

# Dacryoscintigraphic Findings in the Children with Tearing

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**Purpose:** To investigate the diagnostic effectiveness of dacryoscintigraphy in children with tearing; to evaluate tear clearance rate as a diagnostic factor of dacryoscintigraphy in children with tearing; and to analyze the results of treatment according to dacryoscintigraphic findings in children with tearing.

**Methods:** Between January 2010 and April 2014, 176 eyes of 88 children with tearing (49 boys and 39 girls; mean age, 23.81 ±14.67 months; range, 12 to 72 months) were studied retrospectively. Of these, 37 of 88 children with tearing were bilateral cases, and 51 were unilateral cases. None of the patients had a history of craniofacial disorder or trauma. The chief complaint of tearing with or without eye discharge and delivery mode, past history of neonatal conjunctivitis, syringing, or probing were collected from parents, grandparents, or previous hospital data. The drainage pattern of the nasolacrimal duct was analyzed, and the clearance rate of 50 μCi 99m technetium pertechnetate was measured by dacryoscintigraphy.

**Results:** According to the dacryoscintigraphy results, 98 of 125 eyes (78.4%) with tearing showed nasolacrimal obstruction and 29 of 51 eyes (56.9%) without tearing showed patency. There was a significant difference between tearing eyes and normal eyes ( $p = 0.001$ ). The clearance rate difference after 3 and 30 minutes was 16.41 ± 15.37% in tearing eyes and 23.57 ±14.15% in normal eyes. There was a significant difference between epiphoric eyes and normal eyes ( $p = 0.05$ ). Based on the dacryoscintigraphic findings, nasolacrimal-duct obstruction was treated with probing or silicone-tube intubation. The majority of patients showed symptom improvement (75.2%) during the two months of follow-up.

**Conclusions:** Dacryoscintigraphy is a non-invasive method of qualitatively and quantitatively diagnosing nasolacrimal duct obstruction in children with tearing.

**Key Words:** Dacryoscintigraphy, Nasolacrimal duct, Obstruction, Tearing

Tearing is a common symptom encountered in ophthalmology and is usually due to an obstruction of the lacrimal

excretion system [1]. There are a variety of causes of tearing within the pediatric population: central nervous system-related hypersecretion, trichiasis, epiblepharon, keratoconjunctivitis and other ocular inflammation, functional epiphora due to nasolacrimal duct stenosis or ostium partially blocked by hypertrophic or laterally-inclined inferior turbinate, congenital nasolacrimal duct obstruction, or congenital atresia [2-4].

For cases of congenital nasolacrimal duct obstruction, spontaneous resolution is rapid during the first month of

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life, and 96% resolve in the first year without intervention. In addition, probing and syringing the nasolacrimal duct at age 12 to 14 months was effective compared with spontaneous resolution at 15 months. It is preferable to wait until at least age 10 to 12 months before probing unless there is a congenital dacryoceles or acute dacryocystitis [2-4].

Diagnostic methods for tearing are canaliculus irrigation test, probing, ultrasound and dacryoscintigraphy. A canaliculus irrigation test for children older than 12 months is sometimes risky because of possible drainage to the canaliculus or periocular tissue and can be stressful for children even when using local anesthesia in the clinic. Dacryoscintigraphy has some advantages, including a lower dose of radiation, better demonstration of the lacrimal apparatus physiology, and increased safety compared to dacryocystography [5].

Patients who complain of epiphora without tear overproduction, but show easy passage on syringing are said to have functional lacrimal duct obstruction. This delayed or absent excretion of tears without anatomical obstruction of the lacrimal system has been shown to be caused by stenosis of the lacrimal system, aberrant punctum location, blocked flow through the punctum, or dysfunction of the lacrimal excretion pump [5-10]. Dacryoscintigraphy is an effective method of diagnosing functional lacrimal duct obstruction. The goal of this study was to investigate the diagnostic effectiveness of dacryoscintigraphy in children with tearing; to evaluate tear clearance rate as a diagnostic factor of dacryoscintigraphy in children with tearing; and to analyze treatment according to dacryoscintigraphic findings in children with tearing.

## Materials and Methods

Between January 2010 and April 2014, 176 eyes of 88 children with tearing (49 boys and 39 girls; mean age, 23.81 ± 14.67 months; range, 12 to 72 months) were studied retrospectively. None of the patients had a history of craniofacial disorder or trauma. The chief complaint of tearing with or without eye discharge, delivery mode, past history of neonatal conjunctivitis, syringing, or probing were collected from parents, grandparents, or previous hospital data. Thirty-seven of 88 children with tearing were bilateral cases, and 51 were unilateral cases. Nasolacrimal duct drainage was analyzed, and the clearance rate of 50 µCi

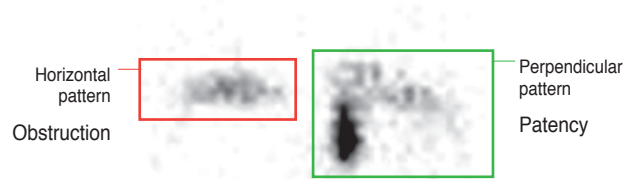


Fig. 1. Patency pattern of dacryoscintigraphic findings.

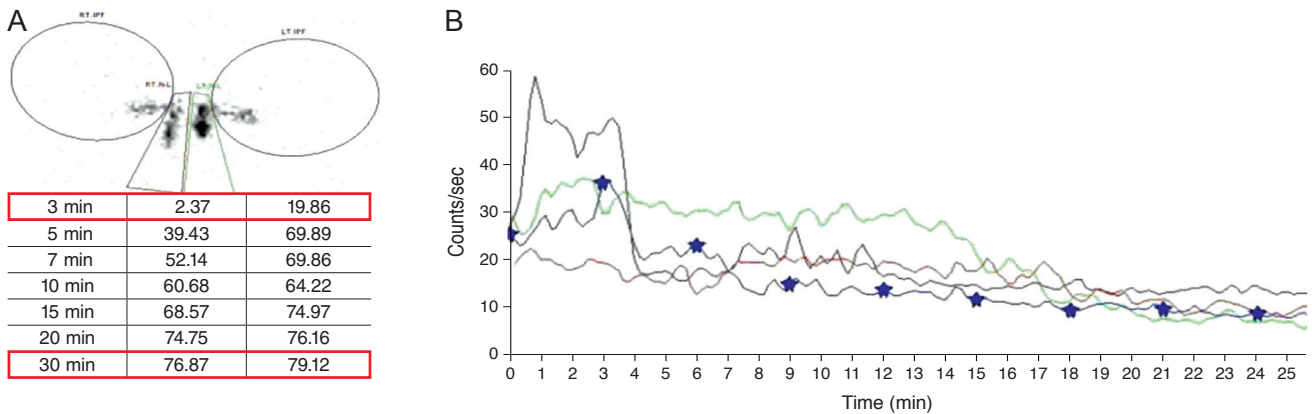
99m technetium pertechnetate was measured by dacryoscintigraphy using Symbia Intevo (Siemens Healthcare, Erlangen, Germany) nuclear imaging system (Fig. 1). Dacryoscintigraphy was performed in all patients. For patient requiring sedation, 10% chloral hydrate (0.8 mL/kg) was used. Patients were supported by adults in order to maintain a standing position in front of the gamma camera. After instillation of two drops of 50 µCi 99m technetium pertechnetate in the lateral portion of each eyeball, we recorded bilateral eyeball images and determined clearance rate at the nasal cavity at 3, 5, 7, 10, 15, 20, and 30 minutes after instillation (Fig. 2).

Based on the dacryoscintigraphic findings, nasolacrimal duct obstruction with tearing was treated using probing or silicone tube intubation. Children with tearing from other causes were observed. Statistical analysis was carried out using the PASW Statistics ver. 18.0 (SPSS Inc., Chicago, IL, USA). Fisher's exact test, the Mann-Whitney *U*-test, and Kruskal-Wallis test were used for analyses. All *p*-values are reported as corrected *p*-values, and *p* < 0.05 was considered to indicate statistical significance.

## Results

Of the 176 eyes of children with tearing, 51 were normal eyes and 125 were tearing eyes. Sex distribution in normal eyes was 28 boys and 23 girls, and that in tearing eyes was 70 boys and 55 girls. There were no significant differences in sex distribution (*p* = 0.48), mean age (*p* = 0.81), or age distribution (*p* = 0.69) (Table 1).

According to the results of dacryoscintigraphy, 98 of 125 eyes with tearing (78.4%) showed nasolacrimal duct obstruction and 29 of 51 eyes without tearing (56.9%) showed obstruction. There was a significant difference in duct obstruction between tearing eyes and normal eyes (*p* = 0.001). In addition, 27 of 125 eyes with tearing (21.6%) showed patency, and 22 of 51 eyes without tearing (43.1%) showed patency, a significant difference (*p* = 0.001). The sensitivi-



**Fig. 2.** (A) Clearance rate measured in the nasal cavity area after 3, 5, 7, 10, 15, 20, and 30 minutes. (B) Time activity curve.

**Table 1.** Demographic characteristics of children with tearing

Characteristics	Normal eyes (n = 51)	Tearing eyes (n = 125)	p-value
Male : female	28 : 23	70 : 55	0.48*
Age (mon)	≤24	87	0.69*
	>24	38	0.69*
Total	24.15 ± 15.07	23.70 ± 14.28	0.81†

Values are presented as number or mean ± SD.

\*Fisher exact test; †Mann-Whitney U-test.

**Table 2.** Dacryoscintigraphic findings in children with tearing

Findings (%)	Normal eyes (n = 51)	Tearing eyes (n = 125)	p-value*
Obstruction†	29 (56.9)	98 (78.4)	0.001
Patent	22 (43.1)	27 (21.6)	0.001
Total	51 (100)	125 (100)	

\*Fisher exact test; †Obstruction was defined as the absence of perpendicular pattern in dacryoscintigraphy.

**Table 3.** Clinical outcomes of children with tearing after treatment

Success* / cases (%)	Tearing eyes (n=125)	
	Patent (n=27)	Obstruction (n=98)
Observation	13 / 17 (76.5)	6 / 29 (20.7)
Probing	3 / 4 (75.0)	13 / 13 (100.0)
Silicone tube intubation	4 / 5† (80.0)	50 / 52 (96.2)
Correction of epiblepharon	3 / 3 (100.0)	8 / 8 (100.0)
Total	21 / 27 (77.8)	73 / 98 (74.5)

\*Success: absence of tearing and discharge more than 2 months after treatment; †Delayed clearance rate compared with the contralateral side.

ty of dacryoscintigraphy was 78.4% and the specificity was 43.1% in our study (Table 2).

The clearance rate after 3 minutes was  $14.21 \pm 13.86\%$  in tearing eyes and  $12.68 \pm 11.98\%$  in normal eyes. The clearance rate after 30 minutes was  $30.56 \pm 18.31\%$  in tearing eyes and  $35.02 \pm 18.31\%$  in normal eyes. There were no significant differences in the clearance rate after 3 minutes or 30 minutes. The difference between clearance rate after 3 minutes and 30 minutes was  $16.41 \pm 15.37\%$  in tearing eyes and  $23.57 \pm 14.15\%$  in normal eyes, a significant difference between ( $p = 0.05$ ) (Fig. 3).

Of the 125 tearing eyes, 27 eyes showed patency and 98 eyes showed obstruction. Seventeen tearing eyes with patent dacryoscintigraphic findings were observed, and 13 of 17 had improved tearing two months after dacryoscintigraphy. In the dacryoscintigraphic findings of four tearing eyes with patency, differences between clearance rate after 3 and 30 minutes were less than 30%. Therefore, four tearing eyes with a patent pattern were treated with probing, of which three were improved. Five eyes showing delayed clearance compared with the contralateral side received silicone-tube intubation. Of these, four improved. Three eyes with epiblepharon received correction operation, all of which improved (Table 3).

Regarding the obstructed eyes, 29 were observed because there were no symptoms of tearing or there was only slight tearing; therefore, the patients' parents didn't want their children to be treated with procedures. In 29 obstructed eyes treated with observation, six were absent of tearing and discharge more than two months after dacryoscintigraphy, and 13 were treated with probing, all of whom were improved.

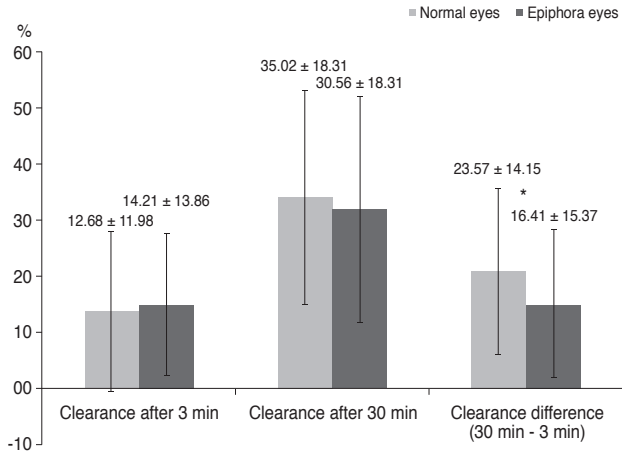


Fig. 3. Tear clearance rate 3 minutes and 30 minutes after institution according to dacryoscintigraphy. \**p* = 0.05.

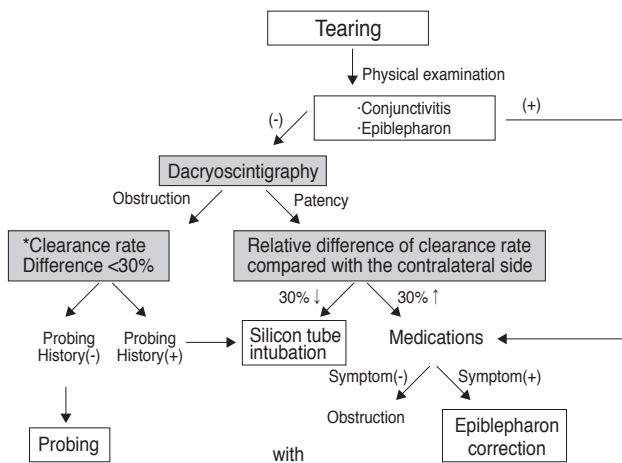


Fig. 4. Flow-sheet for the management in children of tearing in children older than one year. \*30 min - 3 min.

Of the 52 eyes treated with silicone-tube intubation, 50 were improved. All of the eight eyes with epiblepharon received a corrective operation, and all improved. The total success rate of patent eyes was 77.8%, compared with the total success rate of obstructed eyes at 74.5%. The flow-sheet used to manage children with tearing is shown in Fig. 4.

### Discussion

Dacryocystography is the traditional radiological investigation for epiphora. However, like a canaliculus irrigation test, it is an invasive procedure and requires a high dosage of radiation be applied to children [11]. Dacryoscintigraphy

has a more physiologic method of illustrating the lacrimal apparatus and is safer than dacryocystography [1,12-18]. A total of 52 eyes in 43 children with an obstructed pattern and five eyes in four children with a delayed-clearance pattern underwent silicone-tube intubation, and 54 eyes experienced improved symptoms (94.7%).

In tearing eyes with nasolacrimal duct obstruction evaluated by dacryoscintigraphy, most obstructions were at the level of the proximal nasolacrimal duct or distal nasolacrimal duct. In tearing eyes with nasolacrimal duct patency evaluated by dacryoscintigraphy, the majority of cases were believed to be conjunctivitis. Empirically, patients with tearing eyes and a patent nasolacrimal duct on dacryoscintigraphy had conjunctival injection and follicles or papillas on the conjunctiva seen on slit-lamp examination or gross inspection. Tearing symptoms were mostly improved through treatment with antibiotics or anti-inflammatory eye drops. This suggests that the major cause of tearing eyes with patent nasolacrimal duct was conjunctivitis. Others potential causes were functional nasolacrimal obstruction or epiblepharon, which were treated with probing, silicone-tube intubation, or correction of epiblepharon.

In congenital nasolacrimal duct obstruction, the success rate of probing was 75.0% in children aged 6 to 15 months [19] and 50% in children aged 7 and 30 months [20]. The success rate of silicone-tube intubation [21-23] was 89% in children between 12 to 48 months [24] and 83.33% in children between 6 to 30 months [25]. In this study, the success rate of probing was 75.0%, silicone-tube intubation was 80.0% and epiblepharon correction was 100.0% in the tearing eyes with nasolacrimal duct patency by dacryoscintigraphy. The success rates of probing and silicone-tube intubation in this study were greater than or equal to the success rates of previous studies. In the previous studies, the probing or silicone-tube intubation was performed according to tearing symptoms. Therefore, tearing eyes with patent nasolacrimal duct could be also regarded as cases successfully treated by probing or silicone-tube intubation. The age range of these patients was 12 to 72 months in this study, and the outcome of probing or silicone-tube intubation in this study was better than those of previously published reports with younger patients (age range, 6 to 48 months) [19-25]. In normal eyes with nasolacrimal duct obstruction by dacryoscintigraphy, the causes were suggested to be a false-positive result of dacryoscintigraphy or dry eyes with functional nasolacrimal duct obstruction.

Dacryoscintigraphy is a non-invasive modality available to children. According to the study by Heyman et al. [26], the absorbed radiation dose to the lens of the eye in dacryoscintigraphy (estimated to be 4-14m rads/100  $\mu$ Ci of technetium pertechnetate) is considerably less than that of a skull X-ray (360m rads) or dacryocystography (3,000m rads). This procedure is a qualitative diagnosing method with 78.4% sensitivity and 43.1% specificity. In addition, it can be a quantitative diagnosing method by measuring the technetium-pertechnetate clearance rate difference after 3 and 30 minutes. The clearance rate after 3 minutes was lower in normal eyes than tearing eyes, but the clearance rate after 30 minutes in normal eyes was similar to the clearance rate in tearing eyes. Differences in the clearance rate between 3 and 30 minutes were significantly less in tearing eyes than normal eyes. We found that tear clearance from the nasal cavity requires at least 3 minutes. This is the first report about dacryoscintigraphic clearance rates in children with tearing.

This study has the limitation of being a retrospective study. The results of this work lay the foundation for further prospective study, which should be performed to confirm the usefulness of dacryoscintigraphy in children with tearing. In addition, this study was limited by measuring clearance only at the nasal cavity, as 50  $\mu$ Ci 99m technetium pertechnetate drained from the interpalpebral fissure into the nasal cavity. Measuring both the interpalpebral fissure and the nasal cavity can be useful in diagnosing functional nasolacrimal duct obstruction.

In conclusion, dacryoscintigraphy is a non-invasive method of qualitatively and quantitatively diagnosing nasolacrimal duct obstruction in children with tearing.

## Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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