Subjective and objective assessment of the eye drop instillation technique: A hospital-based cross-sectional study

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Purpose: To objectively and subjectively evaluate eye drop technique and assess communicated instructions, and reported problems with eye drop instillation among tertiary care sample eye drop users. Methods: A cross-sectional, observational study was carried out among patients attending our outpatient clinic from June to September 2020. Eligible participants obtained through convenient sampling were assessed for their eye drop instillation performance. The objective evaluation was made using observation of a demonstration and subjective assessment through responses to an interview. Patient inclusion criteria were being aged ≥18 years and using eye drops for ≥ one month; excluded if having a disability in communication or physical barriers in using eye drops. The patient reported difficulties and previous education about the instillation were also obtained. Results: Participants (n = 84) had a mean age of 50.3 ± 14.0 years. During the demonstration, almost everyone (86.9%) successfully instilled at least one drop in the eye. None of the participants exhibited a perfect drop technique. The most common deviations were failing to close the eye (60.7%), touching the bottle to the eye or eyelid (36.9% of patients), and multiple blinks after drop instillation without nasolacrimal occlusion (25.0%). Forty percent of patients reported ≥1 problem and only a small sample recalled having had education in the eye drop instillation technique. Conclusion: Most participants failed to properly execute the eye drop technique. A proactive role of the prescribing practitioner to assess a patient’s ability to instill eye drops correctly could be helpful.

Key words: Clinical outcome, eye drop technique, patient education

An efficacious and guarded regime in the topical administration of ocular medication is requisite in the management of several chronic and acute ocular diseases.[1-3] The World Health Organization (WHO) states that the irrational use of medications is a global health issue wherein over half of all the dispensed prescription drugs are used inappropriately.[4] The critical steps to a proper eye drop technique comprise: administering a single drop into the pocket formed by gently pulling down the lower eyelid, having the drop land in the eye on the first attempt, not touching the applicator tip to the eye, ocular adnexa, or face, and eye closure with nasolacrimal occlusion after administration to reduce systemic absorption.[5,6]

Although instilling eye drops may seem to be an effortless task, administering one correctly may pose a challenge to the patients. A considerable number of studies have evaluated the administration technique for non-oral dosage types such as inhaler devices; the expanse of literature on eye drop administration is inadequate.[7] Former studies have reported poor patient performance while instilling eye drops.[8-12] It is debatable that patient education on appropriate eye drop administration could be one of the simplest and economical ways to grow both compliance and clinical outcomes.[7,13-16] Clinicians may prescribe eye drops without properly educating the patient or demonstrating the technique for the correct eye drop instillation.[19] One reason this may occur could be due to the paucity of time in a busy practice or the failure to recognize that the patient may not be able to use the eye drops appropriately.

Compliance is generally stated as the extent to which patients would adhere to taking medications as prescribed by their health care providers.[15] On the contrary, noncompliance may be in the outline of failure to take the medication, administering a wrong medication, incorrect timing of medication, or infrequently administering a disproportionate dosage of medication.[18] Several studies over the past decade have centered on compliance with ocular medications.[13,19,20] However, a majority of them have failed to appraise the root cause of the noncompliance. Many factors contribute to the latter, which include: visual acuity, the number of medications the patient is currently taking, shape and size of the eye drop bottle, strength involved to expel a drop, angle of the dropper throughout the administration, and the convolution of administration schedules.[21] Improper eye drop technique may reduce the therapeutic response, enhance systemic side effects, increase unnecessary medication waste, cause traumatic ocular surface injuries, and also add to the economic burden of the disease which may amplify patient frustration and
extend to worsening patient compliance. This cumulatively constructs barriers for practitioners to assess the response of an ophthalmic intervention.

The objective of this research was to examine the extent to which (a) participant self-efficacy in eye drops; (b) patient characteristics; and (c) ophthalmologist–patient communication about eye drop administration procedure and demonstration in a busy clinical setting of a developing country are associated with patients correctly performing the critical steps when instilling eye drops.

**Methods**

**Study design**

A cross-sectional design was used in this study carried out between June 2020 and September 2020 in the outpatient clinic of our department. All subjects consented before enrolment and the protocol followed the tenets of the Declaration of Helsinki; the study was approved by the Institutional Ethics Committee.

**Participants**

Patients attending the outpatient department for an Ophthalmology consultation were approached and invited to participate in this study. They were eligible when meeting the following inclusion criteria: being 18 years of age or older, self-administering eye drops with no compliance aids for at least one month (to ensure the patients were already familiar with eye drop instillation procedure), and having visual acuity better than 1.0 LogMAR in either eye. Participants were only excluded if they had a disability in communication or physical barriers in using eye drops [Fig. 1].

**Data collection**

Gender was measured as a dichotomous variable and age as a continuous variable. Levels of education were originally measured as an ordinal variable and then were trichotomized for analyses (i.e. primary, secondary, or higher schooling), described in Table 1.

The subjects were evaluated in accordance with the inclusion criteria as inferred through their past medical history. After consent was obtained from the participants, they were guided to an exam room; facilities were provided for the patient to wash their hands, use a mirror, sit, or lie down depending on the patient’s preference.

A comprehensive list of steps associated with the eye drop instillation technique proforma was adopted, based on prior research. For purpose of counteracting the disadvantage of demand characteristic on part of the respondent, our proforma comprised two components: first, the objective evaluation and then the subjective evaluation. Participants were blinded about the observations that would be made until the observations in either component were completed.

The first component was comprised of asking the participant to demonstrate instilling a 5 ml sterile artificial tear solution contained in sterile low-density polyethylene bottle just as they would usually do at home. Participants were open to another attempt if they were not satisfied with their first attempt but no prompting was provided. The participants were granted the autonomy to demonstrate the procedure in either eye of their choice to avoid any probable impact on performance due to handedness. The entire process was observed and recorded by a single researcher to avoid observer bias [Table 2].

This was followed by a subjective evaluation component wherein participants were interviewed with a set of 10 close-ended questions as described in Table 3. They were also asked to recall whether they had been instructed or a demonstration was provided about instilling eye drops previously, and if so, from whom. Subjective responses were subsequently recorded.

The patient’s perceived difficulty was originally planned to be assessed on a 0–10 visual analog scale. Nevertheless, this was later omitted as most patients could not specify a response. At the end of the interview, patients were explained about the correct eye drop technique and any related queries from the participants were resolved.

**Statistical analysis**

Descriptive statistics are presented as counts with percentages, and means with standard deviations and ranges. They have been specified wherever appropriate.

**Results**

A total of 179 patients were pre-screened with a mean age of 48.5 ± 14.6 years. One-half of these subjects self-instilled their eye drops, while the remainder had their drops administered either by another person (n = 78; 43.6%) or interspersed occasionally by themselves (n = 5; 2.8%). Among these, 96 (53.6%) matched the inclusion criteria and 87.5% of patients (n = 84) agreed to participate. The sample characteristics are presented in Table 1.

**Objective assessment**

As described in Table 2, only one-fifth of the sample population opted for washing hands before drop instillation (n = 19; 22.6%). During the demonstration, almost everyone (n = 73; 86.9%)...
| Table 1: Sample characteristics |
|-----------------------------|
| **Female sex**              | 37 (44.0) |
| **Age (years), mean±SD**    | 50.3±14.0 |
| **Education level**         |           |
| Primary education           | 25 (29.8) |
| Secondary education         | 36 (42.9) |
| Higher education            | 23 (27.4) |
| **Contact lens use**        | 0 (0.0)   |

Data are presented as n (%) or mean±SD

| Table 2: Objective assessment of eye drop technique |
|---------------------------------------------|
| **Wash hands**                             | 19 (22.6) |
| **Sit**                                    | 77 (91.6) |
| **Does touch the dropper tip**             | 10 (11.9) |
| **Tilts the head back slightly**           | 81 (96.4) |
| **Pulls lower eyelid away from the eye to form a pocket** | 57 (67.8) |
| **Holds the dropper tip directly over the eyelid pocket** | 56 (66.6) |
| **At least 1 drop lands into the pocket**  | 73 (86.9) |
| **Tip touches adnexa or ocular surface**   | 31 (36.9) |
| **Eye closure**                            | 33 (39.2) |
| **Performs nasolacrimal occlusion**        | 0 (0.0)   |
| **Blink more than once**                   | 21 (25.0) |
| **Requested second attempt**               | 0 (0.0)   |

Data are presented as n (%)

| Table 3: Subjective assessment interview |
|------------------------------------------|
| **Preferable position at home/work**     |           |
| Sitting                                   | 23 (27.3) |
| Supine                                   | 47 (55.9) |
| Standing                                 | 12 (14.2) |
| **Do you wash hands prior to using eye drops?** | 58 (69) |
| **Do you remove contact lenses before using eye drops?** | 0 (0.0) |
| **Confuse eye drops**                    | 0 (0.0)   |
| **Share eye drops with others**          | 0 (0.0)   |
| **Use more than one ocular medication**  | 22 (26.2) |
| **How long do you wait between instilling multiple eyedrops at the same time** | 22.7±11.1 |
| **Patients with at least one problem**   | 34 (40.5) |
| **Ever received eye drop technique education** | 35 (41.7) |
| **Eye drop technique education included**|           |
| **Verbal instruction only**               | 54 (64.3) |
| **Verbal instruction and physical demonstration** | 28 (33.3) |
| **Did not remember**                     | 2 (2.4)   |

Data are presented as n (%) or mean±SD

Only a fraction of the sample population recollected as having been taught the technique of eye drop instillation by someone. However, on further questioning about the information delivered to them by their eye care provider, we found that only a third of the population had been given verbal instructions along with a physical demonstration. The rest of them were only provided with verbal instructions.

Discussion

This study showed that the vast majority of patients failed to properly execute the eye drop technique, although most participants were able to successfully instill at least one drop into the eye. This response is a reassuring observation, as the key to attaining a therapeutic response is getting the eye drops in the eye. However, it is to be noted that optimal pharmacotherapy also demands that unwanted effects are reserved to a minimum.

In this context, we realized a considerable scope for improvement: 37% of the patients brought the dropper tip of the bottle in contact with the eye surface or surrounding region and none of the subjects performed nasolacrimal occlusion after instilling the eye drops. It is generally advised to avoid potential mechanical contact with any surface as this can allow entry of pathogens, leading to contamination of the medication.

Various studies have reported that ophthalmic preparations can get contaminated with microorganisms during repeated use.[25-28] In developing countries, bottle contamination may happen due to a bad living environment.[25] Intuitively, touching the dropper tip to the ocular surface might also cause mechanical damage to the cornea.[25] Gao et al.[13] have observed touching of the eye drop container to the cornea or the conjunctiva in 37.17% of the study population. Underlying complications may range from infections of the ocular surface or trauma such as corneal abrasions.[26] Dispensing aids could be employed for helping patients instill eye drops more effectively.

Our findings advocate that a substantial quantity of eye drops get wasted as a consequence of the faulty instillation technique. The excess of instilled medication flows out of the eye and rolls down the cheeks and the residue is drained by the lacrimal apparatus contributing to systemic absorption and associated effects. Nasolacrimal occlusion and eye closure not only increase the ocular bioavailability of ophthalmic preparations but further reduce the odds of systemic side

successfully instilled at least one drop in the eye, although the technique adopted by most was inappropriate. Nine-tenth of the participants preferred to sit for demonstrating the procedure. Most common deviations were: touching the bottle to the ocular surface or adnexa (n = 31; 36.9%), failing to close the eye (n = 51; 60.7%), and blinking more than once after drop instillation without nasolacrimal occlusion (n = 21; 25.0%). None of the participants of our sample exhibited a perfect drop technique; no patient had performed nasolacrimal occlusion.
effects. These systemically absorbed drugs circumspect the hepatic circulation and hence are not metabolized in the liver; the extent of systemic absorption of eye drops can be significant. This is specifically of relevance in the case of beta-blockers as eye drops. Major systemic side effects, such as bronchospasm, worsening of heart failure, and bradycardia, have been reported. Furthermore, ophthalmic beta-blockers absorbed into the system can interact with other drugs, e.g. verapamil (augmenting the hypotensive effect) and inhaled beta-2 agonists (decreasing their bronchodilatory effect). The application of nasolacrimal occlusion was observed for several ocular drugs. To illustrate, one study reported that nasolacrimal occlusion after administering timolol 0.5% eye drops reduced systemic absorption by almost 60%.

We found that only a third of the participants had received a practical demonstration by their healthcare professional regarding the eye drop technique. We recognize that this could be an underestimation due to recall bias. Nevertheless, there is scope for improvement as patients can easily acquire information on how to use their medication through alternate sources, specifically over the internet, although under the guidance of a medical professional. Although the study population included participants with higher levels of education (27%), no difference was observed in their performance. In 1984, Brown et al. reported that a good eye drop technique was more likely in patients visiting a private practice and proposed that this was because the private patients received better instructions on eye drop use; however, the effect of education was not directly examined concerning the instillation technique.

The observations made in this study are generally consistent with previous studies indicating improper eye drop technique in selected populations. These investigations primarily converged on the key aspects of successful instillation, i.e. getting one drop in the eye without touching the dropper tip to the eye. The prevalence of missing the eye (13%) in our study is situated in the middle of the prevalence rates seen in other studies (ranging from 0 to 25%), while the observed prevalence of dropper tip contact (37%) is present toward the upper end of the prevalence described in previous studies (ranging from 15% to 80%). To our knowledge, this research is the first to explore eye drop technique using both subjective as well as objective assessment methods in a systematic manner along with documenting patient-reported difficulties with eye drop instillation in a tertiary care setting. All subjects who touched the dropper tip to the ocular surface during the objective evaluation also had responded with never accidentally instilling an eye drop outside the eye. Thus, supporting the evidence of a conclusive observation, we attempted to enroll a patient population as representative as possible from a tertiary setting hospital out-patient department and included broad inclusion criteria (i.e. including an eye drop user regardless of an ocular condition, not excluding patients relying on others to instill their eye medication). A more detailed proforma was devised that included a wider range of characteristics of the eye drop technique.

There were several limitations to this study. First, a confounding factor to be considered is the inclination of the patient to perform the task accurately when being observed by the investigator, thus inducing a behavioral modification. Second, the inclusion of patients only with a visual acuity no less than 1.0 LogMAR in either eye would neglect the significant number of patients who instill eye drops independently, which needs consideration in future studies. Third, the difference in eye drop techniques in either eye when patients have been prescribed medication for both eyes was not investigated. Furthermore, participants were asked to demonstrate in either eye of their choice; possibly introducing a bias from patients choosing their best eye. Lastly, we suspect a recall bias as the questions regarding education about drop technique relied on patients remembering what was conveyed to them by their practitioner.

Prior studies have established that an incorrect eye drop instillation may damage the ocular surface, augment systemic side effects, and decrease therapeutic response. Appropriate administration of eye drops may pose challenges to the patients.

Conclusion

In reflection to the objectives of this research, the authors conclude that (a) a vast majority of patients are instilling eye drops incorrectly; (b) incompetence in this task can lead to stern consequences on the quality of life of the patients, especially for those who are dependent on others for administering their medication; (c) it is fundamental that practitioners necessarily explain and demonstrate the eye drop instillation procedure to every patient. Clinicians must rethink the role of over-the-counter ophthalmic interventions in patients without proper knowledge of drop administration procedures as these patients are more susceptible to incorrect use of medication, ocular surface injury, dropper contamination, and medication waste. The authors recommend that in the eye care workflow, practitioners ensure patient comprehension, compliance, and satisfaction. Furthermore, it is advisable to promote inclusion of formal yet economical patient education tools such as instructional handouts and demonstration videos.

This study adds about (1) unwarranted efficacy: most patients were able to successfully instill at least one drop into the eye, but none could successfully perform all steps of the eye drop technique, (2) high prevalence of unwanted errors: not performing nasolacrimal occlusion, touching the dropper tip to the eye or eyelid, and failing to close the eye and, lastly, (3) a need to encourage patient education in practice: a considerable number of patients never receive sufficient knowledge regarding eye drop technique.

Acknowledgements
The authors would like to thank the participating patients.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

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