Preventing and Treating Diabetic Retinopathy

At the most fundamental level, diabetic retinopathy (DR) is a metabolic disease of the retina. When excessive glucose is present in the blood stream—as is the case with poorly controlled type 1, type 2, and gestational diabetes—several metabolic pathways are upregulated to handle the hyperglycemic state. One of these is the polyol pathway, which converts glucose into sorbitol and then into fructose. However, the polyol pathway's capability is limited within the retina because this tissue does not have the enzyme required to complete the second half of the conversion. Thus, sorbitol builds to toxic levels, causing damage to the retina. Beyond the build-up of sorbitol, all the upregulated pathways produce reactive oxygen species—free radicals that cause oxidative stress and inflammation within the delicate tissues of the eye.

In addition to the metabolic changes within the retinal cells, the function of multiple cells that support the retina are also negatively affected by high levels of blood glucose. Damage to the tight junctions of the inner-blood-retinal barrier (primarily retinal epithelial cells) impair signal transmission from the eye to the brain. The excess glucose and LDL cholesterol in the blood damage the tiny blood vessels that supply the retina, resulting in blocked blood vessels that can then leak fluid and large molecules including proteins, lipoproteins, cholesterol or blood. Simultaneously damage to the outer-blood-retinal barrier (primarily retinal pigment epithelial [RPE] cells) exacerbates the accumulation of toxins in the retinal cells and hinders transport mechanisms designed to prevent this problem. High blood pressure, whether caused by hyperhomocysteinemia, excess blood glucose, dehydration, or other root causes, also worsens eye damage by increasing harmful free radical production and weakening the body's natural defenses against them.

The Dietary Link

Given the rapid increase in diabetes worldwide and the corresponding ophthalmic complications, understanding how nutrition influences the development and progression of DR is of utmost importance. Research has shown that dietary modifications and appropriate use of supplements are promising approaches to mitigating the risk of DR.

Healthy eating patterns and appropriate supplementation can combat oxidative stress and inflammation, both of which are critical in DR pathogenesis. Glycemic control, lipid profile management, and blood pressure regulation are critical to reduce the risk of DR, and all can be positively influenced through appropriate nutrition interventions.

Role of Fatty Acids

Epidemiological research shows that a high intake of trans fats is positively correlated with the risk of diabetes and with increasing levels of total cholesterol and LDL cholesterol, which are linked to the development of DR. Conversely, monounsaturated and polyunsaturated fatty acids have a protective effect. In particular, one study found consuming oily fish, like salmon, mackerel, and sardines at least twice weekly can reduce the risk of retinopathy by up to 70%. Another study found that consuming 500 mg per day of omega-3 fatty acids considerably lowered the risk of developing DR.

Micronutrients and Antioxidants

People with diabetes often have lower micronutrient levels than those without diabetes. Many vitamins and minerals are free radical scavengers in the body, and help regulate blood pressure and inflammation, and also promote insulin release and sensitivity. For example, vitamin C plays a role in capillary endothelial function, while vitamin B1 (thiamin) and B9 (folate) are beneficial in modulating blood glucose levels. Vitamins B9, B2 (riboflavin), B6, and B12 can also help lower homocysteine levels, thereby reducing the risk of DR.

Antioxidants are critical in stabilizing cell membranes and preventing oxidative damage, a key contributor to DR progression. Retinoids such as lutein and zeaxanthin, which are abundant in dark leafy greens and egg yolks, are particularly beneficial in maintaining retinal health and have been shown to both decrease the risk of DR and delay its progression within five years. A crucial component of the antioxidant enzyme Cu-Zn superoxide dismutase, zinc is present in high concentrations in the retina, and decreased serum levels in diabetic patients with retinopathy may be a contributing factor to increased oxidative stress and the progression of DR. Other antioxidants include coenzyme Q10, copper, manganese, selenium, and alpha lipoic acid, a powerful antioxidant within the retina's ganglion cells and pigment epithelial cells.

Polyphenols, such as those found in many plant-based foods and green and black tea, may offer further antioxidant and anti-inflammatory benefits. In multiple studies, tea consumption has been shown to have a protective effect against DR. Green tea has been shown to protect retinal neurons and regulate the subretinal environment by reducing reactive oxygen species. Polyphenols that have shown a positive impact on glycemic control and free radical activity include resveratrol, chlorogenic acid, and lycopene.