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Pre-operative Near Acuity Test as Predictor for Post-operative Distance Visual Acuity in Cataract Surgery

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Abstract

Background and objectives: While surgical interventions are the most common and successful treatments for cataract, the need for preoperative assessment to accurately predict postoperative visual outcomes is crucial not only for patient counseling and surgical planning but also to set realistic expectations. Therefore, the aim of the present study is to evaluate the ability of the preoperative near acuity test to successfully predict the improvement in distance eyesight following the cataract surgery.

Methods: Data for this cross-sectional retrospective study was collected from North Eye Center, which is an ophthalmic medical center in Erbil, Iraq from January 2020 to January 2024. Results for the preoperative near acuity test from 400 patients, who were 40-80 years old prior to cataract surgery, were analyzed. Postoperative distance visual acuity data were also collected for these patients. The outcomes from the preoperative near acuity test were then compared with postoperative distance visual acuity results to assess the predictive accuracy of the test.

Results: The test was able to predict cataract surgical outcomes in 87.5% (350/400) of patients in comparison to 12.5% (50/400) who were not predicted by the test ($P<0.001$). Patients who were not predicted by the preoperative near acuity test were found significantly older (75.7±2.3 years) than patients who were predicted by the test, 75.7±2.3 vs. 60.4±2.2 years, respectively, $P<0.01$.

Conclusions: the preoperative near acuity test may serve as a valuable predictive tool in preoperative evaluations for cataract surgery, particularly effective in younger patients. Its integration into standard preoperative assessments could enhance surgical outcomes by enabling more personalized patient management strategies.

Keywords: Cataracts, Macula, Preoperative Near Acuity Test, Visual acuity

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Introduction

The World Health Organization defines cataract as a visual acuity of less than 6/60 in the better eye. It affects approximately 18 million people, 90% of them in low- and middle-income countries.[1] Cataract can result in blindness if left untreated. Surgical interventions are the most effective procedures to treat cataract. It restores impaired vision caused by the opacification of the crystalline lens of the eye. The process involves removing the clouded lens and replacing it with an intraocular lens.[2] However, even with this established procedure, predicting visual outcomes remains a challenging and a critical step. Although the procedure has a high success rate, the prediction of postoperative visual outcomes remains a significant challenge that directly affects patient satisfaction and surgical success.[3] Standard preoperative assessments such as biometry and corneal topography have traditionally been used to predict postoperative visual outcomes. However, both assessments focus on anatomical aspects and refractive measurements of the corneal shape and axial length; thus, they do not fully predict postoperative functional vision.[4] In recent years, the preoperative near acuity test (PNAT) has become a specialized visual assessment used to predict postoperative outcomes in patients undergoing cataract surgery and to complement the traditional preoperative assessments. This test measures a patient's near vision acuity prior to surgery, providing functional assessment and crucial information that can influence clinical decisions, patient counseling, and surgical planning.[5] There are several mechanisms by which PNAT provides these predictions. First, unlike the aforementioned standard assessments that are influenced by the lens opacity and transparency, PNAT bypasses lens opacity. The preoperative near acuity test primarily evaluates near vision acuity, which is a direct indicator of macular function. The macula plays a critical role in visual acuity at near distances. Since near vision is less affected by lens opacities than distance vision, PNAT can provide a clearer assessment of the underlying health of the macula. If near vision is good despite the presence of a cataract, it suggests that the macula is functioning well, indicating a higher likelihood of good postoperative distance vision once the cataract is removed.[5-6] Second, since PNAT is minimally influenced by the clarity of the lens, it serves as an indirect measure of retinal health. Effective performance on PNAT suggests that the retina is likely healthy, indicating positive visual outcomes post-surgery.[7] Third, PNAT can provide information about the integrity of vision neuronal pathways, suggesting that effective neural processing is likely to result in better postoperative visual outcomes.[8] Finally, in patients with additional ocular conditions or systemic diseases, PNAT can help with overall assessment of visual potential in these complex cases, aiding in more personalized surgical planning and management.[5] The aim of the present study is to test the ability to use PNAT as a selection criterion for patients with cataracts because such a test may help to determine which patients can benefit from cataract surgery. This means if the PNAT is successfully capable of predicting eyesight improvement following cataract surgery, the test can then be incorporated into the routine procedures and preparations before cataract surgeries. If this will be the case, PNAT may not only minimize the potential false interpretation of ineffective cataract operations but also reduce cost, effort, and labor by medical personnels and patients by admitting only the patients that can benefit from cataract surgery.

Patients and methods

This is a cross-sectional retrospective study. Data for 400 patients with cataracts were

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collected from North Eye Center, which is an ophthalmic medical center in Erbil, Iraq from January 2020 to January 2024. The data were for visual acuity of patients before and after the cataract surgery. Our selection criteria for patients consisted of men and women of age 40 to 80 years who were referred for cataract surgery at North Eye Center. In addition, our inclusion criteria also included patients with Type I and II diabetes mellitus, hypertension, age related macular degeneration, and glaucoma. Our exclusion criteria consisted of patients who had not undergone pre – near or post -distance operative visual acuity test, had mature cataract, or did not comply with the near visual acuity test. Demographic data for patients of age, body mass index, smoking habit, gender, and education levels were collected. Patients were considered illiterate when unable to read or write, of basic education when had primary to high-school education, or of advanced education when have obtained a college degree or higher. All data collection performed in this study were approved by the Research Protocol Ethics Committee of Kurdistan Higher Council of Medical Specialties, which is in accordance with the international ethical standards as laid down in the 1964 Helsinki declaration and its later amendments. The acuity test was conducted as previously described.[6-8] Briefly, patients were tested in a well-lit environment to ensure consistent lighting conditions and to mimic the typical scenarios where near vision is used, like for reading. Patients were then asked to read from near vision charts, which included smaller print than in standard distance vision charts. These charts were typically held at a reading distance (35-40 cm) from the eyes. Usual common charts used included the Jaeger chart, Rosenbaum card, or SNELLEN near vision chart. To rule out any possible variable, we had included data from patients who were tested using Jaeger Chart. This chart is a handheld card that features rows of short blocks of text in various font sizes. The Jaeger scores, which ranges from J1 to J10, indicate the level of visual clarity, with J1 being the smallest text. If the patients normally use corrective lenses for near tasks, they were tested with the lenses on. The patient was asked to cover one eye with an occluder and read out. Starting with larger print, the patient read aloud the lines of text, progressing to smaller lines until they were no longer clearly discerning the letters. The smallest line of text that was read accurately determines the near visual acuity. The patient was asked to repeat the process with the other eye. The results are then recorded in terms of the smallest line the patient was able to read clearly. Near visual acuity is then documented using standard vision measurement metrics (like N5, N8, etc., depending on the print size identified on the chart). High performance in PNAT suggests that the patient is likely to achieve good visual acuity following cataract surgery, assuming no other negative contributing factors exist. The paired t-test was used to determine statistical differences in patients who had acuity test before and after the cataract surgery. The paired t-tests assumptions of normality of distribution, homogeneity of variances, and/or lack of outliers were tested. The non-parametric Pearsons Chi-square test of independence was used to analyze statistical differences among patients predicted or not predicted by PNAT and for patients with different educational levels. When the α level of the P value was less than 0.05 and a pairwise comparison was needed, the 2 x 2 contingency table with an appropriate Bonferroni correction for the P value was used to test statistical differences between particular percentages.[9] Student's t-test was used to compare age difference between patients successfully predicted by PNAT and those not successfully predicted by PNAT. Differences were considered statistically significant at $P < 0.05$. The statistical

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software SPSS 18.0 (SPSS Inc., Chicago, IL, USA) was used to conduct all the statistical tests.

Results

Table one shows the demographic data of all patients (n=400) included in this study. Data for 200 patients was not included in this study per our exclusion criteria. Out of those 200 patients, 105 patients were excluded because they did not comply with the test (poor compliance), 62 patients were excluded because they had mature cataract, and 33 patients did not undergo PNAT, Table (1).

Table (1): The demographic data of included and excluded patients

Included patients	Patients (n)	400
	Age range (years)	40-80
	Age average (M±SEM years)	66±3.8
	Males (n)	444
	Females (n)	156
	BMI (kg/m^2)	29.9±0.7
	Smoking (%)	72
	Educational Level Illiterate (%) Basic (%) Advanced (%)	 3 65 32
Excluded patients	Patients (n)	200
	Poor compliance with the test	105
	Mature cataract	62
	Did not undergo PNAT	33

Further evaluation for those patients showed that most of the patients that did not comply with the test were illiterate in comparison to patients who had basic or advanced education, 75% vs. 17% or 8%, respectively P<0.001, Figure (1). No significant differences regarding the different educational levels were observed among patients who were excluded because of having mature cataract or did not undergo the test P>0.05, Figure (1).

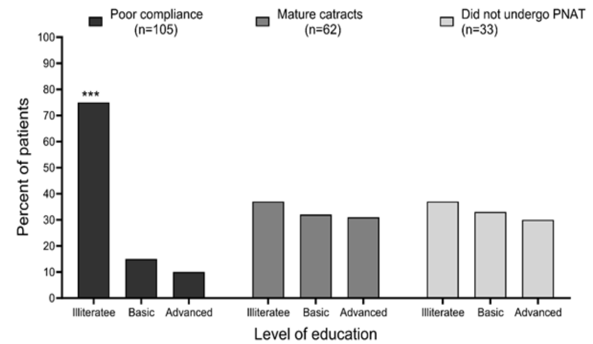

Figure (1): Educational levels among patients that were excluded from this study. Note that most of the patients who did not comply with the test were illiterate. ***P<0.001 within each group using the 2 x 2 contingency table with a Bonferroni correction of P value of 0.016. Data are presented as percentages.

The test predicted most of the patients that benefited from the cataract surgery. Our results show that 87.5% (350/400) of patients were predicted with the PNAT in comparison to 12.5% (50/400) who were not predicted by the test P<0.0001, Figure (2). Further evaluation for those patients who their cataract surgery outcomes where not predicted by the test revealed that most of them were significantly older than those patients who were predicted by the test, 75.7±2.3 vs. 60.4±2.2, respectively P<0.01, Figure (3).

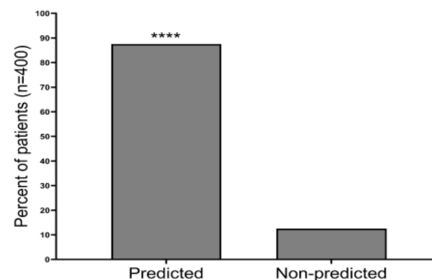

Figure (2): The predictive capacity of PNAT for postoperative outcomes in patients undergoing cataract surgery. ****P<0.0001 using Pearsons Chi-square test of independence. Data are presented as percentages.

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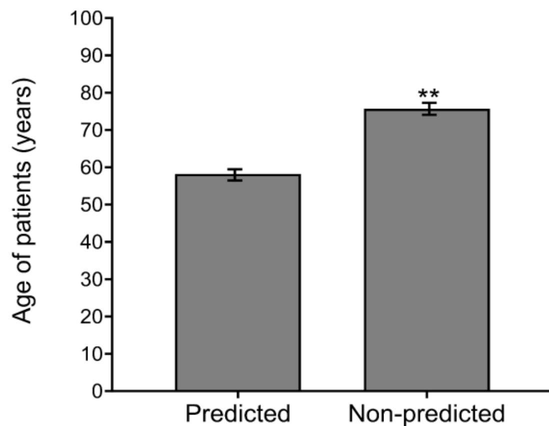

Figure (3): Age difference between patients that were predicted or not predicted by the PNAT. Note that PNAT was unable to predict postoperative outcome following cataract surgery in older people. **P<0.01 using Student's t-test. Data are presented as mean±SEM.

Discussion

The demographic data from our study reveals significant correlations between education levels and ability to perform the PNAT. A notable 75% of non-compliant patients were illiterate, indicating that literacy plays a crucial role in the ability to participate effectively in near vision acuity testing. This finding is consistent with studies suggesting that educational level significantly affects the outcomes of preoperative assessments in ophthalmology.[10] This demographic challenge emphasizes the necessity for tailored communication strategies in preoperative settings to accommodate varying literacy levels. Previous studies have recommended employing easily comprehensible test cards or using verbal instructions and symbols, which could help overcome barriers related to limited reading skills.[6] Furthermore, our data also indicate that cataract maturity does not significantly correlate with educational levels. This is aligned with broader research showing that cataract development is more closely linked to aging and diabetes rather than educational attainment.[11] However, the exclusion of patients with mature cataracts from PNAT underscores the limitations of this test in cases where lens opacity is too advanced for any meaningful near vision assessment. Mature cataracts create profound opacities that obscure any reliable measurement of near vision acuity. This exclusion criterion of patients with mature cataracts aligns with existing research suggesting that preoperative assessment tools may need to be supplemented by enhanced imaging modalities (e.g. optical coherence tomography) to assess the retinal status in patients with mature cataracts.[12] The predictive capacity of PNAT was demonstrated to be robust, with 87.5% of patients correctly predicted to benefit from cataract surgery based on their preoperative near vision acuity tests. This high predictive accuracy highlights PNAT's utility as a valuable tool in preoperative evaluation, aligning with findings from Achiron and his research group (2016), who reported a similar predictive reliability in their cohort.[13] Similarly, another group reported that patients who scored higher on the PNAT tended to have better postoperative distance visual outcomes, providing robust support for the predictive value of PNAT.[14] This suggests that good near vision before surgery is a proxy for the overall health of the retina and the visual system. The fact that PNAT was less predictive in older patients may reflect age-related changes in the visual system not directly related to lens opacities, such as macular degeneration or changes in neural processing speed, which are not accounted for by PNAT alone.[15] For example, the macula is crucial for reading and recognizing faces. Age-related macular degeneration can cause significant deterioration in this area, leading to distorted or blurred vision even if the lens is clear after cataract surgery.[7] Another example is aging

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can also impact the neural pathways that process visual information from the eye to the brain. Changes in neural efficiency can slow down the processing speed and accuracy, affecting overall visual perception disregard of lens health.[16] This suggests that PNAT may have limitations in older populations, potentially due to the presence of concurrent age-related ocular comorbidity, which can independently affect vision apart from cataracts. The presence of these conditions often complicates the ability of standard preoperative tests like PNAT to predict surgical outcomes accurately.[8] These findings suggest the need for integrating more comprehensive diagnostic assessments that consider age-related ocular conditions for older patients undergoing cataract surgery.

Conclusion

Our results underscore the utility of PNAT in predicting postoperative outcomes for most patients undergoing cataract surgery. Patients who have basic or advanced levels of education and do not have mature cataracts are the most to benefit from the test. In addition, the test was also able to benefit patients who are in their late 50s and early 60s (60.4±2.2 years), but becomes of weaker predictive capacity as the candidates age and is unable to predict patients in the middle of their 70s (75.7±2.3). Therefore, a different test should be developed for patients who are illiterate, old, or with mature cataracts or potential comorbidities. Furthermore, the ability to predict visual outcomes accurately after cataract surgery is crucial for multiple reasons. First, it helps in selecting the most suitable intraocular lens for each patient. Second, it aids in setting realistic expectations, which is vital for patient counseling and satisfaction. Third, it can identify patients with concurrent retinal issues that could affect postoperative vision. Finally, the test may also minimize the potential false interpretation of ineffective cataract operations and reduce cost, effort, and labor. In addition, the PNAT is a non-invasive nor interventional test, which means it does not carry any potential complications on vision.

Conflict of interest

The authors declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

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