European Archives of Oto-Rhino-Laryngology (2019) 276:1671–1675
https://doi.org/10.1007/s00405-019-05382-z

RHINOLOGY

Evaluation of the effect of inferior turbinate outfracture on nasolacrimal transit time by saccharin test

Kerem Kökoğlu[1] · **Alperen Vural**[2]

Received: 29 January 2019 / Accepted: 11 March 2019 / Published online: 15 March 2019

Abstract

Aim To evaluate the effect of inferior turbinate outfracture on nasolacrimal transit time by saccharin test.

Materials and methods Twenty patients who underwent septoplasty + unilateral radiofrequency ablation and outfracture of inferior turbinate were enrolled into study. They had no complaints about their eyes and denied previous ocular surgery. Their nasolacrimal saccharin transit times (NSTTs) were estimated preoperatively and postoperatively in the 1st and 2nd months. The non-fractured side eye was measured only once preoperatively. The fractured-side eye was measured three times. These times were compared statistically.

Results There were 8 men and 12 women. Mean age was 29.04. Killian incision was used in 14 and hemitransfixion incision was used in 6 patients. Median NSTT was 484, 461, 490 and 446 s for the non-fracture side, preoperatively and postoperatively in the 1st and 2nd months, respectively. There was no statistically significant difference between the two eyes preoperatively, and in the fractured side preoperatively and postoperatively in the 2nd month. There were significant differences between median NSTT in postoperative 1st month and median NSTT in the preoperative measure, and between postoperative 1st and 2nd months ($p < 0.05$). Median NSST in the 1st month was longer than the others.

Conclusion Outfracture of inferior turbinate had no permanent effect on NSTT 2 months after surgery in patients that had a healthy nasolacrimal system.

Keywords Jones test · Epiphora · Mucociliary clearance

Introduction

There are three turbinates which divide the nasal passage into meati, superior, middle and inferior, on the lateral nasal wall [1]. The inferior meatus is between the inferior turbinate, the floor of the nose, and the lateral nasal wall. The lacrimal excretory pathway begins with superior and inferior punctums, and continues through the superior and inferior canaliculi, common canaliculus, nasolacrimal sac and nasolacrimal duct. The lacrimal sac is related to lacrimal bone, frontal process of the maxilla. The nasolacrimal duct runs 4–9 mm to the maxillary bone. The inferior orifice of the nasolacrimal canal is located at the roof of the inferior nasal meatus. It can be located approximately 1.5 cm superior to the nasal floor, 1.5 cm posterior to the anterior attachment of the inferior nasal turbinate to the lateral nasal wall, and 2.4 cm from the anterior nasal spine. This opening is covered by a mucosal valve, known as the Hasner's valve [2, 3].

Nasal obstruction is one of the most common complaints in otolaryngology clinics and two major reasons are septal deviation and enlarged inferior turbinate. Various procedures are defined to reduce inferior turbinate size in the literature. Turbinate outfracture or lateral infracture is a common one among these choices [4, 5]. The nasolacrimal system has an anatomical neighborhood with the inferior turbinate and the upper part of the medial wall of the maxillary sinus [6]. Surgeries at this area can affect the nasolacrimal system. In a study, the angle between inferior turbinate and medial wall of maxillary sinus has been found to be significantly less in epiphora patients than control group [7]. In addition, case reports that have been published mentioned that epiphora is due to inferior turbinate cysts [8].When an inferior

✉ Kerem Kökoğlu
dr.kokoglu@gmail.com

[1] Department of Otolaryngology, Kayseri City Hospital, Kayseri, Turkey

[2] Department of Otolaryngology - Head and Neck Surgery, Faculty of Medicine, Erciyes University, Kayseri, Turkey

turbinate outfracture is performed, the size of inferior meatus decreases. For this reason, exploring the effect of inferior turbinate outfracture which can shrink the size of inferior meatus on nasolacrimal drainage was aimed in this study.

Materials and methods

The study was planned as a prospective study. After ethical committee approval (Decision Number: 2018/261), 20 patients whose informed consent was obtained were enrolled in the study. The study was performed in Develi State Hospital, Kayseri, Turkey. All patients were picked from a population of nasal surgery candidates. They were diagnosed with nasal septal deviation and contralateral inferior turbinate hypertrophy. Patients who were smokers and had nasal polyposis, allergic rhinitis, antrochoanal polyp, adenoid hypertrophia, revision surgery, eye operation in the past and epiphora in their history and physical examination were excluded. Their age and gender were recorded.

Surgery and postoperative care

All septoplasty and turbinate surgeries were performed by direct vision with a headlight and speculum by the same surgeon. Operations were performed with a closed technique. Hemitransfixion incisions were performed in patients with caudal septal deviation and Killian incision in the others. The active tip of the radiofrequency probe (10 mm) (Celon AG Medical Instruments, CelonLAB ENT, Hyderabad, India) was submucously introduced into the compensatory hypertrophic inferior turbinates unilaterally and they were broken outwardly by a blunt instrument. Inferior turbinates on the same side of septal deviation were protected. The setting was kept at 9W and energy was delivered for 50–60 s; care was taken not to injure the mucosa. A total of three applications, one each at the anterior, middle and posterior end of turbinate was applied, the duration of each application being the same. 4.0 vicryl was used for transfixion suture. Nasal splints were placed in all patients and fixed. All patients were discharged 24 h postoperatively after the surgery with dexketoprofen, nasal lavage and restriction of heavy activity recommendations. Internal nasal splints were removed 2–3 days after the surgery. Patients were examined in the 1st and 2nd months after the operation. None of them were prescribed intranasal steroid postoperatively.

Measuring of transit time

In a calm environment and erect sitting position, 4 ml of a 1% saccharin solution was instilled in the conjunctival cul-de-sac of one eye. The patient was asked to report when a bittersweet taste was sensed in the mouth. Transit time was recorded for both eyes preoperatively and one eye on the operated side postoperatively in the 1st and 2nd months by the same chronometer application. All estimations were performed on different days. First, an examination of the eye on the non-fractured side was done once preoperatively to all patients. Eye on the fractured side was tested three times, preoperatively and postoperatively in the 1st and 2nd months. Nasolacrimal saccharin transit times (NSTTs) were measured. Data were compared in terms of significant differences between preoperative and postoperative values and preoperative values of two sides (fractured and non-fractured).

Statistical analysis

Data were evaluated by IBM SPSS 23.0 programme. Descriptive statistics were given as mean and median. Normality of distributions was evaluated by the one-sample Kolmogorov–Smirnov test. Because of the anormal distribution, median NSTTs were compared by Wilcoxon signed-rank test. $P < 0.05$ was accepted as significant statistically.

Results

Twenty patients were enrolled in the study. There were 8 men and 12 women. The minimum and maximum ages were 18 and 45, respectively, mean age was 29.4 ± 8.03. There were 13 patients with a right-sided nasal septal deviation and 7 with left. Killian incision was used in 14 and hemitransfixion incision was used in 6 patients. No patient had septal perforation after the operation.

Median NSTT was 484, 461, 490 and 446 s for the non-fracture side, preoperatively and postoperatively in the 1st and 2nd months, respectively (Table 1). Although the median preoperative NSST on the fractured side was shorter, there was no significant differences between median NSST of non-fractured side and median NSTT of preoperative fractured side ($P > 0.05$) (Table 1). There was also no significant difference between preoperative median NSTT and postoperative 2nd month of the fractured side ($P > 0.05$) (Table 1). However, there were significant differences between median NSTT in preoperative and postoperative 1st month;, and median NSTT in postoperative 1st and 2nd months in binary comparisons ($P < 0.05$) (Table 1). Median NSST in the 1st month was longer than the others.

No patient reported epiphora 2 months after the surgery.

Discussion

The nasolacrimal system can be evaluated by various methods [3]. Schirmer's Test, primary and secondary Jones dye tests, and probing are the commonly used clinical tests. In primary Jones dye test, 2% of fluorescein is instilled into the

Table 1 Mean and median nasolacrimal saccharin transit times in different measures and binary comparisons of these measures

	Mean NSTT (s)	Median (25–75%) *P* (s)	Fractured side eye preoperative	Fractured side eye postoperative 1st month	Fractured side eye postoperative 2nd month
Non-fractured side eye	515.24 ± 137.4	484 (386–619)	*P* = 0.056		
Fractured side eye preoperative	483.25 ± 119.1	461 (393–582)		***P* = 0.005**	0 = 0.403
Fractured side eye postoperative 1st month	519.75 ± 116.3	490 (427–588)			***P* = 0.005**
Fractured side eye postoperative 2nd month	494.75 ± 121.4	446 (405–576)			

NSTT Nasolacrimal saccharin transit time, *s* second

Bold values are statistically significant

conjunctival sac and cotton is placed under inferior turbinate at the 2nd and 5th min. If dye is recovered, the test is positive and indicates patent anatomy and normal physilology. If the primary Jones Test is negative, secondary Jones test is performed to distinguish partial obstruction and insufficiency of pump mechanism. Residual fluorescein is cleaned and then the nasolacrimal system is irrigated by salin. If cotton is dyed by flourescein, it indicates partial obstruction [9]. Hornblass described a modified form of primary Jones test. In this test, 1% of saccharin solution is instilled into the conjunctival sac and the patient is asked to report when he feels the bittersweet taste. Hornblass found the mean NSTT to be 3.5 min. Sixty-five percent of people reported the taste in 6 min and 90% reported positive results in 15 min [10].

Nasolacrimal duct opens underneath the inferior turbinate and the nasolacrimal system is clearly related to lateral nasal wall. Therefore, nasal surgeries can effect the nasolacrimal system. Osguthorpe [11] reported common transient epiphora after maxillary sinus and rhinoplasty surgeries. Meyers and Hawes [12] reported four permanent nasolacrimal duct obstructions, three of which were subjected to dacryocystorhinostomy, after inferior meatus nasal antrostomy. Serdahl [13], Bolger [14], Unlu [15] and Ali [16], reported lacrimal system injury during functional endoscopic sinus surgery (FESS) in different studies. Serdahl et al. [13] reported eight patients who had epiphora after FESS and underwent dacryocystorhinostomy (DCR) in 1990. Bolger et al. [14] reported 24 patients who underwent FESC and had an injury in their nasolacrimal system. Fortunately, they did not have epiphora. Unlu et al. [15] evaluated patients who underwent FESS by dacryocystography. They concluded that nasolacrimal injury was more common on the left side although not causing epiphora. Ali et al. [16] reported very few nasolacrimal injuries during FESS in 2015. It may be related to increased experience in this surgery. They did not use the saccharin test to evaluate the system. Nasolacrimal ductus had been injured during endoscopic medial maxillectomy. Nakayama et al. [17] defined a new procedure to preserve nasolacrimal ductus and inferior turbinate.

Inferior turbinate surgery has a possible effect on nasolacrimal drainage theoretically. Martinez et al. [18] reported an epiphora case after inferior turbinectomy. Passali et al. [19] did not report epiphora in a 382-patient series, 94 of whom had underwent submucosal resection and outfracture of inferior turbinate.

Besides surgical interventions, postoperative care after nasal surgery can also affect the nasolacrimal system. Awan and Iqbal [20] reported that patients in whom septoplasty and nasal packing were performed experienced epiphora more than patients without nasal packing. Habesoglu et al. [21] found more intranasal pathologies such as concha bullosa, maxillary sinusitis and inferior turbinate hypertrophy in patients with primary nasolacrimal duct obstruction. For these reasons, it is not possible to separate nasal surgeries from nasolacrimal duct function.

Inferior turbinate hypertrophy is one of the most common causes of nasal obtruction. Surgery is recommended for refractory cases to medical treatment. Total or partial turbinectomy, submucosal resection, laser, electrocautery, cryosurgery and RFA have been described as surgical techniques used for reduction of inferior turbinate size [22].Outfracture is one of the most common combined procedures for resolving nasal obtruction. Inferior turbinate is broken by an Boise elevator from medial side outwardly [23]. It can be performed alone or combined with other procedures [24]. In this technique, the angle between inferior turbinate and lateral nasal wall decreases. Lee et al. [24] reported that the angle between lateral nasal wall and inferior turbinate was still significantly less than the preoperative values 6 months after the surgery. As a result, nasolacrimal duct opens underneath the inferior turbinate and inferior turbinate outfracture causes the narrowing of this area. It could effect the nasolacrimal flow. Thus, Gul et al. [7] found that patients with primary nasolacrimal duct obstruction had a significantly less degree angle between inferior turbinate and medial wall of the maxillary sinus in a 35-case study.

For the aforementioned reasons, the effect of the inferior turbinate outfracture was aimed to evaluate in the presented

paper. NSTT was significantly longer in the postoperative 1st month. It, however, turned to preoperative values in the 2nd month. According to Hornblass [10], NSTT up to 15 min (900 s) is accepted as normal for clinical sight. Median NSST was 491 s in the postoperative 1st month in the presented study. Although it was longer, median NSST was in the normal range. However, the study group was formed by patients who had no epiphora history and had no epiphora postoperatively, as well. Inferior turbinate outfracture can be a problem in patients who already have a borderline nasolacrimal system disorder. These patients can be warned about development of epiphora especially in the period of postoperative 1st month. Inferior turbinate outfracture could make a borderline pathology clear. This surgery has no effect in patients who have a healthy nasolacrimal system. Longer NSTT can be related to nasal mucociliary function. For positive saccharin test, saccharin is needed to move up to pharynx by nasal mucociliary flow. Nasal mucociliary flow can be affected by surgery and nasal packing [25]. Kula et al. [26] reported that nasal packing had no effect on nasal mucociliary clearance. They also referred that nasal mucociliary clearance was better after septoplasty. For this reason, the linking between longer NSTT in the 1st month and mucociliary clearance does not make sense. Furthermore, less NSTT may be seen because of better nasal mucociliary clearance. Last of all, median NSTT was longer in the 1st month. It can be related to the decreased angle between inferior turbinate and lateral nasal wall rather than nasal mucociliary clearance.

In the presented study, NSTTs were done in the same order, non-fractured side eye, fractured-side eye preoperative, postoperative 1st and 2nd months. Patients did not know the taste of saccharin. As a result, patients were more experienced about the saccharin test after the first test. Even though it was not significant, preoperatively less median NSTT on fractured side eye could be related to this experience.

This is the first study which evaluated nasolacrimal transit after turbinate surgery by the saccharin test in the literature.

The limitation of the presented study was its relatively small sample size.

Conclusion

As conclusion, outfracture of inferior turbinate had no permanent effect on NSTT in the postoperative 2nd month. However, this study was performed in patients with healthy nasolacrimal systems. The effects of turbinate surgery in patients with a nasolacrimal system pathology may be further assesed.

Funding None.

Compliance with ethical standards

Conflict of interest All authors declare that they have no conflict of interest.

Informed consent Informed consent was obtained from all individual participants included in the study.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

References

1. Mafee MF, Chow JM, Meyers R (1993) Functional endoscopic sinus surgery: anatomy, CT screening, indications, and complications. AJR Am J Roentgenol 160(4):735–744
2. Ogle OE, Weinstock RJ, Friedman E (2012) Surgical anatomy of the nasal cavity and paranasal sinuses. Oral Maxillofac Surg Clin 24(2):155–166
3. Cohen AJ, Brazzo BG, Mercandetti M (2006) The lacrimal system. Springer, New York
4. Goode R, Pribitkin E (1995) Diagnosis and treatment of turbinate dysfunction. American Academy of Otolaryngology-Head and Neck Surgery Foundation. Inc, Alexandria
5. Jackson LE, Koch JR (1999) Controversies in the management of inferior turbinate hypertrophy: a comprehensive review. Plastic Reconstruct Surg 103(1):300–312
6. Groessl SA, Sires BS, Lemke BN (1997) An anatomical basis for primary acquired nasolacrimal duct obstruction. Arch Ophthalmol 115(1):71–74
7. Gul A, Aslan K, Karli R, Ariturk N, Can E (2016) A possible cause of nasolacrimal duct obstruction: narrow angle between inferior turbinate and upper part of the medial wall of the maxillary sinus. Curr Eye Res 41(6):729–733
8. DelGaudio JM, Wojno T (2007) Nasolacrimal duct orifice cysts in adults: a previously unrecognized, easily treatable cause of epiphora. Laryngoscope 117(10):1830–1833
9. Dutton JJ, White JJ (2006) Imaging and clinical evaluation of the lacrimal drainage system, the lacrimal system. Springer, New York, pp 74–95
10. Hornblass A (1973) A simple taste test for lacrimal obstruction. Arch Ophthalmol 90(6):435–436
11. Osguthorpe JD, Calcaterra TC (1979) Nasolacrimal obstruction after maxillary sinus and rhinoplastic surgery. Arch Otolaryngol 105(5):264–266
12. Meyers AD, Hawes MJ (1991) Nasolacrimal obstruction after inferior meatus nasal antrostomy. Arch Otolaryngol Head Neck Surg 117(2):208–211
13. Serdahl CL, Berris CE, Chole RA (1990) Nasolacrimal duct obstruction after endoscopic sinus surgery. Arch Ophthalmol 108(3):391–392
14. Bolger WE, Parsons DS, Mair EA, Kuhn FA (1992) Lacrimal drainage system injury in functional endoscopic sinus surgery: incidence, analysis, and prevention. Arch Otolaryngol Head Neck Surg 118(11):1179–1184
15. Unlu HH, Goktan C, Aslan A, Tarhan S (2001) Injury to the lacrimal apparatus after endoscopic sinus surgery: surgical

implications from active transport dacryocystography. Otolaryngol Head Neck Surg 124(3):308–312
16. Ali M, Murphy J, Wormald P, Psaltis A (2015) Bony nasolacrimal duct dehiscence in functional endoscopic sinus surgery: radiological study and discussion of surgical implications. J Laryngol Otol 129(S3):S35–S40
17. Nakayama T, Asaka D, Okushi T et al (2012) Endoscopic medial maxillectomy with preservation of inferior turbinate and nasolacrimal duct. Am J Rhinol Allergy 26(5):405–408
18. Martinez SA, Nissen AJ, Stock CR, Tesmer T (1983) Nasal turbinate resection for relief of nasal obstruction. Laryngoscope 93(7):871–875
19. Passàli D, Anselmi M, Lauriello M, Bellussi L (1999) Treatment of hypertrophy of the inferior turbinate: long-term results in 382 patients randomly assigned to therapy. Ann Otol Rhinol Laryngol 108(6):569–575
20. Awan MS, Iqbal M (2008) Nasal packing after septoplasty: a randomized comparison of packing versus no packing in 88 patients. ENT Ear Nose Throat J 87(11):624–628
21. Habesoglu M, Eriman M, Habesoglu TE et al (2013) Co-occurrence and possible role of sinonasal anomalies in primary acquired nasolacrimal duct obstruction. J Craniofacial Surg 24(2):497–500
22. Batra PS, Seiden AM, Smith TL (2009) Surgical management of adult inferior turbinate hypertrophy: a systematic review of the evidence. Laryngoscope 119(9):1819–1827
23. Feldman EM, Koshy JC, Chike-Obi CJ et al (2010) Contemporary techniques in inferior turbinate reduction: survey results of the American Society for Aesthetic Plastic Surgery. Aesth Surg J 30(5):672–679
24. Lee DC, Jin S-G, Kim BY et al (2017) Does the effect of inferior turbinate outfracture persist? Plastic Reconstruct Surg 139(2):386e–391e
25. Hess M, Lamprecht J, Horlitz S (1992) Experimental study of airflow in the main nasal cavity of the human using a nose model. Laryngo Rhino Otol 71(9):468–471
26. Kula M, Yuce I, Unlu Y et al (2010) Effect of nasal packing and haemostatic septal suture on mucociliary activity after septoplasty: an assessment by rhinoscintigraphy. Eur Arch Otorhinolaryngol 267(4):541–546