Original Article

Dacroscintigraphy by Pediatric Dropper Technique: A User-friendly Instillation Procedure of Radiotracer

Abstract

Context: Instillation or application of the radiotracer over the tear film is one of the important parts of dacroscintigraphy. Our study explains the value of an improvised dropper technique so that desired amount of radioactivity in desired volume can be instilled over the tear film. **Aim:** The aim of the study is to introduce a simple and convenient instillation method based on dropper technique for performing dacroscintigraphy. This improvised dropper technique can be used so that desired amount of radioactivity in desired volume can be instilled over the tear film. The objectives of this experiment are to measure the volume and activity of each drop from the dropper. **Settings and Design:** Experiment of volume and activity measurement standardization was carried out in two parts. In the first part, we calculated the volume of each drop indirectly to standardize the volume of drop. In the second part, we standardized the activity in each drop by measuring it in a dose calibrator. **Subjects and Methods:** In this study, we used a common pediatric dropper of approximately 1 ml capacity, radioactivity (^{99m}TcO4 pertechnetate), sample vial (container), vial holder, a pair of nonsterile gloves, dose calibrator, etc., Experiments of volume and radioactivity standardization were carried out in two parts. The first part of experiment calculated volume of each drop indirectly, and in the second, we standardized the activity in each drop by measuring it in dose calibrator. Statistical analysis used: Analysis of variance test was used to calculate the correlation of readings by same individual as well as among the three individuals **Results:** After analysis of result obtained, it was understood that there was no significant difference found in volume and activity of each drop in the readings recorded by same individual as well as among the three individuals. The calculated activity and observed activity were 86.64 and 79.16 µCi, respectively. The difference was only 8.63% lying within acceptable limits.

Keywords: *Dacroscintigraphy, drop technique, instillation, pediatric dropper*

Anurag Jain[3], Deepak Aheer[1], Amit Arora[2], Arun Ravi John[3], Solanki KP[3], Braj Kishore[3], Vishnoi MG[3], Abhishek Mahto[3], Surya Prakash[1], Pandit AG[3]

[3]Departments of Nuclear Medicine, Army Hospital R and R, [2]Department of Opthalmology, Base hospital Delhi Cantt, [1]PET Scan Center and Cyclotron facility Army Hospital R and R, New Delhi, India

Introduction

The line of tears (phora) running over the eye (epi) is termed as Epiphora – a Greek word.[1] Epiphora is a clinical condition in ophthalmology in which the tears does not flow through normal nasolacrimal system and abnormal overflow of tears down the face occurs. It is commonly caused by tear drainage system anomalies including nasolacrimal duct obstruction. Assessment of morphological abnormalities is done by dacroscintigraphy, and computed tomography is used when contrast material is syringed into the lacrimal drainage system. Dacroscintigraphy is a noninvasive method to diagnose the functional nasolacrimal duct obstruction.[2,3]

Dacroscintigraphy was introduced by Rossomondo *et al*., in 1972, and this procedure is noninvasive, widely employed in diagnosing abnormalities of the lacrimal system.[4] Instillation or application of the radiotracer at the tear film is one of the important parts of dacroscintigraphy technique. The physical properties of the tear film including thickness, volume, and turnover rate will be the determinative factors for proper distribution and holding of the instilled/applied radiotracer. The existing literature provides limited articles on the methods for instillation or application of the radiotracer at the tear film. Our study explains the value of an improvised dropper technique so that desired amount of radioactivity in desired volume can be instilled over the tear film more accurately.

Subjects and Methods

This study was conducted only in our department. In this study, we used a common pediatric dropper of approximately 1 ml capacity, radioactivity (^{99m}TcO4 pertechnetate), sample vial (container),

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Address for correspondence:
Dr. Anurag Jain,
Army Hospital R and R,
New Delhi - 110 010, India.
E-mail: triplea.jain@gmail.com

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vial holder, nonsterile gloves pair, dose calibrator, etc. [Figure 1]. Experiments for volume and activity standardization in one drop were carried out in two parts. The number of samples used in the study was 15 in part first and 10 in part second. In the first part, we calculated the volume of each drop indirectly to the standardized volume of drop (drop volume standardization). In the second part, we standardized the activity in each drop using dose calibrator (drop activity standardization). After that, we used analysis of variance (ANOVA) test on both data to show the correlation between and among the groups.

First part (drop volume standardization)

A volume of 0.5 ml normal saline was sucked/withdrawn into a simple pediatric dropper (1 ml). This volume was emptied drop by drop method in a sequential manner into a sample vial and the numbers of drops were counted. This experiment was repeated thrice by three different individuals (Experiment no: 1-3) with sample size 15, and observations were tabulated [Table 1].

Second part (drop activity standardization)

About 0.5 ml volume of measured radioactivity was sucked/withdrawn in a simple pediatric dropper (1 ml) in the same manner as in first part. This volume was emptied drop by drop in a sequential manner into a sample vial and the amount of activity in sequential drops measured with dose calibrator with background corrected. The initial activity in 0.5 ml volume and sum of observed activity in all drops were measured. This experiment also repeated three times by three different individuals with sample size 10. A simple pediatric dropper was filled with 0.5 ml volume of $^{99m}TcO4$ pertechnetate. We measured the activity in 0.5 ml volume. After that, we measured the activity of individual drops in a drop by drop cumulative manner till 0.5 ml volume is finished. The observed values were tabulated [Table 2].

ANOVA is a statistical tool used to test the variation among the groups in an experimental situation. ANOVA can be defined as the average sums of square of the deviations from the mean of the scores of the distribution. This tool was devised by Sir Ronald Fisher in 1923. The test mainly deals with variance but not with the standard deviation and standard errors. In this study, ANOVA test is done among three different individuals. Variance is the most important measure of variability within a group or between the groups. ANOVA test was used to find out any significant difference within and among the experiments [Tables 3 and 4]. The calculated F-value in ANOVA test and F-value obtained from the standard table were compared. ANOVA is to test the significant differences between the means of different populations.

Figure 1: Common pediatric dropper of approximately 1 ml capacity, radioactivity ($^{99m}TcO4$ pertechnetate), sample vial (container), vial holder, and dose calibrator

Results

As we mentioned above, this study was conducted in two parts. The first part was conducted for volume standardization, whereas in the second part, the activity standardization for a drop was made by a simple pediatric dropper. The observations and result are as follows:

First part

In the volume standardized, we counted the number of drops in each and every experiment. The average number of drops observed was 10 in number when using 0.5 ml volume. We calculated average volume of one drop was found to be 0.048 ml [Table 5]. There was no significance difference found when we performed ANOVA test for the given groups. It was observed that there was no difference between the calculated F-value and standard table F-value which shows that there was no significant difference. The standard deviation of three individual experiments found 0.0021, 0.0018, and 0.0025, respectively.

Second part

In this, we performed activity measurement by three experiments with three different individuals and found that average activity in each drop was 79.16 μCi [Table 5]. On the basis of the results obtained, it was understood that there was no significant difference found in volume and activity of each drop measured by same individual as well as among the three individuals. The calculated activity was 86.64 μCi, and the observed activity was found 79.16 μCi. The difference was only 8.63% which is within the limit (10%).

As per the guidelines of dacroscintigraphy, we have to inject 100–500 micro-Curie activity with minimum number of drops so with this improvised technique/method, we can instill 173.28–259.92 μCi activity with the help of 2–3 drops of volume.

Discussion

On review of literature, it is seen that while performing dacroscintigraphy various procedures for instillation of radiotracer into eye were followed. A study by Chung *et al*. mentions application of 0.1 ml of $^{99m}TcO4$ pertechnetate of

Table 1: Drop volume standardisation

Volume	Experiment no 1		Experiment no 2		Experiment no 3	
	No. of drops	Volume of one drop	No. of drops	Volume of one drop	No. of drops	Volume of one drop
0.5	11	0.045454545	10	0.05	11	0.045454545
0.5	10	0.05	10	0.05	10	0.05
0.5	11	0.045454545	10	0.05	10	0.05
0.5	10	0.05	11	0.045454545	11	0.045454545
0.5	10	0.05	10	0.05	10	0.05
0.5	10	0.05	10	0.05	11	0.045454545
0.5	10	0.05	10	0.05	11	0.045454545
0.5	11	0.045454545	10	0.05	11	0.045454545
0.5	10	0.05	10	0.05	11	0.045454545
0.5	10	0.05	11	0.045454545	10	0.05
0.5	10	0.05	10	0.05	10	0.05
0.5	11	0.045454545	10	0.05	11	0.045454545
0.5	10	0.05	10	0.05	10	0.05
0.5	10	0.05	10	0.05	10	0.05
0.5	10	0.05	10	0.05	10	0.05

Volume taken in sample each time=0.5 ml

Table 2 : Drop activity standardisation

Experiment no 1			Experiment no 2			Experiment no 3		
No. Of drops accumulated	Total measured activity (µci)	Activity in one drop	No. Of drops accumulated	Total measured activity (µci)	Activity in one drop	No. Of drops accumulated	Total measured activity (µci)	Activity in one drop
1	67	67	1	68	68	1	69	69
2	148	81	2	148	80	2	144	75
3	229	81	3	228	80	3	230	86
4	309	80	4	309	81	4	306	76
5	392	83	5	393	84	5	390	84
6	477	85	6	477	84	6	475	85
7	560	83	7	566	89	7	568	93
8	639	79	8	638	72	8	635	67
9	718	79	9	718	80	9	715	80
10	790	72	10	790	72	10	795	80

Volume taken in sample each time=0.5 ml

1.85–3.7 MBq (50–100 µCi) in the lateral portion of each eyeball and recording bilateral eyeball images at 2-min intervals for 30 min by pin-hole collimator.[4] A study by Wearne *et al*. used a technique of placing drop of ^{99m}TcO4 pertechnetate was instilled into the inferior fornix of both eyes and the patient remains still but can blink eyes normally. A dynamic study is performed initially, with the tracer distribution imaged every 10 s for the first 160 s, and static views at 5, 10, 15, and 20 min after patient being sitting upright in front of the pin-hole collimator or with a hexagonal collimator.[5] Micropipette was used for instillation of 5 MBq of ^{99m}TcO4 pertechnetate into the lacrimal lake of both eyes simultaneously.[2] Rózycki *et al*. describe a study of 200 patients in which one drop of sterile ^{99m}TcO4 pertechnetate, in dose 3.7–7.4 MBq (100–200 uCi) was instilled by dropping in the conjunctival sac, and distribution of this drug was visible on the monitor.[5] MacDonald and Burrell performed the procedure with approximately 3.7 MBq (0.1 mCi) of ^{99m}TcO4 pertechnetate in a saline solution administered per eye to the supine patient with an eyedropper or a needleless 1-ml tuberculin syringe. During the procedure, it was ensured that contamination is prevented if the patient is teary by encouraging them to blot not smear. It was mentioned that radiation dose to the eye may be as low as 0.14 mSv/eye for an unobstructed eye and upward to 4 mSv in the presence of an obstruction.[6]

Lacrimal scintigraphy requires application of a radioactive tracer such as ^{99m}TcO4 pertechnetate at the lower marginal tear strip.[7,8] The distribution of the tracer and the transit time of the tracer through the system is done through imaging. Instillation of radioactivity in the lower fornix of the eye is the first step and is of utmost importance in the procedure of dacroscintigraphy, appropriate imaging, and interpretation. If this step is followed properly by the technician and doctor, it will be ensured that the desired amount of radioactivity is instilled over the tear film, in minimum volume. If the volume is more, it may overflow

Table 3: Analysis of variance :Volume standardization

Groups	Sample size	Sum	Average	Variance		
Summary						
Experiment no 1	15	0.73	0.048666667	5.2381E-06		
Experiment no 2	15	0.74	0.049333333	3.09524E-06		
Experiment no 3	15	0.715	0.047666667	6.66667E-06		
Source of variation	**Square sums (ss)**	**Degrees of freedom (df)**	**Average square sum (ms)**	**Test size (*F*)**	***P***	**Critical *F* value**
Anova						
Between groups	2.11111E-05	2	1.05556E-05	2.111111111	0.133772811	3.219942293
Within groups	0.00021	42	5E-06			
Total	0.000231111	44				

Anova: Single-factor variance analysis

Table 4 : Analysis of variance :activity standardization

Groups	Sample size	Sum	Average	Variance	
Summary					
Exp no. 1(Mci)	10	790	79	30	
Exp no. 2(Mci)	10	790	79	41.77777778	
Exp no. 3(Mci)	10	795	79.5	63.83333333	
Source of variation	**Square sums (ss)**	**Degree of freedom (df)**	**Average square sums (ms)**	**Test size (*F*)**	**Critical *F*-value**
Anova					
Between groups	1.666666667	2	0.833333333	0.018435068	3.354130829
Within groups	1220.5	27	45.2037037		
Total	1222.166667	29			

Anova: Single-factor variance analysis

Figure 2: Instillation of radiotracer activity over lacrimal lake by pediatric dropper in dacroscintigraphy

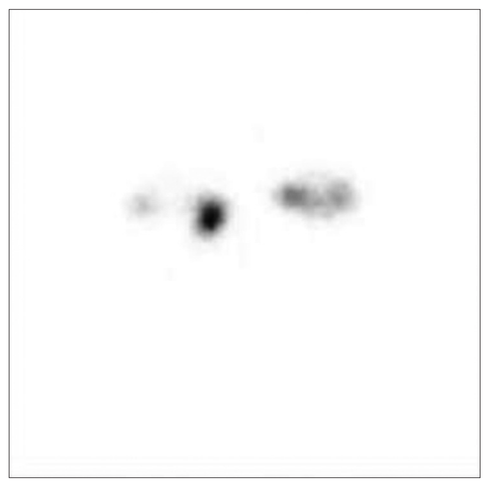

Figure 3: Anterior static image of dacroscintigraphy

affecting the procedure. Furthermore, the excess volume may cause unnecessary radiation as well as contamination. The technician must be confident while instillation of radioactivity and the procedure should be in such a way that it does not cause injury to the eye. Our study shows that we can standardize any pediatric dropper for instillation of desired radioactivity with minimum volume in the form of minimum drops. The technician can have adequate control during withdrawal of radioactivity and releasing of drop one at a time. The release of drop in the lower fornix of the eye can be better maneuvered, minimizing the chances of overflow and contamination.[Figure 2 and 3]

Instillation of aqueous radioactive tracer over the tear film by a dropper was introduced in 1972 by Rossomondo *et al*.[9] The benefit is that as this tracer is not injected, it identifies tear progression and elimination in physiological conditions. Researchers suggest that many factors affect the elimination of tears from the sac and the nasolacrimal duct such as gravity, head position, and volume of tears that has accumulated in the sac. However, if standardization of testing conditions is done, it may make this quantitative procedure more meaningful in evaluating a patient's entire lacrimal drainage pathway.[8,10]

Table 5: Average value of volume and activity of a single drop

	Volume of one drop	Activity in one drop
Experiment 1	0.04866	79
Experiment 2	0.04933	79
Experiment 3	0.04766	79.5
Average	0.04855	79.16666667

Conclusion

Instillation of radioactivity in the lower fornix of eye is the first step and is of utmost importance in the procedure of dacroscintigraphy, which may affect appropriate imaging as well as interpretation. If this step is followed properly by the technician or physicians, it will be ensured that desired amount of radioactivity is instilled over the tear film, in minimum volume. Our experiment shows that usage of improvised pediatric dropper technique is simple, user-friendly and convenient. The technologist and physician are more confident during instillation. They have a better control during the release of drops. This technique gives good cooperation by the patient during the procedure. Better control during the procedure results in fewer chances for repetition of the study. Regarding radiation safety, using fewer drops prevent spillage and therefore lesser chances of contamination.

Overall, this improvised technique is simpler, user-friendly, convenient, and feasible in comparison with a conventional technique where insulin syringe is used for the instillation.

This method can be adopted universal and with the help of simple experiments described above, they can also standardize the volume and activity in the drop and can use this method easily.

This experiment is very simple as well as economical and can be valuable in any department.

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Conflicts of interest

There are no conflicts of interest.

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