Assessment of the Accuracy of Lacrimal Scintigraphy Based on a Prospective Analysis of Patients’ Symptomatology

ABSTRACT Background: Dacryoscintigraphy is a noninvasive method frequently used for assessment of the lacrimal drainage system. Sometimes conflicting results with patients’ complaints are obtained, which have no clear explanation. In our hypothesis, follow-up of patients evaluated with dacryoscintigraphy could be helpful in determining possible explanations for these conflicting results. Method: Thirty-eight consecutive patients (76 eyes) who had not previously undergone dacryocystorhinostomy or probing were entered in the study. Following instillation of 4 MBq $^{99m}$Tc-pertechnetate, a routine procedure of dacryoscintigraphy was performed. After a mean follow-up time of 1.2 ± 0.3 years (range 0.9–1.6 years), all patients were reassessed clinically. Results: Using initial patients’ symptoms as the gold standard, the sensitivity, specificity, NPV, and PPV of dacryoscintigraphy were calculated to be 82.1%, 75%, 60%, and 90.1%, respectively. The kappa value as a measure of agreement was 0.52. Considering the follow-up study as the gold standard, the sensitivity, specificity, NPV, and PPV were calculated as follows, respectively: 96.3%, 90.4%, 96.3%, and 90.4%. The kappa value was 0.86. There were three initially symptom-free eyes with obstructive pattern on the scans, which developed epiphora on the follow-up. In fact, these eyes were initially classified as false positive, but follow-up assessment showed that they were true-positive scans in a subclinical state. Conclusion: Despite certain drawbacks inherent to the technique, dacryoscintigraphy provides valuable independent information and allows more accurate management decisions. In some patients, data obtained from lacrimal scintigraphy could be predictive, and it makes possible determination of subclinical nasolacrimal duct obstructions.

KEYWORDS Dacryoscintigraphy, epiphora; lacrimal

INTRODUCTION

Epiphora is a relatively common ophthalmologic complaint, particularly in the elderly. Unfortunately, there are only limited objective methods in the assessment of lacrimal drainage system (Chmielowski et al.,
exclude any cause of reflex epiphora (e.g., facial nerve palsy, lower eyelid laxity, and post-traumatic deformity). All patients had normal palpebral statics, and no ocular surface irritation and infections were present.

**Dacryoscintigraphy**

A routine procedure of dacryoscintigraphy was performed for all patients. The patient’s head was immobilized on a support in front of a gamma camera. The distance of the cornea to the surface of the collimator was relatively equal and less than 20 mm for all patients. A single-head gamma camera (ADAC) equipped with a low-energy, high-resolution collimator was used, and images were acquired in a 256 × 256 matrix. Image acquisition was performed for 20 min (at one frame per minute) following instillation of 4 MBq sterile 99 mTc-sodium pertechnetate with a micropipette into the conjunctival sac of both eyes.

The visual analysis was performed by two experienced nuclear medicine physicians familiar with dacryoscintigraphy who were blinded to other clinical data, and the final diagnoses were made by consensus. The visual interpretation was categorized as normal or evidence of some degree of obstruction. These criteria were only based on the experience of our physicians. Remarkable drainage of activity from the lacrimal sac before the 5th minute of the study was considered as normal. Delayed radiotracer washout from the lacrimal sac or absence of remarkable radiotracer washout up to the end of the study was regarded as tear flow obstruction.

After a mean follow-up time of 1.2 ± 0.3 years (range 0.9–1.6 years), all patients were reassessed clinically by a blinded physician. Patients were interviewed again and a complete history concerning surgical intervention (such as probing or DCR), medical treatments, and the course and present severity of symptoms were obtained exactly. All the patients had been referred by their ophthalmologist for a scintigraphic assessment, and no additional intervention was performed on patients. However, the purpose of the study was described for all patients and verbal consent was obtained. The study was approved by the committee on ethics at the faculty of medicine, Tehran University.

**Statistical Analysis**

Results were analyzed on a per-eye basis. Using patients’ symptoms on the initial evaluation and

**PATIENTS AND METHODS**

Thirty-eight consecutive patients (24 females and 14 males) with a mean age of 57.1 ± 14.3 years (age range 28–72 years) who had not previously undergone DCR or probing were entered in the study. All patients had undergone a routine ophthalmologic examination to
follow-up period as the gold standard, the results of the scan were analyzed for sensitivity, specificity, negative predictive value (NPV), and positive predictive value (PPV). The kappa value as a measure of agreement was also calculated; $p < 0.05$ was considered to be statistically significant.

**RESULTS**

The study was carried out between November 2003 and November 2005 on 38 consecutive patients who were referred with unilateral or bilateral epiphora. Out of all 76 eyes, 56 (73.7%) were epiphoric and 20 (26.3%) were symptom free on the initial assessment. Scan interpretations found that, in our studied population, no case of pre-sac obstruction was present. Of 56 symptomatic eyes, 46 eyes (82.2%) revealed some degree of sac or post-sac obstruction, and 10 eyes (17.8%) showed normal pattern of drainage on the dacryoscintigraphic analysis. Of all 20 symptom-free ones, 15 eyes (75%) showed normal pattern, and 5 (25%) eyes indicated obstruction on the scan. Using patients’ symptoms as the gold standard, the sensitivity, specificity, NPV, and PPV of dacryoscintigraphy were calculated to be 82.1%, 75%, 60%, and 90.1%, respectively. The kappa value as a measure of agreement was calculated and was 0.52.

**FOLLOW-UP**

In the follow-up assessment, 50 of initially epiphoretic eyes showed either persistence or aggravation of symptoms without any intervention (DCR or probing) or revealed improvement after intervention. We assumed these eyes as the true-positive scan results (50/76). Of the remaining six epiphoretic eyes (all six were those which had normal scintigram), four were symptom free in the follow-up (true-negative scan) and two were symptomatic (false-negative scan). Of those 20 symptom-free eyes in the initial evaluation, 17 were normal in the follow-up examination, which were classified as 15 true-negative scan and 2 false-positive scan. The remaining 3 eyes developed epiphora on the follow-up, and all were those who had obstructive pattern on the scans (true-positive scan). After appointing the follow-up study as the gold standard (with 53 true-positive, 19 true-negative, 2 false-negative, and 2 false-positive scans), the sensitivity, specificity, NPV, and PPV were calculated as follows, respectively: 96.3%, 90.4%, 96.3%, and 90.4%. The kappa value was 0.86.

**DISCUSSION**

Over the years, several techniques have been used to image the nasolacrimal system, providing functional (dacryoscintigraphy) or morphologic (dacryocystography, CT dacryocystography [CTD]) information (Manfré et al., 2000; Phillip et al., 2001). Dacryoscintigraphy is a valuable technique for the determination of the functional patency of the nasolacrimal apparatus (Phillip et al., 2001). Although dacryoscintigraphy did not delineate the anatomical features quite as well as contrast dacryocystography, it yielded very useful information about flow mechanisms and tear transit times. Some authors have concluded that scintigraphy of the lacrimal pathways is a useful supplementary method, which must be evaluated in the context with other methods, in particular, methods that provide information on the anatomy of the lacrimal system (dacryocystography) (Jager et al., 2005; Kominek et al., 1998). In contrast, some other even claimed that the site of obstruction can be determined by lacrimal scintigraphy, and therefore it can facilitate the planning of the appropriate surgery (Hanna et al., 1992).

The lacrimal scintigraphic study is rapid, simple, non-hazardous, easy to perform (both in inpatient and outpatient settings), and facilitates definite diagnosis of obstructions and stenosis of the lacrimal drainage system, with little stress to the patient (von Denffer et al., 1984). Together with x-ray dacryocystography, it has been regarded as an important diagnostic tool, especially for pre- and postoperative evaluation of the drainage apparatus (von Denffer et al., 1984). However, it has been emphasized that it is not a substitute for other methods in general use, and it only complements them and expands their diagnostic accuracy (von Denffer et al., 1984). von Denffer and Dressler (1978), in one of the first reports of lacrimal scintigraphy, noticed that the absorbed radiation dose using radionuclide dacryography is very low as compared to radiological methods, which should be considered as one of the most important advantages of this imaging modality. Pegasusin has also confirmed advantages of scintigraphy over other imaging modalities and stated that scintigraphy of the lacrimal ducts appeared to be the least traumatic and more functional method as compared to x-rays (Pegasusin, 1988).

Several studies have been targeted to assess the accuracy of this imaging modality. In the study of Hana et al. (1992), the value of lacrimal scintigraphy in the
assessment of nasolacrimal duct obstruction was determined by comparing the results with syringing in 83 eyes. Of 28 lacrimal drainage systems that were obstructed on syringing, 82% had abnormalities of tear drainage on scintigraphy. Also, of 55 lacrimal drainage systems that were patent on syringing, in 65% of eyes, some degrees of drainage abnormality were detected on scintigraphy. Thus, scintigraphy has considered a very useful technique in the assessment of nasolacrimal duct obstruction, particularly in systems patent on syringing. Chmielowski et al. (2000), by the study of 221 lacrimating patients, concluded that dacryoscinintigraphy is a sensitive and reliable method imaging tear flow disturbances in persons with lacrimation. They stated that the method is the only truly physiological method for the assessment of lacrimal duct patency and tear flow. In the authors' opinion, it facilitates the diagnosis of lacrimation cause and simplifies the verification of the surgical management results and conservative treatment. Rozycki et al. (2002), in the comparison of dacryoscinintigraphy and dacryocystography, concluded that these techniques are methods of choice in establishing correct diagnosis. They emphasized that high sensitiveness and mutual completion of both methods let us quickly explain the reasons of epiphora and settle further management.

The results of our study (with sensitivity of 96.3% and specificity of 90.4%) are not very different from those of Wearne et al. (1999). In their study, the sensitivity for the lacrimal drainage scintigraphy was 95%. Other studies also confirmed that when considering all cases of epiphora, the scintigram is a more sensitive investigation than other modalities (such as dacryocystography) and should always be done first (Rose & Clayton, 1985).

However, one of the main drawbacks of the scintigraphic analysis of lacrimal drainage system is some conflicting results with patients' symptoms. This fact that has been minimally explained is not very uncommon (as it was seen in 15/76 eyes in our study population). In fact, there is a subgroup of symptomatic patients in whom an increased tear line is associated with patent lacrimal systems, a status termed “functional” nasolacrimal duct obstruction (Wearne et al., 1999). Considering that one of the most common types of the lacrimal outflow obstruction is involutional stenosis of nasolacrimal duct, this discrepancy could be explained by some degree of subclinical stenosis in the asymptomatic eyes, which are going to show clinical stenosis in the future. In our hypothesis, this pattern could be a major cause of conflicting results. Our study results confirm this hypothesis, as there were three symptom-free eyes in the initial assessment, with obstructive pattern on the scan, which developed epiphora in the one-year follow-up interview. However, another explanation is present: a study of normal volunteers has shown that a large proportion (32%) has delayed passage of the radioactive solution from sac level to nose (Chavis et al., 1978). It was concluded that lacrimal scintigraphy would be useful in assessing canalicular stenosis, but unreliable for assessing the duct below sac level. Also in the study of Hilditch et al. (1983), it was found that failure to achieve satisfactory linear compartmental results in most of the asymptomatic systems studied suggests that variable tear flow is a feature of normal lacrimal drainage, which precludes linear analysis. Therefore, it should be accepted that the positive predictive value of this test could be inherently lower than the ideally 100%.

In contrast, epiphora in the context of a normal dacryoscinintigraphy could be due to nonobstructive causes (such as irritation), which could again resolve with time and some medical treatments. Opinion in the literature also suggests that a normal lacrimal scintigram obviates the need for dacryocystography, as there are no instances when the latter would uncover a significant abnormality (Rose & Clayton, 1985). The same fact was observed in our study, with detection of four cases of true-negative scan in eyes suffering from epiphora.

CONCLUSION

Despite certain drawbacks inherent to the technique, dacryoscinintigraphy provides valuable independent information and allows more accurate management decisions. In some patients, data obtained from lacrimal scintigraphy could be predictive, and it makes it possible to determine the subclinical cases of nasolacrimal duct.

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