

การศึกษาปัจจัยที่มีผลต่อความสำเร็จของการผ่าตัดรักษาโรคท่อน้ำตาอุดตันชนิดปฐมภูมิโดยการส่องกล้องในโรงพยาบาลเมตตาประชารักษ์ (วัดไร่ขิง)

มิ่งขวัญ จำเริญดาราวิชิต พ.บ., ชินสุต อรุณากูร พ.บ., ณัฐพร สมสนิท พ.บ.,
สุนิสา สิ้นธุวงศ์ พ.บ., อาริย์ นิमितวงศ์สกุล พ.บ., กาญจนา ลีลาภัทรานุรักษ์ พ.บ.,
ณัฐวุฒิ วัฒนาคำ พ.บ.

บทคัดย่อ

วัตถุประสงค์: เพื่อศึกษาหาปัจจัยที่มีผลกระทบต่อความสำเร็จของการผ่าตัดรักษาโรคท่อน้ำตาอุดตันแบบปฐมภูมิโดยวิธีการส่องกล้องผ่านจมูก

วิธีการ: การวิจัยเชิงวิเคราะห์แบบย้อนหลังโดยเก็บข้อมูลทั้งหมดจากผู้ป่วย 84 คน จำนวน 107 ตา ซึ่งได้รับการวินิจฉัยเป็นโรคท่อน้ำตาอุดตันชนิดปฐมภูมิ และได้รับการรักษาด้วยการผ่าตัดโดยวิธีการส่องกล้องผ่านจมูกในโรงพยาบาลเมตตาประชารักษ์ (วัดไร่ขิง) ระหว่างวันที่ 1 มกราคม พ.ศ. 2550 ถึงวันที่ 31 ธันวาคม พ.ศ. 2553 ข้อมูลที่เก็บได้แก่ เพศ อายุ การวินิจฉัย ผลสำเร็จของการผ่าตัด ผลข้างเคียงของการผ่าตัด และปัจจัยที่อาจมีผลต่อความสำเร็จของการผ่าตัด ได้แก่ อายุ ระยะเวลาที่มีน้ำตาไหล การติดเชื้อของถุงน้ำตา ตำแหน่งขอบบนของช่องกระดูกซึ่งเปิดเพื่อระบายน้ำตา (superior rhinostomy extension) และการมี lacrimal mucosal flap โดยใช้สถิติ Chi-square และ logistic regression เพื่อหาความสัมพันธ์ของปัจจัยต่างๆ กับความสำเร็จ

ผลการศึกษา: อายุของผู้ป่วยอยู่ระหว่าง 22-82 ปี (อายุเฉลี่ย 56.58 ± 14.90 ปี) เป็นท่อน้ำตาอุดตัน 1 ข้าง จำนวน 61 คน (ร้อยละ 72.62) และ 2 ข้าง จำนวน 23 คน (ร้อยละ 27.38) ระยะเวลาเฉลี่ยที่ผู้ป่วยมาตรวจติดตามหลังผ่าตัดคือ 11.07 ± 7.6 เดือน (ระหว่าง 6-45 เดือน) อัตราสำเร็จของการผ่าตัดเท่ากับร้อยละ 82.2 (88/107 ตา) ปัจจัยที่ศึกษาว่าอาจมีผลต่อความสำเร็จของการผ่าตัด อันได้แก่ อายุ ระยะเวลาที่มีน้ำตาไหล การติดเชื้อของถุงน้ำตา ตำแหน่งขอบบนของช่องกระดูกซึ่งเปิดเพื่อระบายน้ำตา (superior rhinostomy extension) และการมี lacrimal mucosal flap พบว่าไม่มีความสัมพันธ์กับความสำเร็จของการผ่าตัด อย่างมีนัยสำคัญทางสถิติ อัตราการเกิดผลแทรกซ้อนของการผ่าตัดเท่ากับร้อยละ 14.02 โดยผลแทรกซ้อนที่พบบ่อยที่สุดคือการติดกันของรูเปิดท่อน้ำตา (punctal webbing) และการหลุดของสายซิลิโคน (stent displacement) ก่อนเวลา

สรุป: การผ่าตัดรักษาโรคท่อน้ำตาอุดตันโดยวิธีการส่องกล้องผ่านจมูก เป็นการรักษาที่มีประสิทธิภาพในผู้ป่วยที่เป็นโรคท่อน้ำตาอุดตันชนิดปฐมภูมิ และมีข้อได้เปรียบการผ่าตัดแบบแผลภายนอก เนื่องจากสามารถลดการบาดเจ็บของกล้ามเนื้อ orbicularis oculi และลดโอกาสเกิดแผลเป็น สำหรับปัจจัยต่อความสำเร็จที่ศึกษา (อายุ ระยะเวลาที่มีน้ำตาไหล การติดเชื้อของถุงน้ำตา ตำแหน่งขอบบนของช่องกระดูกซึ่งเปิดเพื่อระบายน้ำตา และการมี lacrimal mucosal flap) ไม่มีความสัมพันธ์อย่างมีนัยสำคัญทางสถิติกับอัตราสำเร็จของการผ่าตัด **จักษุเวชสาร 2558; กรกฎาคม-ธันวาคม 29(2): 66-74.**

คำสำคัญ: ปัจจัยที่มีผลต่อความสำเร็จ, การผ่าตัดรักษาโรคท่อน้ำตาอุดตันโดยการส่องกล้อง

การศึกษานี้ได้รับการอนุมัติจากคณะกรรมการจริยธรรมของร.พ.เมตตาประชารักษ์ (วัดไร่ขิง)

Factors Affecting Success Rate of Endoscopic Dacryocystorhinostomy in Primary Acquired Nasolacrimal Duct Obstruction in Mettapracharak (Wat Rai Khing) Hospital



Mingkwan Jumroendararasmee, M.D.

Chinasut Arunakul, M.D., Natthaporn Somsanit, M.D., Sunisa Sintuwong, M.D., Aree Nimitwongsakul, M.D., Kanjana Leelapatranurak, M.D., Nattawut Wanumkarng, M.D.

Abstract

Objective: This study aimed to evaluate some factors which may affect the success rate of endoscopic Dacryocystorhinostomy (DCR) operation in patients with primary acquired nasolacrimal duct obstruction.

Patients and Methods: This was a retrospective cross-sectional study. One hundred and seven eyes from 84 patients who were diagnosed with primary acquired nasolacrimal duct obstruction and who underwent endoscopic DCR operation in Mettapracharak (Wat Rai Khing) hospital between 1 January 2007 to 31 December 2010 were recruited. Demographic data, and success rate of the operation were reported and 5 affecting factors (age, duration of epiphora symptom, history of dacryocystitis, position of the superior border of rhinostomy and mucosal flap of the lacrimal sac presenting) were statistically analyzed using Chi-square and logistic regression test to find out which factors influence the success rate of this operation.

Results: Age range of patients was 22-82 years (average age 56.58 ± 14.90 years), 61 patients had unilateral nasolacrimal duct obstruction (72.62%), 23 patients had bilateral nasolacrimal duct obstruction (27.38%). Average follow up time was 11.07 ± 7.6 months (range 6-45 months). Success rate of the endoscopic DCR operation in this study was 82.2% (88 /107eyes). For 5 affecting factors there was no statistical significant relationship of any factors with the success rate of this operation. The complication rate was 14.02%. Punctal webbing and stent displacement were the 2 most common complications.

Conclusions: Endoscopic DCR is an effective treatment for primary acquired nasolacrimal duct obstruction and has some benefits over traditional external DCR such as no facial scarring and less orbicularis oculi muscle injury. The 5 factors (age, duration of epiphora symptom, history of dacryocystitis, position of the

superior border of rhinostomy and mucosal flap of the lacrimal sac presenting) were not associated with the success rate of the endoscopic DCR operation in patients with primary acquired nasolacrimal duct obstruction. **Thai J Ophthalmol 2015; July-December 29(2): 55-.**

Keywords : Factors Affecting Success Rate, Endoscopic DCR

Approval to conduct this study was obtained from the ethics committee of Mettapracharak (Wat Rai Khing) hospital.

No author has a financial or proprietary interest in any material and method mentioned.

Department of Ophthalmology, Mettapracharak (Wat Rai Khing) Hospital, Nakhonpathom, Thailand

Introduction

Primary acquired nasolacrimal duct obstruction (NLDO) is one of many causes of clinical epiphora in patients. Pathology of this disease is the obstruction in the intraosseous portion of the nasolacrimal duct. Some previous studies have found that this obstruction is related to the idiopathic inflammation of nasolacrimal duct. Linberg and McCormick have studied the histopathology of tissues from the DCR operation and found that the fibrosis at the level of obstruction was caused by chronic inflammation of the inner mucosa of the nasolacrimal duct¹. Besides clinical epiphora, primary acquired NLDO is known to be one cause of serious intraocular infection such as postoperative endophthalmitis after intraocular surgery. Lopez et al. have reported three pneumococcal endophthalmitis patients with unrecognized or untreated chronic nasolacrimal obstruction². So most primary acquired NLDO patients should be recommended for complete treatment before they go on intraocular surgery.

In 1893 the first operation for treatment of NLDO called dacryocystorhinostomy (DCR) was performed via the intranasal route by Caldwell³ but this procedure failed to gain popularity due to

unsatisfactory outcome because of poor visualization for intranasal surgery at that time. The new operation for NLDO "External DCR" was introduced in 1904 by Toti⁴, this operation was accomplished via skin incision. External DCR was very popular, many studies reported 90-95% success rate of this external technique⁵⁻⁸. In 1980, endoscopic devices for intranasal & sinus surgery were developed and provided better visualization for intranasal surgery; therefore endoscopic DCR has been of interest to many surgeons. In 1989 McDonough & Meiring reported the results of endoscopic DCR but they found that endoscopic DCR had poorer results than external DCR⁹. So External DCR was still the gold standard technique for treatment of NLDO for 100 years.

According to development in intranasal anatomy knowledge and better endoscopic instruments, many surgeons reported higher success rate of endoscopic DCR as 80-95%¹⁰⁻¹⁶. Endoscopic DCR has many benefits over external DCR such as no facial scarring, rapid post operative rehabilitation time, decreased injury to the orbicularis oculi muscle that has an important role in lacrimal pumping system and this procedure also decreases injury to the medial canthal ligament. Although endoscopic DCR has some

disadvantages compared with the external technique (need more learning time for surgeons regarding the unfamiliar intranasal anatomy, the assistance from ENT surgeons in complicated patients e.g. small nasal cavity, intranasal fibrosis, nasal septal deviation were crucial), endoscopic DCR is of interest because of its many benefits. Nasal endoscopic devices were expensive nevertheless, ophthalmologist and rhinologist were able to use for accomplice.

Many previous studies have reported factors, which affect the results of endoscopic DCR. Tripathi et al. studied factors that affect the success rate of endonasal endoscopic laser DCR and found that patients younger than 50 years old, never had an operation for NLDO or had epiphora symptom less than 6 months before surgery had higher success rate¹². In Thailand endoscopic DCR was introduced about 10 years ago but there has been no study which report factors that affect the success rate of this operation. So this study collected data of patients who underwent an endoscopic DCR operation in Mettapracharak (Wat Rai Khing) hospital to report the success rate of the endoscopic DCR operation, complications of this operation and to determine which factors affect the success rate of the operation.

Materials and Methods

This is a retrospective cross-sectional study to report the success rate of the endoscopic DCR operation and the relationship of some factors with the success rate of this operation. The authors collected data from OPD cards, IPD cards and operative notes of patients who had an endoscopic DCR operation at Mettapracharak hospital in the period of 4 years (from 1 January 2007 to 31

December 2010). Data collected have been divided into two parts, part 1 is general data such as gender, age, diagnosis, operated eye side, success at 6 months after surgery, follow-up time, intraoperative & postoperative complications of surgery and part 2 included 5 factors that may affect the result of the operation e.g. age, duration of epiphora symptom, history of dacryocystitis, position of the superior border of rhinostomy and mucosal flap of the lacrimal sac presenting. For the first factor "Age", we compared success rate between of patients who were less than 50 years old with the elders. The second factor "Duration of epiphora symptom", we compared the success rate between of patients who had symptom less than 6 months with 6 months and more. The third factor "History of dacryocystitis" we compared the group who had a history of dacryocystitis with the group who had no previous infection. The fourth factor "Position of superior border of rhinostomy" was the position where the surgeon removed the frontal process of the maxilla bone; if the superior border level was the same as the common canaliculi level it was defined as rhinostomy position 0 degree, but if the superior border level was higher than the common canaliculi level it was defined as rhinostomy position more than 0 degree. This study compared the success rate between of the position 0 degree group with the position more than 0 degree group. The fifth factor "Mucosal flap of the lacrimal sac presenting" we compared the success rate between of the group whose mucosal flap had been removed with the group whose flap had been presented. In this study the successful operation was defined as patients had no epiphora symptom with normal lacrimal sac irrigation at 6 months or more postoperatively.

All patients in this study had general anesthesia during surgery and they must have complete postoperative eye examination and irrigation of the lacrimal sac with normal saline at 1 week, 1 month, 3 months and 6 months postoperatively. In every postoperative visit patients' epiphora symptom was recorded. Silicone stents were removed at 6 weeks to 3 months postoperatively. Inclusion criteria included diagnosis with primary acquired nasolacrimal duct obstruction and treatment with endoscopic DCR between 1 January 2007 to 31 December 2010, and completion of all postoperative visits for at least 6 months post operation. Exclusion criteria included secondary nasolacrimal duct obstruction from other causes (for example, midfacial fracture from previous trauma; tumors of lacrimal system or extraocular tissues; chronic inflammatory diseases such as Wegener's granulomatosis, sarcoidosis, idiopathic orbital inflammatory disease, cystic fibrosis, HIV infection; previous sinus or intranasal surgery; previous radiotherapy on facial or nose or orbital space); previous surgery for nasolacrimal duct obstruction; prelacrimal sac obstruction at punctum and lacrimal canaliculi; diagnosis of "functional nasolacrimal duct obstruction". The authors also excluded data that were not recorded completely and could not be analyzed. The total number of patients' data that were analyzed in this study was 84 patients (107 eyes).

All records of patients who were included in this study were reviewed and coded by number, no patient's name or hospital number had been revealed. All patients' data were recorded in a form that only the researchers can use. Approval to conduct this study was obtained from the ethics committee of

Mettapracharak (Wat Rai Khing) hospital. This study had no financial support from any sources.

Statistical Analysis

The statistics used for analysis in this study were in two parts: descriptive statistics (gender, age, diagnosis, side operated on, success rate of operation, follow-up time, and complications) presented as mean, standard deviation, and percent ; relationship of these factors with operation's success rate, analyzed by chi-square test and logistic regression.

The formula used to calculate sample size for this study for 80% or 0.8 success rate at 95% confidence interval ($\alpha = 0.05$) was $N = 10k/p$ (k = number of factors, p = success rate). The sample size needed for this study was at least 63 patients. Statistical analyses in this study used SPSS version 16 and statistical significances are regarded when P values were less than 0.05.

Results

The total number of patients' records included into this study was 84 (107 eyes), 19 male patients, 65 female patients. The age range of patients was 22-82 years (average age 56.58 ± 14.90 years). The young age group (< 50 years old) had 29 patients and the old age group (≥ 50 years old) had 55 patients. 61 patients had unilateral NLDO (72.62%), 23 patients had bilateral NLDO (27.38%). The total postoperative follow up time range was 6-45 months (average follow up time 11.07 ± 7.6 months). The success rate of endoscopic DCR operation was 82.2% (88 eyes) and failed 17.8% (19 eyes), the complication rate was 14.02% (Table 1). Punctal webbing and stent displacement were the two most common complications.

Table 1. Complications of surgery

Complications	Number of patients (%)
<i>Intraoperative</i>	
Bleeding	1 (0.93%)
Prolapsed fat	1 (0.93%)
Ethmoidal sinus injury	1 (0.93%)
Punctal slit tear	1 (0.93%)
<i>Postoperative</i>	
Punctal webbing, granulation, kissing	3 (2.80%)
Stent displacement	3 (2.80%)
Massive blood clot	2 (1.87%)
Dry eye	1 (0.93%)
Sump syndrome	1 (0.93%)
Secondary increase IOP	1 (0.93%)
<i>Total</i>	15 (14.02%)

Table 2. Relationship of 5 factors with the success rate of endoscopic DCR

Factors	Successful Surgery	Failed Surgery	Total Number	P value ^a
Age				
< 50 yrs.	33(86.8%)	5(13.2%)	38	0.356
≥ 50 yrs.	55(79.7%)	14(20.3%)	69	
Duration of epiphora				
< 6 months	17(85.0%)	3(15.0%)	20	0.54
≥ 6 months	48(76.2%)	15(23.8%)	63	
History of dacryocystitis				
Yes	22(95.7%)	1(4.3%)	23	0.068
No	66(78.6%)	18(21.4%)	84	
Position of superior border of rhinostomy				
0 degree	8(100%)	0(0%)	8	0.189
> 0 degree	45(76.3%)	14(23.7%)	59	
Mucosal flap of the lacrimal sac presenting				
Yes	78(81.3%)	18(18.8%)	96	0.685
No	10(90.9%)	1(9.1%)	11	

^a chi-square test

For the results of analysis for the relationship of 5 factors (age, duration of epiphora symptom, history of dacryocystitis, position of superior border of rhinostomy and mucosal flap of the lacrimal sac presenting) with the success rate of the operation by chi-square & logistic regression, we found that there was no statistical significant relationship of any factor with the success rate of this operation (Table 2).

Discussion

Primary acquired NLDO is one of the common problems for ophthalmologists. Patients may come with many complaints such as epiphora, infectious conjunctivitis and dacryocystitis. Tirakunwichcha et al. found that 45% of patients came with epiphora caused by primary acquired NLDO¹⁷. Many previous studies reported the incidence of this disease, for example in 1964 Dalgleish studied preoperative irrigation of the lacrimal sac in 3,487 patients who would have intraocular surgery and reported the incidence of primary acquired NLDO was 22%¹⁸; Woog reported the incidence of symptomatic primary acquired NLDO was 20.24 per 100,000 persons¹⁹. Many previous studies also reported that primary acquired NLDO is predominantly found more in females than males; Linberg and McCormick reported the incidence of this disease as 3 times greater in females than in males and the predominant age group was 50-60 years old¹, and Woog reported incidence of this disease as 73% in females, 27% in males¹⁹. Similar to Linberg and McCormick's study¹ this study also found that the average age of patients was 56.58 ± 14.90 years and the number of female patients was 3.4 times more than male patients (19 male patients, 65 female patients). The explanation for the predominance of females is still unclear. It

might due to many factors such as the anatomy of the female's nasolacrimal canal is narrower than the male's canal. Takahashi et al. measured the transvers' width of the nasolacrimal canal in cadavers and found that the female's canals were significantly narrower than the male's canals²⁰. McCormick et al. measured the diameter of the nasolacrimal canal from patients' computerized tomography images and reported the average diameter in males was 3.9 mm (95%CI : 3.8-4.1), females' average diameter was 3.6 mm (95% CI: 3.5-3.8; *P* value = 0.01)²¹. Another hypothesis is that primary acquired NLDO may be caused by idiopathic inflammation or from some autoimmune diseases that always have more incidence in females than males.

The success rate of the endoscopic DCR operation in this study was 82.2% (success 88 eyes, failed 19 eyes) nearly the same as many previous reports with the success rate of about 80-95%¹⁰⁻¹⁶. Furthermore many studies reported 90-95% success rate with the standard surgery "External DCR"⁵⁻⁸. Although the success rate of Endoscopic DCR was slightly lower than that of the standard surgery, the endoscopic technique also has some benefits over the standard External DCR relate to facial scarring reducing, rapid post operative rehabilitation time, decreased injury to the orbicularis oculi muscle which preserves the pumping function of the lacrimal system and decreased injury to the medial canthal ligament. So endoscopic DCR can be the new choice of treatment for primary acquired NLDO especially in some groups of patients who concern about facial scarring and patients who had acute dacryocystitis at the time of surgery that was caution in external DCR.

Many previous studies reported on the relationship of some factors with the success of endoscopic DCR operation. Gupta studied the causes of failure of endoscopic DCR in 60 patients who were referred for revised endoscopic DCR and reported that the most common cause was inadequate lacrimal sac opening (38.3%), low rhinostomy (28.3%), contracture of the rhinostomy site (10%), improper selection of cases (3.3%), laser burn canalicular scarring (3.3%), laxity of the lids and atonic sacs (3.3%) and preexisting canaliculitis (1.6%)²². Onerci et al. studied long term results and the factors influencing the success of intranasal endoscopic DCR and found that the most common causes of operation failure were inexperienced surgeon, improper localization of the lacrimal sac, granulation tissue formation around the tubes at the rhinostomy, atonic sac, persistence of bony spicules causing obstruction to the nasal cavity, synechia between the nasolacrimal duct and the middle turbinate, small fenestration between the sac

and the nasal cavity and failure to remove the medial half of the membranous sac wall²³. As mentioned above, Tripathi et al. reported that younger age patients (< 50 years old) and shorter duration of epiphora (< 6 months) were the factors that made significantly higher success rate of endonasal endoscopic laser DCR¹². In the present study we found that younger age patients (< 50 years old) had slightly higher success rate than older age patients (\geq 50 years old), 87.2% versus 79.7%, and also shorter duration of epiphora (< 6 months) had slightly higher success rate than the longer duration group (\geq 6 months), 85.7% versus 76.2%, but without statistical significance for both factors. It may be that the lack of relationships found in the current study is due to the small number of subjects and unequal number of patients in subgroup (for each factor). A prospective study with a greater number of subjects may show relationships of the five factors determining the success rate of endoscopic DCR.

References

1. Linberg JV, McCormick SA. Primary acquired nasolacrimal duct obstruction. A clinicopathologic report and biopsy technique. *Ophthalmology*. 1986;93:1055-63.
2. Lopez PF, Beldavs RA, al-Ghamdi S, Wilson LA, Wojno TH, Sternberg P, et al. Pneumococcal endophthalmitis associated with nasolacrimal obstruction. *Am J Ophthalmol* [Internet]. 1993 Jul 15 [cited 2012 Jul 15];116:56-62. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/8328544>
3. Caldwell GW. Two new operations for obstruction of the nasal duct with preservation of the canaliculi, and an incidental description of a new lachrymal probe. *N York M J*. 1893;57:581.
4. Toti A. Nuovo metodo conservatore di cura radicale delle suppurazioni croniche del sacco lacrimale (dacriostorinostomia). *Clin Mod Pisa*. 1904;10:385-7.
5. Tarbet KJ, Custer PL. External DCR. Surgical success, patient satisfaction, and economic cost. *Ophthalmology*. 1995; 102:1065-70.
6. Hartikainen J, Antila J, Varpula M, Puukka P, Seppä H, Grénman R. Prospective randomized comparison of endonasal endoscopic DCR and external DCR. *The Laryngoscope*. 1998;108: 1861-6.
7. Ibrahim HA, Batterbury M, Banhegyi G, McGalliard J. Endonasal laser DCR and external DCR outcome profile in a general ophthalmic service unit: a comparative retrospective study. *Ophthalmic Surg Lasers*. 2001;32:220-7.
8. Hurwitz JJ, Merkur S, DeAngelis D. Outcome of lacrimal surgery in older patients. *Canadian J of Ophthalmol*. 2000;35: 18-22.
9. McDonogh M, Meiring JH. Endoscopic transnasal DCR. *J Laryngol otol*. 1989;103:585-7.
10. Tsirbas A, Wormald PJ. Endonasal DCR with mucosal flaps. *Am J Ophthalmol*. 2003;135:76-83.
11. Massegur H, Trias E, Ademi JM. Endoscopic DCR: modified technique. *Otolaryngol Head Neck Surg*. 2004;130:39-46.

12. Tripathi A, Lesser THJ, O'Donnell NP, White S. Local anaesthetic endonasal endoscopic laser DCR: analysis of patients' acceptability and various factors affecting the success of this procedure. *Eye* 2002;16:146-9.
13. Fayet B, Racy E, Assouline M. Complications of standardized endonasal DCR with unciformectomy. *Ophthalmology*. 2004;111:837-45.
14. Durvasula VSP, Gatland DJ. Endoscopic dacrocystorhinostomy: long-term results and evolution of surgical technique. *The J of Laryngo Otol*. 2004;118:628-32.
15. Wormald PJ, Tsirbas A. Investigation and endoscopic treatment for functional and anatomical obstruction of the nasolacrimal duct system. *Clin Otolaryngol Allied Sci*. 2004;29:352-6.
16. Ben Simon GJ, Joseph J, Lee S, Schwarcz RM, McCann JD, Goldberg RA. External versus endoscopic DCR for acquired nasolacrimal duct obstruction in a tertiary referral center. *Ophthalmology*. 2005;112:1463-8.
17. Tirakunwichcha S, Rengwanidchakul E, Asawaphureekul S et al. Incidence of acquired lacrimal drainage system obstruction in epiphoric patients in Thailand. *Asian Biomed*. 2010;4:159-62.
18. Dalgleish R. Incidence of idiopathic acquired obstruction in the lacrimal drainage apparatus. *Br J Ophthalmol*. 1964;48:373-6.
19. 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.
20. Takahashi Y, Kakizaki H, Nakano T. Bony nasolacrimal duct entrance diameter: gender difference in cadaveric study. *Ophthal Plast Reconstr Surg*. 2011;27:204-5.
21. McCormick A, Sloan B. The diameter of the nasolacrimal canal measured by computed tomography: gender and racial differences. *Clin Experiment Ophthalmol*. 2009;37:357-61.
22. Gupta N. Improving results in endoscopic DCR. *Indian J Otolaryngol Head Neck Surg*. 2011;63:40-4.
23. Onerci M, Orhan M, Ogretmenoglu O, Irkeç M. Long-term results and reasons for failure of intranasal endoscopic DCR. *Acta Otolaryngologica*. 2000;120:319-2.