Original Article

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Prediction of Post Phacoemulsification Visual Acuity in Patients with Different Degree of Lens Opacity using Heine Retinometer

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Abstract

Objective: The objective was to find the usefulness in predicting the visual outcome in patients who are undergoing cataract surgery by using a convenient and standard instrument.

Patients and Methods: This retrospective cohort study was done using Heine lambda 100 retinometer to find the usefulness in predicting the visual outcome at the Eye Center in King Abdulla Medical City, Makkah, KSA.

Results: It is highly specific in the prediction of post-operative visual acuity (VA) (93.5%). It has higher accuracy 87.5%, sensitivity 86%, and specificity 100% in mild cataract than denser one.

Conclusion: The Heine lambda 100 retinometer appears to be a clinically useful device to use in patients with comorbid eye condition such as Amblyopia, macular degeneration, and a corneal disease in predicting the visual outcome.

Key words: Phacoemulsification, Retinometer, Visual acuity

INTRODUCTION

The primary aim of cataract surgery was to improve visual acuity (VA). The prediction of post-operative VA needs to be accurate and precise. Some of the patients do not express a significant and satisfactory visual improvement because of ocular co-morbidities that affect the visual potential. Overestimation of the visual outcome will undoubtedly result in patient disappointment and should be avoided whenever possible. There are innumerable tests developed to assess to predict accurately potential VA after cataract surgery.

The purpose of these tests was to determine, if the calculated visual potential is effected by cataract opacity alone or other underlying ocular pathology. It is an important pre-operative test in identifying those patients in whom cataract extraction will not yield a satisfactory postoperative VA. Hence, it helps to inform properly and prepare those patients.

Cataract surgery may improve other aspects of visual function such as contrast sensitivity, color perception, reduction of glare, and visual field.[1] The potential visual test can help to determine, which part of the visual loss is because of macular retinal pathology seen preoperatively or because of lens opacity alone.

A number of different examination instruments have been used and described such as electroretinography, visual evoked potentials (Bertrand *et al.*; Odom *et al*; Sherman *et al.*), color saturation discrimination[2] critical flicker frequency, laser or white-light Interferometry, blue-field entoptic tests (Sinclair *et al.*; Morris and Missotten) B-scan ultrasonography[3], and potential acuity meter (PAM) other tests using routine eye examination equipment have also been proposed: Potential acuity pinhole test. Furthermore, illuminated near card assessment and

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reading speed test these have been compared to the more sophisticated methods.

A simple and inexpensive macular function test using a Parinaud near reading chart by Vryghem *et al.*[1] Consisting a +8 D trial lens and a Heine ophthalmoscope, which they called the Vryghem macular function test (VMFT). At the end of a study, consisting of 396 uneventful consecutive cataract surgeries, it was concluded that the VMFT test was a simple and reliable method of estimating the visual outcome after cataract surgery. Since the test is easily available and simple, we decided to compare it to the Lot mar-light interferometer, currently the instrument used in our clinic to predict VA after cataract surgery.

A very dense cataract does not permit satisfactory fundoscopic examination. In such cases, a reliable potential VA test may be helpful in the preoperative decision-making process.

A perfect potential visual test should be easy to use, precise, reproducible, and should require only minimal examination equipment. It should have fairly good accuracy and high predictive value.

A prospective study was done in 1994 to compare the Heine retinometer with the mentor Guyton-Minkowski[4] PAM to assess the potential VA before cataract surgery. Neither instrument was accurate in predicting actual final VA.

Another study to evaluate multiple pinhole accuracy and Heine retinometer[5,6] to assess the VA after lens extraction. It was found that the Heine retinometer has accuracy similar to the multiple pinholes in the prognosis of VA. The results concluded Lens extraction should not be deferred due to the large number of false negative results Reis.

However, another study in 2010 revealed that in most cases Heine retinometer underestimated or maintained best corrected VA (BCVA) 3 months postoperatively in patients. With regards to the morphological classification of cataracts, the higher the opacity of the lens, the greater the VA underestimation.[7]

In our study, we utilized the Heine lambda 100 retinometer, which is very easy to use clinically. We included patients with a comorbid eye condition such as amblyopia, macular degeneration, corneal disease, and to find the usefulness in predicting the visual outcome.

PATIENTS AND METHODS

This retrospective cohort study was done at the eye center in King Abdulla Medical City, Makkah, KSA, between March 2011 and May 2013. The range of age of patients varied from 18 to 80 years with no predilection for sex. All cases with pre- and post-operative complications were excluded.

Methodology

Chart review was performed, and data were collected for the following: Patients age, preoperative VA in decimal scale, potential VA using retinometer, post-operative BCVA.

VA of counting fingers was given a decimal value of 0.0140 and "hand movement" was given a value of 0.0052 according to the approximation of Kilian Bonsel, *et al.*

Patients were Divided into 3 Groups

Those who had VA with Heine retinometer equal to the postoperative BCVA, patients in whom VA was overestimated and patients in whom VA was underestimated with Heine retinometer comparing to the postoperative BCVA.

Statistical Analysis

Data were analyzed on SPSS 21.0 at King Abdullah Medical City Research Center. Numeric data were presented as a mean ± standard deviation or the median and range, according to distribution. For analysis purpose patient's data classified according to Heine retinometer or postoperative VA decimal values into those with values <0.5 and those with VA values of 0.5 or more. Between the groups, comparison was done using the independent sample *t*-test or ANOVA as appropriate for numeric variables and using Chi-squared test for categorical variables. A two-sided alpha was set at 0.05. The sensitivity, specificity, and accuracy of Heine retinometer in predicting post-operative VA of 0.5 or more was calculated as follows:

Sensitivity = (True positives)/(true positives + false negatives)

Specificity = (True negatives)/(true negatives + false positives)

Accuracy = (True positives + true negatives)/total number of cases

True positives = Cases correctly predicted by HR to have a post-operative BCVA of 0.5 or more.

True negatives = Cases correctly predicted by HR to have a post-operative BCVA of <0.5.

Ethical and Confidentiality

The study was approved by KAMC IRB.

RESULTS

The review of hospital records from March 2011 to May 2013 showed 164 eyes fulfilling the eligibility criteria.

Two eyes were excluded from the analysis because of having predicted post-operative VA of "light perception," and so a numeric value could not be assigned. The age of patients ranged from 28 to 93 years at the time of cataract surgery. However, only 6 eyes belonged to patients 40 years of age or less. Most of the eyes (68.5%) had a moderate cataract, (4.9%) had mild cataract, and (26.5%) had a severe cataract.

Table 1: Post-operative VA by HR between mild, moderate and severe cataract density

	Cataract severity		
	Mild *n*=8	Moderate *n*=111	Severe *n*=43
Pre-operative VA (decimal scale)			
Mean±SD	0.35	0.17	0.142
Median	0.30	0.10	0.014
Interquartile range			Missing=1
Pre-operative HR value (decimal scale)			
Mean±SD	0.45	0.323	0.216
Median	0.50	0.30	0.15
Interquartile range			
Post-operative BCVA (decimal scale)			
Mean±SD	0.75	0.646	0.603
Median	0.75	0.70	0.60
Interquartile range			
The difference between post-operative BCVA value and pre-operative HR value			
Mean±SD	−0.216 logmar	−0.323	−0.911*
Pre-operative VA <0.5 (decimal scale) *n* (%)	6 (75)	104 (93.9)	37 (86)
Pre-operative HR value <0.5 (decimal scale) *n* (%)	2 (25)	82 (73.9)	37 (86)
Post-operative BCVA <0.5 (decimal scale) *n* (%)	1 (12.5)	19 (17.1)	11 (25.6)

BCVA: Best corrected visual acuity, SD: Standard deviation, VA: Visual acuity

There is a statistical significant difference in the prediction of post-operative VA by HR between severe and mild ($P = 0.002$), and severe and moderate cataract ($P = 0.000$) with better predication in case of mild and moderate cataract density. In contrast, there is no statistical significant difference in the prediction of post-operative VA by HR between Mild and moderate cataract density $P = 0.844$ (Table 1). The distribution of different cataract types is shown in (Table 2) almost 28% of eyes had all types of cataract while around 27% had nuclear and posterior subcapsular cataract, 18% had nuclear cataractn and only 13% had posterior cataract. At least one comorbidity was present in 28.6% of the eyes, Comorbidities took the form of amblyopia $n = 10$ (6.1%), macular diseases $n = 16$ (9.8%), corneal diseases $n = 14$ (8.5%), glaucoma $n = 13$ (7.9%). However, in the presence or absence of comorbidities there is a statistical significant difference in the predicted values by HR and BCVA $P = 0.001$ and $P = 0.002$, respectively (Table 3).

DISCUSSION

The predication of post-operative VA needs to be accurate and precise.

Overestimation of the visual outcome will undoubtedly result in patient disappointment and should be avoided whenever possible.

This study showed a statistically significant difference between pre-operative Heine Retinometer VA and BCVA after phacoemulsification with $P = 0.002$.

Table 2: Distribution of different type of cataracts

	Cataract type			
	Nuclear *n*=27	Posterior *n*=21	Nuclear and posterior *n*=44	All *n*=45
Pre-operative VA (decimal scale)				Missing=1
Mean±SD	0.166	0.169	0.168	0.155
Median	0.05	0.15	0.10	0.05
Interquartile range				
Pre-operative HR value (decimal scale)				
Mean±SD	0.276	0.362	0.307	0.247
Median	0.30	0.30	0.30	0.30
Interquartile range				
Post-operative BCVA (decimal scale)				
Mean±SD	0.65	0.776	0.591	0.625
Median	0.70	0.80	0.70	0.70
Interquartile range				
The difference between post-operative BCVA value and pre-operative HR value				
Mean±SD	−0.63	−0.445	−0.345	−0.646
Pre-operative VA <0.5 (decimal scale) *n* (%)	26 (96.3)	20 (95.2)	41 (93.2)	40 (90.9)
Pre-operative HR value <0.5 (decimal scale) *n* (%)	19 (70.4)	14 (66.7)	32 (72.7)	39 (86.7)
Post-operative BCVA <0.5 (decimal scale) *n* (%)	5 (17.9)	1 (4.8)	9 (20.5)	10 (21.7)

BCVA: Best corrected visual acuity, SD: Standard deviation, VA: Visual acuity

Table 3: Predicted values by HR and BCVA in presence or absence of co-morbidities

	Total *n*=162	No eye co-morbidity *n*=114	With one or more eye co-morbidities *n*=48
Pre-operative VA (decimal scale)	Missing=1	Missing=1	
Mean±SD	0.174	0.178	0.163
Median	0.1	0.1	0.075
Interquartile range			
Pre-operative HR value (decimal scale)			
Mean±SD	0.301	0.312	0.275
Median	0.3	0.3	0.3
Interquartile range			
Post-operative BCVA (decimal scale)			
Mean±SD	0.64	0.714	0.464
Median	0.7	0.7	0.5
Interquartile range			
The difference between post-operative BCVA value and pre-operative HR value			
Mean±SD	−0.474	−0.565	−0.257
Pre-operative VA <0.5 (decimal scale) *n* (%)	147 (90.7)	104 (91.2)	43 (89.6)
	Missing=1		
Pre-operative HR value <0.5 (decimal scale) *n* (%)	121 (74.7)	83 (72.8)	38 (79.2)
Post-operative BCVA <0.5 (decimal scale) *n* (%)	31 (19.1)	9 (7.9)	22 (45.8)

BCVA: Best corrected visual acuity, SD: Standard deviation, VA: Visual acuity

Table 4: Differences between estimated and post-operative VA

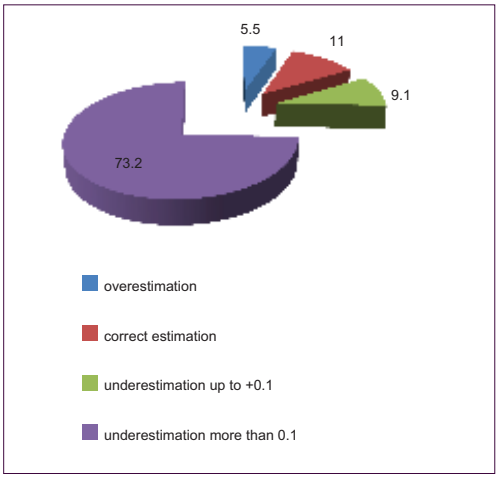
Difference between post-operative BCVA and retinometer estimated VA (on logMAR scale)	In all included eyes	In eyes without co-morbidities	In eyes with one or more co-morbidities	*P* value
Minimum	−2.28	−2.28	−1.98	0.002
Maximum	1.03	0.05	1.03	
Median	−0.33	−0.39	−0.19	
Mean±SD	−0.47±0.59	−0.57±0.59	−026±0.52	

BCVA: Best corrected visual acuity, SD: Standard deviation, VA: Visual acuity

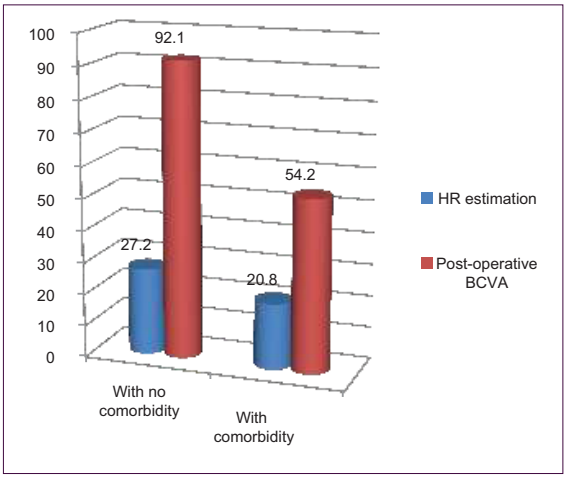
Table 5: Differences between estimated and post-operative VA in relation to cataract severity

Difference between post-operative BCVA and retinometer-estimated VA (on logMAR scale)	Mild	Moderate	Severe	*P* value
Minimum	−0.3	−1.76	−2.28	0.002
Maximum	−0.12	0.18	1.03	(significantly
Median	−0.2	−0.3	−0.67	different from
Mean±SD	−0.22±0.076	−0.32±0.3	−0.91±0.91	the other two)

BCVA: Best corrected visual acuity, SD: Standard deviation, VA: Visual acuity



Graph 1: HR estimation



Graph 2: Estimated VA by HR in patients with and without ocular co-morbidities.

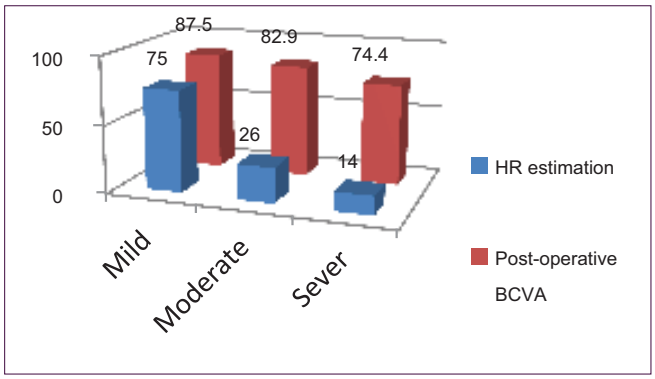
In spite of the less optimal accuracy of Heine retinometer, it is a highly specific device in a different degree of lens opacity.

The underestimation of VA by Heine retinometer within one line of post-operative BCVA in 9.1% of the cases and within two to three lines for 73.2% of the cases is not different than other reported studies (Graph 1 and Table 4). HR underestimates the visual acuity in the majority of our patients 82.3%, while the correct estimation was with only 11% and it overestimate in 5.5% of our population study Graph 1.

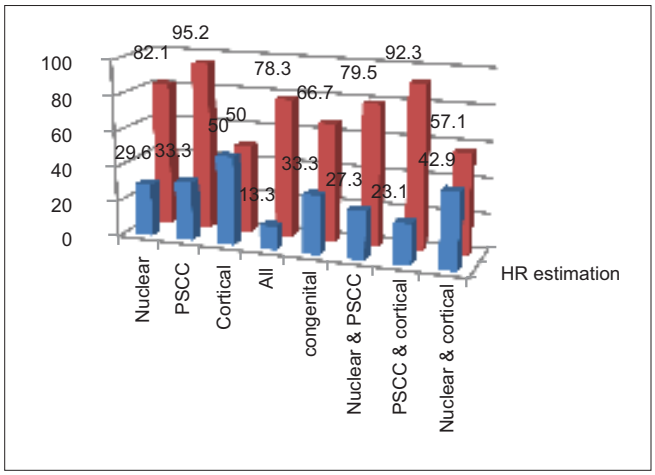
Table 6: Sensitivity, specificity, and accuracy of HR in predicting post-operative VA 0.5 or more

Parameter	In all included eyes (%)	In eyes without co-morbidities (95% CI)	In eyes with one or more co-morbidities (%)	Mild (%)	Moderate (%)	Severe
Sensitivity	29.8	30.0 (0.29-0.30)	30.7 (0.29-0.32)	86 (0.82-0.89)	30.4 (0.29-0.30)	15.6 (0.14-0.16)
Specificity	93.5	100 (1-1)	91.0 (0.90-0.91)	100 (1-1)	94.7 (0.94-0.95)	90.9 (0.89-0.92)
Accuracy	42	35 (0.34-0.35)	58.3 (0.57-0.59)	87.5 (0.84-0.90)	41.4 (0.41-0.42)	34.9 (0.33-35)

BCVA: Best corrected visual acuity, CI: Confidence interval, VA: Visual acuity



Graph 3: Estimated VA by HR and Post operative BCVA in different types of cataract



Graph 4: Estimated VA by HR and Post operative BCVA in cortical cataract in comparison with other types of cataracts

CONCLUSION

Graph 2 shows the estimated VA by HR in patients without ocular comorbidities was 0.5 or better in 27.2% while the post-operative BCVA was 0.5 or better in 92.1% in the same patients. In patients with ocular comorbidities, the VA was 0.5 or better in 20.8% estimated by HR and post-operative BCVA of 0.5 or better in 54.2%. Regarding the cataract density, in patient with mild cataract density the estimated VA was 0.5 or better in 75% using HR and post-operative BCVA of the same value in 87.5%. In contrast, patients with moderate cataract density 26% have estimated visual acuity of 0.5 or better using HR and 82.9% have post-operative BCVA of 0.5 or better Graph 3. Graph 4 shows the estimated VA in 50% of patients with cortical cataract was equal (0.5 or better) both by HR and post-operative BCVA, in contrast to other types of cataract where there was a statistical significant different in the percentage of patients with VA of 0.5 or better estimated using HR compared to post-operative BCVA with higher percent post operatively.

The Heine lambda 100 retinometer appears to be an easy device to use clinically. It is highly specific in the prediction of post-operative VA (93.5%) (Table 5). It has higher accuracy 87.5%, sensitivity 86%, and specificity 100% in mild cataract than denser one (Graphs 3 and 4, Table 6).

In the presence of ocular comorbidity, Heine retinometer is a good predictor for patients who will have poor improvement in VA post-phaco with high true positive results (Graph 2).

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