

# Assessment of eye drop instillation technique in glaucoma patients

## Técnica de instilação de colírio em pacientes com glaucoma

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### ABSTRACT

**Purpose:** To study the technique of eye drop instillation in glaucoma patients and identify independent factors that may influence their performance.

**Methods:** In this cross-sectional study, 71 consecutive patients with glaucoma or ocular hypertension, self-administering topical anti-glaucoma medications for  $\geq 6$  months were evaluated. All patients instilled a tear substitute into the eye with the worst eyesight using the technique normally used at home. The following parameters were evaluated: age, number of years receiving treatment with ocular hypotensive eye drops, time spent to instill the first drop, number of drops instilled, correct location of the eye drops, contact of the bottle with the eye, closing of the eyelids or occlusion of the tear punctum, and asepsis of the hands.

**Results:** The mean age of the patients was  $66 \pm 10.8$  years, and patients were on ocular hypotensive drugs for  $11.3 \pm 7.3$  (range, 2-35) years. Only 28% of the patients were able to correctly instill the eye drops (squeeze out 1 drop and instill it into the conjunctival sac without bottle tip contact). Touching the tip of the bottle to the globe or periocular tissue occurred in 62% of the patients. In 49% of the patients, the eye drops fell on the eyelids or cheek. Two or more drops were squeezed by 27% of the patients.

**Conclusions:** The majority of glaucoma patients were unable to correctly instill eye drops. Age was an independent factor associated with eye drop instillation performance.

**Keywords:** Glaucoma/drug therapy; Medication adherence; Ophthalmic solutions/therapeutic use; Instillation drug

### RESUMO

**Objetivo:** Avaliar a técnica de instilação de colírio em portadores de glaucoma e identificar fatores independentes que pode influenciar o desempenho.

**Métodos:** Neste estudo transversal 71 pacientes consecutivos com glaucoma ou hipertensão ocular que auto instilam seus colírios há pelo menos 6 meses, foram avaliados. Todos os pacientes instilaram um colírio lubrificante no olho de pior visão utilizando a mesma técnica de instilação de colírio que utilizam rotineiramente em casa. Foram avaliados parâmetros como: idade, número de anos em tratamento com colírios hipotensores oculares, tempo gasto para instilação da primeira gota, número de gotas instiladas, localização correta do colírio, contato do frasco com o olho, fechamento de pálpebras ou oclusão do ponto lacrimal e assepsia das mãos.

**Resultados:** A idade média dos pacientes foi de  $66 \pm 10,8$  anos. Os pacientes estavam em tratamento com colírios hipotensores oculares por, em média,  $11,3 \pm 7,3$  anos (variando de 2 a 35 anos). Apenas 28% dos pacientes foram capazes de instilar corretamente o colírio (instilação de 1 gota em saco conjuntival sem contato com a ponta do frasco). Contato da ponta do frasco com o olho ou tecido periocular ocorreu em 62% dos pacientes. Em 49% dos casos, o colírio caiu nas pálpebras ou fora do saco lacrimal na primeira tentativa. Duas ou mais gotas foram instiladas por 27% dos pacientes.

**Conclusão:** A maioria dos pacientes com glaucoma é incapaz de instilar o colírio corretamente. A idade é um fator independente que influencia o desempenho da instilação de colírio.

**Descritores:** Glaucoma/quimioterapia; Adesão à medicação; Soluções oftálmicas/uso terapêutico; Instilação de medicamentos

### INTRODUCTION

The efficacy of topical ocular pharmacotherapy depends on patient adherence and compliance with the prescribed treatment regimen<sup>(1)</sup>. In ocular diseases, noncompliance could result even from improper technique of administering medication<sup>(2,3)</sup>. Although instillation of eye drops may be perceived as a simple task, studies have shown that patients frequently have difficulty instilling eye drops<sup>(3-8)</sup>. In chronic ocular diseases, such as glaucoma, wherein the elderly population constitutes a major share of those affected, this issue is of great importance<sup>(2,7)</sup>. The consequences of improper drop installation are treatment failure, wastage of medication, overmedication with systemic absorption, adverse effects, predisposition to infection from contaminated bottle tips, corneal abrasions, and ulcerations<sup>(9-11)</sup>.

Eye care practitioners may prescribe eye drops without properly explaining or showing the technique for correct instillation of eye drops because of the lack of time in busy practice or lack of awareness

of the fact that the patient does not know how to correctly instill drops<sup>(12,13)</sup>. Over the past decade, although several studies have reported that 25% to 90% of subjects fail to administer their eye drops correctly<sup>(3-12)</sup>, data is sparse about the technique of eye drop administration in a public practice of a developing country<sup>(8)</sup> where the issue of noncompliance is considered to be very significant<sup>(14,15)</sup>.

Therefore, the purpose of this study was to evaluate the technique of eye drop instillation in glaucoma patients of a public hospital in the southeast of Brazil and to identify independent factors that may influence instillation performance.

### METHODS

In this cross-sectional study, 71 consecutive patients with glaucoma or ocular hypertension, who had been self-administering topical anti-glaucoma medications for  $\geq 6$  months, were evaluated between July 10, 2015 and December 31, 2015. This study was appro-

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ved by the ethics committee of the Federal Hospital of Bonsucesso and adhered to the tenets of the Declaration of Helsinki. Informed signed consent for research was obtained from each subject before enrollment.

Only patients who were routinely self-instilling eye drops were enrolled. Patients with motor difficulties (tremors, motor paralysis, arthritis) and visual acuity in the better eye worse than hand movement were excluded.

The age, sex, diagnosis, current anti-glaucoma medication (posology was classified as once a day, twice a day or  $\geq 3$  times a day), education level, visual acuity at the time of enrollment, previous experience applying eye drops, intraocular pressure, and history of receiving an explanation about the technique were recorded. Previous instruction on how to administer eye drops was defined as receipt of either an oral or written presentation by the physician or medical assistant. Subjects were escorted to a dedicated examination room with a sink, soap, towels, and mirror readily available; they were uniformly instructed to instill a tear substitute by using a 5-ml Systane® bottle (Alcon, Hünenberg, Switzerland) just as they would instill their medications at home. The study eye was the one with worse eyesight. The same observer throughout the study was stationed at a comfortable viewing distance and viewing angle so as to carefully and clearly observe the technique of eye drop instillation by the patient. The following parameters were recorded by the observer for each patient: the time required to instill the first drop after uncapping the bottle, number of drops squeezed out from the bottle, location as to whether the drops landed either on the face or the eye, whether the patient touched the tip of the bottle to any part of the globe or eyelids, whether the patient had shaken the bottle before, whether the patient had washed their hands before, whether the patient closed eyelids for  $\geq 1$  minute after instilling the eye drop, and/or whether the patient occluded the punctum after instillation of eye drop. Proper instillation of the eye drop (good technique) was defined as placing a single drop on the eye without touching the eye surface.

Statistical analysis was performed by using a commercially available statistical software package (JMP, version 12.0; SAS Institute, Inc, Cary, NC). Normality assumption was assessed by inspection of histograms and by using Shapiro-Wilk tests. Categorical variables were expressed as percentages, and continuous variables were expressed as means and standard deviations. The independent samples t-test was used to compare continuous variables, whereas Pearson's chi-square test was used to compare categorical data. Univariate logistic regression was used to calculate the crude odds ratio (OR) of the proper instillation technique associated with various demographic and clinical predictors. A multivariate logistic regression model was run to determine predictors of proper administration technique. Variables studied were those with univariate significance of  $\leq 0.6$ , and included sex, age, education level, and previous drop education. Statistical significance was accepted if the p-value was  $< 0.05$  or if the 95% confidence interval (CI) of the OR excluded 1.0.

## RESULTS

Table 1 shows the characteristics of the 71 patients enrolled in the study. The mean age of the study population was  $66.1 \pm 10.8$  years (range, 31-88 years). There were 20 men (28%) and 51 women (72%). The patients were on ocular hypotensive drugs for a mean of  $11.3 \pm 7.3$  (range, 2-35) years. The mean intraocular pressure (IOP) was  $17.7 \pm 4.2$  (range, 10-32) mmHg. IOP  $> 21$  mmHg was observed in 12 (17%) patients. The majority (85%) of the patients had low education level (only basic schooling). Fifteen (21%) of 71 subjects were instilling medication once a day (posology of glaucoma medications), 30 (42%) were instilling twice a day, and the rest were instilling  $> 3$  times a day (Table 1). Overall, 22 (31%) patients reported having received instruction on how to administer eye drops previously, whereas 49 (69%) reported never having received instruction.

The results of the major parameters studied are summarized in table 2. Only 20 (28%) patients were able to correctly instill the eye drops (squeeze out 1 drop and instill it into the conjunctival sac without the bottle tip contacting the eye or eyelid). Touching the tip of the bottle to the globe or periocular tissue occurred in 44 (62%) patients (Table 2). In 35 (49%) patients, the eye drops fell on the eyelids or cheek. Two or more drops were squeezed by 19 (27%) patients. Only 8 (11%) patients washed their hands before drop instillation.

There was a trend toward better performance by women than by men. Those considered to have had a successful attempt had a mean age of  $61.2 \pm 12.9$  years compared with those who did not ( $68.0 \pm 9.2$  years), ( $p=0.02$ ) (Table 3). The univariate analysis showed that younger age was the only factor significantly associated with good technique ( $p=0.02$ ). Table 4 shows the results of the univariate logistic regression for predicting proper drop instillation technique. Variables with a  $p < 0.6$  in the univariate analysis were included in the multivariate regression model. In the multivariate model, age remained significant (Table 5).

## DISCUSSION

The present study focused on the "unintentional" noncompliance in the form of improper eye drop instillation and evaluated

**Table 1. Descriptive statistics for demographic and clinical variables**

Mean age, years (SD)	66.1 $\pm$ 10.80
Sex, n (%)	
Female	51 (72)
Male	20 (28)
Duration of prior use of topical IOP-lowering, years (SD)	11.3 $\pm$ 7.30
Level of education, n (%)	
Basic schooling (elementary)	60 (85)
Intermediate	8 (11)
University	3 ( 4)
Intraocular pressure $> 21$ mmHg, n (%)	12 (17)
Previous drop education, n (%)	
Yes	22 (31)
No	49 (69)
Visual acuity of study eye (logMAR)	0.63 $\pm$ 0.33
Posology of glaucoma medications, n (%)	
Once a day	15 (21)
Twice a day	30 (42)
$> 3$ times a day	26 (37)

**Table 2. Summary of various eye drop parameters evaluated**

Parameter	Result
Mean time taken to instill the first drop (up to 1/100 <sup>th</sup> of a second) $\pm$ standard deviation	22 $\pm$ 14.5
Mean number of drops squeezed $\pm$ standard deviation	1.4 $\pm$ 0.8
Mean number of drops reaching the conjunctival sac at the first attempt	0.7 $\pm$ 0.8
Patients who had the eye drops fall on the lid/cheek, n (%)	35 (49)
Patients who touched the tip of the dropper to the globe, n (%)	44 (62)
Patients who did not close eyelids for $> 1$ min or who did not occlude the tear duct, n (%)	61 (86)
Patients who did not wash hands prior to instillation, n (%)	63 (89)
Patients who did not shake the ophthalmic suspension (n=4) bottle before use, n (%)	3 (75)

not only the technique of glaucoma patients but also the factors associated with their performance in a developing country.

A study conducted in a developing country reported a high non-compliance rate (53.6%) among glaucoma patients compared to the average of other studies in the developed world<sup>(14)</sup>. Compliance is a multifactorial complex behavior and in developing countries, economic factors definitely have a role<sup>(16,17)</sup>.

The results of the current study indicate that difficulty with self-instillation of eye drops is a significant problem for patients with glaucoma in a developing country. All subjects enrolled in this study admitted to instilling their own eye drops, not being reliant on others, and also had 6 months of experience in drop instillation. When defining proper instillation as "instilling a single drop in the eye without touching the eye with the bottle tip," only 28% of patients were able to do it correctly. These results are generally consistent with those of previous studies, which demonstrates that even experienced patients frequently have difficulty instilling their drops<sup>(3-5,7,8,18)</sup>.

**Table 3. Comparison of descriptive statistics between patients who underwent good eye drop instillation technique (successful instillation) and those who underwent poor technique**

	Good technique (n=20)	Poor technique (n=51)	P value
Age (years)	61.20 ± 12.90	68.00 ± 9.20	0.04 <sup>£</sup>
VA worse eye (logMAR)	0.63 ± 0.35	0.63 ± 0.34	0.94 <sup>£</sup>
IOP (mmHg)	17.90 ± 4.40	17.60 ± 4.10	0.81 <sup>£</sup>
Duration of eye drop use (years)	11.50 ± 8.40	11.20 ± 6.80	0.99 <sup>£</sup>
Posology (number of eye drops applied every day)	2.60 ± 1.30	2.60 ± 1.10	0.89 <sup>£</sup>

VA= visual acuity; IOP= intraocular pressure.

Good eye drop instillation technique (successful instillation)= placing just 1 drop on the eye without touching the surface of the eye.

£= t-test; §= Fisher's exact test.

**Table 4. Univariate logistic regression for predicting instillation technique; log odds of improper/proper technique**

Variable	Odds ratio	95% CI	P value
Age (years)	1.1	1.1-1.2	<b>0.02</b>
Sex [female]	1.6	0.4-4.0	0.42
Level of education [low]	1.6	0.4-6.0	0.52
Previous drop education [no]	1.3	0.4-3.8	0.64
VA worse eye (logMAR)	1.1	0.2-5.0	0.94
IOP (mmHg)	0.7	0.9-1.2	0.80
Duration of eye drop use (years)	1.0	0.9-1.1	0.88
Posology (number of eye drops applied every day)	1.0	0.6-1.5	0.87

VA=visual acuity; IOP=intraocular pressure; CI= confidence interval.

Good eye drop instillation technique (successful instillation)= placing just 1 drop on the eye without touching the surface of the eye.

**Table 5. Results of multivariate logistic regression for predicting instillation technique; log odds of improper/proper technique**

Variable	P value
Age (years)	0.03
Previous drop education [no]	0.67
Sex [female]	0.72
Level of education [low]	0.97

For most patients with poor technique, the problem was contact between the tip of the bottle and the globe or eyelid. This finding is consistent with those of other studies that reported touching of the eye or ocular adnexa with the bottle as the most frequent error<sup>(6,19)</sup>. Besides the risk of trauma, this issue may also lead to contamination of the bottle tip<sup>(10,11)</sup>. Some devices to improve drop instillation have been reported to significantly reduce touching of the bottle tip to the eye and eyelid<sup>(20-22)</sup>. The drawbacks of these devices are that they are often suitable for only a single-bottle design and many patients find it easier to use drops without such a device<sup>(21)</sup>.

Another important problem observed in this study was that a substantial amount of the eye drops were wasted because of faulty instillation technique; 35 (49%) of 75 patients missed the eye. Previous studies have reported that in 3% to 40% of subjects the drop missed the eye, and 2 drops were almost always needed to achieve a successful application<sup>(4-8,18)</sup>. Missing the eye may result in disease progression from missed drops and dermatitis from drops contacting the skin<sup>(23)</sup>. Moreover, poor drop administration techniques may also result in wasting drops, which has economic implications for patients, insurance companies, or government<sup>(24)</sup>. This assumes high importance in low-socioeconomic-level patients from public hospitals of developing countries, such as the setting of the present study<sup>(17)</sup>. The cost of anti-glaucoma eye drops has an economic monthly impact of 29.1% of the value of the minimal wage in Brazil<sup>(25)</sup>. A study reported that ≤41% of the glaucoma patients from a public hospital in Brazil abandoned treatment because of financial difficulties in buying the medication<sup>(17)</sup>.

The results of this study indicate that more should be done to educate patients regarding correct drop instillation technique, particularly as 69% of patients had never received or could not recall having been instructed in the proper technique for eye drop instillation. This could explain why only 10 (14%) patients closed eyelids for >1 min or occluded their tear duct and only 1 of the 4 patients using a suspension shook the bottle before using it. Moreover, washing hands was performed by only 11% of the patients. It is also important to reconsider the definition of what constitutes "successful" eye drop instillation because the only instructions on glaucoma medication bottles currently concern not touching the bottle to the eye<sup>(6)</sup>.

In this study, younger age was the only factor significantly associated with good technique both in univariate and multivariate regression analysis. Similarly, the study of Hennessy et al. found that age was the only significant predictor of instillation technique in visually disabled glaucoma patients<sup>(6)</sup>. However, this finding does not mean that other factors are not important because that finding could have been caused by small sample size. Other authors have shown that older age<sup>(7,18)</sup>, limited school education<sup>(7,26)</sup>, and poor vision<sup>(7)</sup> were associated with poor instillation technique. History of previous eye drop education was strongly associated with good instillation technique when controlled for age in another study<sup>(18)</sup>. Moreover, the literature has shown that educating the patients about the correct instillation technique can significantly improve their performance<sup>(13)</sup>.

The present study had several limitations. First, the history of previous education regarding drop instillation technique relied on patient recall. It is possible that patients with poor drop instillation technique may have forgotten previous instruction regarding eye drop instillation, which may have biased the results. We only used one 5-ml bottle type, and the ability of subjects to use the specific bottle type or shape in this study may have varied.

The Systane® 5-ml bottle for drop instillation used in this study also has been used in similar previous studies and is considered to be an adequate proxy from both a bottle size and viscosity standpoint for primary glaucoma treatment at present<sup>(6,18,22)</sup>. Another limitation is the fact that there was only one evaluation of drop instillation, and the patients were evaluated inside in a different environment, which may have influenced their performance. It also would have been

interesting to consider fluorescein eye drops instead of Systane® because an objective view in the slit lamp would be obtained if the patient properly instilled the eye drop.

The results of this study emphasize the need to develop better instructional methods, devices, and techniques to deliver intraocular pressure-lowering medications especially to older patients because age is an independent factor that influences the performance of drop instillation. To improve skills on self-administering eye drops, it is important to better educate patients, perhaps with videotapes presenting the correct instillation technique<sup>(27)</sup>. A previous study conducted in Brazil has shown a significant improvement in the technique of eye drop instillation as a result of an educational program<sup>(28)</sup>. Care should be taken to present instructional information for patients that is easy to understand and appropriate for the instructional level of the patient<sup>(28)</sup>.

In conclusion, we found that the majority of glaucoma patients in this study were unable to instill eye drops correctly and that age was an independent factor associated with drop instillation performance.

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