagn Res* 2011;5:182-6.
13. Al-Quriashi NKM, Ali SNM, Farhood QK. Endoscopic endonasal dacryocystorhinostomy versus external dacryostorhinostomy. *Iraqi Postgrad Medical J* 2011;10(2):214-9.
14. Sarkar PK, Nath B, Acharjee U, Sarkar S, Noatia C. External dacryocystorhinostomy versus endoscopic endonasal dacryocystorhinostomy: a comparative study. *J of Evolution of Med and Dent Sci* 2014;3(13):3347-59.
15. Ozer S, Ozer PA. Endoscopic vs external dacryocystorhinostomy – comparison from the patients' aspect. *Int J Ophthalmol* 2014;7(4):689-696.
16. 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(3):207-9.
17. Karim R, Ghabrial R, Lynch TF, Tang B. A comparison of external and endoscopic endonasal dacryocystorhinostomy for acquired nasolacrimal duct obstruction. *Clin Ophthalmol* 2011;5:979-89.
18. Duwal S, Saiju R. Outcomes of external and endoscopic dacryocystorhinostomy. *Nepal J Ophthalmol* 2015;7(13):39-46.
19. Dolman PJ. Comparison of external dacryocystorhinostomy with non-laser endonasal dacryocystorhinostomy. *Ophthalmol* 2003;110(1):78-84.
20. Deviprasad D, Mahesh SG, Pujary K, et al. Endonasal endoscopic dacryocystorhinostomy: our experience. *Indian J Otolaryngol Head Neck Surg* 2009;61:223-6.
21. Chougule SS, Suligavi SS, Hiremath CS, Doddamani SS. Endoscopic dacryocystorhinostomy: Our experience. *Clin Rhinol* 2010;3(3):131-3.
22. Pathak VK, Das D, Bhuyan UT, Teron P. A comparative study between conventional and endoscopic dacryocystorhinostomy. *IOSR-JDMS* 2013;6(2):38-40.
23. Kokkeser Y, Evereklioglu C, Hamdi E. Comparative external versus endoscopic dacryocystorhinostomy: results in 115 patients (130 eyes). *Otolaryngol Head Neck Surg* 2000;123(4):488-91.
24. Gauba V. External versus endonasal dacryocystorhinostomy in a specialized lacrimal surgery center. *Saudi J Ophthalmol* 2014;28:36-9.