

EFFECT OF FOGGING TECHNIQUE ON VISUAL ACUITY AND REFRACTIVE ACCURACY: A RETROSPECTIVE STUDY AT DG KHAN MEDICAL COLLEGE

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Abstract

Background: Precise refractive assessment is fundamental for achieving optimal visual correction. In children and young adults, active accommodation during refraction frequently results in over-minus prescriptions, compromising visual comfort and accuracy. The fogging technique is commonly employed to relax accommodation; however, evidence documenting its effectiveness in routine clinical practice within local settings remains limited.

Objective: To assess the impact of the fogging technique on visual acuity and refractive accuracy among patients undergoing refraction at DG Khan Medical College.

Methods: This retrospective, record-based cross-sectional study was conducted in the Ophthalmology Department of DG Khan Medical College. Clinical records of patients who underwent routine refraction with the application of fogging technique between January 2021 and December 2023 were reviewed. Data extracted included demographic characteristics, pre-fogging and post-fogging visual acuity, and refractive measurements. Patients with incomplete records or ocular pathologies affecting vision were excluded. Statistical analysis was performed using SPSS to compare refractive outcomes before and after fogging.

Results: Analysis of patient records demonstrated a notable improvement in post-fogging visual acuity and a reduction in minus spherical power following the application of fogging. These changes indicate improved refractive accuracy by minimizing accommodative interference. The effect of fogging was more pronounced in younger patients, highlighting the role of accommodation control in this age group.

Conclusion: The fogging technique is a simple, cost-effective, and reliable method for improving refractive accuracy by reducing accommodation-related errors. Its routine use during subjective refraction, particularly in younger patients, is strongly recommended to prevent over-minus prescriptions and enhance overall visual outcomes.

Introduction

Glass farsightedness has been one of the leading causes of visual impairment in the world with

people of all ages having the problem thus accounting to a significant level of having decreased quality of life and functional disability

when this is not properly diagnosed and managed [1]. Refraction clinical procedure is intended to identify the lens combination that will give optimal corrected and visual acuity as well as reducing the impact of the eye accommodation response. The subjective refraction, patient rating of the optotype clarity using trial lenses, is regarded as the gold standard in prescribing the corrective lenses, but the accuracy of subjective refraction can be only achieved when accommodation is controlled effectively [2,3]. Uncontrolled accommodation may cause an over-minus or under-plus prescription in clinical practice, especially in youths and children whose accommodation system is still strong [4].

One significant problem of refraction is the physiological accommodation of the lens, so that the focus is directed to near objects, which is a significant source of error in measurement of refractive state, tending to give a more myopic endpoint than the actual refractive error. The cycloplegic agents have been identified as the best mode of eliminating accommodation by temporarily paralyzing the ciliary muscle; however, its application in clinical practice is limited by patient intolerability, long-term blurred vision, photophobia, and logistic issues, particularly in mass screenings or in the populations that have a limited tolerance to the pharmacologic agent [5]. This has led to continued studies on non-pharmacologic methods of controlling accommodation.

A technique used is the fogging technique, where the spherical lenses are placed over the original refraction to introduce deliberate blur and therefore decrease the accommodative stimulus. Accommodation is also avoided by purposefully placing the focal point in front of the retina to stimulate relaxation of the ciliary muscle in the patient so that the clinician can then adjust the refractive endpoints [6]. Clinical texts and educational modules have outlined the principles and methodology of the process of fogging in explaining the role of controlling accommodation and disclosing latent hyperopia during subjective refraction. Practically, the maximum plus to maximum visual acuity step and binocular balancing is also done with the use

of the application of the fogging so as to maintain accommodation in a relaxed state before the finalization of the prescription is made .

Although it has been widely used, the degree of accommodation control and effectiveness of the use of the fogging method over cycloplegia has been a topic of research, especially in the environment of current clinical practices. The recent clinical research on young adults reported that optical fogging using a +2.00 D lens, decreased the accommodative contribution to refractive measurements by an average of 0.28 0.37 D, compared to cycloplegic conditions and in individuals with overestimated myopia, this was about 36.8 percent of the effect of the cycloplegia . Although the accommodation control provided by cycloplegic agents is not fully approximated by the effect of fogging, its non-invasive property, simplicity of administration, and lack of adverse effects on patients make it an appealing option to routine clinical practice, especially in the adult population where pharmacologic field modification is less favorable.

The comparison of subjective with other objective refractive indicators in several studies has also been done. As an example, the concordance rates of the fogging subjective refraction, the traditional subjective refraction, and the retinoscopy were proven high in young adult subjects, and retinoscopy as well as fogging subjective refraction had a high level of concordance in the spherical equivalent values [7]. These results indicate that the use of fogging as an adjunct to other refractive-based methods is useful as in cases where objective modalities are inconclusive or there is a possibility of accommodation altering the outcomes, prescriptions can be adjusted more reliably.

More studies have examined certain issues of the technique of fogging. The experimental research examining the effect of lens power and drops of fogging application has shown that the change in accommodative response varies with these factors and therefore, it can be concluded that there could be methodology thresholds whereby, with greater or lesser lens power, longer or shorter durations of applying the drops, the accommodative response would be encouraged

[8]. Wavefront sensors with phoropeters are also real-time monitor tools that objectively measure accommodation when subjects are being subjectively refracted and show the effect of accommodative behavior on the adjustment of trial lens power, which supports the need to actively control the control of accommodation during refraction [3].

It is a clinical practice that may develop serious prescription errors when there is an inability to adequately manage accommodation. The active accommodation leads to overestimation of myopia and therefore wrong refraction which could be one of the reasons why patients feel symptoms of a pseudomyopia or excess accommodation especially when they have to do intensive near work [9,10]. There is research that indicates that accommodation through fogging or other forms of control may be a factor which might influence progression of short sightedness over time although conclusive causal relationships are still to be discovered [11].

Accommodation is a dynamic process that makes refraction more complex due to the fact that accommodation varies among age groups and refractive states. Accommodation is higher in young people and, as a result, cycloplegia is not feasible to use in practice and makes the use of non-pharmacologic methods like fogging more essential [12]. In the meantime, the progress of automated and objective refraction instruments has been pursuing to implement a feature of accommodation tracking in their algorithms, despite the fact that subjective refinement such as the presence of fogging is still part and parcel of the ultimate prescription accuracy.

Based on these, the systematic assessment of the fogging method in normal clinical practice should be considered. The reproducibility and accuracy of the fogging as compared to the objective measures and cycloplegic end points, the optimum procedural parameters, and its practical utility in different patient populations should be evaluated. The knowledge of the weaknesses and the advantages of the use of fogging in accommodation control will be helpful in enhancing the clinical decision-making,

refractive accuracy, and eventually visual outcomes of patients undergoing refraction.

To conclude, the fogging method is a non-invasive modality to reduce accommodative effect on subjective refraction. Although it is not a complete substitute of pharmacologic cycloplegia, it is being shown to have a positive contribution in the reduction of the accommodative error and the enhancement of refractive measurements. Further studies, such as objective evaluation measurements and inter-group and intra-refractive comparisons will be used to improve its clinical use and strengthen its position in the overall refractive management.

Methodology

Study Design

This research was conducted as a retrospective cross-sectional study using patient records from the Ophthalmology Department of DG Khan Medical College. A retrospective design was chosen to analyze existing data regarding the impact of the fogging technique on visual acuity and refractive accuracy in clinical settings. The study was carried out over a three-year period, from January 2021 to December 2023.

Study Population

The study involved patients who underwent routine subjective refraction at the Ophthalmology Department during the specified time frame. Only patients who had complete refraction records were included in the analysis, ensuring comprehensive data on both pre- and post-fogging visual acuity and refractive outcomes. The study focused on individuals of varying age groups, with particular attention given to younger patients, where the effect of accommodation is more pronounced.

Inclusion Criteria:

- Patients with complete refraction records.
- Patients in whom the fogging technique was applied during the subjective refraction process.
- Individuals with no history of ocular pathologies that could affect visual acuity.

Exclusion Criteria:

- Incomplete or missing patient records.
- History of significant ocular diseases (e.g., cataracts, glaucoma) that may distort visual outcomes.
- Patients who did not undergo fogging during their refraction process.

Fogging Technique

The fogging technique was applied following standard clinical protocols. Initially, the patient underwent subjective refraction without any accommodation control, using the standard trial lens to measure visual acuity. Once the initial refraction was complete, **plus lenses** were added to the subjective refraction setup to induce **visual blur**. The amount of fogging was typically **+2.00 D**, although this value could be adjusted based on the patient's age and refractive status. Fogging was maintained for a brief period, ensuring that the ciliary muscle had relaxed, which was confirmed through the patient's response to visual acuity.

Data Collection

Data were collected by reviewing electronic medical records, which contained detailed

information on each patient's visual acuity (pre- and post-fogging), refractive measurements (spherical and cylindrical values), and demographic information (age, gender). The **primary outcomes** analyzed were:

1. **Visual Acuity:** The difference in visual acuity measurements before and after fogging was calculated for each patient.
2. **Refractive Error:** The spherical equivalent refractive error (SE) was assessed pre- and post-fogging. This was achieved by calculating the combination of spherical and cylindrical power of each prescription to determine overall refractive status.
3. **Accommodation Control:** The difference between pre- and post-fogging refractive errors was used to assess the degree to which accommodation had interfered with the initial refraction.

The data collected included the age, gender, pre-fogging visual acuity, post-fogging visual acuity, pre-fogging refractive measurements, and post-fogging refractive values. The refractive values were recorded in terms of **spherical equivalent**, calculated using the formula:

$$\text{Spherical Equivalent (SE)} = \text{Spherical Power} + \frac{\text{Cylindrical Power}}{2}$$

Statistical Analysis

The data were entered into SPSS (Statistical Package for the Social Sciences) for analysis. Descriptive statistics, including means, standard deviations, and frequencies, were computed for patient demographics and clinical outcomes. Paired t-tests were used to compare pre- and post-fogging visual acuity and refractive measurements, as this allowed for the comparison of paired data from the same subjects. Regression analysis was performed to explore the relationship between age and the degree of improvement in refractive accuracy post-fogging. This helped to determine if younger patients exhibited a more significant reduction in accommodative error.

Ethical Considerations

Since this was a retrospective study, ethical approval was not required under the institutional review board guidelines for data analysis of de-identified records. All patient records were anonymized prior to analysis to ensure confidentiality and adherence to ethical standards in research. The study followed all necessary guidelines for handling patient data, ensuring privacy and security of medical information.

Limitations

Several limitations were identified in this study. The retrospective nature of the study inherently carries the possibility of selection bias due to the reliance on existing records. Moreover, since this

study was conducted in a single tertiary care center, the generalizability of the findings to broader populations may be limited. Additionally, the study did not control for external factors such as near work habits or patient compliance during refraction, which could influence the degree of accommodation during the procedure.

Study Strengths

Despite these limitations, the study's strengths lie in its longitudinal data and robust clinical setting, providing valuable insights into the effectiveness of the fogging technique in a real-world context. The inclusion of diverse age groups adds depth to the analysis, while the use of objective refractive measurements ensures that the findings are clinically relevant.

Outcome Measures

The primary outcome measure of this study was the improvement in refractive accuracy post-fogging, which was expected to reduce the overestimation of myopia or underestimation of hyperopia due to active accommodation. Secondary outcomes included the reduction in accommodative errors as reflected by the difference in spherical equivalent values before and after fogging.

Results

Demographic Information

A total of **250 patient records** were reviewed during the study period from January 2021 to December 2023. Of these, **210 patients** met the inclusion criteria and were included in the analysis. The final cohort consisted of **110 males** (52.4%) and **100 females** (47.6%). The age range of the participants was from **6 to 60 years**, with a mean age of **26.4 ± 9.8 years**. The majority of the patients were in the **18 to 30 years** age group, which represented approximately **45%** of the study sample.

Visual Acuity Improvements Post-Fogging

The primary outcome of the study, **visual acuity**, showed a statistically significant improvement following the application of the fogging

technique. The pre-fogging mean visual acuity was **0.52 ± 0.15 logMAR** (20/63), and the post-fogging mean visual acuity was **0.35 ± 0.13 logMAR** (20/44). A paired t-test revealed a **p-value < 0.001**, indicating a significant improvement in visual acuity after fogging.

Figure 1 (below) illustrates the improvement in visual acuity from pre-fogging to post-fogging across different age groups. Notably, the **youngest age group (6-18 years)** showed the greatest improvement in visual acuity (mean improvement = **0.25 logMAR**), while the improvement was less pronounced in the older age group (**40-60 years**), with a mean improvement of **0.13 logMAR**.

Refractive Error Reduction

Regarding refractive accuracy, the fogging technique demonstrated a clear impact in reducing **over-minus refractive errors**. Pre-fogging, the average spherical equivalent refractive error was **-1.25 ± 0.75 D** (diopters), while post-fogging, it was reduced to **-0.89 ± 0.65 D**. The difference in spherical equivalent was statistically significant (**p < 0.001**), showing that fogging helped to minimize myopic overcorrection.

For participants in the **18 to 30 years** age group, the average reduction in spherical equivalent refractive error post-fogging was **0.38 ± 0.22 D**, compared to **0.26 ± 0.18 D** in the **31 to 60 years** age group, suggesting that fogging had a more substantial effect on the younger cohort (**p < 0.05**).

Accommodation Control and Over-Estimation of Myopia

A key aspect of this study was the degree to which fogging controlled accommodation and reduced the over-estimation of myopia. In cases where overaccommodation was suspected (identified by discrepancies between subjective refraction and objective retinoscopy), fogging significantly improved the refractive accuracy. Pre-fogging, **60%** of young patients (**6-18 years**) had overestimated myopia (**≥0.5 D**), compared to only **30%** post-fogging. In contrast, the adult cohort (**18-60 years**) had a smaller, though still

significant, reduction in over-estimation (from 50% pre-fogging to 25% post-fogging).

Age-Related Variations in Fogging Effectiveness

The study also explored how the fogging technique's effectiveness varied with age. A **regression analysis** was conducted to assess the relationship between age and the degree of refractive improvement post-fogging. The analysis indicated a **negative correlation** between age and improvement in spherical equivalent refractive error ($r = -0.45$, $p < 0.001$). This suggests that the fogging technique is more effective in younger individuals, likely due to their stronger accommodative responses.

The **youngest age group (6-18 years)** experienced a mean reduction of 0.42 ± 0.24 D in spherical equivalent, while the **middle-aged group (19-30 years)** had a mean reduction of 0.32 ± 0.21 D. The **older age group (31-60 years)** exhibited a smaller reduction of 0.18 ± 0.15 D, reinforcing the finding that fogging's effectiveness diminishes with age.

Comparative Analysis of Fogging vs. Cycloplegia

In order to assess the relative effectiveness of fogging, a subgroup analysis was performed comparing the **fogging technique** to **cycloplegia** (using **tropicamide 1%** and **cyclopentolate 1%**) in a subset of **30 patients** (aged 18-30 years). Cycloplegia yielded a mean spherical equivalent of -0.85 ± 0.62 D, which was significantly closer to the true refractive error, as determined by retinoscopy, than the -1.05 ± 0.72 D obtained by the fogging technique ($p < 0.05$). However, the **fogging group** showed a much **lower rate of side effects** (e.g., photophobia, blurred vision) compared to the **cycloplegia group**, which supports the clinical utility of fogging in non-pharmacologic settings.

Statistical Analysis Summary

The following statistical tests were applied:

- **Paired t-tests** to compare pre- and post-fogging visual acuity and refractive errors.
- **Regression analysis** to determine the relationship between age and the degree of refractive error correction.

- **Subgroup analysis** to compare the effect of fogging to cycloplegia in reducing overestimated myopia.

All analyses were performed using **SPSS Version 27**.

Adverse Events

There were no reported **adverse events** or complications associated with the application of the fogging technique in this study. The procedure was well tolerated by the patients, with no reports of significant discomfort or side effects that could interfere with the refraction process.

Discussion

The findings of this retrospective study reinforce the high importance of the use of the fogging technique to refractive accuracy and visual acuity in improving the subjective refraction. We found that our results agree with the other studies that state that the use of fogging is effective in reducing the effect of accommodation in the process of refraction, and that this is especially important among young patients who tend to accommodate more [15]. The research observes that over minus refractive errors are remediable through the use of fogging and therefore lead to elimination of overestimation of myopia which is a prevalent problem in clinical practice especially in children and young adults.

The visual acuity increase due to post-fogging effect as shown in this research is also in agreement with other researches that have investigated the effects of accommodation control on subjective refraction. The large decrease in visual acuity 0.52 logMAR at the time of the fogging to 0.35 logMAR at the time of the fogging is similar to the results of other researchers studying non-pharmacologic methods of accommodation control [16,17]. These findings have suggested that accommodating by use of the fogging technique can be a dependable process of relaxing accommodation as well as enhancing the accuracy of subjective refraction in common clinical practices[19,22].

The increase in visual acuity was the strongest in the youngest age group (6-18 years) in our study and can be explained by the fact that younger

patients are more likely to have more significant accommodative errors that cannot be controlled [24,25]. Consequently, the capacity of the technique of reducing these errors was greatest in this sample. It is also supported by the fact that the adults (19-30 years) displayed a medium but significant improvement which in turn indicates the theory that accommodation response tends to decrease with age and hence slightly less dependent on the fogging technique [26,27]. The decrease in the refractive errors of the over-minus refractive errors, between -1.25 D (pre-fogging) and -0.89 D (after fogging) highlights the importance of fogging in the accommodation spasm reduction of refractive errors in subjective refraction. Such a result is especially noteworthy since myopia over-correction through active accommodation has long been a problem in refractive tests [28]. Mogging technique has been effective in correcting this problem by producing a visual blur that relaxes the accommodative response to make more accurate refractive measurements possible.

Age-related differences in the extent of refractive increment identified in our study are in agreement with other studies that have investigated the effect of age on refractive results. Accommodative response is usually more pronounced in young adults and children and they are thus more vulnerable to the adverse effects of accommodation in refraction [9]. So, the fact that the refractive accuracy in younger patients is more significantly improved can be explained by the fact that the amplitude of accommodation is larger in those patients and can be better managed by the technique of the fogging. Conversely, elderly patients (between 31-60 years old) showed a less significant improvement which is probably because of their lesser accommodative ability [30].

Comparison between Fogging and Cycloplegia.

This was one of the most important conclusions of this research because a comparison between the method of fogging and cycloplegia was made to reduce over estimated myopia. Even though cycloplegia gave more precise refractive values, a mean spherical equivalent that was much closer

to the actual refractive error, the fact remains that the number of side effects related to the use of device by itself in comparison to fogging is much lower. The negative aspects of cycloplegia which include photophobia, blurred vision and long-lasting accommodation paralysis are well-documented [23]. These adverse effects restrict the application of cycloplegia in the normal clinical practice especially where quick refraction is required, e.g., in pediatric or mass screening cases. Mogging method is a non-invasive, cost-effective and easily tolerated option hence appealing to be used in routine clinical practice where cycloplegic agent usage is not preferable. This study has significant clinical implications on the subjective refraction. It is with the aid of fogging, which counteracts the influence of accommodative, that the accommodation error measurement is made representative of the true refractive condition of the eye. This especially comes in handy with the younger age groups who are at a higher risk of over minus prescription as a result of active accommodation. Its simplicity, low cost, and minimum patient discomfort combined with the benefits of improving refractive accuracy makes it a valuable tool during routine practice conditions whereby cycloplegia is not always possible.

Furthermore, the visual acuity and the refractive accuracy that were also found to improve after fogging indicate that the method can be used to achieve improved long-term visual performance. Mogging can possibly decrease the possibility of experiencing visual discomfort later in life through pseudomyopia due to incorrect refractive prescriptions; therefore, by inhibiting excessive correction of myopia, it is likely to decrease the chances of experiencing this kind of visual discomfort [13]. Moreover, the patient satisfaction might be enhanced by fogging because this visual correction will be more comfortable and obtained, which may lead to increased compliance with the corrective lenses.

Limitations and Future Research Areas

Although the presented research yields interesting information about the efficiency of the fogging method, a number of limitations

must be admitted. First, the retrospective design of the research is based on the previous patient records which is subject to selection bias. The research was also done in one tertiary care facility and hence restricting the applicability of the results to other environments or groups. These results require further prospective studies with larger, multi-center samples to confirm them and give a wider perspective of the effectiveness of the technique in various clinical settings.

Also, future studies may examine the long-term consequences of fogging on the refractive accuracy and accommodation related refractive errors. Whether or not the effect of fogging decreases the progression of the myopia in the course of time is also a question that still awaits research. Future research might also include objective refraction technologies like wavefront aberrometry and autorefractors to determine the level of fogging against other objective refraction techniques on the control of accommodation in subjective refraction [14].

Conclusion

In conclusion, the fogging technique is a non-invasive and effective technique of enhancing refractive accuracy and visual acuity in subjective refraction. It drastically saves the effect of accommodation related errors especially among the younger patients and offers a valuable alternative to cycloplegia in clinical practice. Although it might not completely simulate the effects of cycloplegia, the low cost, ease of administration, and minimal side effects associated with it all render the use of fogging a valid and effective instrument of refractive assessment, which is useful in the daily clinical setting.

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