Original Article

Predicting postoperative visual outcomes in cataract patients with maculopathy

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Purpose: To assess the accuracy of the potential acuity meter (PAM) in predicting postcataract surgery visual acuity outcome in patients with healed inactive maculopathies. **Study Design:** Prospective interventional clinical trial. **Patients and Methods:** Patients scheduled for phacoemulsification had preoperative and 1 month postoperative best-corrected visual acuity (BCVA), PAM test, fluorescein angiography, and macular optical coherence tomography. Patients were grouped to following preoperative BCVA: PRE1: 0.29 and better, PRE2: 0.25–0.13, and PRE3: 0.1 or worse; age: G1 <60, G2 = 60–70, and G3 >70 years. PAM accuracy was divided into: Grade 1: Postoperative BCVA ≤1 or less line error of the PAM score, Grade 2: Between 1 and 2 lines error, and Grade 3: ≥3 lines or more error. **Results:** This study enrolled 57 patients with a mean age of 71.05 ± 6.78 years where 34 were females. There were 21 (36.84%) patients with diabetic maculopathy and 36 (63.16%) with age-related macular degeneration. The mean preoperative BCVA was 0.198 ± 0.12 (0.1–0.5). The mean PAM score was 0.442 ± 0.24 (0.1–1.3). The mean postoperative BCVA was 0.4352 ± 0.19 (0.17–1.00). The PAM score was in Grade 1, 2, and 3 in 46 (80.7%), 54 (94.7%), and 56 (98.2), respectively. There was a highly significant correlation between the PAM score and the postoperative BCVA (P < 0.001, Chi-square test). There was no correlation between the PAM test accuracy and age, gender, diagnosis, and preoperative BCVA (P = 0.661, 0.667, 0. 0.991, 0.833, Chi-square test; respectively). **Conclusion:** The PAM is an accurate method of predicting postoperative visual acuity for eyes with nuclear cataracts Grade I and II and inactive maculopathies.

Key words: Age-related macular degeneration, best-corrected visual acuity, cataract surgery, diabetic maculopathy, potential acuity meter

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The prediction of postcataract surgery visual acuity outcomes is challenging in patients with known maculopathies. Patients who have concomitant retinal disease are at the major risk for unsuccessful outcomes, and an accurate prediction of visual acuity is of great benefit to this population. Many protocols have been developed to assess potential vision tests.[1-5] The Mentor Guyton-Minkowski potential acuity meter (PAM)[2] and other machine-based potential vision tests are not commonly available to many ophthalmologists, especially in developing countries including Egypt, whereas the pinhole (PH) test is readily available and relatively easy to administer.

In 2005, Uy and Munoz[6] concluded that "The PAM was more accurate than the PH in predicting visual acuity after cataract surgery." The accuracy of both tests decreased in patients with poorer preoperative visual acuity. Although many studies have investigated the use of the PAM test as a predictor of postcataract surgery visual outcomes, none of them have properly evaluated this test in the specific population included in our study.[1,4,7-13] The aim of this study is to investigate the reliability and accuracy of the PAM test in predicting the visual outcomes in patients with moderate cataracts and inactive treated maculopathies.

Patients and Methods

Approval for the study was obtained from the hospitals' ethical committee. All patients received a thorough explanation of the study design and aim and were provided with written informed consent. This is an interventional prospective study carried at two eye centers during a period of 2 months, March–April 2009; all patients scheduled for surgery during this period were included. All patients had preoperative full ocular evaluation including best-corrected visual acuity (BCVA), PAM test under completely dilated pupils, cataract morphology and grading, fluorescein angiography (FA), and macular optical coherence tomography (OCT).The patients underwent phacoemulsification procedure in one eye through a 3 mm corneal incision and one side port (0.9 mm). Under Healon®5 (sodium hyaluronate 2.3%), a 5 mm capsulorhexis was done, and a prechopping and/or phacoaspiration techniques were used to emulsify the nucleus. Lens cortex was aspirated by a J-cannula through the 3 mm corneal incision. A STAAR Elastic Lens® (single piece silicone intraocular lens)

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was implanted in the bag. The patients received topical antibiotic and steroid drops 4 times daily with no eye patches. Routine postoperative eye examination was done 1 day and 1 week. In 1 month, the patients were re-evaluated for: BCVA, FA, and OCT.

Inclusion criteria

(1) Cataract: Only nuclear cataracts Grades I and II were included; however, dense nuclear Grade III and IV and/or presence of posterior subcapsular cataracts were not included, (2) nonactive treated (dried) maculopathy: (a) Diabetic maculopathy, or (b) neovascular age-related macular degeneration (AMD), (3) preoperative BCVA of <3/60, and (4) PAM score equals to the preoperative BCVA. We used a simplified 4-stage senile nuclear cataract grading. Nuclear opacity grading is based on the intensity of scattering at the nucleus (Grade I, II, III, and IV). Grading of lens coloration is divided into pale-yellow (Grade I), yellow (II), brownish-yellow (III), and brown including reddish and black brown (IV).[14,15]

Exclusion criteria

(1) Active maculopathy (preoperative and/or 1 month postoperative): Leaking on FA, and/or intraretinal edema, subretinal fluids or pigment epithelial detachments on OCT, (2) patients who could not complete the PAM test or any patient whose pupil could not be fully dilated, (3) any postoperative and/or intraoperative complications, (4) high postoperative astigmatic error ≥2.00 D, (5) patients with extensive macular scarring or macular ischemia, and (6) any other ocular pathology.

BCVA was measured using Snellen chart in the foot and was converted to decimals accordingly [Table 1]. The patients were divided into three groups according to preoperative visual acuity: PRE1: 20/70 (6/21 or 0.29) and better, PRE2: 20/80–20/160 (6/24–6/48, 0.25–0.13), and PRE3: 20/200 (6/60. 0.1) or worse. The patients were divided into another 3 groups according to age: G1 = below 60 years, G2 = 60–70 years, and G3 = above 70 years. PAM accuracy was divided into three levels: Grade 1: Postoperative BCVA within 1 line error of the PAM score, Grade 2: With 2 lines error, and Grade 3: With 3 lines or more error. Analysis was done to evaluate the accuracy of the PAM test, and if there is any correlation between this accuracy and the patient age, gender, preoperative BCVA, and the diagnosis.

Table 1: Visual acuity scale used; in foot, meter, and decimals

Foot	Meter	Decimal
20/400	3/60	0.05
20/300	4/60	0.06
20/240	5/60	0.08
20/200	6/60	0.10
20/160	6/48	0.13
20/120	6/36	0.17
20/100	6/30	0.20
20/80	6/24	0.25
20/70	6/21	0.29
20/60	6/18	0.33
20/50	6/15	0.40
20/40	6/12	0.50
20/30	6/9	0.63
20/25	6/7.5	0.80
20/20	6/6	1.00
20/16	6/4.8	1.25
20/12	6/3.6	1.67
20/10	6/3	2.00

Data were statistically described in terms of range, mean ± standard deviation (±SD), frequencies (number of cases), and percentages when appropriate. Comparison was done using Chi-square (χ^2) test. Exact test was used instead when the expected frequency is <5. Accuracy of PAM test referring postoperative VA was calculated for exact results, within 1 line error, with 2 lines or with 3 lines or more error. A $P < 0.05$ was considered statistically significant. All statistical calculations were done using computer programs Microsoft Excel 2003 (Microsoft Corporation, NY, USA) and SPSS (Statistical Package for the Social Science; SPSS Inc., Chicago, IL, USA) version 15 for Microsoft Windows. Shapiro-Wilk test provided by the SPSS software is used to test for normality of data.

Results

A total of 623 eyes of 573 cataract patients were operated by five surgeons through the entry period (March–April 2009), of which 69 were legible for our study protocol. This selected study sample (69) had a mean age of 69.7 years (SD ± 7.35) and a range of 55–83 years. There were 41 females (59.42%) and 28 males (40.58%) with 26 (37.68%) diabetics and 43 (62.32%) AMD patients.

Twelve patients were excluded from the study as follows one patient died, 2 patients had open posterior capsule during surgery, 2 patients did not show up for the 1-month evaluation, 3 patients had >2.0 astigmatic error postoperative, and 4 diabetic patients had minimal dye leakage on FA and macular thickening on OCT. However, the demographics of the 12 patients excluded were similar to the rest of study population and did not alter the structure of the final study sample. The data for 57 patients were complete and included for analysis.

The 57 patients included in the study had a mean age of 71.05 years (SD ± 6.781) and a range of 56–81 years with 34 (59.6%) females. There were 21 (36.84%) patients with treated diabetic maculopathy and 36 (63.16%) with treated neovascular AMD. The mean preoperative BCVA was 0.198 SD ± 0.1232 (0.1–0.5). The mean PAM score was 0.442 SD ± 0.2404 (0.1–1.3). The postoperative BCVA was 0.4352 SD ± 0.19433 (0.17–1.00).

The postoperative BCVA was within 1, 2, and 3 lines of the PAM score in 46 (80.7%), 54 (94.7%), and 56 (98.2%), respectively, and 46 (80.7%), 8 (14%), and 3 (5.3%) of patients were in Grade 1, 2, and 3, respectively [Fig. 1]. Statistical analysis showed a highly significant correlation between the PAM scores and the postoperative BCVAs (Pearson correlation = 0.825, $P < 0.001$, Chi-square test). However, there was no correlation between the accuracy of the PAM test and the age, gender, diagnosis, and preoperative BCVA ($P = 0.661$, 0.667, 0.991, 0.833, Chi-square test; respectively).

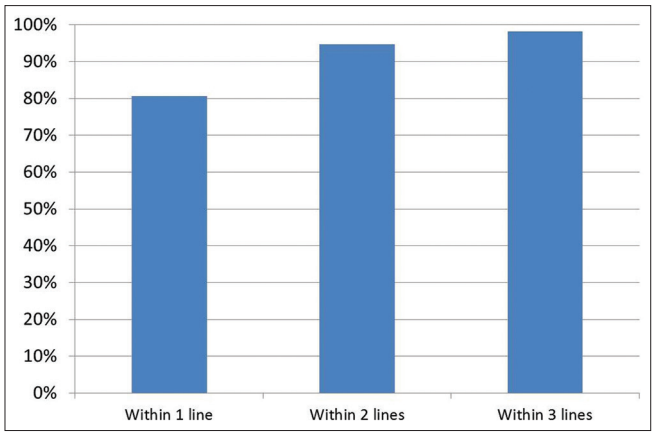

Figure 1: The percentage of patients with postoperative best-corrected visual acuity within 1, 2, and 3 lines from the preoperative potential acuity meter score

Discussion

The PAM test is considered to be a reliable method for predicting postoperative visual acuity, especially in cases of early cataract.[1-5] Prediction of postoperative visual acuity is extremely important in the senile population, in whom other ocular conditions may compromise the final visual result and thus render surgery not beneficial. Early identification of poor outcomes may prevent unnecessary healthcare costs and patient exposure to surgical risks. The Mentor Guyton-Minkowski PAM projects a Snellen visual acuity chart onto the retina using a minute aerial aperture of 0.15 mm diameter through "windows" in the lens (clearest areas in the cataract).[2] The PH test is performed using an occluder with a 0.94–1.75 mm hole through which the letters of an illuminated Snellen chart are read. The PH admits central rays of light that do not require refraction, increasing the eye's depth of focus, and decreasing the light-scattering effect of lenticular opacities.

Although Uy and Munoz[6] concluded that the PAM was more accurate than the PH, the PAM test is not without limitations. The PAM has been found to be both time consuming and prone to providing erratic results. Cuzzani *et al*. found a mean examination duration of 9 min with a longer time required for patients with poor predicted results.[7] Mentor have acknowledged that the PAM is not accurate if the preoperative visual acuity is worse than 6/60.[8] Later studies have equivocal conclusions.[7,1,4,9-11] Tharp *et al*. concluded that the PAM does not predict final visual acuity accurately[4] with Cuzzani *et al*. reporting a mild correlation between PAM and final visual acuity.[7] The studies by Lasa *et al*.[1] and Alio *et al*.,[9] however, found PAM results useful in moderate cataract. It is worth noting that when the 6/60 visual acuity is used to mark the accuracy of the PAM test, it referral mainly to the degree of crystalline lens opacity rather to the actual visual acuity, in another words these studies were done on patients known to have no other ocular pathologies. Thus, we included only patients with nuclear cataracts Grades I and II even if they had BCVA up to 3/60. As we projected lens opacities "alone" of those patients with 3/60 to a visual acuity of 6/60, if they did not have any maculopathies.

The influence of cataract type was also considered as a possible factor influencing the efficacy of PAM results. Cuzzani *et al*. suggested PAM may be less accurate in posterior subcapsular cataract where the opacity is central and has the potential to scatter the incandescent light of the PAM.[7] Based on that, we excluded those with a dense sheet of posterior subcapsular cataracts. Our careful patients selection is probably the main reason for the higher accuracy rate (80% and higher) of the PAM test in predicting the postoperative BCVA than most of other studies.[6,12,13] We did not find any correlation between the preoperative BCVA and the accuracy of the PAM test, which is another indication of the importance of the density of the lens opacity rather the preoperative BCVA for the PAM test.

Few studies[9,11] addressed the accuracy of the PAM examination for cataract patients with maculopathies. However, these studies, though with a larger number of patients, had some limitations. The procedure used for cataract removal was extracapsular cataract extraction, with no exclusions for patients developing postoperative high astigmatic error. All types of cataracts were enrolled including posterior subcapsular and those with dense opacities and lower visual acuities. There was no pre- and/or post-operative assessment and exclusion of active maculopathies by FA and/or OCT. In addition, BCVA was assessed 3 months postoperative, which is long enough for a change of the potential BCVA to occur in those elderly patients. The limitations of our study are the specially selected population. Patients with only nuclear cataracts Grade I and II were included, and patients with dense nuclear Grade III and IV or those with posterior sub-capsular cataracts were excluded. This excluded many patients that the PAM test might not be accurate. Moreover, patients with preoperative BCVA of < 3/60 were not included. A larger study might be needed to confirm our results.

The ideal predictive test should be accurate, reproducible, and easy to administer. The PH test is among the easiest to administer and requires only standard eye examination equipment. Uy and Munoz[6] found that the PH test was less accurate than PAM and the PH more frequently underestimated the visual outcome. The PH test may be useful as a screening tool. Patients with good postoperative visual acuity predicted by the PH test probably do not require PAM or other more sophisticated instrument-based tests. For surgeons, the early identification of poor outcomes may prevent unnecessary healthcare costs and patient exposure to surgical risks. Identifying patients with potential postoperative poor visual outcome will allow the surgeons to properly discuss it with his patients. It will allow the patients to be prepared psychological for these outcomes, avoiding high expectation from their surgeries.

Conclusion

The results of this study showed that the PAM is an accurate method of predicting the postoperative visual acuity for eyes with nuclear cataracts Grade I and II and inactive maculopathies with preoperative BCVA of 3/60 or better. Although the level of preoperative visual acuity should be considered as a factor that reflects the density of the lens opacity which might affect the performance of these patients on the PAM test, it is not as an absolute value. The preoperative BCVA in these patients could be partly related to maculopathies, and the PAM test could accurately predict their postoperative BCVA.

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Conflicts of Interest

There are no conflicts of interest.

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