

Comparison of Hasner valvulotomy outcomes in pediatric and adult patients: does age matter?

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Abstract

Background: Hasner valve incision has been recently introduced as a new treatment for ophthalmic patients with epiphora symptoms. The aim of this study was to examine whether surgical outcomes of Hasner valve incision for inferior nasolacrimal duct obstruction were different between pediatric and adult patients.

Methods: A total of 53 eyes of 52 patients who underwent Hasner valve incision in the Beijing Tongren Hospital from October 2016 to November 2019 were retrospectively observed. Patients were divided into two groups, including pediatric group (23 eyes of 22 patients, <18 years old) and adult group (30 eyes of 30 patients, ≥18 years old). Success rate of surgery was determined by both subjective measure (complete resolution of epiphora) and objective measure (lacrimal passage irrigation and tear meniscus height). Fisher exact test was conducted.

Results: By conducting Fisher exact test and comparing complete resolution of epiphora ($P=0.627$), lacrimal passage irrigation ($P=0.663$), measurement of Tear Meniscus Height ($P=0.561$), and appearance of complication ($P=0.339$), there was no statistically significant difference of surgical outcomes between pediatric and adult patients ($P>0.05$).

Conclusion: Hasner valve incision was effective for both adult and children with inferior nasolacrimal duct obstruction, with no difference in surgical outcomes between the two groups.

Keywords: Hasner valve incision; Nasolacrimal duct obstruction; Lacrimal passage irrigation; Tear meniscus height

Introduction

Epiphora, which is one of the most common symptoms of the ophthalmic outpatients, is mainly resulted from nasolacrimal duct obstruction (NLDO) in children and adult patients,^[1] which were further defined as congenital nasolacrimal duct obstruction (CNLDO) and acquired nasolacrimal duct obstruction (ANDLO), respectively. In many of the cases, the obstruction presents at the level of Hasner valve.^[2-4]

To be specific, previous literature has reported that 66.6% of pediatric patients and about 4.2% of adult patients have obstructions at the level of Hasner valve.^[5] The conventional treatments for CNLDO patients are as follows: probing, and then repeatedly probing, silicone intubation (SI) and/or balloon dilatation, then finally conduction of dacryocystorhinostomy (DCR).^[6] The success rates of these treatments vary greatly. In particular, success rate of probing and SI are 33.3% to 97.0%^[6-9] and 50.7% to 53.8%,^[10,11] respectively. For ANDLO patients, success

rate of endonasal endoscopic dacryocystorhinostomy (En-DCR) is 93.4% with silicone tubing and 92.2% without silicone tubing.^[12] In general, probing or intubation procedure is usually performed in a blind procedure and consequently increases the risk of false passage formation, slit punctum, corneal abrasion, or nasal mucosa injury.^[13] The intubation tube may also be ruptured, prolapsed, or even lost.^[14] The disadvantages of En-DCR procedures are mainly reflected in the high complexity and invasiveness.

As is known to all, a good surgical procedure design should be a technique with a high rate of success and a low rate of complications occurring. To overcome the disadvantages of the probing or intubation and DCR, for patients with inferior NLDO, several recent studies have presented a new approach called Hasner valve incision.^[1,15,16] The procedure of Hasner valve incision was first introduced in 2008 and 2009.^[1,17] Specifically, Rogers and DelGaudio^[17] described a single case involving an adult patient. In the following 2009 study^[1] (17 adults, 33–75 years old), nasal endoscopic surgery was performed in the inferior meatus

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(IM) with success rate of 55% in patients with nasolacrimal diseases in particular. Similarly, in 2012, Cnaan *et al*^[16] used a microvitrectomy blade to incise Hasner valve in the IM of a 37-year-old man.

As opposed to few successful cases in adult patients, most recent literature suggests excellent outcomes of Hasner valve incision for pediatric patients in much larger sample sizes. In particular, in 2013, Korkmaz *et al*^[18] reported the outcomes of 48 children who received Hasner valve incision with a success rate of 92.7%. The most recent study by Keilani *et al*,^[15] comprising 484 pediatric patients, showed a success rate of 91% for patients without historical probing on nasolacrimal duct.

Given the previous reports demonstrating unbalanced results, the purpose of this study was to compare whether surgical outcomes of Hasner valve incision were different between adult and pediatric patients, or whether adjuvant therapy for adult patients should be recommended.

Methods

Ethical approval

The study was conducted in accordance with the *Declaration of Helsinki* and followed the policies of the Ethics Committees of the Department of Ophthalmology, Beijing Tongren Hospital, Capital Medical University. All patients approved and signed the consent form.

Patients

All successive Hasner valve incision procedures performed between October 2016 and November 2019 in the Beijing

Tongren Hospital were included. Patients who were younger than 18 years were divided into the pediatric group, others who were 18 years or older were categorized as the adult group.

A total of 60 procedures in 59 patients were reviewed and analyzed. Patients with incomplete data and those with no follow-up visit were excluded from the analysis. Overall, seven procedures on seven patients were excluded leaving a total of 53 procedures on 52 patients in this study. All included surgeries were performed by one experienced oculoplastic surgeon (Dr. Hua Sun). Fifty-one patients underwent unilateral Hasner valve incision and one patient (in the pediatric group) underwent bilateral Hasner valve incision. In total, 22 patients (23 eyes) in the pediatric group and 30 patients (30 eyes) in the adult group were analyzed. There were eight female patients (36.4%) in the pediatric group, while 28 female patients (93.3%) in adult groups, respectively. The follow-up period was determined by the date of the last visit, which was between 3 months to 2 years, with the average of 6.75 ± 2.59 months.

To ascertain whether the obstruction occurred at the position of the lacrimal sac or nasolacrimal duct, all patients received pre-operative and post-operative enhanced computed tomographic dacryocystography (CT-DCG). The contrast agent was Iohexol. Overall, pre-operative evaluation mainly included the following criteria: clinical manifestations (epiphora, mucopurulent discharge) and the confirmation by the CT-DCG [Figure 1]. As shown in the figure, the contrast agent is located at the inferior nasolacrimal duct, in particular Hasner valve. Several CT slides also show arc-like changes. The bulging membrane prevents the lacrimal duct contrast agent from entering the nasal cavity.

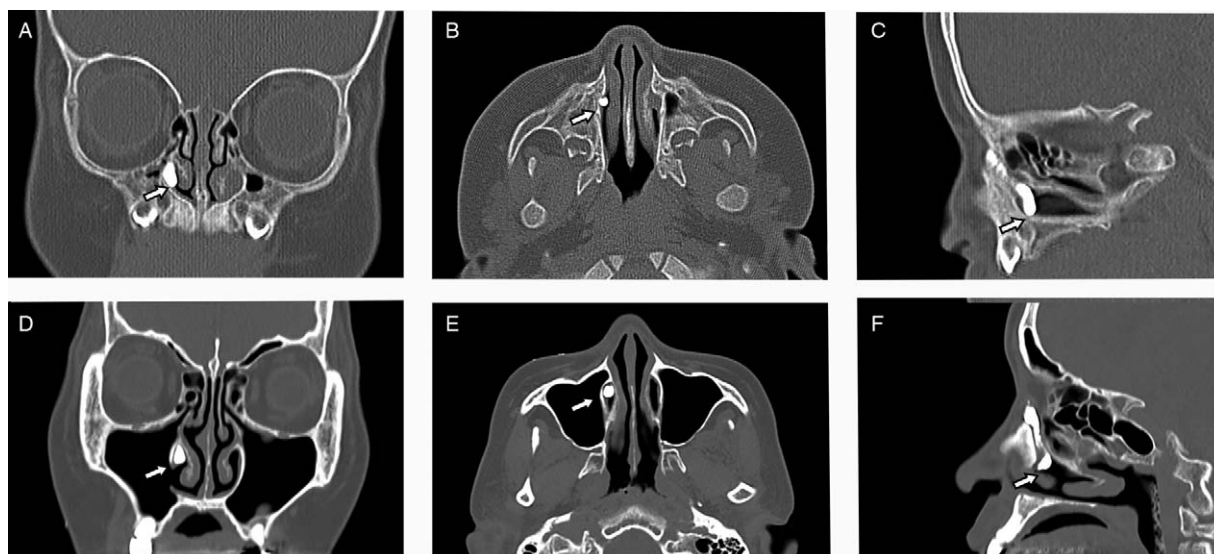


Figure 1: Pre-operative lacrimal angiogram of computed tomography dacryocystography of a 6-month old child (A–C) and a 61-year old adult patient (D–F). (A, D) Coronal plane. (B, E) Horizontal plane. (C, F) Sagittal plane. Contrast agent is blocked by Hasner valve, and Hasner valve is arcuate bulging posterior and then inferior to inferior nasal meatus (arrow). (D–F) Patients with lacrimal duct obstruction after radical maxillary sinus resection. (D) The defected area of the medial wall of maxillary sinus below the arrow is adjacent to the Hasner valve obstruction.

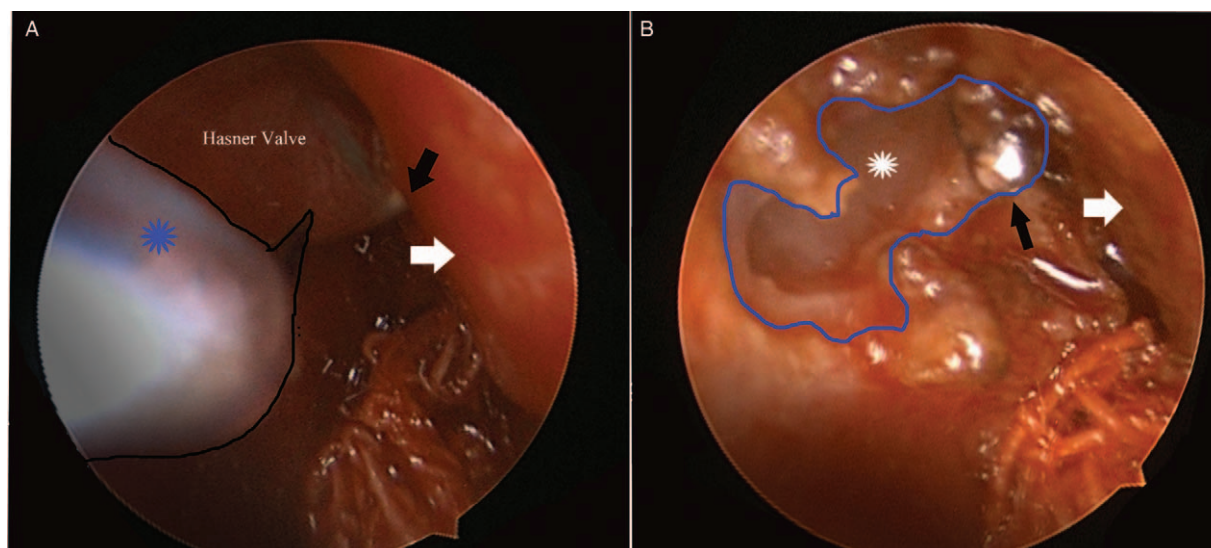


Figure 2: Key procedure of Hasner valve incision. Black arrow indicates probe and white arrow indicates outer side of inferior turbinate. (A) Hasner valve is blocked on the right nasolacrimal duct. Probe blocked at the Hasner valve level. While the probe is supporting, needle electrode (blue asterisk) incises the Hasner valve; (B) Blue lines showing the outer wall of the inferior opening of the nasolacrimal duct mucosa (white asterisk), which seems lighter than nasal mucosa.

Surgical procedures

First of all, all patients were given general anesthesia. Nasal endoscopy was performed with a 3 mm 30° rigid endoscope. A video recorder was launched simultaneously. To acquire adequate vasoconstriction, cotton strips soaked with 1:1000 adrenaline were placed into inferior nasal meatus and the medial surface of the inferior turbinate for about 7 to 10 min. The inferior turbinate was displaced inwards using a freer elevator to expand the space of the inferior nasal meatus. By repeatedly compressing the medial canthal skin, tears were pushed through the nasolacrimal duct to the area of the Hasner valve. The exact position of Hasner valve could be easily identified by the bulging membrane in the lateral wall of the inferior nasal meatus.

The probe was gently inserted through the upper punctum, lacrimal sac, nasolacrimal duct, and halted before reaching the area of Hasner valve. If the lacrimal duct was not too narrow and the probing was not severely resisted, Hasner valve incision could be continued, otherwise other surgical methods such as DCR should be considered. The probe was used to brace the Hasner valve. Meanwhile, the oculoplastic surgeon used a needle electrode (Tungsten Alloy, LM-A1, Jiangsu Yi Bo Lei Ming Medical Technology, Taizhou, Jiangsu Province, China) in the through-cutting model to incise the mucosa of Hasner valve [Figure 2]. The electrical power of the needle electrode ranged from 5 to 15 W. If the reaction was insufficient, the electrical power could be increased by 3 to 5 W increments. During the process, it is critical to prevent the needle electrode from touching the metal probe. Muco-purulent discharge could flow out of the cutting site at that moment. The needle electrode was continued to be used to cut the Hasner valve until it was completely removed. To prevent circumferential scarring, trauma to the lateral nasolacrimal duct wall mucosa should be avoided.

Antibiotic irrigation was performed to examine the obstruction removal of the lacrimal duct. If the IM was too narrow, SI would be adopted. Topical antibiotics (0.5% levofloxacin), steroids (0.1% fluorocethylene), and corneal lubrication ointment were given to patients. The tube was usually removed 1 to 2 months after the operation. Nasal douching with saline solution should be carried out two times per day at home for about 2 months. The whole steps of the surgery procedures are as follows [Figure 3].

Evaluation of surgical outcomes

Similar to previous studies, complete resolution of epiphora combined with discharge symptoms were considered as successful results. Some other symptoms were also observed in the follow-up visits, including the disappearance of nasal bleeding, the tube position for case of silicone tube implantation, and the adherence to mucous membrane of the nasal cavity. To objectively evaluate the surgical outcomes, in this study we also presented two objective measures: lacrimal passage irrigation and changes of tear meniscus height (TMH). TMH was measured by Keratograph (Oculus, Wetzlar, German).

Results of lacrimal passage irrigation was coded as follows. (1) Obstructed completely, reflux when normal saline solution was injected into the upper or lower lacrimal punctum; (2) Reflux through the upper punctum when solution was injected into the lower lacrimal punctum; reflux under pressure; (3) Reflux when solution was injected into the lower lacrimal punctum while the upper punctum is unobstructed; (4) Reflux through the upper punctum when the solution was injected into the lower punctum; unobstructed under pressure; (5) Stenosis: when the solution was injected into the lower lacrimal punctum, it was unobstructed under pressure; (6) Unobstructed and no reflux.

Statistical analysis

SPSS 23.0 (IBM Corp, Armonk, NY, USA) was implemented for data analysis. We conducted Chi-square test, specifically Fisher exact test, which is appropriate to calculate an exact *P* value with small number of frequencies. *P* > 0.05 indicates that the difference was not statistically significant between two groups, and vice versa.

Results

The age range of the patients in the overall study included those from 4 months to 79 years (mean age: 25.2 ±

23.2 years, for pediatric patients [mean age: 2.4 ± 1.8 years] and the adult patients [mean age: 42.7 ± 15.1 years]). The distribution of different age groups is shown in Figure 4. In the pediatric group, the majority of the patients were equal or under 1-year-old (16 cases, 72.7%), three patients (13.6%) were older than 1 but under 5 years old. Additionally, among pediatric patients, 15 eyes (65.2%) have received clinical treatments, 23 eyes have probing history (average 2.33 ± 1.57 times) and seven eyes (30.4%) have intubation surgery history. In the adult group, 53.3% (16 cases) were 30 to 49 years old, 26.7% (eight cases) were elder than 50 years. A silicone stent was placed in eight pediatric patients (36.4%), and in 21 adult patients (70.0%). The proportion of stented patients was significantly higher in adult group than that in pediatric group (*P* < 0.05).

Symptoms and complications

We have calculated the frequency of the complications, including post-operative bleeding (0 case *vs.* 0 case), recurrent obstruction (1 case *vs.* 3 cases), and adhesion of nasal mucosa (0 case *vs.* 1 case) between the children group and the adult group. There was no significant difference in frequency between the children group and the adult group (Fisher exact test *P* = 0.339). No life-threatening or major complications were noted in this study.

Symptomatic success (ie, complete resolution of symptoms of epiphora) in the pediatric group was found to be 95.7% (22/23 eyes), comparable to success rate of 90.0% (27/30 eyes) in adult group. The success rate, as determined by symptom of epiphora, was statistically equal between pediatric and adult groups (Fisher exact test *P* = 0.627).

Lacrimal passage irrigation

The post-operative lacrimal passage irrigation was significantly improved overall. In the pediatric group, pre-operative lacrimal passage irrigation of 23 eyes were coded as 1 or 2. However, post-operative outcomes have been significantly improved, specifically 21 eyes (91.3%) were coded as 6, two eyes (8.7%) were coded as 5. The same pattern was shown in adult group as well. In particular,

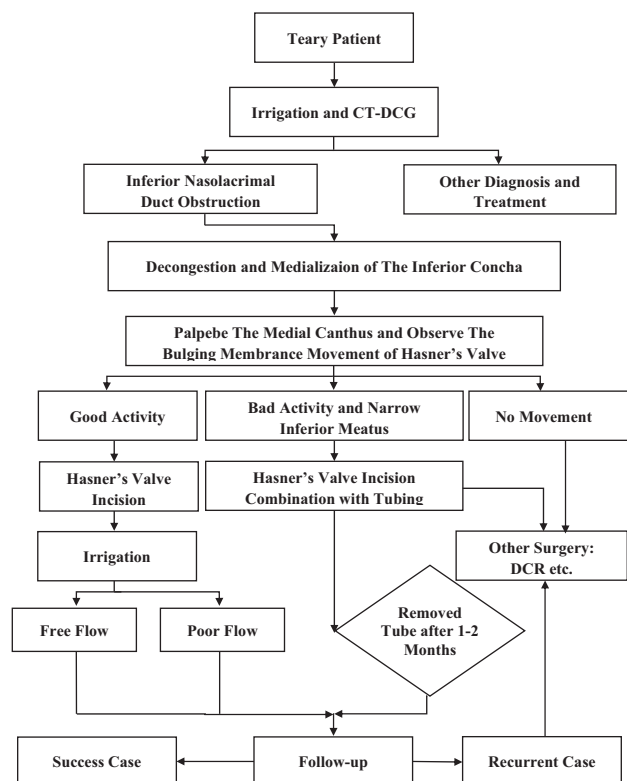
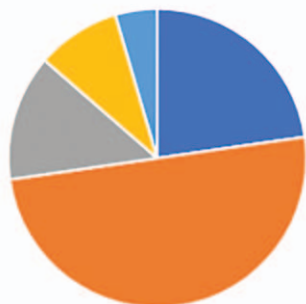


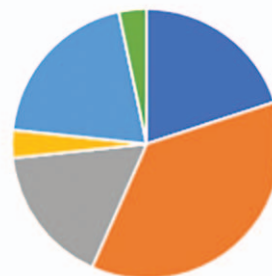
Figure 3: Flow chart of surgery procedures. CT-DCG: Computed tomographic dacryocystography, DCR: Dacryocystorhinostomy.e

Age Group of Pediatric Patients



■ 0-5 months ■ 6 months-1 year old ■ 2-5 years old ■ 6-9 years old ■ 10-18 years old

Age Group of Adult Patients



■ 20-29 years old ■ 30-39 years old ■ 40-49 years old
■ 50-59 years old ■ 60-69 years old ■ 70-79 years old

Figure 4: Age group of pediatric patients and adult patients.

29 eyes (96.7%) were coded as 1 or 2, but 27 eyes (90.0%) were coded as 6 after patients underwent Hasner valve incision. By comparing how many patients have achieved the optimal outcome (ie, coded as 6: unobstructed and no reflux), we find that there is no significant difference (21 cases *vs.* 27 cases, Fisher exact test $P=0.663$) between adult group and pediatric group. To examine whether this result is robust, we also compared the pre-operative lacrimal passage irrigation between the pediatric and adult groups. No statically significant difference was discovered ($P > 0.05$).

TMH

The mean of TMH was measured pre- and post-surgery for efficacy of Hasner valve incision. Overall, the pre-operative mean of TMH (0.63 ± 0.31 mm) was significantly higher than normal (normal TMH ranges 0.23–0.40 mm),^[19-22] while the post-operative TMH was significantly reduced and decreased to 0.29 ± 0.10 mm. Specifically, the pre-operative and post-operative TMH in the adult group were 0.64 ± 0.33 mm and 0.31 ± 0.10 mm, while the TMH in the pediatric group were 0.58 ± 0.23 mm and 0.21 ± 0.06 mm. To conduct further examination, we checked the number of patients whose TMH has decreased into normal range after Hasner valve incision for both adult and pediatric group. No significant difference was discovered (6 cases *vs.* 24 cases, Fisher exact test $P=0.561$). After counting the number of patients whose TMH was higher than 0.40 mm both pre- and post-surgery, no statically significant difference was discovered ($P > 0.05$) either.

Of note, the success rate of Hasner valve incision, as determined by appearance of complications, symptoms of epiphora, lacrimal passage irrigation, and the changes of TMH, was not significantly different between adult and pediatric groups.

Discussion

Acute and chronic dacryocystitis caused by NLDO are common ophthalmological diseases. Probing, intubation and DCR are the preferential surgical treatments for both CNLDO and ANDLO, respectively.^[6,23-25] The disadvantages of these methods should not be neglected, such as false passage formation, punctum erosion, prolapsed tube, traumatic obstruction, and formation of pyogenic granuloma.^[26,27]

In pediatric patients, the probing cure rate was significantly different ($P < 0.001$) between the membranous (90.2%) and complex (33.3%) CNLDO, indicating that simple probing was only effective in membranous CNLDO.^[6] In general, the older the age, the lower the success rate of the probing. It has been showed that success rate was 85% in children aged 2 to 3 years, 75% in those between 3 and 4 years, and 63% in those 4 to 5 years old.^[28] This phenomenon may be caused by the following reasons. Membranous Hasner valve is more common in younger children, in contrast, membrane will become thicker and more complex as age increases. In terms of intubation, a meta-analysis reported that immediate and deferred

probing had similar rates of success (82.7% *vs.* 81.8%).^[29] Whereas, balloon dacryocystoplasty and SI had similar rates of success (79.8% *vs.* 77.8%). On the other hand, the probing was not an optional approach for adult patients, and to the best of our knowledge, rare research regarding adult's probing was reported. The success rate (complete long term resolution of symptoms) of SI in adults was documented as 50.7%.^[11] With the assistance of endoscopy guidance, the success rate was increased to 53.8%.^[10] DCR is the gold treatment intervention for ANDLO patients. SI increases success rates and double SI further increases the success rates of DCR for recurrent and refractory patients.^[30,31]

Furthermore, the diameter of most nasolacrimal probes is only about 0.8 mm, while the diameter of the nasolacrimal canal in children is approximately 3 mm and larger than 3 mm in adults.^[2,4,32] Intubation or probing will easily result in adhesion at Hasner valve position, which may cause re-obstruction consequently.

To further minimize the likelihood of injury and maintain the function of tear pump, some recent studies have presented a new approach for those patients with inferior NLDO, that is, Hasner valve incision under endoscopic intranasal surgery.^[1,15,16] Yet, according to existing reports, more favorable outcomes have been reported in pediatric patients compared to adult patients. Given the fact that the study population of published reports including adult patients only involved single case or small sample size, the question regarding whether surgical outcomes of Hasner valve incision are significantly different between pediatric patients and adult patients is worth studying. Our study directly compares the outcomes of Hasner valve incision in pediatric patients to adult patients, using a sample with a wide range of patients ages (4 months to 79 years old) and utilizing various convincing criterion for success evaluation. In particular, we utilized both subjective criterion (resolution of symptoms of epiphora) and objective measures (appearance of complications, lacrimal passage irrigation, and TMH). Overall, our findings of this current study have shown that there was no statistically significant difference in success rate.

Whether Hasner valve incision is appropriate should be considered with extreme attention to patients with any of the following symptoms. (1) Imperforate punctum lacrimale. (2) Alternatives that could cause tearing (trichiasis, entropion, ectropion, corneal, and conjunctival foreign body). (3) Lacrimal tumor, historical nasolacrimal duct surgeries (probing, SI, DCR). If CT-DCG or nasal endoscopy shows hypertrophy of the inferior turbinate, extreme narrow inferior nasal meatus, the obstruction of nasolacrimal duct higher than the level of Hasner valve, severe nasal septum deviation, sinusitis, and the proximal occlusion (eg, obstruction or stenosis occurred in the canalicular, nasolacrimal duct's upper or middle part), other surgical procedures should be considered.

Our results should be interpreted with the following limitations. First, there were 14 male patients (63.64%) in the pediatric group, while this percentage in adult group was only 6.67%. Despite the fact that a high incidence of

ANDLO in women was observed in clinical practice, it is a potential confounding factor. It is worth to note that when we calculated the success rate (as determined by TMH and lacrimal passage irrigation) for female and male patients specifically, the success rate according to lacrimal passage irrigation was higher in female patients than that in male patients. Second, the percentage of patients receiving silicone tube was extremely high in the adult group (21 eyes, 70.0%) than in the pediatric group (eight eyes, 34.78%). It attributes to more complicating factors in adult patients. However, we calculated the success rate in stented patients and non-stented patients specifically, no significant difference was found ($P > 0.05$). Compared to younger persons, older persons normally have a longer course of the disease, and the greater number of historical surgery operations, which probably negatively affect the Hasner valve incision outcome. During the process of operating, whether to implant a silicone tube should be determined by the dynamics of the Hasner valve and local space of inferior nasal meatus. In particular, the better the mobility, the greater the local space and; therefore, the higher the success rate of Hasner valve incision without intubation, and vice versa. Surgeons can make their judgment by palpation of lacrimal sac associated with the observation of Hasner valve mobility under nasal endoscopy. Third, the length of follow-up was relatively short, and the number of cases observed is limited as well. Especially, there are too few children in the pediatric group who can cooperate with TMH. Therefore, it is necessary to extend the follow-up period. The sample size should be expanded as well.

In summary, our results provide support for Hasner valve incision as one choice of surgical technique for patients with epiphora. More importantly, in our study, age does not appear to be a prognostic factor for the surgical outcome of Hasner valve incision.

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Conflicts of interest

None.

References

- Rogers GA, Murchison AP, Wojno TH, DelGaudio JM. Inferior meatus endoscopy and directed treatment for epiphora: early experience with a novel approach. *Otolaryngol Head Neck Surg* 2009;140:579–584. doi: 10.1016/j.otohns.2008.12.009.
- Weiss AH, Baran F, Kelly J. Congenital nasolacrimal duct obstruction: delineation of anatomic abnormalities with 3-dimensional reconstruction. *Arch Ophthalmol* 2012;130:842–848. doi: 10.1001/archophthol.2012.36.
- Schnall BM. Pediatric nasolacrimal duct obstruction. *Curr Opin Ophthalmol* 2013;24:421–424. doi: 10.1097/ICU.0b013e3283642e94.
- Fayet B, Racy E, Bordonne C, Katowitz JA, Katowitz WR, Bremond-Gignac D. Complex stenoses and CT features of the nasolacrimal canal in congenital nasolacrimal duct obstruction. *Ophthalm Plast Reconstr Surg* 2019;35:594–599. doi: 10.1097/IOP.0000000000001411.
- Francisco FC, Carvalho AC, Francisco VF, Francisco MC, Neto GT. Evaluation of 1000 lacrimal ducts by dacryocystography. *Br J Ophthalmol* 2007;91:43–46. doi: 10.1136/bjo.2005.088187.
- Kashkoui M, Karimi N, Khademi B. Surgical management of congenital nasolacrimal duct obstruction; one procedure for all versus all procedures for one. *Curr Opin Ophthalmol* 2019;30:364–371. doi: 10.1097/ICU.0000000000000584.
- Lee DH, Fudenberg SJ, Davitt BV, Cruz OA. Success of simple probing and irrigation in patients with nasolacrimal duct obstruction and otitis media. *J AAPOS* 2005;9:192–194. doi: 10.1016/j.jaapos.2004.12.009.
- Al-Faky YH, Al-Sobaie N, Mousa A, Al-Odan H, Al-Huthail R, Osman E, *et al.* Evaluation of treatment modalities and prognostic factors in children with congenital nasolacrimal duct obstruction. *J AAPOS* 2012;16:53–57. doi: 10.1016/j.jaapos.2011.07.020.
- Repka MX, Melia BM, *et al.* Pediatric Eye Disease Investigator Group. Primary treatment of nasolacrimal duct obstruction with balloon catheter dilation in children younger than 4 years of age. *J AAPOS* 2008;12:451–455. doi: 10.1016/j.jaapos.2008.07.001.
- Kashkoui MB, Beigi B, Tarassoly K, Kempster RC. Endoscopically assisted balloon dacryocystoplasty and silicone intubation versus silicone intubation alone in adults. *Eur J Ophthalmol* 2006;16:514–519. doi: 10.1177/112067210601600402.
- Connell PP, Fulcher TP, Chacko E, O' Connor MJ, Moriarty P. Long term follow up of nasolacrimal intubation in adults. *Br J Ophthalmol* 2006;90:435–436. doi: 10.1136/bjo.2005.084590.
- Sarode D, Bari DA, Cain AC, Syed MI, Williams AT. The benefit of silicone stents in primary endonasal dacryocystorhinostomy: a systematic review and meta-analysis. *Clin Otolaryngol* 2017;42:307–314. doi: 10.1111/coa.12751.
- Gupta N, Neeraj C, Smriti B, Sima D. A comparison of the success rates of endoscopic-assisted probing in the treatment of membranous congenital nasolacrimal duct obstruction between younger and older children and its correlation with the thickness of the membrane at the Valve of Hasner. *Orbit* 2018;37:257–261. doi: 10.1080/01676830.2017.1383483.
- Andalib D, Mansoori H. A comparison between monocalicular and pushed monocalicular silicone intubation in the treatment of congenital nasolacrimal duct obstruction. *Int J Ophthalmol* 2014;7:1039–1042. doi: 10.3980/j.issn.2222-3959.2014.06.24.
- Keilani C, Keller P, Piaton JM. Incision of Hasner's valve under endoscopic intranasal surgery for the treatment of nasolacrimal duct obstruction in children. *J Laryngol Otol* 2020;134:56–62. doi: 10.1017/S0022215119002597.
- Cnaan RB, Moosajee M, Heatley CJ, Olver J. Endoscopic endonasal retrieval of a nasolacrimal duct stone via the valve of Hasner in the inferior meatus. *Ophthalmic Plast Reconstr Surg* 2012;28:e48–e50. doi: 10.1097/IOP.0b013e318220861f.
- Rogers GA, DelGaudio JM. Inferior meatus dacryolith: an easily managed cause of epiphora. *Arch Otolaryngol Head Neck Surg* 2008;134:1110–1111. doi: 10.1001/archotol.134.10.1110.
- Korkmaz H, Korkmaz M, Karakahya RH, Serhatli M. Endoscopic intranasal surgery for congenital nasolacrimal duct obstruction—a new approach. *Int J Pediatr Otorhinolaryngol* 2013;77:918–921. doi: 10.1016/j.ijporl.2013.03.005.
- Tian L, Qu JH, Zhang XY, Sun XG. Repeatability and reproducibility of noninvasive keratograph 5M measurements in patients with dry eye disease. *J Ophthalmol* 2016;2016:621–626. doi: 10.1155/2016/8013621.
- Arriola-Villalobos P, Fernández-Vigo JI, Díaz-Valle D, Peraza-Nieves JE, Fernández-Pérez C, Benítez-Del-Castillo JM. Assessment of lower tear meniscus measurements obtained with Keratograph and agreement with Fourier-domain optical-coherence tomography. *Br J Ophthalmol* 2015;99:1120–1125. doi: 10.1136/bjophthalmol-2014-306453.
- Park DI, Lew H, Lee SY. Tear meniscus measurement in nasolacrimal duct obstruction patients with Fourier-domain optical coherence tomography: novel three-point capture method. *Acta Ophthalmol* 2012;90:783–787. doi: 10.1111/j.1755-3768.2011.02183.x.
- Stahl U, Francis IC, Stapleton F. Prospective controlled study of vapor pressure tear osmolality and tear meniscus height in nasolacrimal duct obstruction. *Am J Ophthalmol* 2006;141:1051–1056. doi: 10.1016/j.ajo.2005.12.051.

23. Huang J, Malek J, Chin D, Snidvongs K, Wilcsek G, Tumuluri K, *et al.* Systematic review and meta-analysis on outcomes for endoscopic versus external dacryocystorhinostomy. *Orbit* 2014; 33:81–90. doi: 10.3109/01676830.2013.842253.
24. Robb RM. Success rates of nasolacrimal duct probing at time intervals after 1 year of age. *Ophthalmology* 1998;105:1307–1309. doi: 10.1016/S0161-6420(98)97038-5.
25. Vagge A, Ferro Desideri L, Nucci P, Serafino M, Giannaccare G, Lembo A, *et al.* Congenital nasolacrimal duct obstruction (CNLDO): a review. *Diseases* 2018;6:96. doi: 10.3390/diseases6040096.
26. Chu ZD, Lu GH, Tan Y, Deng Y. Repositioning a prolapsed tube after bicanalicular intubation of the lacrimal system. *Ophthal Plast Reconstr Surg* 2019;35:623–627. doi: 10.1097/IOP.0000000000001400.
27. Andalib D, Nabie R, Abbasi L. Silicone intubation for nasolacrimal duct stenosis in adults: monocanalicular or bicanalicular intubation. *J Craniofac Surg* 2014;25:1009–1011. doi: 10.1097/SCS.0000000000000708.
28. Rajabi MT, Abrishami Y, Hosseini SS, Tabatabaee SZ, Rajabi MB, Hurwitz JJ. Success rate of late primary probing in congenital nasolacrimal duct obstruction. *J Pediatr Ophthalmol Strabismus* 2014;51:360–362. doi: 10.3928/01913913-20140909-02.
29. Lin AE, Chang YC, Lin MY, Tam KW, Shen YD. Comparison of treatment for congenital nasolacrimal duct obstruction: a systematic review and meta-analysis. *Can J Ophthalmol* 2016;51:34–40. doi: 10.1016/j.jcjo.2015.10.002.
30. Ing EB, Bedi H, Hussain A, Zakrewski H, Ing R, Nijhawan N, *et al.* Meta-analysis of randomized controlled trials in dacryocystorhinostomy with and without silicone intubation. *Can J Ophthalmol* 2018;53:466–470. doi: 10.1016/j.jcjo.2017.12.006.
31. Kim DH, Kim SI, Jin HJ, Kim S, Hwang SH. The clinical efficacy of silicone stents for endoscopic dacryocystorhinostomy: a meta-analysis. *Clin Exp Otorhinolaryngol* 2018;11:151–157. doi: 10.21053/ceo.2017.01781.
32. Wilhelm KE, Rudolf H, Greschus S, Garbe S, Lussem M, Lischka T, *et al.* Cone-beam computed tomography (CBCT) dacryocystography for imaging of the nasolacrimal duct system. *Klin Neuroradiol* 2009;19:283–291. doi: 10.1007/s00062-009-9025-9.

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