IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.67
Volume 5, Issue 8, March 2025

A Review on Diabetic Retinopathy

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Abstract: *Diabetic Retinopathy is a vascular microvascular complaint also called diabetic eye complaint caused by microangiopathy leading to progressive damage of the retina and blindness. The uncontrolled blood glycemic position or sugar position results in diabetic retinopathy. There are two stages of diabetic retinopathy proliferative diabetic retinopathy and nonproliferative diabetic retinopathy. Symptoms of diabetic retinopathy constantly have no early warning signs, indeed muscular edema, which can beget rapid-fire- fire vision loss. Macular edema in which the blood vessels leak can also do at any stage of diabetic retinopathy. Symptoms are darkened or distorted images and blurred vision that are n't the same in both eyes. This review study primarily discusses the pathophysiology, genetics, and ALR, ages, VEGF, EPO, and eNOS involved in diabetic retinopathyThe longer a person has diabetes, the advanced their trouble of developing some optic problems. During gravidity, diabetic retinopathy may also be a problem for women with diabetes. NIH are recommends that all pregnant women with diabetes have an overall eye examination. opinion of diabetic retinopathy is made during an eye examination that comprises ophthalmoscopy or fundus photography, and glow- in angiography for Fundus. also, we present a review of the current perceptivity into pathophysiology in diabetic retinopathy, as well as clinical treatments for diabetic retinopathy cases. new laboratory findings and related clinical trials are also analysed.*

Keywords: Diabetes mellitus, diabetic retinopathy, retina, PHARMACOLOGICAL TARGETS

I. INTRODUCTION

Diabetic retinopathy(DR) involves microaneurysms or worse lesions affecting at least a single eye. It's one of the most pervasive secondary microvascular complication natural in diabetes mellitus(DM), induced by leakage from breakdown of the inner blood – retinal barricade and microvascular occlusion. DR plays a vital part in blindness and vision impairment in the working- class population(aged 20 – 65 times) worldwide. A total of 2.6 of global blindness is a attendant of hyperglycemia. In South Asian developing countries, DR is occasional(19.9) compared to the advanced European homes(45.7). Within South Asia, depending on salutary patterns and life variations, the communal population is more susceptible to DR than the suburban or pastoral communities. On the other hand, several epidemiologic studies suggest that DR is more current in immature individualities with type 1 rather than type 2 DM and therefore presents a substantial burden to the socio- economy due its goods on working- progressed individualities DR is nearly asymptomatic; veritably many visual or ophthalmic symptoms are noticed before complete blindness. Its pathogenesis is also not certain, although some studies have demonstrated a significantco-relation with sleep apnea,post-translational emendations of histones within chromatins, and methylation of DNA andnon-coding RNAs. Some specified risk factors for DR include hyperglycemia, hypertension, obesity, age, sex, race, and genetics.

Hence, following a healthy diet as well as maintaining blood pressure and glucose within the normal range is likely to delay the birth and progression of the complaint. DR is a progressive health challenge, but forestallment is possible, and bettered knowledge about the introductory mechanisms of the complaint and its early discovery could minimize vision loss. This review aims to epitomize the epidemiology, threat factors, operation, and pharmacological intervention of diabetic retinopathy.

II. MECHANISM OF DIABETIC RETINOPATHY AND CLASSIFICATION

DR has been classified as the most generally being major secondary complication in individualities diagnosed with DM. It has also been classified as the most provedmicrovascular trouble to diabetic cases.

ISSN 2581-9429 IJARSCT
DOI: 10.48175/IJARSCT-24521

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A lack of opinion or timely remedial intervention could affect in visual impairment, partial blindness, and ophthalmic complications beyond these goods. therefore, understanding the mechanisms involved in DR is of great significance in order to insure the proper opinion, assessment, and treatment of this complaint.

Depending on the pathophysiology of microvascularaneurysms,pre-retinal vascularization, retinal hemorrhages, intraretinalmicrovascular abnormalities(IRMA)(Figure 1), and other clinical patterns, DR can be discerned into two major classes, videlicet, PDR and NPDR. PDR primarily begins with the abnormal growth of stringy connective towel on the retinal face, whereas NPDR occurs due to lesions inside the retinal capillaries performing from edema, hemorrhage, microaneurysms of the blood vessels, and/ or capillary blockage.(Figure 1).

In addition, patient DME as well as vascular leakage causes the conformation of hard exudates at the core of the macula(Figure 1). These patterns can range from mild to severe, depending upon the onset and duration of the complications.

Multiple types of exploration have been conducted and are ongoing, yet the pathological medium of DR remains unclear as a result of the absence of retinal samples of creatures and the attainability of mortal samples.

In DR conformation pattern of different intercessors including cytokines, growth factors, coagulation factors, neurotrophic factors, vasoactive agents, and seditious intercessors are affected due to metabolite disturbances therefore can be used as remedial targets.

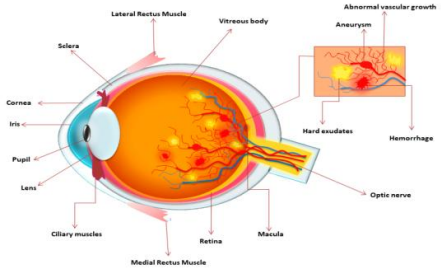

Figure 1. Different pathological complications in diabetic retinopathy: Anatomy of complications faced such as retinal vessel hemorrhage and microaneurysms, abnormal vascular development on the retinal surface, and the accumulation of yellowish thick fluids towards the middle of the retina results in edema formation.

Hyperglycaemia in Diabetic Retinopathy

Hyperglycemia is a clinical incarnation in diabetes and refers to an escalated position of blood glucose due to an insufficiency of insulin. An escalated glucose positioncausesnon-enzymatic glycosylation that causes an increase of complexcross-linked substances known as advanced glycation end products(AGE). AGE conformation leads to multitudinous secondary complications, for illustration, the addition of intracellular reactive oxygen species(ROS), which causes oxidative- stress- convinced damage to retinal cells. In addition, the raising product of AGE have shown reduction in standard mRNA situations of color epithelium- deduced factor(PEDF), which coherently initiates inflammation and damage inside the microvascular endothelial cells of the retina since PEDF has a defensive part. This contemporaneously triggers the enzyme complex nicotinamide adenine dinucleotide phosphate(NADPH) oxidase and nuclear factor- B(NF- kB), leading to inflammation and cells damage. The inflammation caused in the vessels includes the conditioning of biomolecules similar as lipoprotein- PLA2, secretory phospholipase A2 IIA, andpro-inflammatory cytokines(TNF- α and IL- 1β). also, the elevation in glucose situations activates the metabolic polyol pathway, which in hyperglycemic conditions causes the product of sorbitol from glucose with the cofactor NADPH. Sorbitol is accordingly metabolized to fructose by sorbitol dehydrogenase using the cofactor NAD and the response is regulated by an enzyme called aldose reductase.

Due to its hydrophilic characteristics, hyperproduction of sorbitol does damage to retinal cells by causing an intracellular bibulous imbalance. likewise, the metabolism of fructose produces its glycosylating derivations 3-

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deoxyglucosone and fructose-3-phosphate, which latterly escalates oxidative stress at the pericytes and other retinal cells via the creation of AGE.

It's apparent from the previous literature that the induction of oxidative stress, compromising the retinal cells, is a direct pathway for hyperglycemia to develop into DR. This adding oxidative stress causes the loss of neuronal and pericyte cells, performing in blocked capillaries. The blocked capillaries and increased number of blood vessels beget deformation and distortion of the microvascular structure of the retina. The degeneration of pericyte cells starts with the progressive stimulation of PKC- 8 signaling, caused by elevated blood glucose situations. The signaling swell stimulates the expression of protein kinase C- 6(PKC- 8, decoded by Prkcd) and p38 mitogen- actuated protein kinase, and causes dephosphorylation of PDGF receptors and declines its downstream signaling and therefore results in the tone- intermediated death of the cells of the pericytes. In hyperglycemic situations, the elevated glucose situations beget a flux in the glycolytic pathway, which latterly escalates intracellular NADH situations, giving contemporaneous rise in the tricarboxylic acid cycle, and the rates of lactate to pyruvate in the towel. This response progresses into an affluence of inordinate electrons into the mitochondria that impact the conformation of reactive oxygen species, again leading to retinal oxidative stress. This causes DNA metabolism that potentiates the nuclear enzyme PARP(poly- adenosine diphosphate- ribose polymerase) and the emphasis of NF- kB activation, which enhances the conformation of excrescence necrosis factor- a(TNF- a) and NF- kB-dependent genes, producing an exacerbation in oxidative stress. Controlled exploration conducted on galactosemic canine models, illustrated significant fleck and spot hemorrhages and retinal vascular aneurysms following the incarnation of retinopathy. still, the rear action of extreme damage generally caused to the microvascular retinal cells can not be fluently done, indeed with largely ferocious treatment and effective glycemic control.

Malfunction of Insulin Signaling in Retinopathy

The peptide anabolic hormone, insulin has a major influence on the immersion of different macromolecules, similar as adipose acids, carbohydrates, proteins, etc., in the cells. Insulin equally interacts with glucagon to regulate glucose metabolism in the liver. These responses are intermediated by the signal transduction pathway. The blood – retina hedge acts naturally furnishing vulnerable honor to the eye; therefore, at the physiological standard position of insulin the transport medium across this hedge works potently. still, with abnormal coagulation or a lack of insulin, this medium is disintegrated. The results of exploration conducted on exsanguinated creatures to examine insulin transport situations suggested a decline in the transport rate of insulin as the physiological function of glial, neuronal, and vascular cells of the retina were disintegrated. still, the exact pathway in which the medium of transport is compromised has not entirely been illustrated but some presumptive causes have been proposed. Recent examinations have set up that activation of the insulin receptor in retinal microvascular cells has various goods analogous as imbrication of insulin receptor, insulin receptor substrate- 1(IRS- 1), phosphatidylinositol 3- kinase(PI3K), and phosphotyrosine in neuronal cells of rats. Since the insulin signaling pathway is regulated by various proteins, different IR subsets are likely to gesture differently than the below- mentioned routes. Another study, conducted on hyperglycemic rats showed an increase in insulin receptor situations in the cells of the retina. thus, it's apparent that there is a correlation of insulin position with retinopathy; still, further disquisition needs to be conducted to interpret the medium.

Risk Factors of Diabetic Retinopathy

Diabetic retinopathy(DR) is a diabetes- related eye complaint that affects the blood vessels of the retina, leading to implicit vision impairment and blindness if left undressed. Several threat factors contribute to the development and progression of diabetic retinopathy. These factors can be astronomically distributed into adjustable andnon-modifiable orders. The threat of diabetic retinopathy is told by both adjustable andnon-modifiable factors. While some threat factors, like inheritable predilection and age, can not be controlled, individualities with diabetes can manage numerous aspects of their health to lower their threat of developing diabetic retinopathy through careful monitoring and life

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variations. Beforehand discovery and intervention are critical for precluding vision loss associated with diabetic retinopathy.

1. Duration of Diabetes

Increased duration of diabetes is one of the most significant risk factors for diabetic retinopathy. The longer someone has diabetes (both type 1 and type 2), the higher the likelihood of developing DR. This is due to the chronic exposure of the retina's blood vessels to high blood sugar levels, which can damage them over time.

Type 1 Diabetes: Retinopathy tends to develop after 5–10 years of diabetes.

Type 2 Diabetes: Retinopathy can occur even at the time of diagnosis, as some people may have had undiagnosed diabetes for many years before being diagnosed.

2. Poor Blood Sugar Control (Hyperglycemia)

Consistently **high blood glucose (sugar) levels** can damage the small blood vessels in the retina, leading to diabetic retinopathy. **Poor glycemic control** is a significant risk factor for both the development and progression of DR.

Studies, such as the Diabetes Control and Complications Trial (DCCT), have shown that tight control of blood glucose reduces the risk and slows the progression of diabetic retinopathy.

3. High Blood Pressure (Hypertension)

Hypertension or high blood pressure accelerates the damage to the retinal blood vessels. It can lead to increased pressure in the blood vessels of the eye, which can exacerbate the effects of high blood sugar.

People with both diabetes and hypertension are at significantly greater risk of developing diabetic retinopathy, and controlling blood pressure is crucial in preventing progression.

4. High Cholesterol and Dyslipidemia

High levels of **cholesterol** and other lipids (fats) in the blood (dyslipidemia) can contribute to the development of diabetic retinopathy. Elevated cholesterol levels may promote inflammation in the blood vessels, making them more susceptible to damage.

Cholesterol levels are an important factor to control for diabetes patients, as lowering cholesterol may help reduce the risk of DR.

5. Obesity and Poor Lifestyle Choices

Obesity can worsen insulin resistance and increase the risk of both type 2 diabetes and diabetic retinopathy. A diet high in unhealthy fats and sugars, along with sedentary behavior, can worsen blood sugar control and hypertension, thus exacerbating the risk of DR.

Maintaining a healthy weight and engaging in regular physical activity can significantly reduce the risk of diabetic retinopathy.

6. Pregnancy

Pregnancy in women with diabetes (particularly those with preexisting diabetes) can increase the risk of diabetic retinopathy, especially if the woman is unable to maintain good blood glucose control during pregnancy. This condition is called **pregnancy-induced diabetic retinopathy**.

Pregnant women with diabetes should be closely monitored to detect any early signs of retinopathy, and blood sugar levels should be tightly controlled.

7. Ethnicity

Certain ethnic groups have a higher predisposition to developing diabetic retinopathy. For instance:

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African Americans, **Hispanics**, and **Native Americans** have been shown to have a higher prevalence of diabetic retinopathy compared to **Caucasians**.
These ethnic groups often experience higher rates of diabetes and may face other socioeconomic factors that contribute to the development of DR.

8. Age
Older adults are at greater risk for developing diabetic retinopathy, largely due to the longer duration of diabetes and the cumulative effects of aging on vascular health. Older people are also more likely to have comorbidities, such as hypertension or hyperlipidemia, which further increase the risk.

9. Gender
Some studies suggest that **males** may have a slightly higher risk of developing diabetic retinopathy compared to females, though this may be due to other factors like poorer glycemic control or other health-related issues.

10. Kidney Disease (Nephropathy)
Diabetic nephropathy, or kidney disease due to diabetes, is often associated with diabetic retinopathy. Both conditions are related to the damage of small blood vessels in the body, and their presence often indicates systemic vascular issues. People with both diabetic retinopathy and nephropathy are at greater risk of developing complications like vision loss.

11. Smoking
Smoking is a modifiable risk factor for diabetic retinopathy. The harmful substances in tobacco smoke can damage blood vessels, reduce blood flow to the retina, and make it harder for the body to control blood sugar levels, all of which contribute to an increased risk of DR.
Smoking cessation can reduce the risk of diabetic retinopathy and other diabetes-related complications.

12. Genetic Factors
Genetic predisposition plays a role in the development and progression of diabetic retinopathy. People with a family history of diabetic retinopathy may be at increased risk, although this is often influenced by other modifiable factors like blood sugar control and hypertension.

13. Presence of Macular Edema or Retinal Vein Occlusion
Macular edema, which occurs when fluid accumulates in the macula (the part of the retina responsible for central vision), is a common complication of diabetic retinopathy.
Additionally, retinal vein occlusion (blockage of a vein in the retina) can occur in individuals with diabetic retinopathy, leading to further vision problems.

14. Psychological Stress
While not a direct cause, psychological stress may exacerbate the progression of diabetic retinopathy by negatively affecting blood sugar levels, increasing inflammation, and contributing to poor lifestyle habits (e.g., poor diet, lack of physical activity). Managing stress through techniques such as mindfulness and relaxation exercises can help improve overall health.

Preventive Measures:

- ***Routine eye exams***: People with diabetes should have annual dilated eye exams to detect early signs of diabetic retinopathy.
- ***Blood sugar management***: Tight control of blood glucose levels is crucial in preventing DR.

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- ***Control of blood pressure and cholesterol***: Medications, diet, and exercise to maintain healthy blood pressure and cholesterol levels can help prevent the onset and progression of retinopathy.
- ***Smoking cessation***: Quitting smoking can significantly reduce the risk of complications from diabetes, including DR.

Genetic Risk Factors of Retinopathy

In agreement with colorful binary studies, DR is classified as a polygenic complaint that's genetically inherited, with experimenters having discovered an egregious domestic clustering. DRandPDRarefoundto be 27and52heritable, independently. Studies have shown that a family history of DR increased the threat of DR among individualities by nearly two to triple. The circumstance of diabetic retinopathy is also told by race according to theMulti-Ethnic Study of Atherosclerosis(MESA) which reported frequence rates of 36.7 in African Americans, 37.4 in Hispanics, 24.8 in whites, and 25.7 in Chinese- Americans. Asub-linkage analysis for DR was conducted in Pima Indians among individualities with T2D(type 2 diabetes) and set up a faint possibility of a relation at chromosomes 3 and 9 with LOD(logarithm of the odds) scores of 1.36 and 1.46, re spectively. A genome-wide meta- analysis linked a close association between the intergenic SNP(single- nucleotide polymorphism) rs476141 and DR. still, the results werenotconsistent with the Wisconsin Epidemiologic Study of Diabetic Retinopathy, which rather linked that in the gene CEP125, an intronic SNP at rs4865047 has a implicit relation with DR. also, several relation analyses, seeker gene association superstudies, and genome-wide association studies(GWAS) have proposed a many possible inheritable variants similar as the ALR2(aldose reductase), VEGF and RAGE(receptor for advanced glycation end-products) genes. still, the loci which act as threat factors in DR have n't yet been discovered.

III. PHARMACOLOGICAL TARGETS AND FUTURE PERSPECTIVES

Diabetic retinopathy can be treated pharmacologically in multiple ways. High blood glucose situations beget significant changes in cellular metabolisms, similar as endothelial dys function, which starts the morphological process of diabetic retinopathy. numerous diabetic cases suffer from DR, which can lead to a variety of other serious ails, taking ray photocoagulation treatment, as well as the operation of blood glucose situations and blood pressure. Pharmacologically, the metabolic damage caused by habitualhyperglycemia can be significantly impacted, although not inescapably restored, with colorful drug groups now under development. As a result, tight glycemic operation, together with an effective ophthalmologic discovery and follow- up program in diabetic cases, is a critical step in avoiding the onset or progression of DR. Antiplatelet medicines have been shown to decelerate the elaboration of diabetic retinopathy in its early stages, including a dropped degree of microaneurysms, suggesting that endothelial dysfunction is intertwined. still, a new strategy for regulating endothelial dysfunction, substantially through the use of VEGF impediments, appears to be promising. These medicines might be particularly salutary in the treatment of PDR. Antioxidant drugs and impediments of the development of advanced glycation end- products have also had positive issues. Along with significant fi nancial and societal consequences, DR affects cases psychologically as well. Taking this into account, scientists are working hard to develop remedy for DR. The polyol pathway, advanced glycation end-products, protein kinase C, and oxidative stress have all been intertwined in the development of DR, and multitudinous remedial studies have also been accepted to assess the effectiveness of colorful specifics. Recent results also show that DRhasfeatures related with habitual seditious and neurological complaint, adding the possibility of pharmaceutical operation.

Due to its multifactorial nature, DR is a complicated optical condition. The main remedial challenge is to find a drug that can target several pathways intertwined in DRdevelopment. DR can be distributed as the vascular degeneration of the retina and mitochondrial dysfunction. The restoration of mitochondrial exertion and normalization of vascular degeneration is a feasible remedial strategy for managing complaint progression. Continued studies in this area will clearly yield new perceptivity into the forestallment and treatment of DR.

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IV. CONCLUSIONS

The possibility of circumstance of diabetic retinopathy in individualities continues to escalate at a significant rate. still, exploration is on going to seize the underpinning pathophysiology. This review discusses several mechanisms and prospective remedial targets to intermediate in retinopathy progression. Despite a many limitations, the current operation of DR, including glycemic control, control in blood pressure situations, use ofanti-inflammatory corticosteroids, and focal ray treatment, have proven to be salutary in the antedating exploration. nonetheless, specifics similar as AGE impediments, antiplatelet and antioxidant drugs, and others have shown implicit as well. farther exploration is needed to overcome the downsides and develop effective treatments with reduced side goods.

REFERENCES

[1]. Maurya, R.P. Diabetic retinopathy: My brief synopsis. Indian J. Clin. Exp. Ophthalmol. 2015, 1, 189–190.
[2]. Song, P.; Yu, J.; Chan, K.Y.; Theodoratou, E.; Rudan, I. Prevalence, risk factors and burden of diabetic retinopathy in China: A systematic review and meta-analysis. J. Glob. Health 2018, 8, 010803.
[3]. Watkins, P.J. Retinopathy. Br. Med. J. 2003, 326, 924–926.
[4]. Fowler, M.J. Microvascular and macrovascular complications of diabetes. Clin. Diabetes 2008, 26, 77–82.
[5]. Porta, M.; Bandello, F. Diabetic retinopathy. Diabetologia 2002, 45, 1617–1634.
[6]. Fong, D.S.; Aiello, L.; Gardner, T.W.; King, G.L.; Blankenship, G.; Cavallerano, J.D.; Ferris, F.L.; Klein, R. Retinopathy in diabetes. Diabetes Care 2004, 27, s84–s87.
[7]. Stitt, A.W.; Curtis, T.M.; Chen, M.; Medina, R.J.; McKay, G.J.; Jenkins, A.; Gardiner, T.A.; Lyons, T.J.; Hammes, H.P.; Simo, R.; et al. The progress in understanding and treatment of diabetic retinopathy. Prog. Retin. Eye Res. 2016, 51, 156–186.
[8]. Raman, R.; Gella, L.; Srinivasan, S.; Sharma, T. Diabetic retinopathy: An epidemic at home and around the world. Indian J. Ophthalmol. 2016, 64, 69.
[9]. Aiello, L.M. Perspectives on diabetic retinopathy. Am. J. Ophthalmol. 2003, 136, 122–135.
[10]. Wang,W.; Lo, A. Diabetic Retinopathy: Pathophysiology and Treatments. Int. J. Mol. Sci. 2018, 19, 1816.
[11]. Madsen-Bouterse, S.A.; Kowluru, R.A. Oxidative stress and diabetic retinopathy: Pathophysiological mechanisms and treatment perspectives. Rev. Endocr. Metab. Disord. 2008, 9, 315–327.
[12]. Duh, E.J.; Sun, J.K.; Stitt, A.W. Diabetic retinopathy: Current understanding, mechanisms, and treatment strategies. J. Clin. Investig. 2017, 2, e93751.
[13]. Shani, M.; Eviatar, T.; Komaneshter, D.; Vinker, S. Diabetic Retinopathy–Incidence and Risk Factors in A Community Setting- A Longitudinal Study. Scand. J. Prim. Health Care 2018, 36, 237–241.
[14]. Davidson, J.A.; Ciulla, T.A.; McGill, J.B.; Kles, K.A.; Anderson, P.W. How the diabetic eye loses vision. Endocrine 2007, 32, 107–116.
[15]. Ola, M.S.; Nawaz, M.I.; Siddiquei, M.M.; Al-Amro, S.; Abu El-Asrar, A.M. Recent advances in understanding the biochemical and molecular mechanism of diabetic retinopathy. J. Diabetes Complicat. 2012, 26, 56–64.
[16]. Yamagishi, S.; Matsui, T.; Inoue, H. Inhibition by advanced glycation end products (AGEs) of pigment epithelium-derived factor (PEDF) gene expression in microvascular endothelial cells. Drugs Exp. Clin. Res. 2005, 31, 227–232.
[17]. Yamagishi, S.; Matsui, T.; Nakamura, K.; Takeuchi, M.; Imaizumi, T. Pigment epithelium-derived factor (PEDF) prevents diabetes or advanced glycation end products (AGE)-elicited retinal leukocytosis. Microvasc. Res. 2006, 72, 86–90.
[18]. Yamagishi, S.; Matsui, T. Advanced Glycation End Products (AGEs), Oxidative Stress and Diabetic Retinopathy. Curr. Pharm. Biotechnol. 2011, 12, 362–368.

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DOI: 10.48175/IJARSCT-24521

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International Journal of Advanced Research in Science, Communication and Technology
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Impact Factor: 7.67
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[19]. Ibrahim, A.S.; El-Remessy, A.B.; Matragoon, S.; Zhang, W.; Patel, Y.; Khan, S.; Al Gayyer, M.M.; El-Shishtawy, M.M.; Liou, G.I. Retinal Microglial Activation and Inflammation Induced by Amadori-Glycated Albumin in a Rat Model of Diabetes. Diabetes 2011, 60, 1122–1133.

[20]. Calderon, G.; Juarez, O.; Hernandez, G.; Punzo, S.; De la Cruz, Z. Oxidative stress and diabetic retinopathy: Development and treatment. Eye 2007, 31, 1122–1130.

[21]. Lorenzi, M. The Polyol Pathway as a Mechanism for Diabetic Retinopathy: Attractive, Elusive, and Resilient. Exp. Diabetes Res. 2007, 2007, 1–10.

[22]. VandenEnden,M.K.;Nyengaard,J.R.; Ostrow, E.; Burgan, J.H.; Williamson, J.R. Elevated glucose levels increase retinal glycolysis and sorbitol pathway metabolism, Implications for diabetic retinopathy. Investig. Ophthalmol. Vis. Sci. 1995, 36, 1675–1685.

[23]. Steinmetz, P.R.; Balko, C.; Gabbay, K.H. The Sorbitol Pathway and the Complications of Diabetes. N. Engl. J. Med. 1973, 288, 831–836.

[24]. Szwergold, B.; Kappler, F.; Brown, T. Identification of fructose 3-phosphate in the lens of diabetic rats. Science 1990, 247, 451–454.

[25]. Gonzalez, R.G.; Miglior, S.; Von Saltza, I.; Buckley, L.; Neuringer, J.; Cheng, H.-M. 31P NMR studies of the diabetic lens. Magn. Reson. Med. 1988, 435–444.

[26]. Ido, Y.; Kilo, C.; Williamson, J.R. Cytosolic NADH/NAD+, free radicals, and vascular dysfunction in early diabetes mellitus. Diabetologia 1997, 40, S115–S117.

[27]. Drel, V.R.; Xu, W.; Zhang, J.; Kador, P.F.; Ali, T.K.; Shin, J.; Julius, U.; Slusher, B.; El-Remessy, A.B.; Obrosova, I.G. Poly (ADP Ribose) Polymerase Inhibition Counteracts Cataract Formation and Early Retinal Changes in Streptozotocin-Diabetic Rats. Investig. Ophthalmol. Vis. Sci. 2009, 50, 1778.

[28]. Engerman, R.L.; Kern, T.S. Hyperglycemia as a cause of diabetic retinopathy. Metabolism 1986, 35, 20–23.

[29]. Holman, R.R.; Paul, S.K.; Bethel, M.A.; Matthews, D.R.; Neil, H.A.W. 10-year follow-up of intensive glucose control in type 2 diabetes. N. Engl. J. Med. 2008, 359, 1577–1589.

[30]. Reiter, C. Functions of insulin and insulin receptor signaling in retina: Possible implications for diabetic retinopathy. Prog. Retin. Eye Res. 2003, 22, 545–562.

[31]. Ferguson, T.A.; Griffith, T.S. A vision of cell death: Insights into immune privilege. Immunol. Rev. 1997, 156, 167–184.

[32]. James, C.R.; Cotlier, E. Fate of insulin in the retina: An autoradiographic study. Br. J. Ophthalmol. 1983, 67, 80–88. [CrossRef]

[33]. Folli, F.; Bonfanti, L.; Renard, E.; Kahn, C.; Merighi, A. Insulin receptor substrate-1 (IRS-1) distribution in the rat central nervous system. J. Neurosci. 1994, 14, 6412–6422. [CrossRef]

[34]. Baskin, D.G.; Sipols, A.J.; Schwartz, M.W.; White, M.F. Immunocytochemical detection of insulin receptor substrate-1 (IRS-1) in rat brain: Colocalization with phosphotyrosine. Regul. Pept. 1993, 48, 257–266. [CrossRef]

[35]. Zetterstrom, C.; Benjamin, A.; Rosenzweig, S.A. Differential Expression of Retinal Insulin Receptors in STZ-Induced Diabetic Rats. Diabetes 1992, 41, 818–825. [CrossRef]

[36]. Gardner, T.W.; Antonetti, D.A.; Barber, A.J.; Lanoue, K.F.; Nakamura, M. New insights into the pathophysiology of diabetic retinopathy: Potential cell-specific therapeutic targets. Diabetes Technol. Ther. 2000, 2, 601–608. [CrossRef]

[37]. Lechner, J.; O'Leary, O.E.; Stitt, A.W. The pathology associated with diabetic retinopathy. Vis. Res. 2017, 139, 7–14. [CrossRef]

[38]. Ciulla, T.A.; Amador, A.G.; Zinman, B. Diabetic retinopathy and diabetic macular edema: Pathophysiology, screening, and novel therapies. Diabetes Care 2003, 26, 2653–2664. [CrossRef]

[39]. American Diabetes Association. Diagnosis and classification of diabetes mellitus. Diabetes Care 2010, 33, S62–S69. [CrossRef]

ISSN 2581-9429 IJARSCT

DOI: 10.48175/IJARSCT-24521

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.67
Volume 5, Issue 8, March 2025

[40]. Jonas, J.B.; Sabanayagam, C. Epidemiology and Risk Factors for Diabetic Retinopathy. Front. Diabetes 2019, 27, 20–37. [CrossRef]

[41]. Chua,J.; Lim, C.X.Y.; Wong, T.Y.; Sabanayagam, C. Diabetic retinopathy in the Asia-Pacific. Asia-Pac. J. Ophthalmol. 2018, 7, 3–16.

ISSN 2581-9429 IJARSCT

DOI: 10.48175/IJARSCT-24521