

Functional success evaluation of lacrimal drainage system by dacryoscintigraphy after transcanalicular diode laser dacryocystorhinostomy

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Purpose: The purpose of the study was to evaluate the functional success rates using dacryoscintigraphy (DSG) after transcanalicular diode laser dacryocystorhinostomy (TDL-DCR). **Methods:** In this retrospective study, we investigated the records of 56 patients who underwent TDL-DCR for unilateral primary acquired nasolacrimal duct obstruction and anatomic patency was achieved. The lacrimal drainage systems of the other eyes of the patients were normal and were selected as control group. The functional success was evaluated with tear transit time (TT) on DSG and epiphora complaints' score (ECS) at postoperative 6 months. **Results:** Twenty-two (39%) of the patients were male and 34 (61%) were female, with a mean age of 46.6 (21–64). The dacryoscintigraphic findings of the operated and healthy eyes showed that there was statistically insignificant prolongation in the tear TT at the operated side at postoperative 6th month ($P > 0.05$). The mean ECS of operated eyes was 0.89. Functional success was achieved in 43 (76.8%) patients when the ECS of 0 and 1 was accepted as successful. A statistically significant delay in drainage was observed in DSG in all of the cases with epiphora score of 2 and 3 ($P < 0.05$). The tear TT was prolonged with the age increase ($P < 0.05$), but there was no significant difference concerning the gender. **Conclusion:** DSG is an effective tool to evaluate the functional success of TDL-DCR.

Key words: Dacryocystorhinostomy, dacryoscintigraphy, epiphora, tear transit time, transcanalicular diode laser

Primary acquired nasolacrimal duct obstruction (PANDO) is a common cause of epiphora in adults. It is 4–5 times more common in females.^[1] The most common cause of PANDO is dacryocystitis. Surgical treatment is the only choice in chronic cases and acute cases those unresponsive to medical treatment. The aim of the surgical treatment is creating an ostium from lacrimal duct to the nasal cavity for draining the tear. The classical external dacryocystorhinostomy (EX-DCR) is a procedure that has been performed for >100 years, with a high anatomical success rate for PANDO treatment. However, this technique is highly traumatic and invasive, besides the procedure time is too long. Furthermore, there are some more disadvantages such as mostly general anesthesia requirement, medial canthal ligament injury risk, hemorrhage, and scar formation on skin.^[2] Recently, with the support of modern technologies such as endoscopy and laser, new surgical techniques were developed.^[2–4] Transcanalicular diode laser DCR (TDL-DCR), one of this techniques, is an updated choice for EX-DCR. It is easy to perform and takes less time than classical DCR. Furthermore, it can be done without general anesthesia, is less invasive, cosmetically applicable to patients, and affects the lacrimal pump function minimally. This technique has become a preferred procedure in our clinical practice too as in all over the world in recent years.^[3,4]

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To define the success of DCR surgery, two main terminologies are used: the anatomical success and the functional success. The anatomical success means creating a patent ostium from lacrimal duct to the nasal cavity and the functional success means draining the tear into the nasal cavity without any obvious complaint of patient.^[5] The functional success may not be achieved in all cases with anatomical success and postoperative epiphora complaint may continue in some patients after DCR surgery. Functional success can be evaluated by dacryoscintigraphy (DSG) and fluorescein dye disappearance test objectively or by epiphora complaints' score (ECS) subjectively.^[5] DSG is a radionuclide procedure, showing the passage of the radioactive agent with tear from conjunctival sac to the nasal cavity through ampulla, canaliculi, lacrimal sac, nasolacrimal canal, and the nasal cavity. It makes possible to evaluate the lacrimal pump function and the tear drainage.^[6] In this study, we aimed to evaluate the functional success objectively using DSG and subjectively using ECS test after TDL-DCR.

Methods

The records of 56 patients who underwent TDL-DCR for unilateral PANDO, and anatomical success was achieved

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between the dates of January 2013 and August 2014 were included in this retrospective study. All the patients had a full ophthalmological and nasal examination. The patients who had previous classical EX-DCR or had other epiphora causes such as entropion, ectropion, increased eyelid laxity, and facial palsy, were excluded from the study. The control group was the healthy eyes of the patients. There was no lacrimal surgery history or tearing in the healthy eye of the patients. These patients were selected by observing the lacrimal patency in the lacrimal irrigation test applied at 6 months postoperatively. The functional success was evaluated by DSG and ECS tests.

Transcanalicular diode laser dacryocystorhinostomy procedure

This surgery was performed under local anesthesia. The fiber was inserted through the superior canaliculus until it reached the wall of the sac. Reaching a hard stop was essential. An endoscope was used in the nasal passage to visualize the laser light beam. The red light beam was clearly seen and visible through the lacrimal wall, and it was just posterior to the lacrimal ridge below the neck of the middle turbinate. The laser guide light was identified to assure that it advanced in the proper direction. Diode laser (INTERmedic™ diode S30 OFT 980 nm) parameters were settled at 10 W in 500 ms pulse mode potency, taking care not to prolong each impact too much to avoid overheating the structures. Once the nasal fossa was reached, the ostium was broadened by correct fiber manipulations. We preferred toper form large (>5 mm diameters) openings covering the entire height of the lacrimal bone. Then, the fiber was pulled out of the upper canaliculus, and lacrimal irrigation was carried out. Silicone tube was not applied in any of these cases. The nasolacrimal irrigation was applied and new ostium was cleaned at postoperative control examinations.

Dacryoscintigraphy and transit time

We evaluated the transit time (TT) of radionuclide from fornix to nasal cavity by DSG. DSGs were performed and evaluated by nuclear medicine team, in the presence of an ophthalmologist at the nuclear medicine clinic. The tests were performed, using Siemens pinhole collimator. All the patients were removed the eyewear, including contact lenses, before starting the study. First, the patients were positioned in sitting position with head tilted back. Then, one drop (0.01 ml) of 10 mCi/ml 99 mTc-pertechnetate solution was instilled into the lateral fornix with a micropipette. We ensured that eye drop administration was performed with care to prevent contamination of the patient's face with radioactive drops, which could interfere with interpretation of the study. After the eye drop was administered, the patients' heads were positioned as looking directly forward while they were in sitting position for imaging. Pinhole collimator of 4 mm was focused to the nasal region anteriorly, at 10 cm distance from the the cornea. The patient was asked to blink his or her eyes normally. Following a dynamic imaging for 5 min, a frame rate of 1/(1 s per frame) with an image matrix of 64 × 64 pixels was performed, and following a 5 min of dynamic imaging (300 frames), a dynamic imaging of 15 frames in 1 min was performed. At the end of the procedure, the eyes were washed with isotonic solution to reduce the radiation absorption dose. The gained images were evaluated at the computer media by overlaying the 5 s frames on each other [Figs. 1-3]. The TT was starting with first drop

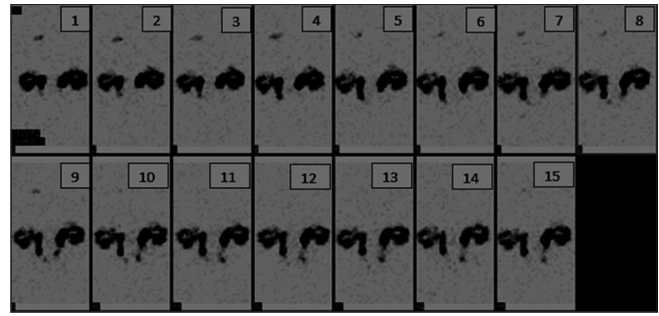


Figure 1: Dacryoscintigraphy images those taken in 1 min interval belong to a patient underwent surgery for the left eye and with Epiphora complaints' score of 1 at postoperative the 6th month. The significant increase in radioactivity in the normal eye of the nasal cavity was observed in the 4th min, whereas the increase in the operated side was observed within 5 min

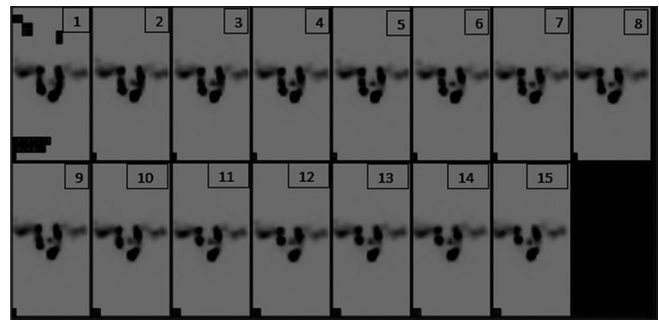


Figure 2: Dacryoscintigraphy images of a patient underwent surgery for the right eye and Epiphora complaints' score of 1 at postoperative 6th month. The transit times in operated and healthy eyes are almost equal

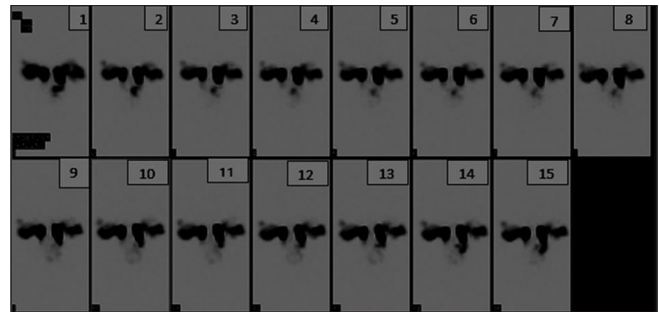


Figure 3: Dacryoscintigraphy images of a patient underwent surgery for the right eye and Epiphora complaints' score of 3 at postoperative 6th month. There is a significant difference between the right and left eye transition time. Radioactivity in left was seen in 1st min. Besides this, it was seen less clearly at later minutes in the right eye

of technetium into fornix and finishing at first detection of it in the nasal cavity. It was measured by the same researcher in all cases.

Epiphora complaints score

The patients were scored using the scale of 0–4 suggested by Munk *et al.* (0: no epiphora, 1: occasionally requiring dabbling with a tissue or handkerchief less than twice a day, 2: epiphora requiring dabbling 2–4 times a day, 3: epiphora requiring dabbling 5–10 times a day, and 4: epiphora requiring dabbling >10 times a day or constant teaming).^[5] The scores

0 and 1 were accepted as functionally successful result, while 2, 3, and 4 were accepted as unsuccessful result at postoperative 6th month. The scoring was performed by the same researcher (not the one who performed the operation).

Ethics approval and statistics

The study was in accordance with the tenets of the Declaration of Helsinki and approved by the local Ethics Committee of Gülhane Military Medical Academy Haydarpaşa Training Hospital. Informed consent had been obtained from all subjects after the nature and possible consequences of the surgery were explained. Statistical analyses: SPSS for Windows 10.0 statistics pocket program was used in analyzing the data. In comparison, Wilcoxon rank, Mann–Whitney U, Pearson’s correlation analysis, and Chi-square tests were used, and $P < 0.05$ was considered statistically significant.

Results

In this retrospective study, 56 patients whom were provided postoperative anatomical patency were included in the study. Twenty-two (39%) of them were male and 34 (61%) were female, with a mean age of 46.6 (21–64). The mean TT was 240.83 s in operated eyes and 227.95 s in healthy eyes. Although there was a small amount of prolongation in operated eyes, this difference was not statistically significant ($P > 0.05$) [Table 1]. The ECS was 4 in all patients before surgery. The distribution of the ECS at postoperative 6th month was 0 in 25 (44.6%) patients, 1 in 18 (32.1%) patients, 2 in 7 (12.5%) patients, 3 in 6 (10.7%) patients, and 4 in 0 patient. The mean ECS was 0.89. Functional success was achieved in 43 (76.8%) patients [Figs. 1 and 2]. Patients with ECS 0 and 1 had no significant prolongation in TT of the DSG test ($P = 0.160$ and 0.330 , respectively). However, in all of the cases with ECS 2 and 3 ($n = 13$), a late drainage was observed in DSG (sensitivity 100%) ($P < 0.05$) [Table 2 and Fig. 3]. In addition, the TT was prolonged with the increasing age ($P < 0.05$), but there was no significant difference in terms of the gender.

Discussion

The epiphora occurs as a result of a blockage or a restriction of the tear drainage from the nasolacrimal system to the nasal cavity due to the anatomical or functional causes. Isolated PANDO is a common anatomical cause of epiphora in adults. It refers to blockage of the tear passage to the nasal cavity as a result of nasolacrimal duct obstruction, without any anatomical pathology at the level of lacrimal sac and at the proximal of the lacrimal sac.^[1-3] It is known that, in chronic cases, surgery is the only choice of treatment. Although the EX-DCR is the gold standard surgery for PANDO, it has many disadvantages. Therefore, nowadays, the TDL-DCR which is an endoscopic laser technique became an important alternative to EX-DCR worldwide with its less risk of complications.^[7] Sufficient osteotomy can be performed easily in shorter time and in more minimally invasive way with this procedure. Therefore, we perform this technique in our clinic for last 5 years too. However, especially, the late term anatomical success rates are still lower than the classical DCR technique. We think that the learning process of this technique is still continues and the lower anatomical success rate is caused by the small number of cases performed by the ophthalmologists using this new technique. Therefore, the success rate will increase with decreasing the surgeon and the technique-related negative factors.

Table 1: Preoperative and postoperative epiphora complaints score according to Munk

ECS	Number of eyes preoperative	Number of eyes postoperative
0	0	25
1	0	18
2	0	7
3	0	6
4	56	0

ECS: Epiphora complaints’ score

Table 2: Statistical analysis of the relationship between epiphora complaints’ score and dacryoscintigraphy at postoperative 6th month

ECS	Patients	Mean transit time (s)	P
0	25	235.54±8.66	0.160
1	18	237.28±9.72	0.330
2	7	241.44±27.35	0.065
3	6	293.87±58.01	0.019

ECS: Epiphora complaints’ score

In our study, we especially investigated the functional results of the TDL-DCR surgery using DSG. We evaluated the TT to detect the drainage differences between operated and unoperated sides objectively. We observed that the mean TT in operated side was minimally longer than the healthy sides, but it was not statistically significant [Table 1]. This showed that the tear was draining from nasolacrimal duct to nasal cavity in a very similar time to normal side in most of the patients. Patients with ECS 0 and 1 had no significant prolongation in TT, and we achieved both anatomical and functional success. Patients with ECS 2 and 3 had significant prolongation in TT. We achieved anatomical success in these patients but not functional success. These results showed that ECS correlates with the TT. We know that the anatomical success doesn’t bring functional success every time. Uludağ *et al.* compared EX-DCR and TDL-DCR in patients with bilateral PANDO. They performed EX-DCR in one eye and TDL-DCR in the other eye. They reported that anatomical success rate was 89.5% in EX-DCR and 73.7% in TDL-DCR at postoperative 12th month. In subjective findings such as watering, pain, and irritation, there was no significant difference between the two groups at postoperative 12th month. Although the anatomical success rate was lower in TDL-DCR group as expected, the functional success was similar in both groups.^[8] This was possibly due to the more destructive effect of EX-DCR on anatomical structures affecting lacrimal pump function. Functional success after DCR means maintaining sufficient tear drainage. A patent opening after DCR is not adequate for this. Also an adequate lacrimal pump function is needed. Besides an adequate lacrimal pump function, an intact medial canthal tendon and active palpebral-canalicular pumping function are also needed.^[8,9] In addition to these factors, the gravity, lacrimal sac volume, and nasolacrimal duct microciliation are other important factors affecting tear drainage. The first part that extends from the conjunctiva to the lacrimal sac is dependent on the lacrimal pump function. The second part that extends from the lacrimal sac to the inferior meatus in the nasal cavity is dependent to the gravity and the resistance

in the nasolacrimal ductus. The physiology of the lacrimal sac is important for the lacrimal pump mechanism. An EX-DCR surgery may be more destructive than a TDL-DCR on all these factors. Possibly this explains why EX-DCR has more anatomical success but the same functional success rates with TDL-DCR.

In a study of Jorge Mario, the lacrimal scintigraphy of patients who had EX-DCR operation showed a significant delay in the tear drainage, compared to the control healthy group. They reported that cicatricial changes around the sac, arising by the excision of the medial wall of the sac in these patients, affect the lacrimal pump mechanism negatively.^[9] Hartikainen *et al.* showed in their study that the irrigation passage rate in the endoscopic DCR patients was higher than the EX-DCR patients. They stated that this situation resulted from the disturbance in the anatomy of the canthus and pericanthal tissues in EX-DCR.^[10] Besides this, it is not possible to achieve functional success in all cases with TDL-DCR too. Kaynak *et al.* investigated the change of anatomical and functional success with respect to time in 125 cases after TDL-DCR procedure at 3rd, 6th, 12th, and 24th month. Anatomical success was reported as 93.1%, 74.6%, 69.5%, and 68.2%, respectively. Functional success was reported as 85.4%, 67.7%, 63.3%, and 60.3%, respectively.^[11]

Our results showed that measuring TT by DSG is a valuable test to functionally evaluate the lacrimal drainage system, and it is quite sensitive in patients with a clinical diagnosis of functional nasolacrimal duct obstruction. Our results also showed that TT shows an important accordance with ECS and it is a useful and objective way of evaluating patients after TDL-DCR surgery. Fard-Esfahani *et al.* emphasized that DSG was a very effective technique in evaluating the physiology of tear drainage. In this study, in some cases without watering complaints, the elongated tear transition time in DSG attracted the attention of researchers. More interestingly; these cases begin to complain about watering over time.^[12] This result shows us that DSG can also be used to predict the long-time success rate of the operation unlike ECS system. Peter and Pearson similarly stated that the scintigraphy is a sensitive diagnostic tool to evaluate the lacrimal drainage system.^[13] As a result, DSG can detect delays in tear drainage, which is too mild to cause watering complaints. Besides this, the lacrimal scintigraphy has also some disadvantages. For example, it is not sufficient in evaluating the lacrimal sac and nasolacrimal ductus morphology as well.^[14,15]

In literature, some complications have been reported related to TDL-DCR; such as tissue necrosis and nasal-cutaneous fistula, orbital cellulite, and transient reduction in olfactory sensation.^[16-18] In our study, we did not reveal any complications that might affect our surgical outcome intraoperatively or postoperatively.

Conclusion

Our results showed that DSG is an effective tool to evaluate the functional success of TDL-DCR. We think that DSG can also be used to predict the long-time success rate of the operation unlike ECS system.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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