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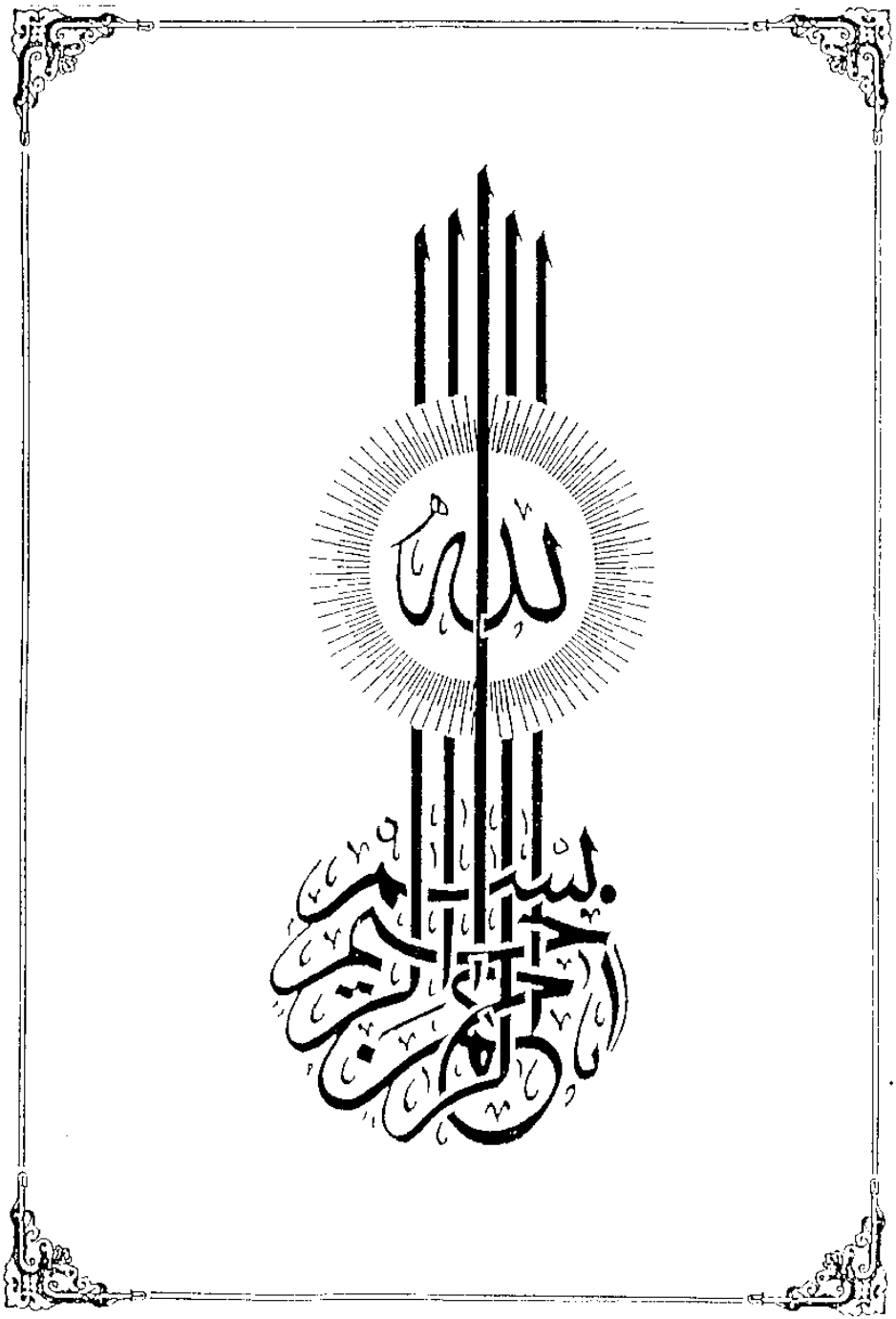

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INTRODUCTION

I- INTRODUCTION

History:

Cardio green (indocyanine green, I.C.G.) is a dark green blue dye which was used in the U.S.A for in vivo diagnostics as early as 1957 and has since then become firmly established in the diagnosis of diseases involving the hepatic function, cardiac out put, liver blood flow, circulati on & pulmonary oedema [*Fox, 1957*].

After using infrared absorption I.C.G. angiography to study the circulation of the dog cerebral surface, *Kogure in (1969)* first demonstrated choroidal absorption angiography using intraarterial I.C.G injection & false color infrared films in monkeys. They demonstrated filling of the smaller choroidal veins and occasional laminar filling of the larger choroidal veins. A choroidal arterial phase was not noted [*Kogure, 1970*].

David in 1969 was the first to perform I.C.G. absorption choroirdal angiography in human patients, who under went intraarterial I.C.G. injections during carotid angiography. He described diffuse choriocapillaries filling and choroidal veins draining toward the vortex veins.

In *1971, Hochheimer* performed choroidal absorption angiography in cats using intravenous I.C.G injections with black & white infrared film. This study solved two major problems, the first was the use of intraarterial injections and the second was the inconsistency of the false color infrared film.

Intravenous I.C.G. absorption angiography was first successfully performed in humans by *Flower & Hochheimer in 1972*. With this method, the fundus is illuminated with infrared light & the reflected light exposes the photographic film. If larger vessles are filled with enough dye to absorb the incident light, the film will not be exposed.

In *1974, Flower* developed a multispectral fundus comera. Simultaneous I.C.G. fluorescence & absorption angiography with fluorescenin angiography was performed. This combination allowed comparison of the various types of angiograms.

Hayashi and associates in 1986 performed I.C.G. angiography in patients with central serous chorioretinopathy using an infrared sensitive video camera. Video angiography has also been used by other investigators to study choroidal neovascular membranes & choroidal blood flow. A digital computer system has also been used to study choroidal blood flow [*Destro, 1989*].

Preliminary results with I.C.G. video angiography with the scanning laser ophthalmoscope were reported by *Scheider & Schroedel in 1989* and *Scheider & coworkers in 1992* recently described their experience with this technique and choroidal neovascularization.

More recently a high resolution digital imaging system has been adapted for diagnostic I.C.G. angiography, which has been especially useful in imaging poorly defined choroidal neovascular membranes [*Yannuzzi, 1992*].

Indocyanine green angiography in the infrared region was long excluded from routine clinical use because of the eye's particular light sensitivity and the poor selectivity of infrared filters available. The energy component of that part of the infrared spectrum required to stimulate fluorescence compared with the total light energy was very small. The results were of low contrast and difficult to interpret. The only monochromatic light source in the red region available so for has been the ruby laser, which is unsuitable because of the lack of absorption by indocyanine green at this wavelength. Modern I.C.G. angiography was made possible only after the development of new Infrared diode lasers emitting in the spectral region 800-810 nm [*HO et al., 1994*].

Previously, significant chromatic aberration occurs when infrared emission is photographed. This problem is compounded by the fact that I.C.G. has only one twenty-fifth of the fluorescence intensity of sodium fluorescin dye. The original system resulted in poor spatial resolution in comparison to fluorescein angiography and consequently poor image quality. In addition, the relatively slow shutter speed of the movie camera (20 frames per second) resulted in loss of images because of the very rapid transit of I.C.G. through the choroidal circulation (i.e. poor temporal resolution). I.C.G. video angiography improves the spatial & temporal resolution of infrared angiograms. Images can be quickly displayed on high resolution monitors & stored on optical laser discs. High resolution hard copy can be produced from the computer via a digital continuous-tone printer [*Guyer, et al., 1992*].

Fluoresein angiography is an important technologic advance in the study of retinal disorders. Although choroidal circulation patterns have been described with fluorescein angiography, the limimitations of this technique for studying the choroid are:

1- The excitation & fluorescence of blue-green wavelengths (peak absorption 465 nm; peak fluorescence 525 nm) are absorbed & scattered by the pigment layers of the fundus including the macular xanthophyll. Thus, the choroidal layers cannot be well visualized.

2- Sodium fluorescein is 60-80 % bound to plasma albumin, it rapidly leaks from the fenestrated choriocapillaries & produces a diffuse back ground fluorescence which further obscures the details of the choroidal vessles.

3- The intricate branching of the choroidal vascular system is difficult to study with fluorescein angiography.

Because the choroid is the major blood supply of the eye and the outer retinal layers, a better method of studying this important tissue was needed [*Monés, 1994*].

ANATOMICAL BACKGROUND

II- ANATOMICAL BACKGROUND

A- Anatomy of the Choroid:

The choroid is the most posterior part of the vascular coat of the eye. It is the homologue of the pia-arachnoid, and just as the latter nourishes the brain, so does the nourish the outer part of the retina. It is a thin membrane, extending from the optic nerve to the ora serrata, that is, the jagged line where the retina ends. It is very difficult to estimate the thickness of the choroid, for it consists largely of vessles. It has been compared to the corpus cavernosum and hence diminishes in thickness on enucleation and as the result of fixation. But it is thicker posteriorly (about 0.22 mm) than anteriorly (about 0.1 mm) and is especially thick in the macular region. Its inner surface, which can be examined by removing the vitreous and retina after opening the eye, is smooth and brown. On separating the choroid from the sclera, on the other hand, the outer surface of the former is found to be rough & shaggy. The choroid is firmly attached to the margin of the optic nerve, and slightly at the points where vessles and nerves enter. It is more firmly attached to the sclera behind the coronal equator than in front of it [*Wolff, 1976*].

Structure:

The choroid consists mainly of blood-vessles, but on each side of these is a non vascular layer. Externally, i.e. nearest the sclera, is the lamina suprachoroidea, and most internally, the homogenous basal lamina (membrane of Bruch). The vessles of the choroid are classically described as being arranged in three super imposed strata, the largest being nearest the sclera and the smallest, the capillaries, called the choriocapillaries, towards the retina [*Wolff, 1976*].

Thus *Wolff in 1976* divided the choroid into five layers, which from without inwards are as follows: