

1 - 0/7 / 12

ELECTROPHYSIOLOGICAL CHANGES IN CHRONIC SIMPLE GLAUCOMA

Thesis

SUBMITTED IN PARTIAL FULFILMENT
FOR THE DEGREE OF (M. D.) IN
Ophthalmology

By

Shamel
Dr. Raafat M. El-Hennawy

Ass. Lec. Research Institute of Ophthalmology

M.B., B.Ch. (M.S.) Ophthalmology

617.741
R.M.

24643

SUPERVISORS

Prof. Dr. Anwar El-Massri

Prof. of Ophthalmology

AIN SHAMS UNIVERSITY

Prof. Dr. Salah Ibrahim

Prof. of Ophthalmology

AIN SHAMS UNIVERSITY

Prof. Dr. Zinab M. Osman

Prof. of Ophthalmology

Research Institute of Ophthalmology

FACULTY OF MEDICINE

AIN SHAMS UNIVERSITY

1984

Abbreviations used in the tables of results:

Acetazol	: Acetazolamide (250 mg. tablets).
A.C.g.	: Acute congestive glaucoma.
af.T.	: After treatment.
b.d.	: Twice a day.
be.T.	: Before treatment.
C/D ratio	: Cup to disc ratio.
Ch.C.g.	: Chronic congestive glaucoma.
C.S.g.	: Chronic simple glaucoma.
Cl.a.g.o.	: Closed angle grade(0)(after Becker,Shaffer).
E or Em	: Emmetrope.
f.	: Female.
I.M., I.V.	: Intramuscular, intravenous injection.
H.M.	: Hand movement.
L or lt	: Left.
lt.Ir.in.	: Left iris inclusion.
Lt or Rt trab.	: Left or right subsclearal trabeculectomy.
m.	: Male.
M	: Myope.
M.As.	: Myopic astigmatism.
N.a.g.1.	: Narrow angle grade(1), (After Becker, Shaffer).
N.a.g.2	: Narrow angle grade(2), (After Becker,Shaffer).
No.	: Number
O.A.g.3 or 4.	: Open angle grade 3 or 4,(after Becker,Shaffer).
Pallor of D	: Pallor of neural rim of optic disc.
Pilo 2%	: Pilocarpine 2%
Q.i.d.	: Four times a day.
R or Rt	: Right.
T.(app)	: Tension by applanation tonometry.
Type of g.	: Type of glaucoma.
T.d.s.	: Three times a day.

Electrophysiological abbreviations in the tables of results:

E.R.G.	
A(a)	: Amplitude of (a) wave in microvolts.
A(b)	: Amplitude of (b) wave in microvolts.
L(a)	: Latency of (a) wave, in milliseconds.
L(b)	: Latency of (b) wave, in milliseconds.
T(a)	: Peak time of (a) wave, in milliseconds.
T(b)	: Peak time of (b) wave, in milliseconds.
R-E.R.G.	: Red E.R.G.
W-E.R.G.	: White E.R.G.
V.E.P.	
A(a)	: Amplitude of (a) wave of V.E.P.
A(b)	: Amplitude of (b) wave of V.E.P.
L(a)	: Latency of (a) wave of V.E.P.
L(b)	: Latency of (b) wave of V.E.P.



E.O.G.
A.R. : Arden's ratio.
Rt or Lt : Arden's ratio of right or left eye.

Abbreviations and grades of field of vision used in the tables of results :

Grade I or g I means : Isolated paracentral scotomas.

Grade II or g II means: Arcuate scotoma.

Grade III or g III means: Arcuate scotoma with isolated paracentral scotomas.

Grade IV or g IV means : Double arcuate scotoma with contraction of the peripheral field of vision.

Grade V : Terminal field with retained central vision and temporal island of vision.

Grade VI or g VI means : Retained island of temporal vision.

INTRODUCTION
AND HISTORICAL REVIEW

HISTORICAL REVIEW

AND INTRODUCTION

The story of the development of our knowledge of the electrical responses of the visual system is long and interesting and is a striking example of how the advances of a subject of this type depend essentially upon the progress of technology. Electrophysiology started more than a century ago by Du-Bois-Remond(1849). He showed that a current flow could be demonstrated in and around almost all of the parts of the living organism. One of the organs he investigated was the eye. Du-Bois-Remond thus discovered a potential difference between the front and the back of the eye. He could detect this potential, which can amount to several millivolts, by means of a simple galvanometer connected to a nonpolarising electrode attached to the cornea, and one on the optic nerve. He found that the anterior external surface of the eye was positive with respect to the back. In Sweden Holmgren (1865), conducted a series of experiments as a follow up of Du-Bois Remond. He used recording procedures similar to those of Du-Bois Remond. Holmgren

found that the resting potential of the eye could be modified by the action of light shining on the retina.

Dewar and M'Kendric (1874) unaware of Holmgrens work, conducted the same experiment in Scotland. They discovered that if light was suddenly allowed to pass through the previously covered pupil, the galvanometer, generally registered a small deflection, the galvanometer, then gradually drifted back to its original position. Figure (1) shows how Deware performed such recording. Stimulation was obtained by extremely simple means as lighted matches, lanterns or even moon light.

A great advance in technology was made by Gotch (1903) whose recording apparatus is diagramed in Fig. (2). Its most significant feature was that it used the capillary electrometer instead of a galvanometer as a recording device. This instrument responded much more rapidly than other types of galvanometers, thus permitting derivation of a more accurate response. A second feature was that a photographic recording of the response waveform was obtained automatically.

Soon afterwards the string galvanometer was invented and used by Bruck and Gartin (1907). Bruck and

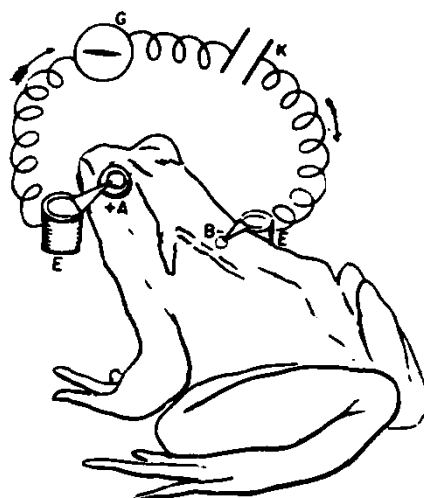


Fig.(1) : The Galvanometer used by Dewar and M'Kendric (1877) to record the E.R.G. from the frog.

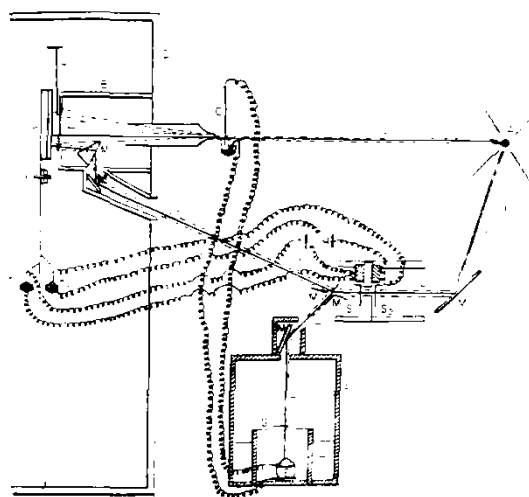


Fig.(2): The apparatus used by Gotch (1903) to obtain a permanent record of E.R.G.

Gartin (1907) enucleated up to ten frog eyes under red light and put them all face up in a box.

Conducting wicks were then used to connect the eyes in series. When the eyes were all stimulated simultaneously, they gave a much stronger response than could be obtained from one eye alone.

The introduction of the Valve amplifier brought about a dramatic improvement. Chaffee and Bovie (1923) used a valve amplifier, so they could increase the sensitivity of their results.

Amplifiers based upon tubes or more recently upon transistors have been used in practically all of electrophysiology since that time.

Granit's (1933-1963) component analysis is without doubt the most important yet made in E.R.G. His analysis was based upon a variety of experimental procedures such as administering ether, alcohol, adrenaline and potassium chloride and also by removing one or more components of the response, leaving the remaining ones intact.

The results of his analysis were three components. These were termed PI, PII, and PIII. PI is the (C) wave, PII is the (B) wave and PIII is the (A) and (D) waves. Granits original ideas about the nature of E.R.G. are still held to be true today.

Evolution of corneal electrodes :

Although the E.R.G. was discovered long ago satisfactory electrodes have been developed rather slowly. This is particularly true of recording from the human eye, where the electrodes must be comfortable, stable and convenient. Wick electrodes were used at first, typically made from short lengths of saline-soaked cotton thread. One end of the thread was placed on the subject's cornea and the other touched a metal wire. Wick electrodes are irritating to the patient. In an attempt to improve recording techniques, Hartline (1925) used a pair of tight fitting goggles. The space between the goggles and the eye was filled with a conducting solution and an electrode was inserted within. This electrode was not suitable because of difficulty of keeping the goggles filled.

Riggs (1941) was the first to hold an electrode close to the eye with a contact lens. This method was a good

one and could be fitted for prolonged recording sessions. Contact lens electrodes are still used for most work with human subjects today. Electrodes have been designed in many ways, but the first models, based upon large scleral lenses, still find widespread use. The Riggs type of electrode, has a small silver disc embeded within the plastic of the lens, the disc is connected to a stiff wire then to a finer flexible wire, the space between the cornea and the contact lens is filled with saline. The Karpe (1945) lens is similar, but the silver electrode disc is inserted through a small side tube attached to the contact lens. Several other electrodes have been devised and are shown in Fig. (3). The response obtained with each style of lens electrode is nearly the same if the lens is used properly.

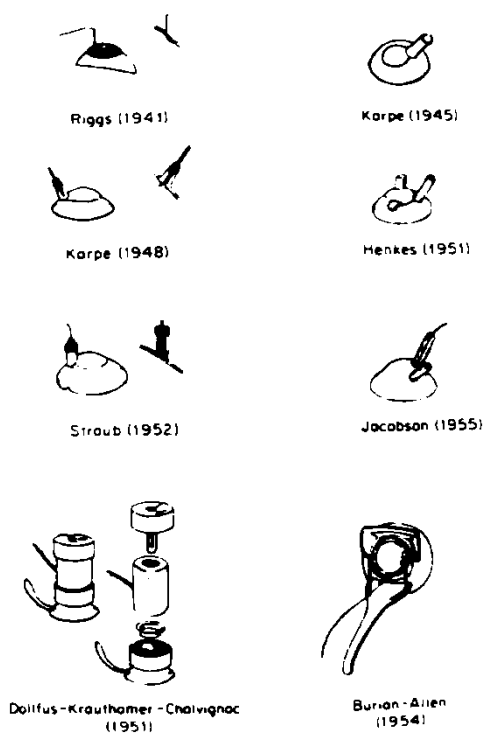


Fig.(3): Types of contact lenses.

HISTORY OF ELECTRO-OCULO-GRAM

The presence of a potential difference between the front and the back of the eye, was first demonstrated by Du Bois-Remond (1849).

In (1877) Dewar realized that eye movement could give changes in potential, but for his experiment, these changes were merely artefacts rather than phenomena of interest to be investigated.

In (1922) Schott looked for a method of recording eye movements in cases of nystagmus. He used two copper wire electrodes, one on the caruncle of the cocainezied eye, the other rested on the bulbar conjunctiva in the outer canthus, and these electrodes were connected to the galvanometer of an electrocardiograph. He made no attempt to quantify the potentials with rotations of the eyes.

Meyers (1929) like schott used an electrocardiograph to study the movements of nystagmus. Meyers regarded his records as originating from the action potentials of the extraocular muscles. In 1930 Jacobson, had the same results and the same conclusion.

In 1936 Mowrer, Ruch, and Miller used silver chloride electrodes in isotonic sodium chloride solution, and these electrodes were connected to a direct current amplifier. They noticed that, the greater the rotation of the eye, the greater the potential, the electrode nearer the retina, was the more negative, passive movement of the eye gave identical results with voluntary movements, no change of potential with eye movements after chemical destruction of the retina in cats, and they were also able to record a standing potential from a freshly excised turtle eye. And thus Mowrer, Ruch and Miller, conclusively proved that, the changes in potential were due to the existence of a standing potential.

Untill the 1950s, electro-oculogram was used only as a method of measuring eye movements, and the earlist accountants of its use as a test of retinal function are those of Francois, Verriest and De Rouck(1955).

In 1962 a more detailed investigations, and a modification of E.O.G. test was done by Arden and Co-workers (Arden, Barrada, and Kelsey, 1962).

THE HISTORY OF VISUALLY EVOKED POTENTIAL

Only over the past 20 years has it become possible to record the electrical changes over the scalp evoked by peripheral stimuli. The V.E.P is one of several evoked potentials which can be recorded from scalp electrodes. In 1932, Fischer recorded the changes evoked by visual stimuli in animals directly from the surface of pia matter. At that time it was found that the alpha rhythm seen in normal electro-encephalographic traces could be accentuated by exposing the eyes to a light flashing.

Signal averaging : The problem of detecting these small electrical signals was largely solved by the introduction of the technique of averaging. This simply entailed the superimposition of the repeated responses after each flash stimulus, thus when a sufficient number of traces had been superimposed, we could get a response which was not visible on the single record. The method of mechanical averaging has now been supplanted by electronic averaging, where the response following each consecutive stimulus is stored in the memory of a computer, and the average can be automatically displayed as