CHAPTER 1

INTRODUCTION TO DIABETIC RETINOPATHY

1.1 BACKGROUND

Proneness to ill health and a better life expectancy have prima facie, a direct relationship, with being inversely proportional, the mitigation of the former leading to the latter. The aging process is a natural link between these. Diabetes, a metabolic disease, tops the list of afflictions for humanity. The rapid spread of this deficiency is causing great concern for those involved in health care, posing difficult challenges in mitigation rather than elimination. The number of persons who develop this affliction is rising at an alarming rate. The International Diabetic Federation estimates the number at more than 345 millions across the globe [1]. The World Health Organization warns that this figure will escalate to 600 million in the next 25 years [2]. The highest number of diabetic patients (41 million) is in India [1]. This is aggravated by the fact that only a half of such afflicted persons are aware of the presence of the affliction in them and in the ambit of medical assistance. Consequences include micro and macro vascular transformations that lead to cardiac disorders, renal problems and retinopathy, the last one having seen with mild signs among 40 percent of the sufferers [3].

Retinopathy is seen to be the common cause leading to visual defect or blindness among working individuals [4]. Despite what appears to be satisfactory health care, individuals with diabetes developing usual defects are 25 times these who are not diabetic[5]. Diabetic retinopathy is a silent disease in the sense that its presence is not experienced till it reaches a rather advanced stage. It lies with the patient to recognize changes within the retina before they defy any benefit from medical treatment. Early diagnosis has definitely helped obviating loss of vision [6] – [8]. It is still a matter for regret that 50% of the individuals with diabetes do not undergo examination of the eye[9].Photography of the retina studied by skilled experts through screening programs has been found to be specific and sensitive in the detection of early signs of diabetic retinopathy[10],[11].
The importance of access to screening services is recognized as a retinal corollary, retinopathy can happen at any point in life, with the on-set of retinopathy aggravating the problem akin to fuel added to fire. Use of automatic computer systems has been advocated by many research teams either for directing the individual to the ophthalmologist or just a return to the screening process a year later[9],[12]-[13]. Screening ophthalmologists find facilitation in their work with a 90% success rate in the detection of diabetic retinopathy. Apart from this, there is a need to reduce the cost of such screenings. State of the art processing methods are of immense use here. They automate the process of detection of abnormalities in retinal images.

1.2 DIABETIC RETINOPATHY

The retina (shown in Figure 1.1) is the light-sensitive layer made up from distinct cells referred to cones and rods at the back of the eye. Light enters into eye and passes over the lens which intern focuses such light onto the retina. The light signals are intern converted into electrical signals, which are sent to the cerebrum through the optic nerve and the mind deciphers such signs to deliver the image. Viable and effective work triggers the need for a steady supply of blood. At some point of time, a high glucose level persisting in the system can cause thinness/ narrowness, leak or bleeding in the veins. This causes damage to the retina and disables its effective functioning. Damage to center of the retinal area caused by such blood vessels is referred to as Diabetic Maculopathy.

The Diabetic retinopathy is a micro vascular inconvenience of diabetes, bringing in anomalies in the retina, and an eventual total loss of vision or deficiency in sight. The word retinopathy refers to several disorders of the retina, which can impact vision. Retinopathy typically is caused by harm to the tiny blood vessels in the retina. It is often caused by diabetes. However, other ailments such as very high blood pressure can be the cause too. Ordinarily there are no remarkable side effects in the early phases of diabetic retinopathy, yet the number and seriousness transcendentally increment over a period. The Diabetic Retinopathy regularly starts as little changes in the retinal vessels. The primary distinguishable anomalies are
microaneurysms which are neighborhood distensions of the retinal capillary and which cause intra-retinal hemorrhage when burst [14].

![Figure 1.1 Schematic of various layers in retina](http://www.patient.co.uk/health/diabetic-retinopathy-leaflet)

**Figure 1.1 Schematic of various layers in retina**

(Courtesy: http://www.patient.co.uk/health/diabetic-retinopathy-leaflet)

1.3 RISK FACTORS

The following are some factors that can have palpable influence on the development and severity of diabetic retinopathy[14] – [15],[1]:

1.3.1 Blood sugar levels

The blood sugar level is the crucial risk factor that can affect an individual. If the blood sugar level goes down, it leads to diabetic retinopathy.

1.3.2 Blood pressure

The most important clinical experiment shows that risk of diabetic retinopathy can be mitigated by efficient control of blood pressure (BP) and aggravation of visual acuity. High BP harms the blood vessels in the retina, increase the incidence of problems in vision. The target BP for most individual with diabetes is under 130/80 mmHg.
1.3.3 Duration of diabetes

The risk of onset of Diabetic Retinopathy and its following progression aggravates in the long run. 80% of Type 1 diabetics experience development of the problem after 15 years from its occurrence, while it is 19 years for Type 2 diabetics. Individuals with diabetes of any type can experience advancing hyperglycemia which is a surplus of serum glucose in blood sugar. Despite the glucose being an important source of energy for the human cells, any alarming rise in the glucose level causes destruction with the system even with the trivial blood vessels in the eyes.

1.3.4 Blood lipid levels (cholesterol and triglycerides)

Increased blood lipid levels can result in the rapid noteworthy gathering of exudates and deposition of protein which leak into the retina. This ailment can cause an increased risk of optimal visual loss.

1.3.5 Ethnicity

Certain ethnic groups are at higher danger of diabetic retinopathy, in light of the fact that they are more prone to have diabetes. These include African Americans, Latinos and Native Americans.

1.3.6 Pregnancy

Pregnancy can result in alterations to the human visual system. In the event that an individual enduring with diabetes and gets to be pregnant, then the risk of diabetic retinopathy sensibly increments while if the individual is now enduring with diabetic retinopathy, it may advance. On the other hand, some studies aver that with treatment can help switching off the progression after delivery, with increment in the long haul movement of the affliction.

1.4 CLASSIFICATIONS

Typically, ophthalmologists perceive diabetic retinopathy as based on features like blood vessel areas, hemorrhages, exudates, micro-aneurysms and texture of the retina. Diabetic retinopathy is classified into 3 phases of non-proliferative retinopathy: (i) mild, (ii) moderate, and (iii) severe; and one phase of proliferative retinopathy [14]. Micro-aneurysms and
Hemorrhages are the initial clinically observable lesions designating diabetic retinopathy. Hence, detection of them plays a pivotal role in the diabetic retinopathy screening system.

1.4.1 Non-proliferative diabetic retinopathy

This is the most well-known kind of diabetic retinopathy that can be designated as mild-to-moderate level. The most widely recognized characteristics are signs of retinal ischemia (hemorrhages, micro-aneurysms, intra-retinal micro-vascular abnormalities, cotton wool spots and venous beading). Nonetheless, the patients may be asymptomatic and ignorant of loss of vision. The primary ophthalmologically visible signs are retinal hemorrhages, and micro-aneurysms. The micro-aneurysms are noticeable as round intra-retinal sores extending from 1 to 100 µm, red or periodically white, which may be connected with retinal thickening or intra-retinal hemorrhage. They occur widely at the posterior pole region, exclusively in the temporal area of the macula. The cotton-wool spots show up as confined whitish rises of the retinal nerve fiber layer. With substantial regions of micro-vascular dead tissues, retina appears diffusely dim. Expanded seriousness of cotton-wool spots and appearance of more spots may be connected with an expanded risk of advancement. The intra-retinal micro-vascular deformities signify either development of new vessel or re-building of pre-existing vessels through endothelial cell production in the retinal tissues. They may be seen all through the fundus as fire-formed (flame-shaped), accentuate spot or bigger blotch hemorrhages with uneven boundaries. The venous beading depicts veins with unpredictable increment in gauge.

1.4.2 Proliferative diabetic retinopathy

This type of diabetic retinopathy occurs with additional retinal ischemia. The utmost widely recognized attributes incorporates the formation of new blood vessels somewhere else and on the optic nerve, fibrous proliferation somewhere else and on the optic nerve, vitreous hemorrhage, pre-retinal and retinal detachment due to scar tissue development. For instance, the abnormal vessels of neovascularization are flimsy; the vitreous
hemorrhaging hypothetically prompting serious loss of vision is incessant. The increased pressure in the eye may harm the optic nerve.

1.5 DIAGNOSTIC METHODS

Patient clinical history should be obtained to enable diagnosis of the vision problems faced by the patients. Existence of diabetic problems as well as health problems which may distress the vision should be deliberated. Detailed eye checkup incorporates visual acuteness assessments, assessment of the visual structures, refraction, the assessment of the retina through a dilated pupil and the assessment of pressure inside the eye. The diabetic retinopathy is perfectly diagnosed by digital fundus-copy, i.e. distended indirect ophthalmoscopy tied with bio-microscopy as well as fundus photography (7-standard field) [9] – [10], [14], [16] – [17]. The diagnosis of diabetic retinopathy is based on the following measures: blood clot or fatty deposits within the retina, abnormal blood vessels, injured nerve tissue, inflammation, progress of new blood vessels / scar tissue, retinal detachment and bleeding in the vitreous [17]. An optical coherence tomography (OCT) [18] – [20] and Fluorescein angiography [21] are used to confirm the disease diagnosis, find the degree of harm, plan the treatment as well as monitoring the efficiency of the treatment. Through Fluorescein angiography, it is promising to identify and spot the leakage in the blood vessels and compromised circulation within the retina. The micro-aneurysms look like pinpoint hyper-fluorescence that do not expand, however, rather blur in the advanced phases of the assessment. The patch and dot hemorrhages look like hypo-fluorescent therefore they can be easily distinguished from micro-aneurysms. The regions of non-perfusion look like identical dark blotches bounded by obstructed blood vessels. The intra-retinal micro-vascular anomalies generally originate in the boundaries of the non-perfused retina and are confirmed by guarantee vessels that do not spill. The OCT is utilized to find out the thickness of the retina, the manifestation of retinal inflammation and vitreo-macular adhesive friction [21].