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Correlation between Diabetes Mellitus and vision loss, the long-term effects of the conjunction, & how treating one may help or impair the other: A Review

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Abstract

Diabetes and related complications are associated with long-term damage and failure of various organ systems. The line of demarcation between the pathogenic mechanisms of microvascular and macrovascular complications of diabetes and differing responses to therapeutic interventions is blurred. Diabetes induces changes in the microvasculature, causing extracellular matrix protein synthesis, and capillary basement membrane thickening which are the pathognomy features of diabetic microangiopathy. These changes in conjunction with advanced glycation end products, oxidative stress, low grade inflammation, and neovascularization of vasa vasorum can lead to macrovascular complications. Hyperglycaemia is the principal cause of micro vasculopathy but also appears to play an important role in causation of macro vasculopathy. There is thought to be an intersection between micro and macro vascular complications, but the two disorders seem to be strongly interconnected, with micro vascular diseases promoting atherosclerosis through processes such as hypoxia and changes in vasa vasorum. It is thus imperative to understand whether microvascular complications distinctly precede macrovascular complications or do both of them progress simultaneously as a continuum. This will allow re-focusing on the clinical issues with a unifying perspective which can improve type 2 diabetes mellitus outcomes.

Keywords: Complications, diabetes, macrovascular, microvascular etc.

Introduction

Diabetic retinopathy is one of the most predominant complications of diabetes and can develop in individuals who are living with either type 1 or type 2 diabetes, and it generally affects both eyes. The condition develops slowly throughout many years; therefore, it is essential to undergo regular eye tests when you have Diabetes. Prevention of retinopathy or slowing down of the progression can be established with keeping excellent control of blood sugar levels. Retinopathy is basically impaired blood vessels in the retina which is

the thin inner light-sensitive layer situated in the back of the eyes. Diabetic retinopathy (DR) is the most frequent complication of diabetes and remains the leading cause of preventable blindness in the working-age population in developed countries. DR has long been considered a microvascular complication of diabetes; however, growing evidence suggests that neurodegeneration is an early event in its pathogenesis. In fact, abnormalities in retinal function can be detected in patients without any evidence of microvascular abnormalities, and the American Diabetes Association (ADA) has recently defined DR as a highly specific neurovascular complication.

Review of literature

(Howells, 1953) studied "*Ocular complications of diabetes mellitus*" and found that Diabetes mellitus (DM) is a important health problem that induces ernestful complications and it causes significant morbidity owing to specific microvascular complications such as, retinopathy, nephropathy and neuropathy, and macrovascular complications such as, ischaemic heart disease, and peripheral vasculopathy. It can affect children, young people and adults and is becoming more common. Ocular complications associated with DM are progressive and rapidly becoming the world's most significant cause of morbidity and are preventable with early detection and timely treatment.

(WT, 1903) studied "*Diabetes Care*" and found that Diabetes is a complex, chronic illness requiring continuous medical care with multifactorial risk-reduction strategies beyond glycemic control. Ongoing patient self-management education and support are critical to preventing acute complications and reducing the risk of long-term complications. Significant evidence exists that supports a range of interventions to improve diabetes outcomes. The American Diabetes Association's (ADA's) "Standards of Medical Care in Diabetes," referred to as the Standards of Care, is intended to provide clinicians, patients, researchers, payers, and other interested individuals with the components of diabetes care, general treatment goals, and tools to evaluate the quality of care

(Bahrami et al., 2016) studied "*Diabetic macular oedema: pathophysiology, management challenges and treatment resistance*" and found that Diabetic macular oedema (DMO) is the leading cause of vision loss in patients living with diabetes. DMO results from

hyperglycaemia-induced activation of pathways that lead to oxidative stress and release of cytokines, impairing the inner and outer blood–retinal barriers. Improved understanding of the pathophysiological mechanisms leading to DMO have led to the development of effective therapies, including vitreoretinal surgery, laser photocoagulation, intravitreal anti-vascular endothelial growth factor drugs and corticosteroids. Advances in imaging, including fluorescein angiography and optical coherence tomography, have also enhanced diagnosis and management of the condition. Despite these advances, there remain patients who do not respond completely to therapy, reflecting the complex pathophysiology of DMO.

(Balaji et al., 2019) studied "*Complications of diabetes mellitus: A review*" and found that Diabetes mellitus (DM) is a chronic disease characterized by hyperglycaemia and complications that include microvascular disease of the eye and kidney and a variety of clinical neuropathies. DM, also known as simply diabetes, is a group of metabolic diseases in which there are high blood sugar levels over a prolonged period. These high blood sugar levels produce the symptoms of repeated urination, increased hunger, and increased thirst. Untreated diabetes can cause many complications. Acute complications include diabetic ketoacidosis (DKA) and non-ketotic hyperosmolar coma. Serious long-term complications include heart disease, stroke, kidney failure, foot ulcers, and damage to the eyes. Metabolic abnormalities in carbohydrates, lipids, and proteins result from the important role of insulin as an anabolic hormone.

(Rahimi-Madiseh et al., 2016) studied "*The research and development on the antioxidants in prevention of diabetic complications*" and found that Diabetes mellitus can damage the eyes, kidneys, nerves and heart. Microvascular and macrovascular disorders are the leading causes of morbidity and mortality in diabetic patients. Hyperglycaemia can increase the indicators of lipid peroxidation and oxidative stress in which free radicals have the main role in the pathogenesis of these complications. Therefore, antioxidants which combat oxidative stress should be able to prevent and repair free radicals induced damages. Although free radicals contribute to kidney damage, atherosclerosis, diabetes, heart disease, nephrotoxicity and hepatotoxicity; however, clinical trials do not uniquely confirm a substantial impact on diabetic damage. It seems that antioxidants in vegetables, fruits and grains help preventing diabetes

complications; however, there is little evidence that taking single antioxidants such as vitamin E or vitamin C protect these complications.

(Lenhard et al., 1998) studied "*Definition, Diagnosis and Classification of Diabetes Mellitus and its Complications*" and found that In the late 1970s both WHO (1) and the National Diabetes Data Group (2) produced new diagnostic criteria and a new classification system for diabetes mellitus. This brought order to a chaotic situation in which nomenclature varied and diagnostic criteria showed enormous variations using different oral glucose loads. In 1985 WHO slightly modified their criteria to coincide more closely with the NDDG values (3). There are now many data available, and also much more aetiological information has appeared. It seemed timely to re– examine the issues and to update and refine both the classification and the criteria, and to include a definition of the "Metabolic Syndrome"

(Sukha & Rubin, 2007) studied "*Definition, classification and visual aspects of diabetes mellitus, diabetic retinopathy and diabetic macular edema: A review of literature*" and found that Diabetes Mellitus (DM) is an interesting and complicated systemic disease. The World Health Organization (WHO) estimated that the global prevalence of DM would rise from 2.8% (171 million) to 4.4% (366 million) by 2030, with the most significant increases predicted in developing countries. The development of DM immediately increases the patient's propensity to develop a number of irreversible acute and chronic complications. For example, impaired glucose tolerance and diabetic ketoacidosis are acute complications while chronic complications include macrovascular and microvascular anomalies. The macrovascular complications include cerebrovascular disease, coronary heart disease, and peripheral vascular disease.

(Cecilia et al., 2019) studied "*Oxidative Stress as the Main Target in Diabetic Retinopathy Pathophysiology*" and found that Diabetes mellitus (DM) is expected to affect around 550 million people all over the world according to global estimates of the prevalence of diabetes. DM is characterized by constant hyperglycemia that damages various organs and manifests in macrovascular complications like premature atherosclerosis resulting in strokes, peripheral vascular disease, and myocardial infarctions and microvascular complications such as nephropathy, neuropathy, and retinopathy

The Link Between Diabetes and Vision Problems

Glucose comes from food, and it is a vital source of energy for the body. Insulin is a hormone (a chemical messenger in the body) that controls glucose, transforming it into fuel.

Diabetes causes people to have high levels of blood sugar.

It's the result of either having too much or not enough insulin. This is type 1 diabetes, which makes up approximately 5 percent of people with diabetes.

It can also be the result of not being able to properly use the insulin being produced. This is type 2 diabetes, which makes up 90 to 95 percent of people with diabetes.

Both types of diabetes cause the body to be unable to store and use glucose. Instead of reaching the cells that need it, glucose collects in the blood, reducing the elasticity of blood cells. This causes the blood vessels to narrow and inhibits blood flow.

The reduced supply of oxygen and blood increases the risk of high blood pressure and damage to both the small blood vessels (microvascular disease) and large blood vessels (macrovascular disease).

Most eye and vision-related diabetes complications are the result of rising and falling blood sugar levels in the body or due to microvascular disease.

Diabetes and Vision: Short-Term Effects

The most common effect of diabetes on short-term vision and eye health is blurry vision. When someone has blurry vision, things may appear out of focus. They may be unable to see details or feel that things look fuzzy. The blurriness may be mild or extremely noticeable.

Blurry vision may be a symptom of long-term diabetes complications or an indication of a more serious problem. When experienced as a short-term side effect of diabetes, blurry vision is the result of rising and falling blood sugar levels.

This type of blurred vision can occur due to:

- **Swelling:** High glucose levels can cause fluid to move into and out of the eye, irritating the eye lens and causing it to swell. The swelling changes the shape of the eye, which causes blurriness, as the lens plays an important role in light reflection and vision.
- **Hypoglycemia:** A crash in glucose can lead to low blood sugar, or hypoglycaemia. This can have a negative impact on brain function, which can cause blurred vision.

Both of the above conditions are short-term issues. Vision will return to normal (non-blurry) after blood sugar levels normalize. Short-term blurred vision is very unlikely to cause vision loss.

Long-Term Effects of Diabetes: Blood Vessel Damage

Eye and vision complications from diabetes are progressive. If left untreated, they get worse with time.

Continually high levels of glucose in the blood over an extended period of time can cause damage to the small blood vessels behind the eyes due to the narrowing of blood vessels and lack of blood and oxygen flow. This damage can even begin in prediabetes — a condition in which a person has consistently high blood sugar levels but has not yet fully developed type 2 diabetes.

Damaged blood vessels behind and near the eye can result in swelling and fluid leakage. New blood vessels may develop and ultimately begin to bleed in parts of the eye. These weaker new blood vessels may cause scarring or high blood pressure inside the eye.

Most serious diabetes-related eye and vision problems are caused by issues relating to blood vessel damage, including the most common diabetic eye diseases.

Prevention and treatment

Treatment of Diabetic Retinopathy

Treatment of diabetic retinopathy may vary according to the extent of the disease.

- **Laser treatment –** Some patients may need laser therapy to repair leaking blood vessels or to prevent other blood vessels from leaking.
- **Injection of medicines –** An optometrist may need to inject medications into the eye to reduce inflammation or to avoid the formation of new blood vessels.
- **Surgical procedures –** People with severe cases of diabetic retinopathy may need to undergo a surgical procedure for removing and replacing the vitreous (gel-like fluid) in the back of the eye. In the case of retinal detachment (separation of the retina from the underlying tissue), surgery is also required.

Conclusion

the presence of DR in a diabetic subject not only means that a "vision problem" does exist but that this patient presents a high risk of developing other micro- and macrovascular diseases, as well as dementia. Hence, the presence of DR is often a forgotten hallmark for implementing a personalized medicine in diabetic patients. In addition, the retina could be a useful window to indirectly explore the brain, thus permitting us to identify patients with cognitive impairment and, consequently, at risk of dementia. A coordinated activity among diabetologists, ophthalmologists, basic researchers, pharmaceutical companies, and healthcare providers will be essential for ameliorating the devastating consequences of this still highly prevalent complication of diabetes.

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