

The negative impact of frequent fasting on eye health

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Abstract:

Intermittent fasting (IF) is a well-known therapeutic dietary strategy that regulates metabolism and helps delay the onset of metabolic disorders. IF has been discovered to have both direct and indirect impacts on the degenerative alterations and physiological structure of the eye, and there is increasing research relating it to ocular illnesses. An outline of how IF controls the physiological elements of the choroid, retina, anterior region of the eye, and ocular vascular system is given on this page. We examined the potential as a remedy for several prevalent ocular disorders. Future investigations into the fundamental processes will provide a precise and uncomplicated approach to the treatment and prevention of eye disorders.

The eye is a vital sensory organ that receives most of the information from the environment. Lifestyle changes have led to a steady increase in eye disorders and the ocular side effects of metabolic diseases such as diabetes and hypertension. Chronic eye disorders have a substantial financial cost on families and society in addition to having a detrimental effect on patients' quality of life. Dietary interventions have shown potential for eye disease prevention and supplementary therapy due to their simplicity of adoption and application. Nevertheless, the data and ocular conditions are inadequate.

Retinopathies and other illnesses of the ocular surface can be significantly impacted by a variety of ocular biological variables. It is essential to comprehend how it impacts the eye's pathological changes and physical traits.

Index Terms –Frequentfasting, lowering of sugar, eye inflammation, irregular lifestyle, Prolong Diabetes.

Introduction

Intermittent fasting (IF), also known as intermittent energy restriction (IER), is a new type of fasting therapy that alternates casual and restrictive eating for a set amount of time with the aim of influencing an organism's metabolism through dietary changes. This simple dietary restriction diet has been shown to have many health benefits, including disease prevention and slowing down the aging process. In 1997, Weindruch and Sohal showed that calorie restriction techniques could increase longevity by lowering body weight and oxidative stress (1); in subsequent studies, these benefits have been extended to include diabetes, cardiovascular disease, cancer, and neurological disorders (2). The most common cause of IF diets today are time-restricted fasting, periodic fasting, and alternate-day fasting, and fasting for religious purposes.

A day of ordinary eating is followed by a day of fasting, which is known as alternate-day fasting. During the fast, make sure you drink enough water. It is currently the most common kind of IF. Periodic fasting is a type of diet where one or two days of the week are fasted and the other days are eaten regularly. The 5:2 light fasting technique, which limits food intake just twice a week, is the most popular kind of periodic fasting. Throughout the time-limited fast, participants only fasted during certain periods of the day. Religion-related fasting is a popular kind of IF that is motivated by religious beliefs.

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Retinopathies and other illnesses of the ocular surface can be significantly impacted by IF, which can alter a variety of ocular biological parameters. It is essential to comprehend how IF impacts the physical traits and pathological changes in the eye. This article outlines the benefits of IF for the eye and the prevention of ocular diseases by describing how it affects several biological parameters of the eye and discussing possible physiological causes of these effects.

Biological Factors Impacting the Eyes and Periodic Fasting

IF is a new eating pattern that has a big impact on how the body uses its energy. The anterior part of the eye, choroidal and retinal thickness, intraocular pressure (IOP), ocular blood circulation, insulin sensitivity, and sympathetic and parasympathetic tone can all be impacted by IF. It can also improve blood circulation and flow patency. It has a major impact on the local metabolism and structure of the eyes.

Frequent Fasting and the Distribution of Blood in the Eyes:

Hypertension has a major effect on ocular blood perfusion and vascular distribution. The retina and other peripheral organs, such as the kidneys and brain, have comparable vascular architecture and physiological traits (8). Localized arteriovenous stenosis and widespread retinal small artery stenosis caused by high blood pressure result in reduced retinal perfusion (9). Prolonged high blood pressure will cause the blood-retinal barrier to be destroyed, resulting in an exudative phase. Cotton wool spots and retinal hemorrhages cause macular edema and optic disc edema during this period (10).

Hua et al. also detected a substantial drop in vascular density in individuals with a 5–10 year history of hypertension; this change is likely related to the long-term consequences of hypertension (11). Early IF may reduce systolic and diastolic blood pressure in obese guys with prediabetes without resulting in weight loss. This improvement in blood pressure

is likely due to a drop in insulin levels during fasting (12). It has been shown that prolonged IF lowers the systolic and diastolic blood pressure of hypertensive individuals (13, 14). Under the same conditions, there was no discernible difference in overall blood pressure between the healthy fasting and non-fasting groups.

However, the maximal systolic velocity of the temporal short posterior ciliary artery, central retinal artery, and ophthalmic artery decreased by about 19.18, 43.60, and 13.92%, respectively (15). This decrease in blood pressure preserves normal ocular perfusion and improves ocular vascular density and structure (15).

The organism's sympathetic tone decreases and its parasympathetic tone increases during IF (16).

Parasympathetic tone declines and sympathetic nerves take control in hypertensive individuals with impaired autonomic function (17). This is because immune cells, under the influence of sympathetic nerves, create proinflammatory substances, and the brain receives this signal and increases sympathetic excitatory output (18, 19). On the other hand, sympathetic nerves can control the quantity of memory effector cells found in the body that are unique to hypertension (20). Blood pressure rises more as a result of these processes, which further constrict the body's blood vessels.

IF reduces blood pressure by peripheral blood vessel dilatation, myocardial contractility, heart rate, and pulse volume, as well as by stimulating the vagus nerve, which innervates the heart and has the opposite impact of sympathetic excitement (17). via modifying the sympathetic and parasympathetic nervous systems, IF can impact blood pressure via influencing ocular blood flow. Diabetes and other chronic metabolic diseases can potentially affect blood flow to the eye. The avascular zone at the center of the foveal center is frequently spherical or round. Around this area, neither the superficial nor deep capillary plexus has any cracks or holes. In diabetics, the superficial and deep capillary plexuses have a greater avascular zone in the central retinal notch (21).

A number of transcription factors are activated when diabetes is first developing. The retina's high levels of pro-inflammatory chemicals trigger a low-grade inflammatory response that destroys endothelium and pericytes, increases vascular permeability, dissolves the blood-retinal barrier, causes retinal edema, and progressively worsens retinal ischemia (22). Chronic hyperglycemia may exacerbate the condition by adding to the damage to the microvascular endothelium and causing oxidative stress in the body (22).

Thickness of the Retina and Frequent Fasting

The retina is the optic part of the eye, a visual sensory organ that is situated inside the choroid's inner layer. The choroid, a highly vascularized tissue located between the retina and the sclera, supplies the retina with the proper quantity of oxygen and nutrients and carries out a number of retinal-related functions (24). The retina has a rigorous self-regulatory mechanism when perfusion pressures fluctuate dramatically (26, 27), which may be why retinal thickness has not altered much during IF (25). In earlier studies on animals, similar self-regulation of retinal blood flow was noted (28). A similar phenomena occurs in the human body (29).

Unlike retinal thickening, IF can cause choroid thickening (30). The choroid's self-regulation may lead to a strong negative correlation between choroidal thickness and systolic blood pressure in the subchoroid, and IF may thicken the choroid by reducing systolic blood pressure (31, 32). Additionally, there is a connection between neuromodulation and subchoroidal thickness. In IF, choroidal thickness under the fovea increases (16, 25), cardiac blood flow reduces (33), and blood pressure lowers when parasympathetic tone rises and sympathetic tone falls. During the fasting phase, the choroidal thickness underneath the fovea increased by more than 3% compared to the non-fasting period (25).

Insulin sensitivity may affect the thickness of the choroidal layer at IF (34). The choroidal thickness is significantly reduced in patients with diabetes and diabetic retinopathy (DR) (35). The subcentral retinal recess had a roughly 37% reduction in choroidal thickness in comparison to healthy subjects,

suggesting that choroidal thickness is a very accurate early marker of DR. Therefore, it is expected that increased insulin sensitivity will have an impact on the change in choroidal thickness. Furthermore, the body has much larger quantities of nitric oxide throughout Ramadan (36). This promotion of endothelial dilatation and intravascular material leakage may be the reason of the increased choroidal thickness under the eye fossa (30).

Pressure inside the eye and sporadic fasting

IOP is the pressure that results from the interaction of the eye's contents and wall. Intraocular contents include the lens, vitreous humor, and aqueous humor; the aqueous humor greatly affects intraocular pressure. It is necessary to balance aqueous intake and outflow in order to maintain normal IOP. It is possible to prevent aqueous humor return and increase intraocular pressure by any factor that interferes with the regular functioning of the aqueous humor circulation route.

Intermittent Fasting and Biological Factors

Among the tissues in front of the lens are the anterior chamber, posterior chamber, atrial angle, lens suspensory ligament, conjunctiva, tear film, and others. The criteria that are commonly used in clinical practice are anterior chamber volume, corneal curvature, central corneal thickness (CCT), and AC depth. These standards are essential for eye disease screening and diagnosis in clinical practice. Intermittent fasting alters anterior chamber volume and depth, mostly due to dehydration. This fluctuation may be seen at various times during the fasting period, as well as in the fasting and non-fasting groups. The axial length and anterior chamber depth of the fasted group were much less than those of the non-fasting group.

Furthermore, during IF, the depth and volume of the anterior chamber changed during the day. According to Nowroozzadeh et al., anterior chamber depth increased by more than 26% during Ramadan compared to non-fasting periods. Anterior chamber depth values were greater in the morning than in the evening ($P = 0.01$), despite no discernible change in the eyes' axial length. Other studies have also been conducted

with similar results. Furthermore, it is hypothesized that IF may change the magnitude of anterior chamber depth via affecting IOP since anterior chamber depth and IOP are interrelated, with deeper anterior chamber depth being linked to lower IOP.

Retinopathy in Diabetics with Periodic Fasting

Nowadays, one of the main causes of visual impairment and blindness in adults is diabetic retinopathy (DR), one of the microvascular effects of diabetes. Pathogenic alterations include retinal inflammation, aberrant neovascularization, retinal ischemia, increased vascular permeability, and abnormalities of neurons and glia. At the moment, the primary therapies for DR are retinal laser photocoagulation, vitrectomy, and vitreous cavity injection. Because it is still unable to control the illness, this therapy is mostly used on patients with advanced DR, even though early prevention relies on dietary and lifestyle modifications to stop the disease from getting worse.

Fasting Intermittently Inhibits Abnormal Capillary Neogenesis in Diabetic Retinopathy

Abnormal callogenesis, disruption of the blood-retinal barrier, and decrease or loss of pericytes are important indicators of early DR. A stromal sheath envelops the endothelial cells of pericytes and retinal capillaries. Hypoxia, the production of late glycation end products, hypertension, and hyperglycemia may all impair the barrier function between pericytes and endothelial cells. Consequently, endothelial cells may generate additional capillaries because of a lack of proliferative control, and pericytes may experience death. Capillary degeneration brought on by a decrease in the ratio of pericytes to capillary endothelial cells in DR may make hypoxia worse. Furthermore, elevated levels of the intercellular adhesion factor ICAM-1 and vascular VCAM-1 result from the activation of the NF- κ B pathway, both of which support aberrant angiogenesis. By reducing blood glucose and inhibiting the synthesis of proinflammatory molecules, IF can enhance retinal microcirculation and decrease retinal neovascularization (22). The research above suggests that

IF, which has anti-inflammatory and anti-vascularization qualities, may soon be utilized as an adjuvant to treat DR.

Periodic Fasting and Inflammation of the Ocular Surface

Both the frequency and length of eye usage, as well as the prevalence of disorders affecting the ocular surface, have increased dramatically in modern culture. The main features of dry eye, a multifactorial ocular surface disease marked by an inability to maintain tear film homeostasis, are increased tear osmolarity, increased tear film instability, and the emergence of ocular surface inflammation. Since almost half of those with type 2 diabetes have symptoms, diabetes is a systemic risk factor for dry eye. Prolonged hyperglycemia directly damages the corneal epithelium, resulting in corneal ulcers and chronic corneal epithelial abnormalities. A vicious cycle is created when elevated tear osmolarity brought on by hyperglycemia causes mucin denaturation, reduced tear film stability, and then another rise in osmolarity.

Apart from directly harming the epithelium, hyperglycemia also lowers mucin, tear film stability, and conjunctival goblet cell density. The integrity of the corneal barrier is compromised, corneal sensitivity is decreased, ocular surface gland production and blink frequency are decreased, and dry eye development is accelerated because to the damage that hyperglycemia can do to corneal neurons and disrupt neurotrophic function.

Intermittent Fasting and its relation with Glaucoma

Glaucoma is the most prevalent neurological condition in the world. It is a progressive visual neuropathy that results in the death of retinal ganglion cells, which leads to permanent blindness. Pathologically high intraocular pressure is a significant glaucoma risk factor. While a tiny number of glaucoma cases are brought on by excessive aqueous humor production, the majority are brought on by limited aqueous outflows, such as trabecular sclerosis and constriction or even closure of the anterior chamber angle. A disturbance of the dynamic balance of the aqueous circulation results in glaucoma. Elevated IOP damages the visual nerve in two ways: mechanical compression and optic nerve ischemia. The

longer the increase in IOP, the more severe the deterioration in visual function. The primary objective of contemporary glaucoma therapy is still to lower IOP.

In conclusion

Intermittent fasting helps prevent the beginning of some eye disorders by improving the local environment surrounding the eyes and the body's metabolism. IF affects the availability of nutrients. Inadequate food intake triggers the body's glucose-ketogenic metabolic shift. Large levels of endogenous ketone bodies take the role of glucose, an essential energy source for the brain, muscles, eyes, and other organs. On the one hand, IF reduces the neurovascular harm brought on by consistently high blood sugar. Ketone bodies, on the other hand, work better as a fuel to reduce oxidative stress and inflammation in the eyes. A shift in nutritional status results in a drop in insulin and leptin and an increase in hormones related to metabolism, such as ghrelin and adiponectin.

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