

Physiology and Pathology of the Eye in Diabetes

Nearly 4 million peoples in this country have diabetes, yet half of them are not aware they have the disease. Diabetes is one of the country's four leading causes of blindness.

After 20 years of diabetes without strict control of blood glucose levels, there is a 90 percent chance of developing eye disease. Ocular complications of diabetes include retinopathy, vitreous haemorrhage, cataract, glaucoma and changes in refraction.

The Disease

Diabetes is a disease in which the body does not produce, or cannot properly use, insulin, an essential hormone needed to convert carbohydrates and other foods into the energy needed for daily life.

Signs and Symptoms

- Frequent urination
- Abnormal thirst
- Excessive appetite accompanied by weight loss
- Fatigue
- Recurrent vaginal yeast infections
- Visual changes

Treatment

People with Type I (insulin-dependent) diabetes, which generally occurs under age 30, must take insulin injections daily.

Type II (usually non-insulin-dependent) diabetes is 10 times more common and usually occurs in people over 40, particularly those who are overweight and inactive.

The cornerstone of treatment is diet modification. If diet alone fails to normalize blood glucose (sugar) levels, patients take a prescribed oral medication that stimulates insulin secretion or improves the body's ability to use insulin. Some people with Type II diabetes use a combination of insulin and oral medication.

In addition to diet and medication, exercise and stress management are important components of treatment for both types of diabetes. Environmental and lifestyle factors, as well as a family history of diabetes, seem to affect the development and control of the disease.

It has long been thought that the complications of diabetes can be delayed or prevented by keeping blood glucose levels close to normal. A long-term study, completed in 1995, provided strong evidence that tight blood glucose control (that is, maintaining blood glucose levels as close as possible to those of someone who does not have diabetes) reduces ocular and renal complications by 70 percent. However, such tight glucose control may not be advisable or possible for all patients; patients should consult their physicians.

Complications of Diabetes

Treatment of diabetes has increased life expectancy dramatically. However, because the disease involves blood vessels and nerves, adults who have had long-term diabetes may experience damage to many body tissues and failure of various organ systems, particularly if control of blood glucose has been sporadic.

Both types of diabetes can cause complications. Commonly involved are the eyes, nervous system, circulatory system and kidneys. Dental, skin and foot problems also are seen.

Visual Symptoms

People with diabetes should never neglect visual symptoms because they might be due to complications of the disease. Early diagnosis and treatment can reduce vision loss. Some symptoms may be corrected with standard prescription lenses, while others may need medication or surgery. However, if the damage to the eye has progressed to haemorrhaging and scarring, remaining vision cannot be restored to normal levels.

The most common diabetes-related eye symptoms are:

- changes in refraction, variable vision or focus;
- blurred or hazy vision;
- sensitivity to glare;
- faulty colour vision;
- Blindness.

Diabetes-Related Eye Disease

Diabetic Retinopathy

About 40 percent of people with diabetes will have at least mild retinopathy. Incidence increases with the disease's duration and when there is inconsistent control of blood glucose. Retinopathy is characterized by leakage of fluid or blood from vessels in the retina. It usually appears in stages:

1. mild background retinopathy, also known as non-proliferate diabetic retinopathy, which has few warning symptoms;
2. macular oedema (fluid), which causes blurred vision and reduced sensitivity to colour;
3. severe proliferate diabetic retinopathy, where leaking blood vessels, which already have caused visual damage, form scar tissue between the retina and the vitreous. This tissue may contract and, eventually, detach the retina. Once the retina is detached, reattaching it requires a lengthy surgical procedure (vitrectomy) involving the retina and vitreous bands. The surgery is not always successful, depending on the amount of scar tissue. Retinal detachment, therefore, may result in severe vision loss, or even blindness.

Retinopathy causes blurred or hazy vision, particularly if there are retinal haemorrhages or oedema (swelling) of the macula.

Although the presence of retinopathy can be detected by looking into the eye, details are best identified by injecting a fluorescent dye into the bloodstream.

This allows the ophthalmologist to photograph and evaluate the retinal blood vessels, and to pinpoint areas that are leaking due to revascularisation (growth of fragile new blood vessels).

If such areas are found in the peripheral retina, laser treatment (pan retinal photocoagulation) is recommended to seal off leaking vessels and destroy abnormal ones. If there is macular oedema, scattered laser treatment in the macula may be recommended. In some cases, early treatment may restore vision, stabilize it or, at least, delay severe loss of sight.

Vitreous Haemorrhage

One of the complications of diabetic retinopathy is haemorrhage from fragile blood vessels leaking into the vitreous, the clear gel-like substance that fills the interior of the eye. If blood clouds the vitreous, light passing from the lens through the vitreous to the retina is blocked, and vision is markedly reduced. Blood can gradually clear up over several months, but if it does not, surgical removal of the vitreous, called vitrectomy, can be performed. Specialists in vitreo-retinal surgery can remove blood and scar tissue from the eye and replace the vitreous with a clear solution. This may result in useful, though reduced, vision.

Cataract

Diabetes increases the possibility of cataract, a clouding of the transparent lens of the eye. Cataract may cause hazy vision and glare sensitivity. If retinopathy has not damaged the retina, surgical removal of a cataract usually results in improved vision. If there is damage to the retina, the cataract may still be removed in order to improve the ophthalmologist's view of the retina. This makes it easier to evaluate the condition of the eye prior to laser treatment. When a person with diabetes has a cataract operation, standard surgical techniques are used.

Secondary Glaucoma

Fragile new blood vessels in the eye of someone with diabetes may form a new network directly on the iris, blocking the outflow of fluid from the eye. This condition, called secondary glaucoma, results in elevated pressure of the fluids within the eye, and can cause optic nerve atrophy and loss of the full visual field. Treatment involves the application of laser to the leaking areas. Standard glaucoma treatment with drops or diuretics may also be recommended to lower intraocular pressure.

Macular Damage

In chronic macular oedema, faulty colour vision may result and usually is irreversible. Even after the macula has been treated with laser, there may still be problems reading because of distortion. Low vision magnifying devices may be needed.

Changes in Refraction

High blood glucose levels that are characteristic of poorly controlled diabetes can also result in changes in refraction (the accurate focus of light rays on the retina). This is due to swelling of the lens, which causes myopia (near-sightedness). Before such transient refractive changes are corrected by standard prescription eyeglasses, improved control of blood glucose should be attempted. Glasses should be prescribed only after blood glucose has stabilized, or consecutive examinations reveal consistent refractions.

Examinations

Because vision can vary with fluctuations in blood glucose levels, a careful refraction and eye examination by an optometrist should be done at intervals to check for presbyopia, secondary myopia, cataract or retinopathy. In addition, every diabetic should periodically have a fluorescein angiography test administered by a retinal specialist to rule out early signs of retinopathy undetectable by a standard vision examination.

Low Vision Management

People with diabetes who develop irreversible vision changes have low vision – vision so impaired that it is inadequate for performance of customary activities. Special types of magnifying and vision-enhancing devices can often help, as well as special devices designed to aid people with diabetes in managing their disease.

Optical Devices

People with permanently impaired sight receive low-vision devices prescribed for the current level of sight and for specific task requirements. For impaired reading vision, magnifying spectacles and/or hand- or stand-magnifiers, or video magnifiers may be recommended. A lightweight, focusable monocular telescope may be used to see distant or intermediate objects.

Non-Optical Devices

Correct lighting is extremely important. Lighting varies with individual needs and specific tasks. For example, some people find daylight or daylight-type fluorescent lighting best for reading blood glucose or ketone test strips. An adjustable lamp generally is recommended for reading. A video magnifier, also known as a closed-circuit television (CCTV), may be used for various tasks, especially reading and writing. Large-print text is often helpful, as is a signature guide.

In addition, people who have impaired vision might benefit from vision rehabilitation teaching. Such teaching can help people learn or relearn the skills needed for independence. Vision rehabilitation teaching can include training in kitchen safety, getting around indoors and outside, keeping records, and assistance with grooming and personal management.

Managing Diabetes

Older adults who have diabetes and vision loss face many challenges in managing the disease and its multiple complications. It is vital that the older person with diabetes have access to as many specialists as necessary to ensure adequate care and treatment for the many systemic problems that can be part of long-term diabetes. Successful management of diabetes also means finding healthful approaches to diet, medication, exercise and stress reduction, and incorporating them into a regular routine. Fortunately, there are a number of devices and techniques that can help someone with impaired vision manage diabetes.

Identifying Medications

People with diabetes often take many medications. A large-print label, brightly coloured dots, red nail polish, rubber bands or other tactile markers can be used to distinguish one medication bottle from another. The shape of a bottle can be an identifying factor; in the future, insulin bottles may be produced in standard shapes for each type, so that short-acting insulin could be readily distinguished from intermediate and long-acting insulin. Daily or weekly pill dispensers and "talking" watches and clocks can help a patient maintain the medication schedule.

Measurement of Blood Glucose

With the emphasis on blood glucose control, it is more important than ever for a person to be able to monitor blood glucose several times a day or as often as recommended. It is now possible for people with impaired vision to measure their own blood glucose accurately with monitors that have digital screens and voice output. More details can be obtained from your

Exercise

Regular moderate exercise contributes to general well-being and can improve blood glucose control. The type of exercise should be appropriate to the individual's medical and eye condition, and should be discussed first with a doctor.

Walking is one of the best and safest exercises. Riding a stationary bicycle is another safe, accessible exercise. For those who use a wheelchair, there are various exercises, some of which can be done to music. Swimming, too, is excellent. (Lane swimming is advisable for those with severe vision impairment.) Keep in mind that other activities that burn calories and contribute to weight control include household chores, gardening and dancing.

People with diabetes should be aware that some people who have elevated blood glucose levels (above 12 mmol/l) for an extended period of time may find their blood glucose rose even higher by strenuous exercise. Therefore, such exercise should be avoided until the blood glucose level is better controlled.

Exercise can also have the effect of lowering blood glucose levels, and this effect may last for hours after the exercise is over. Therefore, people with diabetes should consume adequate carbohydrates before, during and after exercise.

Stress

The hormone adrenalin is produced at elevated levels during periods of stress. Adrenalin acts on the liver to release glycogen, a storage macro-molecule of glucose. This would give energy in a fight or flight situation but results in elevated blood glucose levels which are to be avoided.

Since stress adversely affects control of diabetes and often is avoidable, stress management is a critical element of diabetes management. With guidance, everyone can find stress-reduction and relaxation techniques, including meditation, imaging and combined use of music and movement. Exercise can also reduce stress.

Diet

Diet is essential in managing diabetes. If a physician does not offer instruction, or a nurse diabetes educator is not available, a dietician should be consulted. This should be done not only at the time of diagnosis, but also periodically, and whenever complications of the disease (circulatory, cardiac or kidney problems, for example) necessitate changes in diet.

Since vision impairment can hinder the ability to shop and cook independently, one must beware of relying on convenience foods, which often are high in sodium, fat and sugar. It can be helpful to ask or take a magnifier along when shopping to analyze product labels. These labels provide information about ingredients and are helpful in diet planning.