Diabetic Retinopathy (DR) on Retinal Image: A Pilot Study

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Abstracts. Eyes are part of an organ in a human which is important for vision especially retinal. Retinal images are used to detect and diagnose many diseases such as diabetes or hypertension. Diabetic retinopathy is the name given to disease of the retina due to diabetes. The eyes have to be examined by an optometrist to detect the lesion. Diabetic retinopathy symptoms may include blurred vision, difficulty reading and also vision loss. Generally, DR patients perceive no symptoms until visual loss develops which happens usually in the later disease stages when the treatment is less effective. DR is not a curable disease, but laser treatment can prevent major vision loss if detected in the early stages. In this paper, a fundamental of DR was studied included stages, causes, symptoms, and risks. This study will give the direction for a researcher in order to propose a new DR detection method.

1. Introduction

In human eye consist of three main layers of membrane that each layer performs a different function. The outer layer of the eye is defined as a fibrous tunic that composed of the cornea that admits and refracts the light, and a sclera function is to provide structure, strength and protects the inner parts of the eye [1], [2]. Otherwise, the middle membrane is known as a vascular tunic which is distributed to three components include the iris, ciliary body, and choroid. In details, the purpose of the iris is to regulate the amount of light that enters the eyeball. Meanwhile, ciliary body aqueous humor and alter the shape of the lens for near or far vision and the choroid provides blood supply and absorbs the scattered light. On the other hand, in the anatomical structure of the eye which has the inner sensory located at the innermost layer of the membrane that also called the nervous tunic [3]. This inner sensory is known as a retina which contains information and plays the vital role for the visualization in human.

In this paper, the fundamental about Diabetic Retinopathy (DR) was studied. The objective of this review is to study and explored the Diabetic Retinopathy (DR) on the retinal images such as symptoms, stages, causes, and risk. Section 2 discussed an overview of the Diabetic Retinopathy (DR). Section 2.1 and section 2.2 explained details about stages and causes. The symptoms and risks were described in section 2.3 and 2.4. Finally, section 3.0 described the conclusion of this research. Figure 1 shows the structures of the eye. The details function of the structure was described as below [2], [4];

- Conjunctiva: Supply nutrients to the cell and remove the waste product. It also acts as preventing reflection of light within the eyeball.
- Cornea: Help to maintain the shape of the anterior chamber of the eyeball.
• Sclera: Help to control the amount of light entering the eye. Enough light enters to allow a person to see.
• Iris: Just contains only cone cell. Responsible for good visual acuity. Part of the retina that is directly opposite the pupil.
• Lens: Curved structure, flexible and is transparent. The function is to focus incoming light rays.
• Retina: Acts as a suspension for the lens. Helps to maintain the shape of the posterior chamber of the eyeball.

Figure 1: Structure of eye [5].

2. Diabetic Retinopathy (DR)
The retinal is a specialized part of eye organ in a human which contains the network of blood vessels [6], [7]. In a clinical study, the retinal image is very important in diagnostic tools and helps the ophthalmologists which assist by computer-aided analysis to perform diagnosis, treatment and screening of various epidemic eye diseases, such as glaucoma, age related macular degenerative myopia and Diabetic Retinopathy (DR) [8]–[10]. All these diseases were diagnosed from the information of blood vessel which is the most crucial features in the retina. For information, the first ranking of ophthalmic pathologic that contribute to the blindness among people is Diabetic Retinopathy (DR). In 2000, the estimation of all age groups whose suffered from diabetes is 2.8% and rise up to 4.4% in 2030 thus shows the aggressively increase of 171 million in 2000 to 366 million of diabetes patient in 2030 [11], [12].

Diabetic retinopathy is one of the major eye diseases that affected the retina. This conditions caused by complications of diabetes, which can eventually lead to blindness. The abnormal blood glucose level elevation is the main cause of DR. The first manifestations of DR are tiny capillary dilations known as microaneurysms [13], [14]. On the other hand, DR advancement will cause neovascularization, macular edema and exudates and also the cotton wool spot where at the later phase causes retinal segregation. Figure 1.2 shows the differences between normal retina images with DR retina image.
2.1 Stages of Diabetic Retinopathy
Diabetic retinopathy consists of four stages. The four stages include [17]–[20]:
1. Mild Nonproliferative Retinopathy: At this earliest stage, microaneurysms occur. They are small areas of balloon-like swelling in the retina's tiny blood vessels.
2. Moderate Nonproliferative Retinopathy: As the disease progresses, some blood vessels that nourish the retina are blocked.
3. Severe Nonproliferative Retinopathy: Many more blood vessels are blocked, depriving several areas of the retina with their blood supply. These areas of the retina send signals to the body to grow new blood vessels for nourishment.
4. Proliferative Retinopathy: At this advanced stage, the signals sent by the retina for nourishment trigger the growth of new blood vessels. This condition is called proliferative retinopathy. These new blood vessels are abnormal and fragile. They grow along the retina and along the surface of the clear, vitreous gel that fills the inside of the eye. By themselves, these blood vessels do not cause symptoms or vision loss. However, they have thin, fragile walls. If they leak blood, severe vision loss and even blindness can result.

2.2 Causes of the Diabetic Retinopathy in Retinal
Besides, blood vessels damaged from diabetic retinopathy can cause vision loss in two ways [21]–[27]:
1. Fragile, abnormal blood vessels can develop and leak blood into the center of the eye, blurring vision. This is proliferative retinopathy and is the fourth and most advanced stage of the disease.
2. Fluid can leak into the center of the macula, the part of the eye where sharp, straight-ahead vision occurs. The fluid makes the macula swell, blurring vision. This condition is called macular edema. It can occur at any stage of diabetic retinopathy, although it is more likely to occur as the disease progresses. About half of the people with proliferative retinopathy also have macular edema.

2.3 Symptoms of Diabetic Retinopathy
Diabetic retinopathy often has no early warning signs. Even macular edema, which may cause vision loss more rapidly, may not have any warning signs for some time. In general, however, a person with macular edema is likely to have blurred vision, making it hard to do things like reading or drive. In some cases, the vision will get better or worse during the day.
In the first stage which is called non-proliferative diabetic retinopathy (NPDR), there are no symptoms, it is not visible to the naked eye and patients will have 20/20 vision [28], [29]. The only way to detect
NPDR is by fundus photography, in which microaneurysms can be seen. If there is reduced vision, fluorescein angiography can be done to see the back of the eye. Narrowing or blocked retinal blood vessels can be seen clearly and this is called retinal ischemia means lack of blood flow. Macular edema may occur in which blood vessels leak contents into the macular region can happen at all stages of NPDR. The macular edema symptoms are blurring, darkening or distorted images with not the same between two eyes. 10 percent of diabetic patients will get vision loss related to macular edema.

On the second stage, neovascularization form at the back of the eye as a part of proliferative diabetic retinopathy (PDR), they can burst, bleed and blur vision, because the new blood vessels are weak [30], [31]. The first time this happens, it may not be very severe. In most cases, it will leave just a few specks of blood, or spots, floating in a person's visual field, though the spots often go away after a few hours. On funduscopic exam, a doctor will see cotton wool spots, flame hemorrhages, and dot-blot hemorrhages.

2.4 Risk factors for Diabetic Retinopathy Disease

All people with diabetes mellitus are at risk, those with Type I diabetes and those with Type II diabetes [32]. The longer a person has diabetes, the higher the risk of developing some ocular problem. Between 40 to 45 percent of Americans diagnosed with diabetes have some stage of diabetic retinopathy. Several factors can influence the development and severity of diabetic retinopathy, including [33]–[35]:

1) Blood Sugar: Controlling your blood sugar is the key risk factor that you can affect. Lower blood sugar levels can delay the onset and slow the progression of diabetic retinopathy.
2) Blood Pressure: A major clinical trial demonstrated that effectively controlling blood pressure reduces the risk of retinopathy progression and visual acuity deterioration. High blood pressure damages your blood vessels, raising the chances for eye problems. Target blood pressure for most people with diabetes is less than 130/80 mmHg.
3) Duration of diabetes: The risk of developing diabetic retinopathy or having your disease progress increases over time. After 15 years, 80 percent of Type 1 patients will have diabetic retinopathy. After 19 years, up to 84 percent of patients with Type 2 diabetes will have diabetic retinopathy.
4) Blood lipid levels (cholesterol and triglycerides): Elevated blood lipid levels can lead to greater accumulation of exudates, protein deposits that leak into the retina. This condition is associated with a higher risk of moderate visual loss.
5) Ethnicity: While diabetic retinopathy can happen to anyone with diabetes, certain ethnic groups are at higher risk because they are more likely to have diabetes. These include African Americans, Latinos and Native Americans.
6) Pregnancy: Being pregnant can cause changes to your eyes. If you have diabetes and become pregnant, your risk for diabetic retinopathy increases. If you already have diabetic retinopathy, it may progress. However, some studies have suggested that with treatment these changes are reversed after you give birth and that there is no increase in long-term progression of the disease.

3. Conclusion

In the medical field, the retinal image is very important in diagnostic tools and help ophthalmologist which assist by computer-aided analysis to perform diagnosis, treatment, and screening of various epidemic eye diseases. Diabetic retinopathy is one of the major eye diseases that affected the retina. This conditions caused by complications of diabetes, which can eventually lead to blindness. DR propagation also causes neovascularization, hemorrhages, macular edema and in later stages, retinal detachment. Moreover, the vascular peculiarity is one of the DR emergencies, thus the automated segmentation of blood vessels plays a necessary part in the inspection programs for early detection of eye disease especially in the diabetic retinopathy for further diagnose and treatment.
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