Argon laser photocoagulation of fluorescein stained retina – an unrecognised hazard?

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Abstract

Sodium fluorescein staining of the retina following fluorescein angiography may affect the absorption characteristics of argon ion laser photocoagulation. This hypothesis was investigated by performing laser photocoagulation on control and fluorescein stained porcine retinas. The resultant damage was viewed by scanning electron microscopy. In both specimens, argon irradiation produced damage to the pigment epithelium and overlying photoreceptor layer. The control sample showed a deep cylindrical burn, indicative of internal heating, in both retina and choroid. The fluorescein stained sample showed damage consistent with thermal interaction from the surface downwards leaving the choroid relatively spared. This preliminary study demonstrates that fluorescein staining of the retina changes the absorption site of argon laser light and this subject clearly merits further investigation.

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Figure 1 Scanning electron microscopy photograph of argon lesion on pig's retina (control). Raised, essentially sealed nature of burn indicates internal heating.

Figure 2 Scanning electron microscopy photograph of argon lesion on pig's choroid (control). Deep cylindrical burn indicative of internal heating.

The characteristics of laser photocoagulation lesions depend upon the power, duration, and wavelength of the laser and the nature of the pigment present.¹

Fluorescein staining of the retina following fluorescein angiography is common when disease leads to the breakdown of the tight junctions of the retinal pigment epithelium or vasculature.

The absorption peak of sodium fluorescein (~490 nm) includes the blue and green emission lines of argon radiation (488 nm and 514 nm). For fluorescein the conversion of absorbed light to re-emitted fluorescent light is 100% which represents a quantum efficiency of 1.0.²

In many centres argon laser photocoagulation of the retina is carried out soon after fluorescein angiography and treatment is given to the fluorescein stained retina – for example, in diabetic retinopathy. The stained tissues may thus act as a primary absorption site for argon laser light. The distribution and size of the resultant burns may therefore be different from those observed with unstained retina.

We describe a preliminary scanning electron microscopic study aimed at investigating this hypothesis, in which the features of photocoagulation lesions in fluorescein stained retinal tissue are compared with those obtained from unstained porcine retinas.

Materials and methods

Two porcine eyes were obtained fresh from the slaughterhouse. Eye cup preparations were obtained by removing anterior segment tissue and vitreous. One eye was immersed in Hartman's solution containing 0.02% fluorescein.

Figure 3 Scanning electron microscopy photograph of argon lesion on fluorescein infused pig's retina. Damage is consistent with thermal interaction from surface downwards.

Figure 4 Scanning electron microscopy photograph of argon lesion on fluorescein infused pig's choroid. Shallow annular rings result from surface heating.

cein. This concentration is typical for a human retina and was achieved by injecting 0.1 ml of fluorescein into 500 ml of Hartman's solution. The other was immersed in Hartman's solution only. The eye cups were vertically mounted and argon (Biophysic Médical) blue green laser lesions were applied to both retinas. Two 3×4 matrices of 0.4 W with 100 μm spot size for 0.2 seconds were applied to each eye. Both specimens were fixed in 4% glutaraldehyde, processed for scanning electron microscopy (SEM), and the lesions obtained were photographed. The retinas of both specimens detached during processing. This furnished the opportunity to study both the surface of the retina and pigment epithelial aspects of the lesions, by appropriate tissue mounting, of the four resulting specimens.

Results

In both specimens the argon irradiation resulted in damage to the pigment epithelium and overlying photoreceptors.

The laser burns obtained with the control tissue gave a similar appearance to the retinal surface for all 12 burns (Fig 1). Smooth papillary shaped lesions were observed, but the deep retinal tissue showed that a deep cylindrical burn had been produced through the pigment epithelium and choroid (Fig 2).

The fluorescein stained tissue showed a very different pattern of damage. Craters were produced in the retinal surface (Fig 3) but the deeper specimens exhibited loss of pigment epithelium only (Fig 4). In no case was the deep cylindrical burn of the control tissue obtained.

Discussion

Fluorescein staining of the retina fundamentally alters the characteristics of the laser burn obtained. The lesions produced asymmetrical craters in the retinal surface with an underlying 'shockwave' appearance of the damage to the pigment epithelium. The destructive choroidal lesions with surface retinal spacing seen in the control tissue were not obtained. The laser radiation incident upon the fluorescein stained retina underwent absorption and secondary scattering which presumably led to destruction of several tissues which are normally spared and which were not disrupted in the control tissue.

It has recently been shown that the use of large burns for panretinal photocoagulation for diabetic retinopathy can produce visual field defects.³ Argon laser photocoagulation of fluorescein stained retina could well produce a similar effect by disrupting the normally spared nerve fibre layer. The deep retinal and choroidal tissue may, however, be relatively spared and this could influence the therapeutic efficacy of the treatment. This subject clearly merits further investigation.

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- 2 Maurice DM. The use of fluorescein in ophthalmological research. *Invest Ophthalmol* 1967; 6: 464.
- 3 Vernon SA, Hulbert MFG. Passing the DVLC field regulations following pan-retinal photocoagulation in diabetics. *Eye* 1992; 6: 456–60.