

THE ELECTORETINOGRAM

A THESIS

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ABBREVIATION

A.D. = Autosomal dominant
A.R. = Autosomal recessive
ap = Photopic response of a-wave
as = scotopic response of a-wave
Bp = Photopic response of b-wave
Bs = Scotopic response of b-wave
C.S.N.B. = Congenital stationary night blindness.
dB = Desceble game
E.R.G. = Electroretinogram
E.R.P. = Early receptor potential
Hz = Hertz = Cycle per second.
Ca⁺ = calcium ion and K⁺ = Potassium ion & Na⁺ = Sodium ion
J = Joule = Energy unit
P.R.P. = Panretinal photocoagulation
V = Volt = Potential unit
mV = 1/1000 V
 $\mu\text{V} = 1/10^6\text{V}$
Vit = Vitamin
R.D. = Retinal detachment
R.P. = Retinitis pigmentosa.
Vs = Supply voltage.

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INTRODUCTION AND HISTORY OF E.R.G.

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The study of electrical changes in the eye has now been in progress for more than a hundred years, and electrophysiological measurements on the eye are now becoming part of our clinical routine. In the early years these studies were largely confined to experimental animals, but there is now an international society of clinical electroretinography which has been in existence for over twenty years. The first work in this field was concerned with corneoretinal potential, or the resting potential. This may be defined as the difference in potential between the cornea and the posterior pole of the eye.

It was first described by Emil Du Bois Reymond (1849), Professor of physiology in Berlin. He showed that the cornea is electrically positive with respect to the posterior pole.

However, it was not until 16 years later that Holmgren (1865) observed that the resting potential can be modified by the action of light shining on the retina.

Dewar and Mc Kendrick (1873) rediscovered this light response quite independently. They were able to show that the changes in potential on impact of light amounted to three to ten percent of the normal resting potential and were independent of the anterior portion of the eye. Initially their experiments were carried out by placing electrodes on the cornea and the posterior pole of the eye, but they subsequently shown that the response to light could be recorded between the exposed brain and the cornea allowing the eye to be left in situ. They then found that the same electrical changes could be recorded by placing electrodes on the cornea and an adjacent area of skin. So they were able to produce a human electroretinogram.

Further work was done by Engelmann (1891), Fuchs (1894), Muller (1897), Waller (1900) and Himstedt & Nagel, (1901).

The first work of quantitative accuracy however was due to Gotch, (1903) who used the Cappillary electrometer.

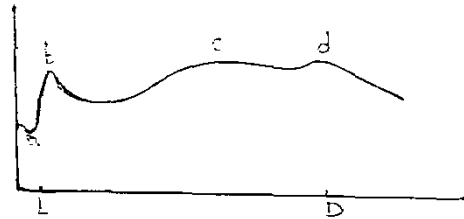


Fig 1 A Typical E.R.G.
L. Light D. Dark

DUKE ELDER Vol (1942)

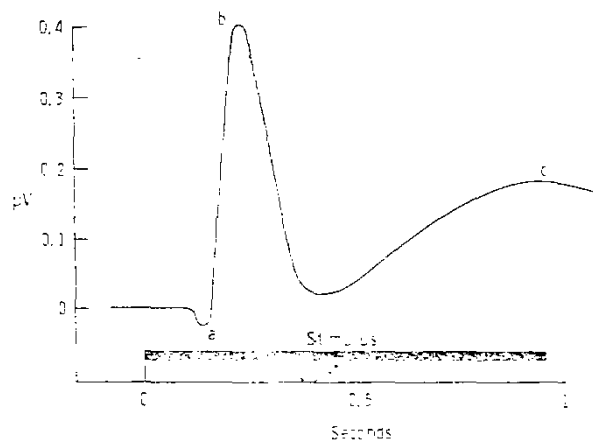


Figure 2 Diagram to illustrate a vertebrate electroretinogram obtained using a pen recorder.
Note the three waves and their time and amplitude relationships.

(Einthoven and Jolly, 1908)

GALLOWAY (1981)

Sachs (1929) was able to show that the human ERG was typically dependent on scotopic visual system of the retina and that the ERG of protanopes was relatively reduced in red light.

In the early 1930 s, attempts were made to record the human ERG using the valve amplifier, but at the same time an important milestone was reached in the study of responses from animals.

This was the classical work of Granit on cats. He developed the ideas put forward by Einthoven and Jolly after the turn of the century, suggesting that the ERG represents the sum of three waveform which he termed processes. These he enumerated as PI, PII and PIII. He showed that if the ERG is recorded from a cat subjected to deepening levels of ether anaesthesia, the wave form was thought to be due to the selective inhibition of each of the three processes PI, PII & P III in turn. Although they have been elaborated to some extent, these original ideas about the nature of ERG are still held to be true (Granit, 1933).

As soon as knowledge of the basic components had become well established, much interest was centered on the relative contribution of photopic and scotopic mechanism to the response.

In (1940) Bernhard noted that the flicker fusion frequency was not the same under photopic and scotopic conditions. This difference is now used in many electrodiagnostic clinics to assess cone function.

Riggs (1941) introduced contact lens electrode, Adrian (1946) showed that E.R.G. can be split into fast and slow components. The former present in the light adapted eye and more prominent in red light, and the later more prominent after dark adaptation and using light of shorter wavelength. Under suitable conditions the two responses were superimposed, producing double humped "a" and "b" waves.

In (1954) Cobb and Morton described a phenomenon in man and named it the oscillatory potential.

Brown and Murakami (1964) discovered the early receptor potential which is a very rapid component which can be seen at the beginning of the response immediately before the a wave. Its importance lies in the fact that it is an electrical manifestation of the bleaching of photopigment in the retina.

Berson (1969), reported that E.R.G. is often described as photopic and scotopic according to light or dark adaptation of the eye.

Oakley (1977) pointed out the physiologic basis of the "C" wave.

Kline and Coworkers (1978) tried to explain how current flow in the extracellular space along the Muller cell generates the "b" wave.

METHOD OF RECORDING

Preparation of the patient:

The patient should be told briefly about the nature of the test. He should look at the flash lamp. contact lens will be placed on the eye. A drop of topical anaesthetic is instilled in each eye. A small area on the center of the forehead is cleansed with an alcohol sponge and then rubbed vigorously (Fig. 3b). A dab of saline jelly (or electrode paste) is rubbed into the center of the cleaned area. The reference electrode with a small amount of jelly is then pressed firmly onto the prepared area and taped into place (Fig. 3 c). The dab of conducting paste should be applied. A ground electrode is attached to the ear or wrist using a squeeze clip for the reference electrode (Fig. 3 D & E). Contact lens electrode, where the speculum portion is coated with a conducting material is used. The bipolar electrode thus has two leads, one from the contact lens and the other from the lid reference. One more drop of anaesthetic is placed and insert the contact lens. The examiner holds the lens speculum between the thumb and first finger. The patient is asked to look towards his feet. The examiner then gently lifts the upper lid with his free hand and insert the flange beneath

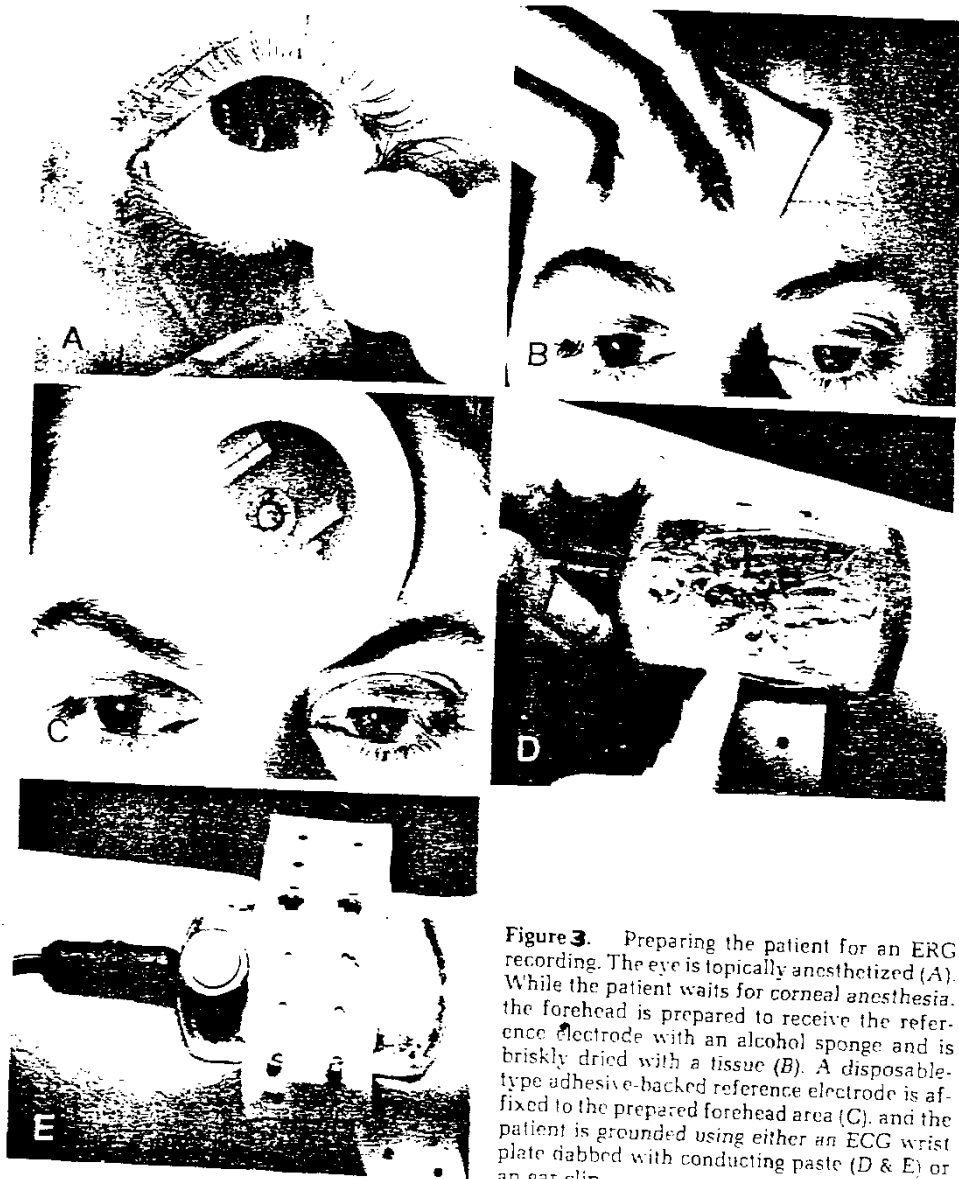


Figure 3. Preparing the patient for an ERG recording. The eye is topically anesthetized (A). While the patient waits for corneal anesthesia, the forehead is prepared to receive the reference electrode with an alcohol sponge and is briskly dried with a tissue (B). A disposable-type adhesive-backed reference electrode is affixed to the prepared forehead area (C), and the patient is grounded using either an ECG wrist plate dabbed with conducting paste (D & E) or an ear clip.

RONALD E. CARR (1982)