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Degree of agreement between dacryoscintigraphy and dacryocystography examinations results in primary acquired nasolacrimal duct obstruction

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Abstract

Background: This diagnostic study aimed to assess degree of agreement between dacryoscintigraphy and dacryocystography as supporting examinations in patients with primary acquired nasolacrimal duct obstruction (PANDO). Patients with PANDO who complained of epiphora and visited our outpatient clinic were subsequently sent for dacryoscintigraphy and dacryocystography examinations. Side effects and convenience of both examinations were assessed by observation and questionnaire.

Material and methods: Through irrigation and probing, there were 47 out of 62 eyes were found with PANDO. As much as 87.1% subjects were female, with mostly (74.2%) aged > 40 years old. With dacryoscintigraphy, time needed to reach sac was 0 minutes, 5 minutes (duct), and 12.5 minutes (nasal cavity).

Results: Degree of agreement between both examinations was 83.8% to determine obstruction and 70.9% to locate obstruction. There were 22 subjects complained about pain in dacryocystography examination while none with dacryoscintigraphy ($p < 0.005$). Sixteen subjects feel dacryoscintigraphy examination was more convenient, eleven subjects feel dacryocystohraphy was more convenient, while 4 subjects feel the two examinations were similar.

Conclusions: Even though dacryocystography examination was considered more painful than dacryoscintigraphy, both examinations had high convenience level for patients. Dacryoscintigraphy and dacryocystography also had a good agreement in detecting and locating obstruction in PANDO.

KEY words: nasolacrimal duct obstruction; dacryocystography; dacryoscintigraphy

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Introduction

Epiphora is an abnormal condition when patients experience watery eyes due to chronic tears overflow. Epiphora induced by nasolacrimal duct obstruction (NLDO) was considered often and accounted for one-third of the total number of epiphora cases [1]. Dacryocystography (DCG) is a form of radiology modality most commonly used to assess the lacrimal drainage system [1]. DCG is a very useful anatomy examination to determine the location of obstruction and stenosis by administering contrast using irrigation cannula through the lacrimal punctum. However, this modality also has some disadvantages. Examination by DCG is invasive because we put instruments into the canaliculus. Moreover, this examination can raise a false positive result in partial obstruction cases [2,3].

Besides DCG, dacryoscintigraphy is another radiology modality used to assess tear drainage systems more physiologically. It uses radioactive (^{99m}Tc) to mark off the tear and record the flow with a gamma camera [1]. Generally, dacryoscintigraphy is used to assess tear flow in patients with lacrimal pump dysfunction [1]. In mechanical obstruction cases, the obstructed parts of the lacrimal drainage system will be visualized by the contrast [4].

Even though dacryoscintigraphy is a good lacrimal drainage system obstruction examination modality, this examination is still rarely used by ophthalmologists [1]. This may be due to a lack of tools or facilities to do dacryoscintigraphy [5]. Therefore, this study aimed to determine the degree of agreement of dacryoscintigraphy and DCG as additional examination in patients with primary acquired nasolacrimal duct obstruction (PANDO). Additionally, we also assessed side effects and patient convenience of both dacryoscintigraphy and DCG examination that have not been published in the previous studies.

Material and methods

Our study was classified as a diagnostic test study. We included patients with PANDO aged ≥ 18 years old with epiphora and negative irrigation test (Anel test). The exclusion criteria were patients with the acute inflammatory process, NLDO caused by tumor/abscess, history of allergy to radioactive contrast, and patients who were in pregnancy or breastfeeding. The participants were selected by the consecutive sampling method. Thirty-one subjects were included in this study. The study protocol was approved by the Ethics Committee of Faculty of Medicine Universitas Indonesia, number KET.142/UN2.F1/ETIK/PPM.00.02/2019.

In the outpatient settings, we conducted an irrigation test on both eyes by injecting saline solution into the lacrimal punctum followed by probe insertion to the canaliculus through the punctum to determine whether there was a hard stop or soft stop. A hard stop was originated from the lower system (nasolacrimal duct) while the latter was originated from the upper system (canaliculus). Subjects with obstruction located in the canaliculus would be excluded.

Dacryoscintigraphy was performed by dripping ^{99m}Tc-Pertechnetate solution into both eyes. Afterward, the picture was taken with a gamma camera at the dynamic phase (first 5 minutes), and then at 10, 15, 20, 25, and 30 minutes. DCG examination was performed by positioning the patient in a supine position. Topical anesthesia was instilled into both eyes. Each punctum was injected with contrast using a blunt needle and a 3 cc syringe. Fluoroscopy was used to observe contrast flow dynamically. Dacryoscintigraphgy and DCG results were analyzed without knowing previous ophthalmology conditions. Side effects and the convenience level of DCG and dacryoscintigraphy examinations were assessed with observation and questionnaires.

We measured both primary and secondary outcomes. The primary outcome was defined as the degree of agreement in deciding the presence and the location of the obstruction, analyzed by concordance rate and Kohens Kappa through SPSS Statistics 20.0. Secondary outcome in this study was the tracer transit time of unobstructed eye in dacryoscintigraphy examination that would be described in minutes when the tracer reaches lacrimal sac, nasolacrimal duct, and nasal cavum.

Results

We recruited 62 eyes from 31 subjects whose characteristics were described in Table 1. Forty-seven out of 62 eyes tested negative in the irrigation test, hence, fulfilled the inclusion criteria as patients with PANDO.

Table 2 showed the degree of agreement between dacryoscintigraphy and DCG in the determination of obstruction in the lacrimal drainage system. There were 45 obstructed eyes (72%) found with a DCG examination whereas a higher percentage (85%) was found in a dacryoscintigraphy examination. Dacryoscintigraphy examination revealed nine eyes without obstruction in the lacrimal drainage system but there was one eye with an obstruction found with irrigation test and DCG examination. The degree of agreement between the two examinations was 83.8%. The concordance rate value was 83.8% showing a strong agreement between the two examinations.

Table 1. Subject characteristics

Subject Characteristics	n	Percentage (%)
Gender		
Male	4	12.9
Female	27	87.1
Age group		
18–40 years	8	25.8
> 40 years	23	74.2
Mean ± SD age (years)	50.8	15.2
Negative irrigation test		
Unilateral	15	48.4
Bilateral	16	51.6

Table 2. Dacryoscintigraphy and dacryocystography conformity of obstruction presence results (n = 62 eyes)

	Dacryocystography (n)		
	Obstruction	No obstruction	Total
Dacryoscintigraphy			
Obstruction	44	9	53
No obstruction	1	8	9
Total	45	17	62

Mc Nemar p = 0.021; degree of agreement = 52/62 (83.8%); p value < 0.005

Table 3. Dacryoscintigraphy and dacryocystography conformity of obstruction height (n = 62 eyes)

	Dacryocystography (n)			
	Sac-duct junction	Duct	No obstruction	Total
Dacryoscintigraphy				
Sac-duct junction	35	7	6	48
Duct	1	1	3	5
No obstruction	1	0	8	9
Total	37	8	17	62

Mc Nemar p = 0.011; degree of agreement = 44/62 (70.9%); p value < 0.005

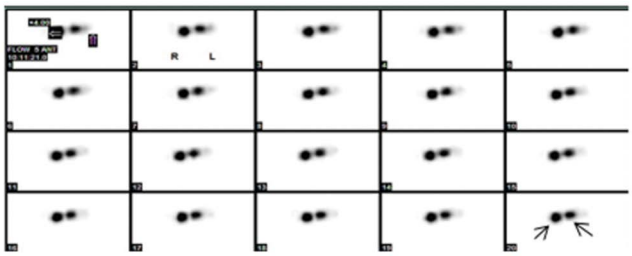

Figure 1. The dynamic phase of dacryoscintigraphy (first 5 minutes). The contrast reached both lacrimal sacs (black arrows)

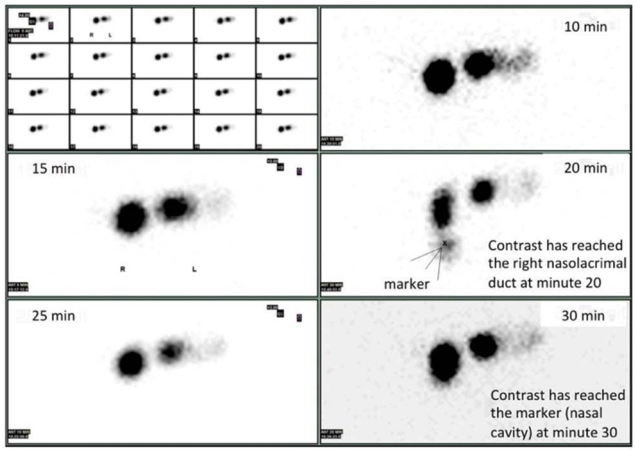

Figure 2. Dacryoscintigraphy in obstruction at left sac-duct (S/D) junction level at dynamic phase, minute 10–30

Table 3 demonstrated the degree of agreement between dacryoscintigraphy and DCG in determining the location of the obstruction. The degree of agreement between the two examinations was 70.9% (44/62). A percentage of 70% to 79% was considered an agreement. In sac-duct (S/D) junction, dacryoscintigraphy could detect more eyes with obstruction (11 eyes, 17.7%). On the other hand, DCG was able to detect more eyes with obstruction located in the nasolacrimal duct (3 eyes, 4.8%).

Figures 1 and 2 showed dacryoscintigraphy examination results of obstruction in the left S/D junction. Figure 1 depicted the examination at the dynamic phase (first 5 minutes). The contrast reached the lacrimal sac right after the recording started. Figure 2 showed dacryoscintigraphy examination from minute 10 to 30.

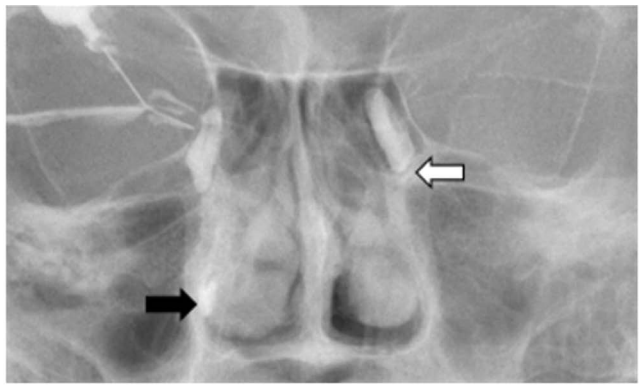

Figure 3. Dacryocystography examination result of obstruction at the left lacrimal sac-duct (S/D) junction level

At minute 20, contrast reached the right nasolacrimal duct but on the fellow eye, the contrast was still in the lacrimal sac (S/D junction). At minute 30, contrast reached the right nasal cavum but on the right eye, contrast stayed in the left S/D junction suggesting an obstruction. Figure 3 showed the DCG result of obstruction at the left lacrimal sac (S/D junction) level. The black arrow points out contrast flow to the right inferior meatus of the nasal cavum. The white arrow indicates that contrast flow stayed in the left S/D junction suggesting an obstruction in the left lacrimal drainage system at the left S/D junction level. However, obstruction in both systems was shown through dacryoscintigraphy (Fig. 4).

Out of 62 eyes, eight asymptomatic eyes with no lacrimal drainage obstruction were found by irrigation test and dacryoscintigraphy. In these eight eyes, not only positive results were found on irrigation test and dacryoscintigraphy but also no contrast blockage seen on dacryoscintigraphy and contrast reached nasal cavum. Tracer transit time of these 8 eyes was determined as the normal value of eyes without lacrimal drainage system obstruction. Table 4 evaluates the tracer transit time needed to reach the lacrimal sac (0 minutes), nasolacrimal duct (median 5 minutes), and nasal cavum (median 12.5 minutes).

According to the side effect and convenience level checklist in the observation section, there were no side effects found on the dacryoscintigraphy examination. However, there were two subjects who experienced hyperemic conjunctiva immediately after DCG and it quickly disappeared in 15 minutes after the procedure (Tab. 5).

On DCG examination, there was one subject who felt inconvenient when being examined due to pain. There was a significant difference ($p < 0.005$) of painful feeling between dacryoscintigraphy and DCG examination.

We included one additional question about which examination the subject would prefer since all of them underwent both examinations. Sixteen patients felt that dacryoscintigraphy was more comfortable than DCG because the procedure did not use any instrumentation into the punctum. Other 11 patients felt more comfortable with DCG in comparison to dacryoscintigraphy because of the shorter examination time and the other four patients said both examinations were similarly convenient.

In this study, the selected subjects were all adults because irrigation tests would be more difficult to be performed in

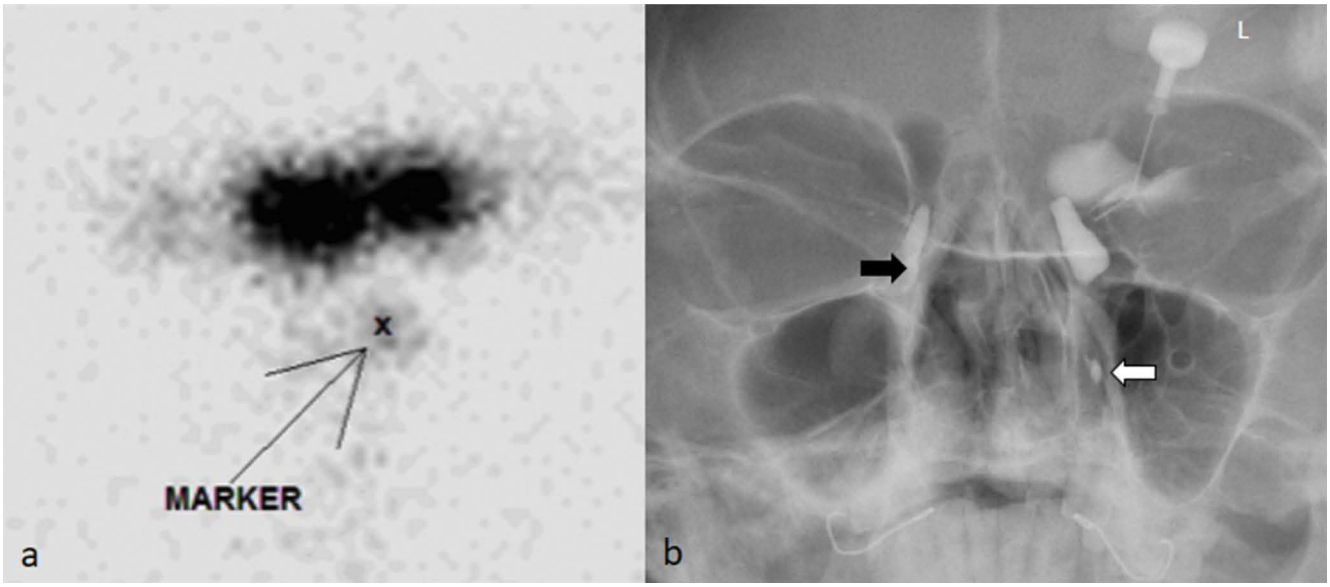

Figure 4. a) Dacryoscintigraphy showed obstruction in both systems; **b)** dacryocystography showed obstruction only in the right lacrimal drainage system (black arrow). The contrast flowed through the inferior meatus of the left lacrimal drainage system (white arrow)

Table 4. Tracer transit time of dacryoscintigraphy examination (n = 8 eyes)

	n	%
Duration to reach sac		
Immediate (0 min)	8	100.0
Duration to reach duct		
Immediate (0 min)	2	25.0
5 min	4	50.0
10 min	1	12.5
20 min	1	12.5
Duration to reach nasal cavum		
Immediate (0 min)	1	12.5
10 min	3	37.5
15 min	3	37.5
30 min	1	12.5

non-sedated pediatric patients. About 74.2% of subjects aged more than 40 years old with a mean value of 50.8 years old. Subjects were mostly female (87.1%). Kashkouli et al. reported that patients with PANDO were mostly female (78.2%) with a mean age value of 61.9 years old [6]. The possible reason is that female nasolacrimal duct anatomy is longer and tighter than male so obstruction is more prone to occur.

The grade of agreement between dacryoscintigraphy and DCG in deciding the presence of obstruction was 83.8%. Both examinations had a strong agreement in determining an obstruction. This result was in accordance with Al-Ghamdi et al. that stated the degree of agreement between dacryoscintigraphy and DCG in epiphora patients with lacrimal drainage system obstruction was 77.9% [7].

Dacryoscintigraphy was carried out in a more physiological process using contrast dripped into the eye. When the eyes blink, eyelids were closed, hence, preseptal orbicularis muscle would be contracted and pulled lacrimal sac to make negative pressure which then pulled the contrast into the lacrimal sac. When the eyes open, orbicularis muscles would be relaxed and elastic force would create positive pressure inside the lacrimal sac and pull contrast down to the nasolacrimal duct [8]. Dacryoscintigraphy has the ability to detect more abnormalities than DCG because dacryoscintigraphy was done with a more physiological process. Through DCG examination in our study, there were 45 (72%) lacrimal drainage system obstructions found while dacryoscintigraphy

Table 5. Percentage of patients who answered *yes* in the questionnaire section (n = 31 subjects)

Questions	Dacryoscintigraphy	Dacryocystography	p value
Comfortable eye	31 (100%)	31 (100%)	No value
Dry eye	2 (6.5%)	2 (65%)	1.000
Gritty sensation	0 (0.0%)	1 (3.2%)	0.313
Burning sensation	8 (25.8%)	6 (19.4)	0.544
Fatigue eye	4 (12.9%)	3 (9.7%)	0.688
Painful eye	0 (0.0%)	22 (71.0%)	< 0.005*
Scratchy sensation	0 (0.0%)	2 (6.5%)	0.492
Blurred vision	0 (0.0%)	0 (0.0%)	No value
Convenient examination	31 (100%)	30 (96.8%)	0.313

found 53 obstructions (85%). This data is in accordance with a study by Wearne et al. [9] that found dacryoscintigraphy could detect more abnormality (95%) compared to DCG (93%) in patients with functional nasolacrimal duct obstruction. A study by Rose et al. [10] performed dacryoscintigraphy and DCG in patients with epiphora. In this study, dacryoscintigraphy detected more obstruction (77%) than DCG (51%). Amanat et al. [11] also reported irrigation tests could detect obstruction as much as 44% while DCG detected 55.7% and dacryoscintigraphy detected 76.6%. This might be due to the DCG examination that created positive pressure into the lacrimal drainage system that could lead to false-positive results in partial obstruction [12]. In addition, dacryoscintigraphy could detect abnormality in patients with lacrimal pump dysfunction or functional epiphora [13]. On DCG examination, patients with lacrimal pump dysfunction and functional epiphora showed a normal result because these conditions were not caused by lacrimal drainage system obstruction.

Our study included one subject with facial nerve paresis abnormality in the unobstructed eye group that caused contrast flow disturbance. Even though we performed a DCG examination, there was no obstruction found. In patients with facial nerve paresis, orbicularis muscles weakness would create lacrimal pump dysfunction [13]. Therefore, tear flow would be obstructed and demonstrate an abnormality on dacryoscintigraphy but no obstruction on irrigation test and DCG (Fig. 4).

The degree of agreement between dacryoscintigraphy and DCG in detecting location or the level of obstruction was 70.9%. The degree of agreement found in this study was higher than the study by Al-Ghamdi et al. [7] and Wearne et al. [9] that found a degree of agreement in detecting obstruction location between dacryoscintigraphy and DCG of 58.3% and 59%. This difference might be affected due to the division of obstruction location. Previous studies divided the location of obstruction into 3 categories (pre sac delay, sac delay, dan duct delay). However, our study divided the location into the sac or sac-duct junction; and duct due to the limited resolution of the imaging modality. Dacryoscintigraphy in our hospital did not have a pinhole collimator to increase resolution. Based on this division, the chance of agreement became greater. Therefore, this study has a higher degree of agreement than previous studies. On S/D junction, dacryoscintigraphy could detect more obstruction than DCG. On the other hand, DCG is superior for the detection in the nasolacrimal duct. These results were in accordance with a study by Wearne et al. [9] that found dacryoscintigraphy detected more proximal locations of obstruction (33%) than DCG. A study by Denffer et al. [14] showed a degree of agreement between DCG and dacryoscintigraphy in detecting the location of obstruction was 85%, and in 15% dacryoscintigraphy, locations of obstruction were found more proximal than in DCG. This may be due to positive pressure that DCG created using contrast into the lacrimal system so that it dilates proximal obstruction and creates it more distal.

In this study, only 8 asymptomatic eyes were assessed normal with irrigation test and dacryoscintigraphy. Table 4 described the contrast transit time needed to reach the lacrimal sac, nasolacrimal sac, nasolacrimal duct, and nasal cavum in minutes. These 8 eyes had contrast transit time to reach the lacrimal sac within 0 minutes (immediate). This result is in accordance to a study by Brizel et al. [15] that found transit time to reach lacrimal sac within 0–120 seconds. This study, however, might have a biased result due to the variety of duration between the start of contrast administration and the start of recording.

In this study, from the 8 lacrimal systems that were assessed normal with irrigation test and dacryoscintigraphy, median values for tracer transit time in nasolacrimal duct were 5 minutes and 12.5 minutes to reach nasal cavum. These results were in accordance with a study by MacDonald et al. [4] that stated that in normal dacryoscintigraphy, there would be contrast visualization through a nasolacrimal duct to nasal cavum in 5 minutes [4]. This result may be various. Consequently, contrast visualization in nasal cavum at minute — 10 to 15 was still considered as a normal variation [4]. There was a great variety of tracer transit time in dacryoscintigraphy in previous studies. Variety was affected by frequency and intensity of blinking, gravitation, tear volume production changes, tear flow variation, lacrimal drainage valve resistance, and other factors, such as emotion, conjunctiva irritation, and contrast volume.

According to the checklist of side effects and convenience level in the observation section, there were no side effects found in dacryoscintigraphy. Meanwhile, in DCG, there were 2 subjects (6.2%) showing conjunctival hyperemia immediately after the procedure. Conjunctival hyperemia might present due to the contrast cleaning process at the end of the DCG procedure using the saline solution on the eyes. This result was similar to a study by Shweel et al. [16] that found only 1 patient (4.7%) experiencing minimal irritation on the eye after DCG.

There was a significant difference between pain during dacryoscintigraphy and DCG ($p < 0.005$). Twenty-two subjects complained of painful sensations during DCG due to instrumentation into the lacrimal punctum. However, 11 subjects felt DCG was more comfortable than dacryoscintigraphy due to shorter examination time while 16 subjects felt both examinations were convenient. This result is similar to a study by Reddy et al. [12] that claimed no uncomfortable complaint found in dacryoscintigraphy examination due to its more invasive procedure.

Conclusions

Dacryoscintigraphy had a good agreement grade with DCG in assessing the presence of obstruction and detecting its location or level in patients with PANDO. There was no side effect found on the dacryoscintigraphy examination. Dacryoscintigraphy and DCG examinations had a similar convenience level although DCG was considered more painful during the examination.

Conflict of interest

The authors declare that they have no conflict of interest.

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