Pathophysiology of diabetic eye disease

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ARTICLE POINTS

1 Diabetic retinopathy is the leading cause of blindness in economically developed countries.

2 Almost all those with type 1 diabetes and 60% with type 2 diabetes will have some degree of retinopathy.

3 The pathological changes in the disease are mainly concerned with changes in the retinal blood vessels.

4 There are three stages of retinopathy: background, pre-proliferative and proliferative.

5 Information, screening and timely treatment can limit sight-threatening retinopathy.

KEY WORDS
- **Diabetic retinopathy**
- **Macula**
- **Sight loss**

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Introduction

Diabetic retinopathy is the leading cause of blindness and visual disability in adults in economically developed societies (O'Keeffe et al, 1999). The links between diabetes and eye disease are well established — the longer the duration of diabetes, the greater the risk of sight loss due to cataract, glaucoma and retinal detachment. In this, the first of two articles, the normal physiology of the eye and the pathophysiology of diabetic eye disease are outlined. The second article will explore screening and treatment for diabetic eye disease and the huge benefits they can bring.

Nearly half of all people with diabetes will develop some degree of diabetic retinopathy during their lifetime (National Eye Institute, 1999). Findings consistent from study to study make it possible to suggest that, 20 years after diagnosis, almost all patients with type 1 diabetes and 60% with type 2 diabetes will have some degree of retinopathy. After examining many British studies, O'Keeffe et al (1999) suggest that up to 40% of people have some retinopathy when type 2 diabetes is first diagnosed. Kohner (1998) also reported that 5-10% of people with diabetic retinopathy will have a sight-threatening form. Treatable risk factors for the development of retinopathy have been identified as poor diabetic control, hypertension and hyperlipidaemia (Shotliff and Herbert, 1997). This article will start by describing the normal structure and function of the retina prior to looking at the disease process.

The normal retina

The retina lines about two thirds of the inside of the eyeball. It consists of two parts: the sensory layer and the pigmented layer. The pigment epithelium abuts the choroid. The pigment cells, like those of the choroid, absorb light; they also act as phagocytes and store vitamin A which is needed by the photoreceptor cells. The inner sensory or neural layer is transparent and contains the millions of photoreceptors that transduce light energy. Although these layers are close together they are not fused, apart from in the area of the optic disc and the very edge of the retina. There is a potential space between the sensory and the pigmented retina; separation of these layers is called a retinal detachment.

When the eye is examined with specialist equipment such as an ophthalmoscope, the retina, also called the fundus, is viewed directly (*Figure 1*). The basic function of the retina is the fixation of images. Light is refracted (focused) via the cornea and the lens onto the retina at the back of the eye. The sensory (or neural) part of the retina contains light-sensitive cells called rods and cones that pick up the image. The image signal is then transferred to the brain via the optic nerve.

The optic nerve leaves the eye at a point called the optic disc. This is also known as the blind spot as it has no rods or cones to receive the image. The fundus has a peripheral and a central part (*Figure 2*). The central part of the retina, called the macula, including a tiny area called the fovea, permits highly acute vision; peripheral vision is of poorer quality. Therefore, any damage or disease of the macula area (*Figure 3*) has a major impact upon the vision experienced by the patient. The macula is avascular; most of the retinal vessels are found in the periphery. So what changes occur in the eye in diabetic retinopathy?

Pathological changes

The longer a person has had diabetes, the greater the likelihood of developing diabetic retinopathy. The pathological changes in the disease are mainly concerned with changes in the retinal blood vessels. These changes are almost always bilateral although each eye may differ in the degree of involvement. The retinal vascular changes are often divided into three major groups, describing the extent of the changes.

- Background
- Pre-proliferative
- Proliferative (Vrabec and Florakis 1992).

Background retinopathy

Background retinopathy presents as an engorgement of the retinal veins and a hyperaemia of the retinal capillaries. This enhances the formation of micro-aneurysms (seen as dots) which often join to form larger ones. Leakage follows, causing intraretinal (blot) haemorrhages (*Figure 4*). There is also macula oedema and seepage of lipid and mucopolysaccharide material. This material forms hard exudates over a period of time and is seen as yellow spots on the fundus (*Figure 3*).

Pre-proliferative retinopathy

In this condition, there is background retinopathy and evidence of ischaemic changes. The fine nerve endings within the retina are damaged due to the ischaemia and micro-infarctions of the nerve fibre layer causing what is known as 'cotton wool' spots. There are also widespread retinal microvascular abnormalities and 40% of patients diagnosed with severe pre-proliferative retinopathy will go on to develop proliferative retinopathy within a year (Berson 1993).

Proliferative retinopathy

In this form of retinopathy, new blood vessels form on the retinal surface (neo-vascularisation). This is a response to the highly ischaemic retina. These new vessels are of poor quality and they grow out into the jelly of the eye which is known as the vitreous humour. Here they obscure vision by their presence but also by their tendency to rupture and bleed causing vitreous haemorrhages. Fibrous tissue often accompanies these new vessels and once these contract they can pull on the retina causing the retina to detach. This form of retinopathy is responsible for most of the profound visual loss in diabetes.

Neovascularisation can occur elsewhere in the eye as part of the same process. Some new vessels can grow forward and cover the iris (a condition known as rubeosis iridis). These vessels grow into the drainage angle of the eye, thereby blocking the drainage of fluid that fills the anterior chamber at the front of the eye (the aqueous humour). The subsequent rise in

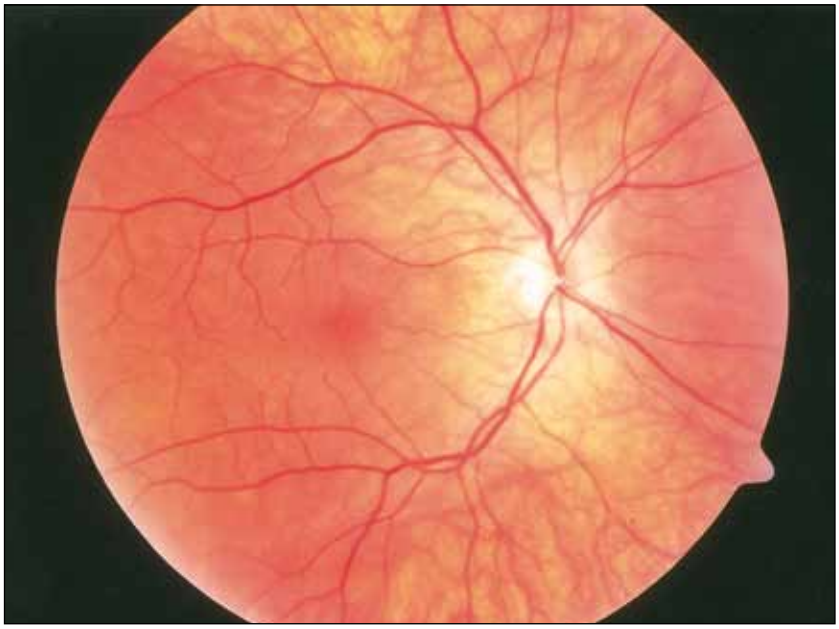

Figure 1. The normal fundus.

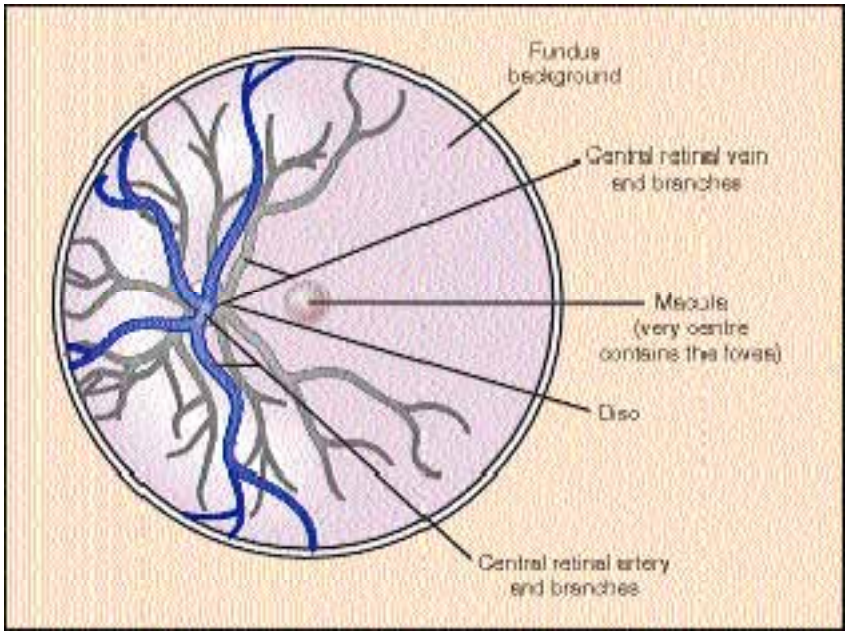

Figure 2. Diagram showing the fundus.

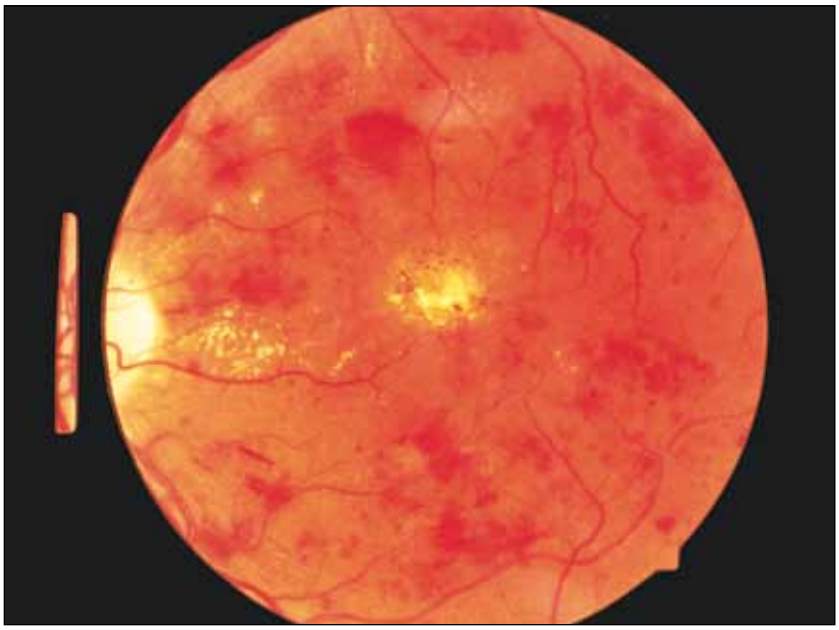

Figure 3. Maculopathy showing haemorrhage and exudate (hard yellowish exudates).

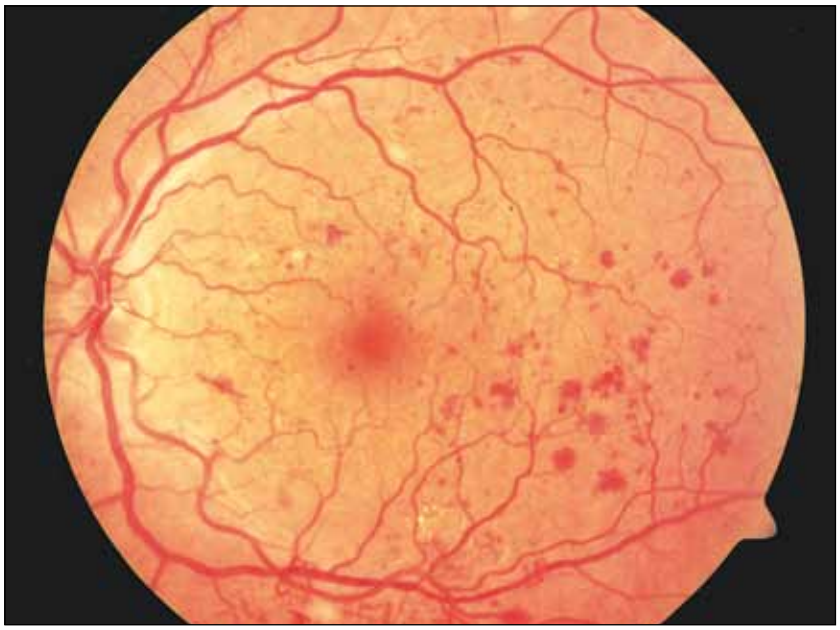

Figure 4. Dot and blot haemorrhage.

intraocular pressure is known as rubiotic glaucoma. The raised pressure adds to the damage of the fine nerve endings creating further problems of sight loss for the patient.

Visual loss in patients with diabetic retinopathy is mainly due to macula oedema, vitreous haemorrhage, ischaemia, exudate deposition and retinal detachment. Secondary glaucoma and cataract can add to the deterioration. The extent to which the 'functional' vision is affected depends upon the area of retina affected. If the changes do not directly involve the macula, or more specifically the fovea, patients may develop the early stages of retinopathy with few visual symptoms.

In cases where the macular is involved (diabetic maculopathy), the visual acuity can be profoundly affected and the patient ultimately blinded. The macular can be affected at any stage of the disease by micro-aneurysms, exudates, haemorrhage and macular oedema.

Conclusion

Diabetic retinopathy is the leading cause of blindness and visual disability in the Western world. The disease is progressive but the extent of the visual impairment is largely dependent upon the area of retina affected. There are many factors that contribute to the incidence and severity of diabetic retinopathy but ultimately it is linked to the disease duration. The longer a patient has the disease the more likely they are to show some retinal changes. This can be devastating for patients with diabetes and their carers as visual impairment has major implications for all activities of living. It is here that nurses with a special interest in diabetes can help their patients.

Information, screening and timely treatment can limit sight-threatening retinopathy. The second article in this series will identify the benefits of regular eye examination, screening and early treatment for the different stages of diabetic retinopathy. This will help the nurse dealing with patients with diabetes to understand the process. In turn they can then help these patients to make informed choices about screening and potential treatment.■

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