Eye (2008) 22, 414–419

www.nature.com/eye

CLINICAL STUDY

Scintigraphic evaluation for tear drainage, after dacryocystorhinostomy, in relation to patient satisfaction

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Abstract

Aim **To measure the degree of physiological patency of the tear drainage system using dacryoscintigraphy before and after external dacryocystorhinostomy (EDCR) in relation to patient complaints.**

Methods **Prospective evaluation of 29 eyes of 24 patients with primary acquired nasolacrimal duct obstruction (PANDO) who underwent EDCR. The epiphora complaints were measured subjectively. Dacryoscintigraphy was performed in all eyes preoperatively, and was repeated 6 months after DCR together with the complaints score. For evaluation of dacryoscintigraphy, we determined T1 (percentage of administered dose still present after 1 min) and linear clearance rate (LCR), defined as: 100%(T1−T15)/T1) from the tracer disappearance curve. Dacryoscintigraphy findings were compared with the results of 20 eyes of normal volunteers without any symptoms. Scintigraphic findings were compared before and after the operation, with the change in patient complaints score as well as with normal values.**

Results **Significant improvement occurred after the operation in the complaints score, T1 and LCR. However, despite absence of complaints (score = 0) postoperative scintigraphic values were still abnormal as compared to normal individuals.**

Conclusion **Despite almost complete remission of epiphora complaints, DCR does not result in normalization of the tear drainage system.**

Eye (2008) **22,** 414–419; doi:10.1038/sj.eye.6702656; published online 24 November 2006

Keywords: dacryocystorhinostomy; dacryoscintigraphy; epiphora

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Received: 12 April 2006
Accepted in revised form: 30 September 2006
Published online: 24 November 2006

No author involved in this study has a financial or other relationship with any commercial product manufacturer

Introduction

Dacryocystorhinostomy (DCR) is still the treatment of choice for primary acquired nasolacrimal duct obstruction (PANDO).[1] The aim of every DCR is to re-establish the functional restoration of the lacrimal system, thus controlling the symptoms of epiphora. However, this achieved anatomical patency can be at odds with the patient's desire for controlling the symptoms.[2,3] This discrepancy makes it difficult to define success of lacrimal surgery. Different authors have used many methods to evaluate the results of this treatment.[4] Objective methods as irrigation and dacryocystography are the mainstay in evaluating the success. Other authors held that subjective control of complaints should yield more credibility in evaluation success.[5]

Dacryoscintigraphy has also been used to evaluate the success of DCR, because it would reflect the patency of the lacrimal duct system in the most physiological way. This method provides objective and physiological data on the degree of tear pathway patency. We used a simple method for evaluation of dacryoscintigraphy, using T1 (percentage of administered dose still present after 1 min) and linear clearance rate (LCR) as parameters to reflect tear flow abnormalities. In normal individuals the T1 is low, whereas LCR is high. This method was validated in a previous study from our group.[6]

As known from the literature, the relation between anatomical successes, the subjective

relief of patients' complaints, and the physiological patency remains unclear.

The aim of this study was to compare the physiological patency of the lacrimal system with the complaint score of patients after successful DCR. We used dacryoscintigraphy as a physiological parameter, patient's complaint score as subjective parameter, and irrigation test as indicator for anatomical patency before and 6 months after DCR.

Methods

Patients

Twenty-nine eyes in 24 consecutive patients (19 women, five men, average age 64 years, range 27–89 years) with severe complaints of epiphora were studied. In all these patients, the irrigation test (Anel) had been performed with abnormal results, that is, no passage or difficult passage of fluids through the lacrimal system. Patients in which the fluid reached the nasopharynx after applying force during the irrigation were considered to have a partial obstruction of the nasolacrimal duct. Patients in which no fluid reached the nose were recorded to have a complete obstruction. None of the patients had an active dacryocystitis. All patients underwent a complete ophthalmic examination to rule out all causes of reflex epiphora. A special attention was paid to the absence of lower lid laxity in all patients. After performing a diagnostic dacryoscintigraphy, the diagnosis of PANDO was reached in all patients.

Preoperatively the complaints score was subjectively determined by one of the authors (not the one who performed the operation) using the score suggested by Munk *et al*.[7]

This scale begins with scale 0, which means no epiphora, and goes up to scale 4, which means constant tear flow (Table 1).

All patients underwent dacryoscintigraphy 1–3 weeks before the operation and 6 months postoperatively. The complaints score according to Munk, as well as a second irrigation test, was determined at the same postoperative point of time. To minimize the possibilities of bias, the assessment of Munk score was performed again by one of the authors who did not perform the surgery.

All patients gave informed consent, and the institutional review board approved the study.

Table 1 Complaints score according to Munk pre- and postoperative

Complaint score	*Number of eyes preoperative*	*Number of eyes postoperative*
4	25	1
3	3	0
2	1	3
1	0	6
0	0	19

DCR

External dacryocystorhinostomy (EDCR) was performed by one of the authors. The surgical procedure was the same in all the patients. Under general anaesthesia, the standard modified Dupuy-Dutemps DCR was performed.[8]

Under general anaesthesia, a 2-cm incision was made at the level of the anterior lacrimal crest. The orbicularis muscle was bluntly dissected and the periostium was exposed. The osteotomy opening was created using an electrical drill. Posterior flaps of the nasal mucosa and the lacrimal sac were sutured with two 5-0 absorbable sutures. Silicone bicanalicular nasolacrimal tubes were used to intubate the lacrimal system. The anterior mucosal flap of the nasal mucosa was sutured to the anterior flap of the lacrimal sac with interrupted 5-0 absorbable sutures. The periostium and subcutaneous tissue were sutured with 5-0 absorbable sutures. The skin was sutured with 6-0 silk.

The skin sutures were removed 5–7 days postoperatively. The lacrimal bicanalicular silicone tube was removed 3 months postoperatively.

Controls

Scintigraphic data were compared with normal values obtained in a previous study using the same method of dacryoscintigraphy, based on 20 eyes in 10 healthy volunteers without any signs or past history of epiphora or dry eyes (two women, eight men, average age 53 years, range 37–65 years).[6]

Dacryoscintigraphy

We used the method validated and described earlier.[6]

Briefly, patients were sitting upright in front of low-energy high-resolution collimator of a gamma camera. The head of the subject was fixed using a chin support. A 10-μl drop of technetium-99m pertechnetate was instilled in the inferior conjunctival fornix of each eye. The subject was requested to remain still, but to blink normally. Within 15 s after the beginning of tracer administration, dynamic images were obtained for 15 min using one frame per minute. Images were acquired without zoom, in a 256×256 matrix.

One region of interest (ROI) was positioned carefully over the entire conjunctival sac. From this ROI, a

time–activity curve was constructed showing the disappearance of the instilled radioactivity. From this curve, two parameters were determined. The first parameter was T1, which is the activity (% of administered dose remaining in the eye) in the first minute after tracer administration. The second parameter was the LCR defined as 100%(T1−T15)/T1, where T15 is the remaining activity as percentage of the administrated dose in the 15th minute. A typical example is illustrated in Figure 1. In three patients, a teardrop was observed on the cheek between the 8th and 12th minute. This resulted in a sharp declining in the time–activity curve suggesting a passage in the lacrimal system. Therefore, in these patients the time–activity curve has been extrapolated to the 15th minute, so that the LCR value could be calculated on the same way.

All studies were performed and analysed in the same way, by the same experienced nuclear medicine technologist, who was not aware of the complaint score of the patients. All studies were performed in the same room under identical conditions of temperature and humidity.

Statistics

Scintigraphic parameters before and after DCR, and between postoperative DCR patients and controls were compared using paired *t*-tests. DCR-induced changes in complaints score were compared with Wilcoxon's test. Defining subgroups and using independent sample Student's *t*-tests determined relation between complaints score and scintigraphic parameters. Two-sided *P*-values 0.05 were considered significant.

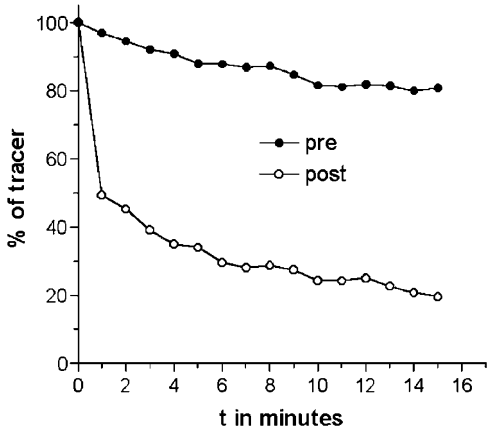

Figure 1 Typical time–activity curves obtained through dacryoscintigraphy from the eye of an epiphora patient pre- and postoperatively. The postoperative curve shows both improved initial drainage (T1 value) and improved overall disappearance (LCR value, steeper linear slope).

Results

Anatomical patency: syringing

Before the operation, we found 26 lacrimal systems with complete stenosis and three lacrimal systems with incomplete stenosis on syringing. After DCR, 28 out of 29 lacrimal systems were patent on syringing. The one system without patency had an incomplete stenosis preoperatively.

Complaints

Preoperatively, 25 eyes showed complaints score of 4; three eyes had a complaint score of 3 and one eye a complaint score of 2. The three eyes with incomplete stenosis all had complaints score of 4. The mean complaints score preoperatively was 3.8 ± 0.5 (SD).

Postoperatively, the complaints score was 0 in 19 eyes, 1 in 6 eyes, 2 in three eyes, and 4 in one eye, the same one with absent patency on syringing (Table 1). The mean complaints score postoperatively was 0.6 ± 0.9. There was a significant difference between the complaints score pre- and postoperatively ($P < 0.001$).

Dacryoscintigraphy

Preoperative T1 was $82.4 \pm 17.0\%$, whereas LCR was $37.2 \pm 22.8\%$. Both values were significantly different from the controls (Table 2). DCR led to a significant improvement as the postoperative T1 had decreased to $69.8 \pm 16.6\%$ ($P = 0.008$). Also LCR had considerably improved, and had increased to $53.8 \pm 21.3\%$ ($P = 0.03$).

Relation between complaints and dacryoscintigraphy

When we classify the eyes according to their postoperative complaint score, postoperatively the T1 was $68.1 \pm 18.0\%$ and LCR was $57.9 \pm 20.9\%$, in the eyes with a postoperative score of 0 ($n = 19$), and 73.2 ± 13.9 and $46.0 \pm 20.7\%$, respectively in the 10 eyes with a postoperative score >0. This difference was not significant. Also classifying patients using other cutoff

Table 2 Results of the complaint score, T1, and LCR

	Complaint	*T1*	*LCR*
Controls	0	46.0 ± 15.7	71.3 ± 19.7
Pat. preoperative	3.8 ± 0.5	82.4 ± 17.0	37.2 ± 22.8
Pat. postoperative	0.6 ± 0.9	69.8 ± 16.6	53.8 ± 21.3
P-value *vs* preoperative	$P < 0.001$	$P = 0.008$	$P = 0.03$
P-value *vs* control	—	$P = 0.001$	$P = 0.03$

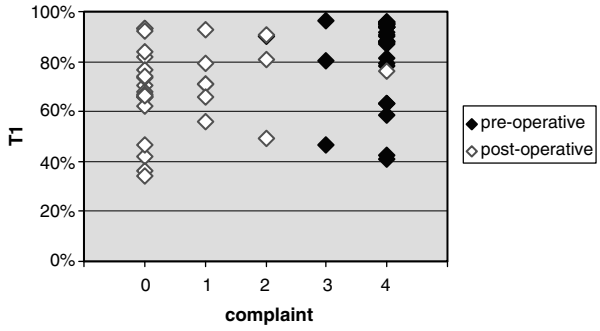

Figure 2 T1 values and complaints pre- and postoperatively.

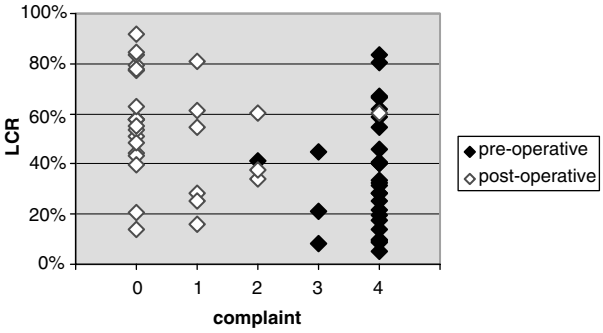

Figure 3 LCR values and complaints score pre- and postoperatively.

points for the complaints score did not produce significant difference (Figures 2 and 3).

Comparison of post DCR values and normal controls

In the control group, the mean T1 was $46.0 \pm 15.7\%$ and the LCR was $71.3 \pm 19.7\%$. These values were significantly better than the results of postoperative DCR patients ($P = 0.001$ and 0.03) (Table 2).

Discussion

This study shows that DCR does not lead to normalization of the tear drainage through the nasolacrimal system, as evidenced by dacryoscintigraphy. However, in nearly all patients complaints of epiphora had disappeared or significantly decreased, and also patency on syringing had normalized. These findings illustrate the differences between subjective evaluation using Munk's score, anatomical evaluation using syringing, and physiological assessment using dacryoscintigraphy.

The evaluation of DCR success is a rather difficult issue. As the main goal of DCR is to free patients from their epiphora complaints, it can therefore be concluded from this study that external DCR is a successful operation. In our study, after 6 months, 28 patients (97%) had a patent nasolacrimal duct on syringing, and 25 patients (86%) had complaints score of 1 or less, 6 months after DCR. In the whole study group, the complaints score had significantly improved ($P < 0.001$). This is in line with previous results in the literature.[1,3,9] However, a patent nasolacrimal system, even on dacryocystography, does not exclude nonsatisfied epiphora patients.[2,3] Therefore, most authors believe that subjective evaluation is more credible than objective methods.

Apart from subjective and anatomical evaluation, also dacryoscintigraphy can be used to evaluate the patency of the lacrimal drainage system, as this is probably the most physiological test that provides quantitative criteria.[6] Von Denffer *et al*[10] concluded that scintigraphy is the best method for measuring the dynamics of tear drainage.

Wearne *et al*[11] even concluded that dacryoscintigraphy is a slightly better diagnostic method than dacryocystography in patients with PANDO.

In our study, we used a simple and validated method of quantification in dacryoscintigraphy, only based on tracer disappearance from the eye. The parameters T1 and LCR are easy to understand and have adequate sensitivity and specificity for the detection of tear drainage dysfunction.[6] Part of the radioactive tracer is absorbed from the mucus membranes of the lacrimal system.[6,12] This explains why T1 even in the patients with complete stenosis is not 100%.

In this study, dacryoscintigraphy clearly detected the effects of DCR. Before DCR, T1 was significantly higher and the LCR was significantly lower than values from controls, as expected. Postoperatively, both scintigraphic values had significantly improved in the patients group underlining the success of the operation. Scintigraphic values, however, did not correlate with complaints scores, as we found no differences in scintigraphic drainage parameters between subgroups that had complaints score >0 as compared to the subgroups with complaints score of 0. Also creating subgroups using other cutoff points did not produce significant differences. In a previous study, we also found no relation between the severity of epiphora complaints and the scintigraphic values after applying dacryoscintigraphy in 66 eyes with severe epiphora.[6] O'Donnell and Shah[2] and Conway[3] reported similar observations.

Despite the improvements in scintigraphic drainage parameters, it appeared that the drainage rate after subjectively and objectively successful DCR remains abnormal, as scintigraphic post DCR values were still worse compared to controls. Even if we only consider the subgroup that had complaints score of 0, this difference was still present.

What could explain the observed differences in tear drainage *vs* symptoms?

Firstly, it is important to note that the complaints score according to Munk is a rather rough measure, in contrast with the precise scintigraphic measurements. Within the large group of patients with complaints score 4, there evidently are large differences in drainage parameters. A possible explanation could be that there is a large overcapacity in the drainage system, and as PANDO progresses, this overcapacity is used up to a point where complaints arise. In addition, there are individual differences in rating the symptoms of epiphora. Scintigraphy may therefore have an unnecessary precision.

Another reason why post DCR patients still have impaired drainage, as compared to controls, is the effects of the lacrimal pump that is disrupted by external DCR. Tear fluid elimination from the lacrimal drainage system is not merely an outflow procedure which is only dependent on the patency of the tear passage way. Chavis *et al*[13] suggested that the lacrimal drainage system is best approached as a bimodal system. The first part from the conjunctiva to lacrimal sac is dependent upon the lacrimal pump. This phase is represented scintigraphically mainly by the value of the T1. The second part, by which tears drain from the sac to the inferior meatus of the nose, is dependent on gravity and the resistance in the nasolacrimal duct. After external DCR, the lacrimal pump is probably less functional, as the medial canthus anatomy is disrupted. Malbouisson *et al*[14] reported that the lacrimal pump mechanism is affected by DCR and does affect the tear kinetics.

Hartikainen *et al*[15] illustrated and reported that patency rates for endoscopic DCR, without this disruption, were higher than those for external DCR when patients with patency to irrigation were studied.

Zilelioglu *et al*[16] evaluated lacrimal drainage in patients who have undergone successful DCR using dacryoscintigraphy. They divided their patients group in three subgroups; group 1: after EDCR; group 2: after endoscopic DCR; and group 3: after conjunctival dacryocystorhinostomy with Jones tube. They found that in groups 1 and 2 the tear drainage was significantly slower than normal individuals. There was no difference in group 3.

A third reason for the still abnormal drainage after DCR was suggested by Paulsen *et al*,[17] who examined the structure of a system of large blood vessels integrated in the bony canal between the orbit and the inferior nasal duct. This area is usually interrupted after DCR. Paulsen concluded that this surrounding vascular plexus of the lacrimal sac and nasolacrimal duct is comparable to a cavernous body. Malfunction in the cavernous body may lead to disturbance in the tear flow cycle. As both the mucus membranes of the lacrimal sac, nasolacrimal duct, and the vascular plexus are all affected by DCR, transmembrane absorption and transport rates of the tear fluid would be affected. Other reasons could be that the absorption rate of tear fluid through the lacrimal system is different after DCR, as compared to normal individuals. Sorensen and Jensen[12] found that the rate of tear absorption is different in patients with dacryocystitis, patients after dacryocystectomy, and normal individuals. This means that the rate of tear absorption is dependant on the anatomical and pathological changes in the lacrimal system.[12]

Also the possible rests of postoperative inflammatory process or irritation in the lacrimal pathway after DCR might cause reflex secretion.[18]

These points may also explain that the physiological tear pathway after DCR does not normalize, and further illustrate the difference between subjective and objective parameters.

In conclusion, the tear drainage system after external DCR functions sufficiently adequate in order to free patients of their complaints. However, the dynamic function of the drainage system remains inferior to a normal system.

Acknowledgements

We thank Dr N Jansonius (Department of Ophthalmology) for his expert statistical assistance in the paper.

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