Effect of Cataract on Electroretinographic Response†

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Objective: *To study the effect of cataract on electroretinographic responses.*
Material and Method: *Thirty subjects with dense cataracts underwent electroretinogram (ERG) recordings before and after cataract surgery, using RETIport32 (Roland Instruments, Germany). The degree of cataract was classified according to the Lens Opacities Classification System III (LOCS III). No significant eye diseases were noted in all subjects. Following the International Society for Clinical Electrophysiology of Vision (ISCEV), scotopic, mesopic, photopic, oscillatory potentials and 30 Hz flicker ERG responses were recorded. The mean amplitudes of a- and b-waves, pre and post-cataract surgery were analyzed using the paired t-test.*
Results: *Following cataract surgery, most of the ERG responses were slightly increased but the difference was not statistically significant. However, the mesopic b-wave amplitude was decreased significantly after cataract surgery.*
Conclusion: *Most of the ERG waves after cataract surgery were slightly higher than pre-operative waves, but the differences were not statistically significant. The ERG remains a reliable guide in evaluation of the visual prognosis before cataract surgery.*

Keywords: *Electroretinogram, ERG, Cataract surgery*

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The electroretinogram (ERG), an electrical potential generated by the retina in response to a brief flash of light, is used for the diagnosis of various retinal and choroidal diseases. It is generally stated that cataract has little or no effect on the ERG response and ERG can be used as a reliable guide for pre-operative evaluation of the retinal function and prediction of visual prognosis after cataract surgery[1]. In pre-operative assessment of the cataract patients, the authors have to evaluate the function of the retina so that the authors can predict the post-operative visual prognosis. When the cataract is immature, the authors can examine the integrity of the retina with indirect ophthalmolscope. In case of dense or mature cataract, the fundi are obscured and the ERG is used to evaluate function of the retina. However, some previous studies reported that media opacities such as produced by cataracts have a significant influence on the ERG response. Hurst and Douthwaite reported that cataracts could reduce the amplitudes of the a- and b-wave of the scotopic flash ERG[2]. Galloway revealed a larger than normal scotopic flash ERG response in patients with cataract and attributed to the light scattering effect of the cataract[3]. If the cataract has significant influence on the electrical response of the retina or the amplitude of the ERG recording can be reduced from dense lens opacities, ERG cannot be used for pre-operative evaluation of the retina or prediction of the post-operative visual prognosis. The purpose of the present study was to evaluate the effect of cataract on electroretinographic responses using a pre- and postoperative comparison.

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Material and Method

The present study followed the tenets of Helsinki Declarations and was approved by the Khon Kaen University Ethics Committee for Human Research (HE480737). Thirty participants, age ranged from 47-79 years were recruited from the eye outpatient

department at Srinagarind Hospital, Khon Kaen University between July 2008-July 2009. Inclusion criteria were patients older than 40 years with dense nuclear or posterior subcapsular cataract. Lens opacities were classified and graded according to the Lens Opacities Classification System III (LOCS III)[4]. All participants had advanced nuclear opalescence (NO), nuclear color (NC) and posterior subcapsular cataract (P) graded NO 3/NC 3 and P5 or greater. Exclusion criteria were cataract from other causes, myopia or hyperopia > 3.00 D, astigmatism > 1.00 D, retinal diseases, optic nerve diseases and uncooperative patients.

All participants received complete ocular examination including measurement of visual acuity, intraocular pressure, slit-lamp biomicroscopic examination, indirect ophthalmoscopy, and ultrasonography in mature cataract.

ERG waves were recorded in all participants prior to and following cataract surgery with RETIport32 (Roland Instruments, Germany). The equipment, ERG settings, and recording conditions followed the International Society for Clinical Electrophysiology and Vision (ISCEV) guidelines. Pupils had been fully dilated and the refractive errors were corrected before recordings[5]. Following corneal anesthesia, recordings were obtained with the DTL electrodes (The Dawson, Trick and Litzkow electrodes). During recordings, the reference and ground electrodes were attached to the ipsilateral outer canthus and forehead respectively. The untested eye was occluded. Following the ISCEV (2004), five common ERG responses, *i.e.* scotopic (rod ERG), mesopic (standard combined ERG), photopic (single flash cone ERG), oscillatory potentials and 30 Hz flicker ERG responses were recorded[5].

The amplitudes of a- and b-waves of all ERG responses were measured before and after cataract surgery. Means and mean of difference with standard error of mean were reported. The effects of dense cataract on ERG recordings were evaluated by using the paired t-test. P-values less than 0.05 were considered statistically significant.

Results

The visual acuity before cataract surgery ranged from 6/36 to HM and visual acuity post cataract surgery ranged from 6/6 to 6/36. None of the participants had any significant eye disease apart from cataract. The effects of dense cataract on ERG recordings are shown in Fig. 1 & 2. The mean amplitudes of a- and b-waves were slightly increased in most of the ERG responses post cataract surgery and the differences were not statistically significant. However, the amplitude of mesopic b-wave was decreased significantly after cataract surgery ($p < 0.05$). Table 1 also demonstrates the mean of difference in amplitudes of a- and b-waves, pre and post cataract surgery in the participants.

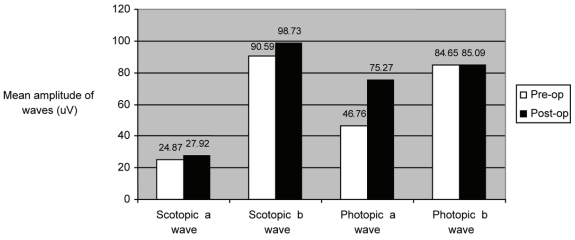

Fig. 1 The mean amplitudes of a and b waves of scotopic and photopic ERG, pre and post cataract surgery. The amplitudes were slightly increased post cataract surgery but the differences were not significant

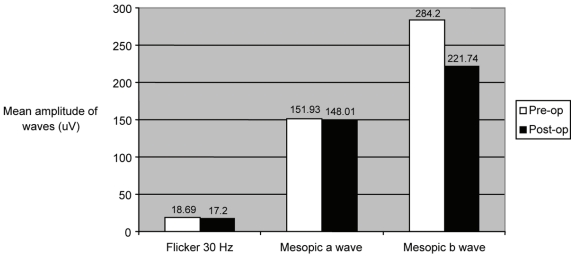

Fig. 2 The mean amplitude of flicker 30 Hz ERG and the mean amplitudes of a and b waves of mesopic ERG, pre and post cataract surgery. Following cataract surgery, there was no significant difference in the mean amplitudes of flicker 30 Hz and mesopic a wave. The mesopic b wave amplitude was decreased significantly after cataract surgery ($p < 0.05$)

Discussion

The present study found that most of the ERG responses were slightly increased post cataract surgery but the differences were not significant. This finding agrees well with the previous reports[1,6]. Cruz and Adachi-Usami compared ERG responses of dense mature cataractous eyes with those of the fellow eyes with good visual acuity in 22 senile patients[1]. The mean amplitudes and implicit time of the a- and b-waves were slightly reduced in the cataractous eyes, but the differences were not significant. The study by Seiple et al reported that the responses of the central retina

Table 1. The mean of difference in amplitudes of a- and b-waves before and after cataract surgery (n = 30)

Waves	Mean	Std. error mean	95% confidence interval		p-value
			Lower	Upper	
Scotopic a	-3.0	10.7	-24.9	18.8	0.78
Scotopic b	-8.1	18.6	-46.2	29.9	0.67
Photopic white a	-28.5	31.5	-92.9	35.8	0.37
Photopic white b	-0.5	21.1	-42.2	43.9	0.97
Mesopic a	3.9	14.6	-3.54	47.2	0.25
Mesopic b	62.5	24.9	11.6	113.4	0.02
Flickering 30 Hz	1.5	2.5	-0.7	6.5	0.55

decreased at a greater rate with age than the responses of more peripheral locations[6]. They concluded that small pupils in older adults and preretinal optical density factors such as cataract do not account for the multifocal ERG changes. Lens opacities could influence the electrophysiological responses through reflection, absorption and light scatter[7]. Arai et al reported that moderate light scattering and distortion do not cause loss of local ERG characteristics[8]. The light scatter that decreased vision from 20/20 to 20/70 did not significantly decrease amplitudes of the ERG responses. The increase in ERG would be the result of the reduction of light scattering after cataract removal.

However, previous studies by Hurst & Douthwaite[2] and Fishman[9] revealed that cataract could reduce the amplitudes of the a- and b-waves of the scotopic flash ERG. The studies with multifocal ERG also found that the central retinal responses of the multifocal ERG were statistically significant decreased in dense cataract[10,11]. Tam et al reported that the multifocal ERG responses from the central retina (central 14 degree) were significantly reduced in participants with mild or moderate cataract when compared with participants with very mild cataract, but the responses from the paracentral retina (14-40 degree) were not affected[10]. Wordehoff et al also observed a significant increase in the mean amplitude of the response of the multifocal ERG in the central four degrees following cataract surgery[11].

Chan et al tested the multifocal ERG under controlled light scattering conditions using a liquid crystal diffuser (LCD) that simulated different degrees of image degradation[12]. The macular multifocal ERG response density was reduced, but the peripheral multifocal ERG response densities were increased under the scattering condition. Burian and Burns reported a reduction in the b-wave amplitudes of the full-field ERG in two-thirds of the patients following cataract surgery[13]. They proposed that the lower post-operative b-wave amplitudes were explained by the action of the cataractous lens changes as a diffusing screen. Consequently, the effect of the lower intensity stimuli was particularly enhanced.

The present study also revealed that the mesopic b-wave amplitude was decreased significantly after cataract surgery. It is not clear why this b-wave amplitude was decreased significantly after cataract surgery. Further studies should be performed to determine the cause and mechanism of this finding.

In conclusion, most of the ERG waves in post cataract surgery were slightly higher than pre-operative responses, but the differences were not significant. Only the mesopic b-wave amplitude was decreased significantly after cataract surgery. This indicates that most ERG tracings still remains a reliable guide for pre-operative evaluation of the retina and prediction of the post-operative visual prognosis.

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ผลของต้อกระจกต่อคลื่นไฟฟ้าจอตา

ธนภัทร รัตนภากร, ธนิกานต์ ภัทรกิจธรรม, สุธาสินี สีนะวัฒน์, ธรรศ สงวนศักดิ์, ชวกิจ ภูมิบุญชู, สุพัฒน์ แก้วพรรณา, ยศอนันต์ ยศไพบูลย์

วัตถุประสงค์: *เพื่อศึกษาผลของต้อกระจกต่อคลื่นไฟฟ้าจอตา*
วัสดุและวิธีการ: *ผู้ป่วยต้อกระจก 30 คน ได้รับการตรวจคลื่นไฟฟ้าจอตา ก่อนและหลังการผ่าตัดต้อกระจก โดยใช้เครื่องตรวจคลื่นไฟฟ้าจอตา RETI port 32 ความขุ่นของต้อกระจกมีการจัดแบ่งตามระบบการจัดแบ่งความขุ่นของต้อกระจกที่เป็นสากล การตรวจคลื่นไฟฟ้าจอตามีการตรวจ scotopic, photopic, mesopic และ 30 Hz flicker ตามมาตรฐานของ ISCEV นำค่าเฉลี่ยของขนาดคลื่น a และ b มาวิเคราะห์เปรียบเทียบ ก่อนและหลังการผ่าตัด โดยใช้สถิติ paired t-test*
ผลการศึกษา: *ค่าเฉลี่ยของขนาดคลื่นไฟฟ้าจอตาหลังผ่าตัด สูงกว่าค่าเฉลี่ยก่อนผ่าตัดเล็กน้อย และไม่มีความแตกต่างอย่างมีนัยสำคัญทางสถิติแต่พบว่า ขนาดคลื่น b ของ mesopic ลดลงอย่างมีนัยสำคัญหลังผ่าตัด*
สรุป: *คลื่นไฟฟ้าจอตาหลังผ่าตัดต้อกระจก ส่วนใหญ่มีขนาดเพิ่มขึ้นเล็กน้อย และไม่มีความแตกต่างอย่างมีนัยสำคัญทางสถิติ ดังนั้นการตรวจคลื่นไฟฟ้าจอตาจึงยังคงเป็นการตรวจประเมินที่น่าเชื่อถือได้ในการพยากรณ์ของการมองเห็นก่อนผ่าตัด*