A COMPARATIVE STUDY BETWEEN SUBJECTIVE TESTS AND ELECTRORETINOGRAPHY IN CASES OF CATARACT

THESIS

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C O N T E N T S

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INTRODUCTION AND AIM OF THE WORK

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The value of an examination or test depends above all on the information obtained by this examination. This information is especially valuable clinically when direct view on the pathological condition is impossible.

In cases of cataract, certain subjective tests, such as those for visual acuity, light projection, colour discrimination, are currently used for assessing the retinal functions. In recent years electroretinography is increasingly used to evaluate the retinal functions in cases of opacities of the medium.

If one test gives exactly the same information obtained from another test, it is not necessary to do both tests, since they give the same information for clinical purposes. It is useful to perform them both only if one is not reliable and the results need to be confirmed by different methods.

In this work both the conventional subjective tests and electroretinography are used in different types of cataract to evaluate the retinal function. Electroretinography is studied in detail to know how much it can help in adding informations besides the subjective tests and if other types of investigations are important to complete the study of the case.

REVIEW OF LITERATURE

CLOSSARY

ACTIVE ELECTRODE

One of two inputs other than the earth connection of a differential amplifier. This is applied as closely as possible to the source of the potential being investigated.

AMPERE

A unit of current. For biological measurements the normal flow is measured in microamperes (uA).

AMPLIFIER

An electonic device for enlarging the size of a signal.

BIPHASIC RESPONSE

A twin response with components of opposite polarity.

EARTH

The zero level to which all potentials are referred. In most electronic equipment the terminals of any components which are to be kept at this level are connected to the chassis of the instrument and this in turn is connected to a metal conductor in contact with the ground, such as a water pipe.

FREQUENCY

The number of waves per second measured in cycles / second or Hertz (Hz).

INDIFFERENT ELECTRODE

The other input to a differential amplifier (see ' active electrode). The signal between active and indifferent electrode is measured.

LEAD

Any wire entering or leaving a component.

STIMULUS ARTEFACT

An extraneous electrical change picked up by the recording electrodes and produced by stimulus equipment.

INTERFERENTIAL FILTER:

An interferential filter is a lens which only lets through a precise wave-length of the light spectrum.

BAND PASS:

The wave-length value of an interferential filter measured at 50% of its transmission around its nominal value.

HISTORY OF ELECTRORETINOGRAPHY

THE DISCOVERY OF THE ELECTRORENINOGRAM

The story of the development of the knowledge in electrophysiology 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. The first work in this field was concerned with the corneo-retinal 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 in 1849. He discovered that this potential, which can amount to several millivolts, may be detected with a simple galvanometer connected to an electrode attached to the cornea and another on the optic nerve. He found that the anterior external surface of the eye was positive in respect to the posterior surface.The potential was most easily observed in fish, but could also be seen in frogs and turtles.

Du Bois Reymond's demonstrations which proved conclusively that nervous structures are electrically charged, had interested many other workers in electrophysiology. In Sweden, Holmgren in 1865 conducted a significant series of experiments. He attempted to see whether an electrical response to light could be found in the living eye. His efforts were completely successful.

Initially unaware of Holmgren's work, but strongly influenced by Du Bois Reymond, Dewar and M'kendrik in 1873 conducted virtually the same experiment in Scotland. They discovered that if light was suddenly allowed to pass through the dark adapted eye, the galvanometer generally registered a small deflection, indicating that the cornea had became more positive with respect to the posterior pole of the eye. The galvanometer needle then gradually drifted back to its original position. The exact thing happened when an eye which had been exposed to light, was suddenly covered. Holmgren was the first man to observe an electroretinogram.

While the first investigations were made with extirpated eyes, it was soon discovered that some responses could be obtained from the entire organism.

THE WAVEFORM AND COMPONENTS OF THE ELECTRORETINOGRAM

ON AND OFF EFFECT

In 1903 Gotch recorded responses from excised frog's eyes. He was able to photograph his records and he found that the positive component of the electroretinogram measured up to 0.001 V and it was known therefore at the turn of the century that a biphasic type of response could be produced by a single flash of light. Gotch could also examine the positive part of the response in detail and observed that rapid fluctuations, or wavelets, could occasionally be seen superimposed upon it. He observed an additional deflection as the light went off. He used the term ON EFFECT and OFF EFFECT to describe the wave complexes seen at these two times of stimulus changes. He found the delay between stimulus onset and the appearance of the on effect to be about 180 m sec. Although this value is faulty, the data made it clear that there is a definite delay between the onset of the stimulus and the initiation of the electroretinogram.

In 1908 Einthoven and Jolly showed the presence of a third and later positive component in the electroretinogram. The three principal deflections of the electroretinogram have been, and still are, termed the a, b and c waves as indicated in the figure. At the same time it was shown that a similar response could be demonstrated in a wide range of vertebrates.

EARLY COMPONENT ANALYSIS

Granit's (1933, 1963) component analysis is without doubt the most important yet made in electroretinography. His analysis of the electroretinogram which was based upon a variety of experimental procedures such as administrating ether or other chemical agents, removed one or more components of the response, leaving the remaining ones intact. The result of his analysis were three component or fundamental processes. These were termed PI, PII, and PIII. With ether, the components disappeared in the order given by their number, as shown in fig. (1). First, PI disappeared completely, leaving a response with a greatly reduced C wave. A short time later, PII disappeared, leaving only PIII. if ether administration was stopped at this point, PI and PII returned, leaving a response of normal waveform. If the ether was continued, however, PIII also disappeared, leaving no response when this happened, the electroretinogram was generally incapable of recovery. Other procedures of treatment could affect the components in a different order. For example, asphyxia, produced through interference with respiration, removed PII leaving the other processes relatively untouched. A similar effect could be produced by interfering with circulation.

The luminance of the stimulus influenced the relative prominence of the components. The analysis in the upper half of fig. (1) is for high luminance, while that below is for low luminance.

THE HUMAN ELECTRORETINOGRAM

EARLY DEVELOPMENT

Dewar (1877) was the first to describe a technique for recording it. The main problem was holding an electrode against the eye. For this purpose, he placed a ring of clay, filled with saline, upon the eye.

An electrode immersed in saline made connection with the cornea. A second electrode was attached to one of the hands. A galvanometer wired to the electrodes gave a deflection whenever the eye was stimulated. The deflections were very small, however, and observations were not easily made. Disturbances produced by eye movements or other activity on the part of the subject interfered with the signals of interest. Sachs in 1929, was able to show that the human electroretinogram was typically dependent on the scotopic visual system of the retina and that the electroretinogram of protanopes was relatively reduced in red light. At this point we had reached the stage when a waveform could be accurately recorded and measured, and it was known beyond doubt that this wave from was produced by the retina, even though, it was recorded through electrodes which were placed at some distance from the eye. In the early 1930s, attempts were made to record the human electroretinogram using the valve amplifier.

THE CONTACT LENS ELECTRODE

Investigations on human subjects had always been hampered by the technical problems of fixing the electrodes. A great step forward was made in 1941 when Riggs introduced the contact lens electrode. Up till this time clinical electroretinography did not realy exist and little was known about alterations in disease. In fact the use of the contact lens remained in abeyance during the war years until the pioneering work of Karpe began to be published from Stockholm in 1945. It soon became apparent that the contact lens electrode eliminated much of the interference due to background noise (Riggs, 1941; Karpe, 1945).

ADVANCES IN RECORDING TECHNIQUE

Until recently the routine method of recording the electroretinogram entailed enlarging or amplifying the minute electrical changes picked up from corneal and skin electrodes and repreducing them on paper by some form of penwriter. This technique was similar to routine electrocardiography. However, the use of the oscilloscope as a recording instrument now gives a more accurate response and the result can be photographed with polaroid film. A further advance has been the introduction of the technique of averaging. Signal averaging is a valuable way of separating the true response frome background