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Clinical Use of Electroretinography

James D. Carter, M.S., D.V.M.*

Introduction

The electroretinogram (ERG) is a useful diagnostic tool in differentiation of various ocular diseases in small animals.

The ERG recording is not a true measure of vision but is a measure of the functional integrity of the outer retinal layers, and of the pigment epithelium. When the retina is suddenly illuminated with a light source of high intensity and very short duration a complex photo-chemical response is initiated. The photosensitive elements of the retina are bleached. These same photosensitive elements then are regenerated for further use. This process of bleaching and regeneration produces a measurable change in electrical potential between the cornea and fundus. This change in electrical potential constitutes the electroretinogram or ERG.

Technique of Electroretinography

The patient to be examined is administered cyclopentolate hydrochloride 1.0% (Cyclogyl)* and phenylephrine hydrochloride 10% to produce mydriasis. Atropine sulfate is then administered by subcutaneous injection. Following complete mydriasis (requiring approximately 1 hour) the

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* Cyclogyl 1.0%. Schieffelin Co., New York, N.Y.

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subject is anesthetized with thiamyal sodium (Surital)\*. He is positioned in sternal recumbency. The Heidbrink 960 System is used to maintain ventilation. Succinylcholine chloride is administered by intravenous injection to provide maximal ocular akinesis since the slightest movement will effect the amplitude of the ERG. Several drops of 1% methylcellulose (Isotop Alkaline)\** are instilled in the eye to be examined. A Karpe contact lens electrode is then positioned on the cornea. The recording electrode is connected to the contact lens. An indifferent (needle) electrode is placed beneath the previously prepared skin of the forehead. A physiograph with the paper speed set at 60 mm per second is used for the tracings. The stimulus is provided by an electrical strobe lamp with a time constant of 0.2 seconds. The photostimulator (strobe lamp) is positioned 12 inches from the patient's eye on the visual axis. The room is then darkened and the patient allowed to adapt to darkness for 10 minutes. The test is performed by flashing the photostimulator at 1, 3, and 5 minute intervals. The patient is then carefully monitored until recovery from anesthesia is complete.

\* Surital, Parke-Davis Co., Detroit, Mich.
\* Isotop Alkaline, Alcon Laboratories, Fort Worth, Texas.

Clinical Application

Case No. 1

Evaluation of a patient for cataract extraction.

A five year old black male Poodle was presented with bilateral cataracts. The patient had suffered progressive visual loss since discovery of the cataracts two years previous to being presented. The patient possessed apparently normal vision prior to the appearance of the cataractous lens changes. The past medical history further indicated no serious illnesses and nothing suggestive of diabetic tendencies. Examination of the eyes indicated the presence of bilateral mature development cataracts. The direct iris reflex was incomplete, the consensual iris reflex was present but also incomplete. Laboratory data were within normal limits and the physical examination was normal. An ERG was requested in order to discern retinal function and to rule out the possibility of a degenerative retinopathy which might be concurrent.

The results of the ERG performed on this patient are illustrated in Figure 2. The presence of a positive response is inconsistent with a diagnosis of degenerative retinopathy with a complete cataract. An extracapsular cataract extraction was performed with favorable results.

Figure 1. Positive ERG.

Figure 2. Case 1, Positive ERG, not consistent with a diagnosis of degenerative retinopathy.

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Case No. 2
Differentiation of retinal lesions from a lesion of the central visual pathway.

A five year old male Dachshund was admitted with a history of progressive visual disturbance of two weeks duration. The past history disclosed no serious illnesses. The ophthalmoscopic examination revealed an essentially normal fundus. The patient was clinically blind when visually tested under both photopic (normal illumination) and scotopic (diminished illumination) conditions. Pupillary responses, both direct and consensual, were absent. Neurologic examination was normal. Lateral and ventrodorsal radiographs of the skull were noncontributory. An ERG was requested to determine relative functional state of the retina. The results of the ERG are shown in Figure 3. The severely depressed ERG is consistent with a diagnosis of blindness due to defects of the inner or outer retinal layers or both.

Case No. 3
Blindness due to lesions of the central visual pathway.

A 16 week old female Chihuahua was presented with a history of apparent blindness. The client indicated intermittent dysmetria and ataxia and that the patient had never seemed to be visually adequate. Physical examination revealed the patient to be lethargic. Dysmetria and ataxia were not in evidence, but the animal appeared to be clinically blind. Direct and consensual iris responses were sluggish. The retina appeared normal for a patient of this age and breed. Routine laboratory values were normal. The client would not consent to pneumoventriculogram or to cerebrospinal fluid tap, however, permission for ERG was obtained. The results of the test are illustrated in Figure 4. The ERG is positive and consistent with a diagnosis of a lesion of central origin which did not involve the outer retinal layers. This may be explained on the basis that the functional elements of the retina (inner and outer retinal layers and pigment epithelium) are functionally intact. The reason for visual loss must therefore be behind the eye, i.e. the central visual pathways.

The patient was euthanized at the owner’s request and permission for post mortem examination was obtained. The necropsy indicated internal hydrocephalus. This diagnosis is consistent with the ERG tracing.
Discussion

Electroretinography as a diagnostic aid in evaluation of cataract patients for surgery should be performed whenever the clinical history indicates progressive defective scotopic vision in advance of cataract formation coupled with incomplete or absent pupillary responses to light as in Case No. 1. Direct and consensual pupillary responses may be absent in the dog with normal vision, however, and is an unreliable index of vision. In complete mature cataract the fundus is obscured, so that direct ophthalmoscopic observation is impossible. The ERG allows the ophthalmologist to assess retinal function without actually being able to view this structure directly.

Rubin1 at the University of Pennsylvania, reports on incidence of cataract with concurrent degenerative retinopathy of 13.4% in a series of 179 ERG tests. Too few tests have been performed at this institution as of this writing to draw a true statistical inference.

In differentiation of central visual pathway lesions from lesions of the outer retinal layers, the ERG may be of immeasurable value. The patient in Case 2 apparently had suffered a defect of the outer retinal layers. This type of lesion may produce a marked depression of the ERG with an ophthalmoscopically normal appearing fundus. Central degenerations tend not to involve the photosensitive layers, and the ERG would not be depressed.

Case 3 illustrates the results of an intracranial defect producing blindness. The patient's retina appeared normal but she was clinically blind. The disease process produced blindness which was cortical in origin. The ERG in this case was positive because the photosensitive layers of the retina were functionally intact. Additional indications for ERG other than those described above are glaucoma, hemeralopia or poor day vision, retinal dysplasia and some degenerative retinopathies.

Summary

The method of performing electroretinography currently in use at Iowa State University is described. Three clinical briefs are presented which indicate the results of the ERG performed in each case and the interpretation of these results.

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