CURRENT CONCEPTS IN THE INVESTIGATION OF MACULAR DISEASE

James D. Cairns, FRCS (Ed), FRCS, FRACS, MRACO*

Introduction

An understanding of the structure and function of the macular area is of paramount importance to a correct approach to this particular area of the fundus.

In children with strabismus many useful tests such as visual acuity, foveal fixation testing, colour vision testing, the four dioptre prism test, the Haidinger brush phenomenon, the 2 log-unit neutral density filter test, the Amsler grid test, the Macular Photostress test, to name just some of the tests, form part of the armamentarium used by the ophthalmologist and orthoptist in the evaluation of the function of the macula.

This paper describes another method of investigating the macular area – fluorescein angiography– a technique widely used in adults and used to a limited degree in children. In the normal clinical situation this test is usually not able to be done in children under the age of 7 or 8 years of age, therefore its application is restricted to the age groups from 8 onwards.

Intravenous injection of fluorescein has been used for many years in fundus diagnosis but it was not until 1961 that*Novotny and Alvis described a method of photographing fundus fluorescence thus marking the origin of fluorescein angiography.

Since that time fluorescein angiography is used routinely in ophthalmology in all major eye centres throughout the world.

Anatomy of the Macula

Before discussing the normal fluorescein angiogram it is important that the correct terminology of the posterior segment of the eye is adhered to.

The **Macula**, contrary to what is commonly believed, is an area of approximately 5,000 μ in diameter centred on the foveola.

The **Foveola** is an area of 500 μ in diameter corresponding to that area of the retina at the posterior pole which is thinner than its surrounds and devoid of rods.

The **Fovea** is an area of 1,500 μ in diameter surrounding the foveola.

The **Retinal Pigment Epithelium** strictly the outermost layer of the retina, situated in front of the choroidal circulation and behind the retinal circulation, is an effective partial filter to the visibility of fluorescein in the choroid. This layer is more dense in the macular area thus more effectively screening the background choroidal fluorescence in this area.

There are two distinct and separate circulations in the posterior segment of the eye. **The Choroidal Circulation** is supplied by approximately 10 short straight vessels, the short posterior ciliary arteries arising from the ophthalmic artery. **The Retinal Circulation** is supplied by the longer, more devious central retinal artery and for this reason intravenously injected fluorescein enters the choroidal circulation approximately one second before the retinal circulation.

Fluorescein angiography depends on the principle of fluorescence. When light falls upon a substance it may be transmitted, reflected, or absorbed. If it is absorbed it may be transformed into heat or chemical energy, or into light of a different wave length. This later property is called luminescence, and fluorescence is that which has a duration of less than 10^{-4} seconds.

When light in the blue wave length band falls upon fluorescein, emission of light in the green wave length band occurs.

The technique of fluorescein angiography therefore depends on photographing this fluorescence using a standard fundus camera modified in the following way:

(a) A blue filter is placed in front of the flash lamp thereby allowing stimulation of the fluorescein within the eye. This filter is known as the excitation filter.

* Department of Ophthalmology, University of Melbourne.

(b) In front of the film is placed a yellow filter which transmits light only in the green wave length band – so that only the structures in the eye which are fluorescent are recorded on the photographic film. This filter is known as the barrier filter.

Procedure in Conducting Fluorescein Angiography

The patient on arrival is given dilating drops. The usual ones used are Mydrilate 1% and Viscous Neo-synephrine 10%. This allows maximum dilatation of the pupils which is more important for high quality fundus photography.

A brief explanation of the procedure and side effects of fluorescein angiography are given to the patient. Particular attention is paid to explaining the yellowish discolouration of the skin and urine for 24-36 hours after the dye is injected.

The patient is then sat at the camera and a small test dose (0.1ml) of fluorescein is injected intravenously to detect any possible side effects of fluorescein in the patient. After waiting 2-3 minutes, 5ml of 20% fluorescein is rapidly injected into the ante-cubital vein. During this time the fundus is viewed by the photographer through the camera and upon the first appearance of dye at the optic nervehead rapid sequence photographs are then taken at approximately every 1-2 seconds. Photography of the appropriate areas is continued at this rate into the venous phase whereupon a break is taken in the sequence. Late photographs are always taken approximately 20 minutes or even longer after the initial injection of the dye. This is important to detect the occurrence of a fluorescein leakage from the intraocular vessels. If necessary a repeat run is done on the fellow eye.

The complications of fluorescein angiography are mild and infrequent. Transient nausea occurring a few seconds after the injection of the dye may occur but usually passes off within half a minute or so and rarely necessitates cessation of the angiography. Occasional allergic phenomenon occurs such as urticarial rash or broncho-spasm. Fainting occasionally occurs, not as a specific reaction to the fluorescein but as a vasovagal response to the whole procedure. Resuscitation equipment is always kept on hand in the angiogram room in case of need.

The Normal Fluorescein Angiogram

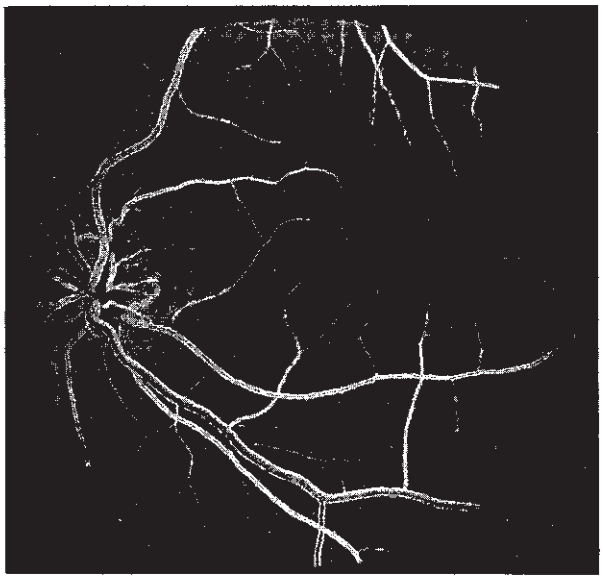

FIGURE 1: Normal Fluorescein Angiogram mid venous phase.

Five to fifteen seconds after fluorescein is injected into the arm vein, it appears in the intraocular circulation. The choroidal circulation is seen to fill first, followed a second or so later by the appearance of the dye in the retinal arterial circulation.

After a rapid transit through the retinal capillary bed, the dye enters the retinal veins where laminar flow is frequently seen in the early phases. The dye then gradually fades from the retinal circulation, small amounts remaining for some hours during recirculation of the dye.

Some Applications of Fluorescein Angiography

The young patient is particularly suitable for investigation by fluorescein angiography The healthy cardio-vascular system, the clarity of the ocular media, and the excellent mydriasis usually obtained, allow good quality angiograms to be obtained.

Conclusion

Fluorescein angiography therefore adds to the ophthalmologists understanding of pathological changes in the retinal and choroidal blood vessels, the optic disc and the retinal pigme epithelium.

Subtle changes seen on clinical examination will often only be properly elucidated by fluorescein angiography.

Children from about the age of 7-8 years are usually suitable for fluorescein angiograph This is a safe test, and apart from a small incidence of nausea immediately following the injection c the dye, it is complication free.

This test may be helpful in cases of unexplained low visual acuity not reponding to normal occlusion treatment, in children who have a family history of macular dystrophy or other hereditary disease of the posterior segment of the eye, or those with any suspected macular pathology as, for example, loss of the normal foveal light reflex.

Apart from adding useful information to the current clinical status of the patient, fluorescein angiography forms a useful baseline for future comparison thus helping in the understanding of the natural history and rate of change of a disease process in that patient. This provides valuable information in stating a prognosis to the parent.

Fluorescein angiography undoubtedly enjoys more widespread use in adults than children, nevertheless it does have a place in the investigation of abnormalities of the structure and function of the posterior segment of the eyes of young people and when discreetly used is a valuable ancillary investigative procedure.

REFERENCE:

*Novotny, H.R. & Alvis, D.L. *A Method of Photographing Fluorescence in Circulating Blood in the Human Retina.* - Circulation 24: 82-86, 1961