

How to Cite:

Sameer, N., Saad, D., Hussein, R., Mohammed, R., & Emad, A. (2022). A comparative study between type 1 & type 2 diabetes mellitus and its effect on the retina. *International Journal of Health Sciences*, 6(S2), 6741–6757. <https://doi.org/10.53730/ijhs.v6nS2.6631>

A comparative study between type 1 & type 2 diabetes mellitus and its effect on the retina

Dr. Nidaa Sameer

Uruk University / College of Health & Medical Technology/ Department of optics

Dalia Saad

Uruk University / College of Health & Medical Technology/ Department of optics

Retaj Hussein

Uruk University / College of Health & Medical Technology/ Department of optics

Riyam Mohammed

Uruk University / College of Health & Medical Technology/ Department of optics

Athraa Emad

Uruk University / College of Health & Medical Technology/ Department of optics

Abstract---Diabetic retinopathy (DR) remains the leading cause of vision loss and blindness in people of working age, in spite of the fact that current treatments are effective. Vision loss occurs in DR due to the development of maculopathy, especially diabetic macular edema, and due to proliferative diabetic retinopathy. Vision loss due to DR is preventable with the appropriate monitoring and timely treatment. Improved patient and health professional, education to encourage tight control of blood glucose and other systemic factors, and the establishment of readily available and appropriately timed eye examinations are necessary steps to further reduce visual impairment of people with diabetes. Material & Method: In this work, the tests that we perform on diabetics will be described to see the effect of the disease on the retina. We also described the disease in a simplified manner. We conducted our tests on 40 patients suffering from retinal problems due to diabetes of all kinds. Results: There were patients with DM type I ,type II more occurring in age (>50years) and in type II more in male than female. Also there was significant different between DM types and gender group ($P < 0.05$). Also there was significant differences between I.O.P range and DM types. Patients with DM type II were more in I.O.P range ($<18\text{mmHg}$) than to have type I , while patients with DM type I were more in I.O.P range ($18\text{-}24\text{mmHg}$) than type II). Also There were significant different study group (without & with DR), DM duration and HbA1c ($p < 0.05$).

Keywords---diabetes mellitus, retina, diabetic retinopathy.

Introduction

Anatomy of the eye

Eye is an important part of overall health. It's crucial to childhood development and independent aging for adults. Most people depend on clear vision. It helps them participate in their occupation, hobbies, and even to perform most everyday tasks. If any part of your visual system is not working, or not conveying the appropriate messages to your brain, vision suffers [1].

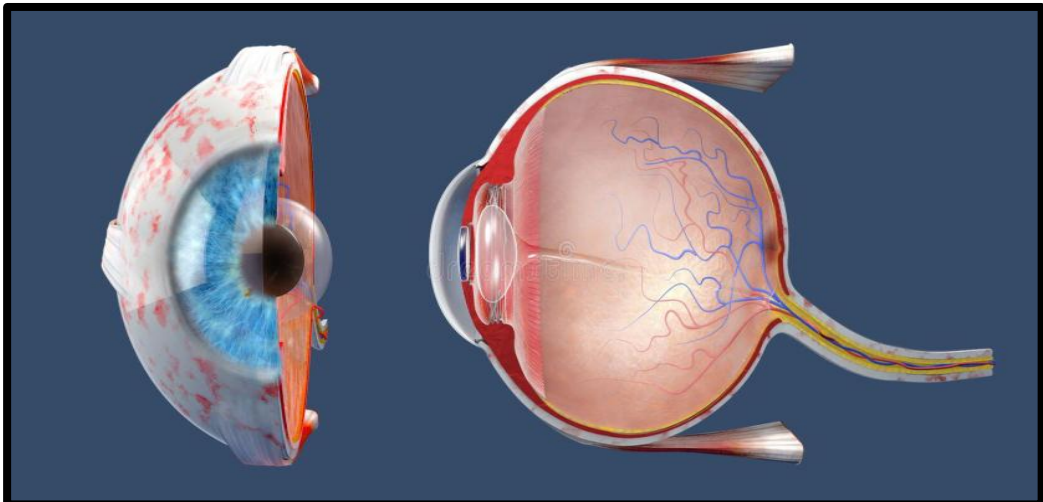


Figure (1): anatomy of the eye [1]

Parts of eye

- Anterior chamber: It is the one-third part of the eyeball which is bound by the cornea anteriorly, and the lens posteriorly. It contains the iris and a fluid called the aqueous humor.
- Posterior chamber: It forms the rest of the two-thirds of the eyeball, bound by the intraocular lens anteriorly and optic nerve head and retina posteriorly. It contains a gelly like fluid called vitreous humor.
- Pupil: It is an aperture of variable size in the center of iris, which regulates the amount of light entering the eyeball.
- Iris: It is the colored membrane behind the cornea and in point of lens with an aperture of variable size called pupil. It has a circular and long muscle fiber. Iris is attached to the ciliary body.
- Lens: It is a transparent, biconvex structure situated between the iris and vitreous humor. Its function is to focus the luminous rays; these rays form a perfect image on the retina. With age, the central portion of the lens compresses by the surrounding fibers and results in opacity, which is called cataract.

- Vitreous humor: This is a gel-like substance which maintains the shape of the eyeball. It is also a refractive media.
- Retina: It is a transparent layer forming the inner coat of the eye, it supports the choroid layer. The rays of light, on entering the eyeball, converge and form an image on the fovea—the posterior part of the eye on retina [2].

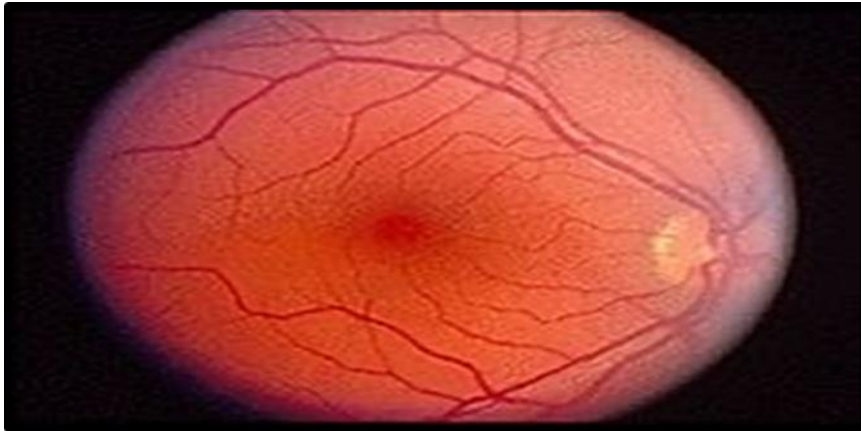


Figure (2): The anatomy of the retina [2]

- Sclera: It is the outermost coat of the eyeball. It maintains strength and structure of the eyeball. It is also known as the white of the eye.
- Cornea: It is the clear, transparent, anterior portion of the external coat of the eyeball. The rays of light enter this layer. Cornea accounts for two-thirds of the total optical power of the eye [3].
- Optic nerve: The ON is formed by the convergence of GC axons at the optic disc or papilla. In the papilla there are no photoreceptors, and it represents the blind spot. Fovea/macular fibers constitute around 90% of all axons leaving the eye and forming the papillary nerve bundle.

The optic nerve has some characteristics that make it unique. It is the only tract in the central nervous system (CNS) to leave the cranial cavity and the only one that can be visualized clinically. It is subdivided into fascicles by connective tissue and glial septa, and it is surrounded by cerebrospinal fluid [4].

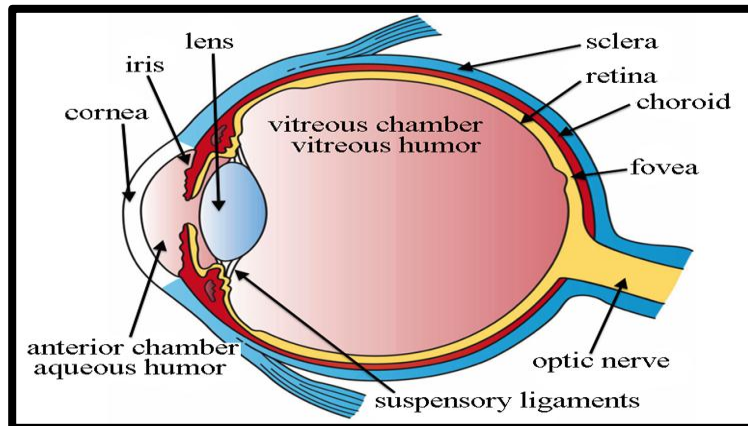


Figure (3) : Diagram of the eye [3]

Diabetes

Diabetes mellitus is a syndrome characterized by a metabolic disorder and abnormally high blood sugar concentration caused by a deficiency of the hormone insulin, or a decreased sensitivity of tissues to insulin. The balance between the hormones insulin and glucagon keeps the level of glucose in the blood stable and avoids sharp changes. The cells responsible for secreting these hormones include the following [5].

Internal secretion cells

In the pancreas, there are cells called beta cells that are very sensitive to high blood sugar levels as they secrete the hormone insulin. Insulin is the main bridge for glucose and sugar molecules to enter the muscle, where it is used as an energy source, and into fat tissue and the liver, where it is stored. Glucose also reaches the brain, but without the help of insulin [6].

Alpha cells

They are also present in the pancreas and secrete another additional hormone called glucagon. This hormone causes the release of sugar from the liver and activates the action of other hormones that block the action of insulin [6].



Figure (4) : Diabetes [4]

DM Type 1

Type 1 diabetes, once known as insulin-dependent diabetes, is a chronic condition in which the pancreas produces little or no insulin. Insulin is a hormone needed to allow sugar (glucose) to enter cells to produce energy. Different factors, including genetics and some viruses, may contribute to type 1 diabetes. Although type 1 diabetes usually appears during childhood or adolescence, it can develop in adults.

Insulin is a hormone secreted by the beta cells of the pancreas, where insulin is involved in the processes of exchanging substances for sugars and fats in all tissues, but its main function is to help introduce sugar, which is a source of energy to the cells [7].

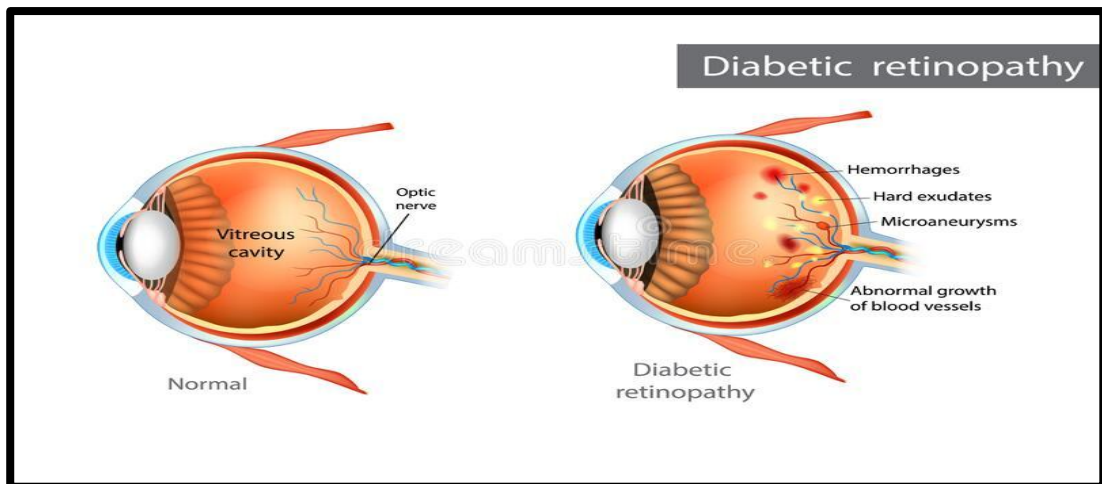


Figure (4): Diabetic retinopathy [15]

Causes

The exact cause of type 1 diabetes is unknown. Usually, the body's own immune system which normally fights harmful bacteria and viruses mistakenly destroys the insulin-producing (islet, or islets of Langerhans) cells in the pancreas. Other causes include:

- Genetics
- Exposure to viruses and other environmental factors
- The role of insulin

Once a significant number of islet cells are destroyed, you'll produce little or no insulin. Insulin is a hormone that comes from a gland situated behind and below the stomach (pancreas). In type 1 diabetes, there's no insulin to let glucose into the cells, so sugar builds up in your bloodstream. This can cause life-threatening complications. Proteins as an alternative to the source of energy [8].

Symptoms

type 1 diabetes signs and symptoms can appear relatively suddenly and may include:

- Increased thirst
- Extreme hunger
- Unintended weight loss
- Irritability and other mood changes
- Fatigue and weakness
- Blurred Vision Causes[9]

Treatment:

People with type 1 diabetes can live long, healthy lives. You will need to monitor your blood sugar levels closely. Your doctor will give you a range in which the numbers should remain. Adjust insulin, food, and activities as necessary as everyone with type 1 diabetes needs to use insulin injections to control their blood sugar [10].

Protection

There is no known way to prevent type 1 diabetes. But researchers are working to prevent disease or further destruction of islet cells in newly diagnosed people [11].

DM Type 2

Type 2 diabetes is a disease that affects the way your body regulates the movement of sugar (glucose) and its use to provide your body with energy. Chronic condition causes too much sugar to enter the bloodstream. Ultimately, high blood sugar levels can lead to disturbances in the circulatory system, nervous system, and immune system. 415 million people live with diabetes worldwide, and an estimated 193 million people have undiagnosed diabetes.

Type 2 diabetes accounts for more than 90% of patients with diabetes. Despite knowledge increasing regarding risk factors for type 2 diabetes and evidence for successful prevention programs, the incidence and prevalence of the disease continues to rise globally [12]. Type 2 diabetes was known to usually start in adults, but today both type 1 and type 2 diabetes can begin in childhood and adulthood. Type 2 diabetes is more common among older adults, but the increase in the number of obese children has led to a higher incidence of type 2 diabetes among young adults [13].

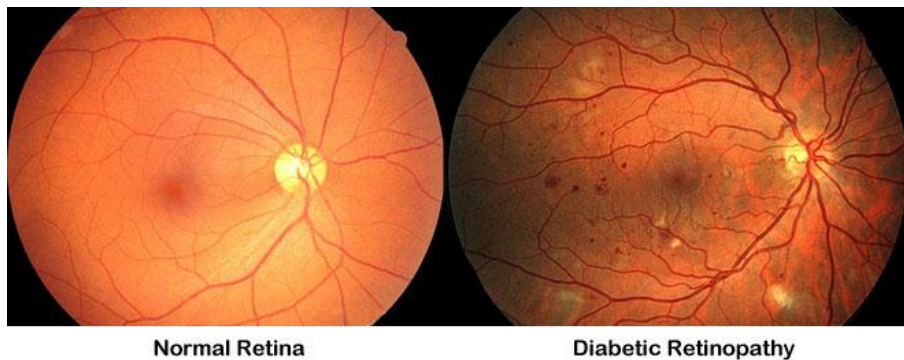


Figure (5): Diabetic eye disease [13]

Causes

Type 2 diabetes is primarily caused by two interrelated problems.

- Cells in muscle, fat, and liver become resistant to insulin. Because these cells do not react normally to insulin, they do not absorb enough sugar.
- The pancreas becomes unable to produce enough insulin to control blood sugar levels. The exact reason for this is still unknown, but one of the main factors that contribute to this condition is being overweight and not exercising [14].

Symptoms

The signs and symptoms of type 2 diabetes usually develop slowly. In fact, you could have it for years without even knowing it. When signs and symptoms do appear, they may include:

- Increased sense of thirst
- Frequent urination
- Increased sense of hunger
- Unintended weight loss
- Fatigue
- Blurred vision
- Slow wound healing
- Recurring infections
- Numbness or tingling in the hands or feet
- Dark areas of the skin appear, usually in the neck or under the armpit[14]

Treatment

- Healthy eating.
- Regular exercise.
- Weight loss.
- Possibly, diabetes medication or insulin therapy.
- Blood sugar monitoring [15].

Protection

Perhaps you have learned that you have a high chance of developing type 2 diabetes, the most common type of diabetes. You might be overweight or have a parent, brother, or sister with type 2 diabetes. Gestational diabetes, which is diabetes that develops during pregnancy. Diabetes can cause serious health problems, such as heart disease, stroke, and eye and foot problems. Prediabetes also can cause health problems. Can prevent or delay type 2 diabetes by losing a modest amount of weight by following a reduced-calorie eating plan and being physically active most days of the week. Ask your doctor if you should take the diabetes drug metformin [NIH external link to help prevent or delay type 2 diabetes](#) [13].

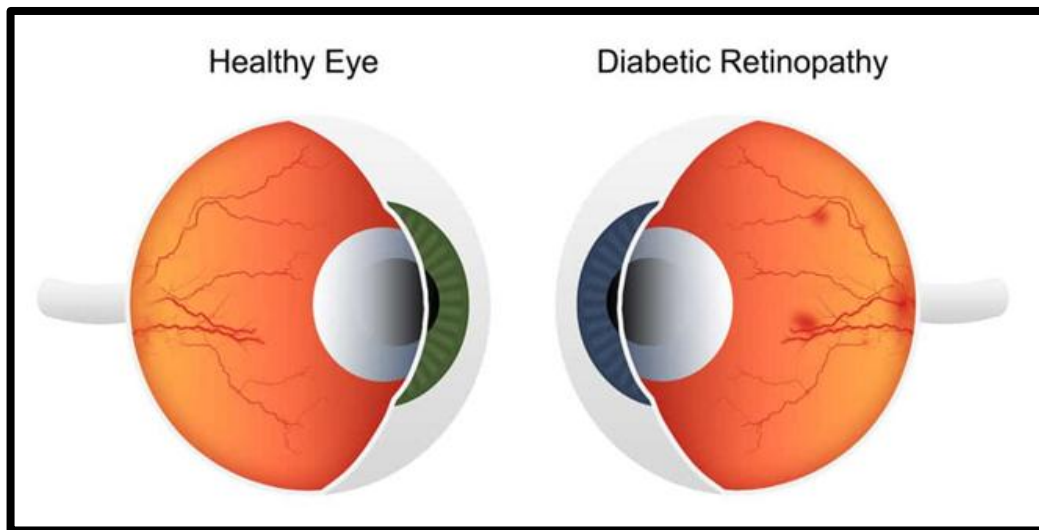


Figure (6): Healthy eye and diabetic retinopathy [14]

The effect of diabetes on the eye

Blood vessels in the eye are clogged, new blood vessels that are weak and easy to rupture grow in their place. Therefore, blood from them filters into the vitreous fluid in the eye, and this blood prevent the light from reaching the retina, and some symptoms may appear from this defect , such as:

- The spread of floating spots in the eyes. Feeling of darkness while looking from a specific area of the eye.
- Swollen and weakened blood vessels can cause tissue scarring, and this scar leads to retinal detachment. Retinal detachment can lead to blindness if not treated quickly [16].

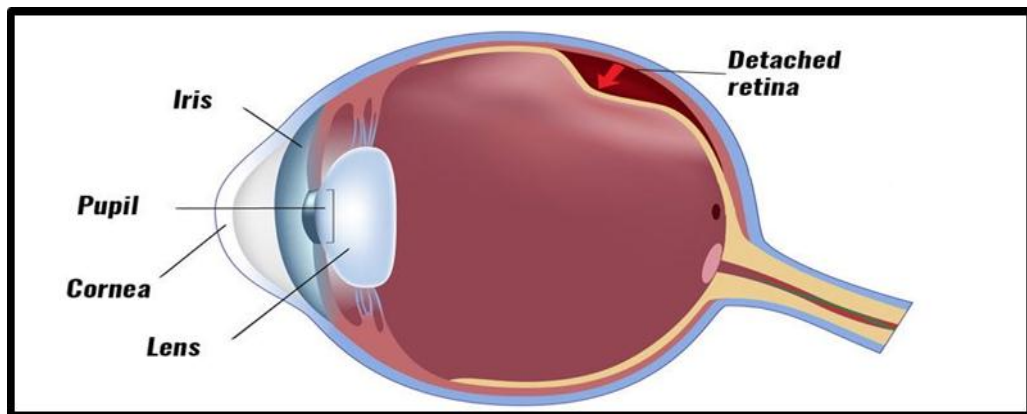


Figure (7): Detached retina [13]

The diseases results by the effect of diabetes on the eye

There are several diseases that result from the effect of: diabetes on the eye, most notably the following:

- Retinopathy, caused by damage to the blood vessels in the. Retina is the most common eye disease in diabetes.
- Retinal detachment retinal detachment is a condition in which a layer of retinal tissue moves from its place, and this leads to the separation of retinal cells from the blood vessels, which leads to a lack of oxygen and food for the retina, leading to blindness in .advanced cases.
- Vitreous hemorrhage the vitreous is a sticky, gelatinous substance that sits between the lens and the retina of the eye, and the vitreous is made up of a large proportion of water in addition to other substances.
- Vitreous hemorrhage is one of the diseases that result from the effect of diabetes on the eye, and it means the leakage of this gelatinous substance from its place and out of the eye leading to poor vision Cataract.
- Cataracts make everything cloudy, and surgery is required to remove the cataract, where the lens is removed and a plastic lens is placed in its place.
- Glaucoma is the increase in pressure inside the eye, which is over the time leads to damage to the optic nerve and blindness.
- The treatment is simple with special eye drops used to reduce .eye pressure, and a laser operation may be performed [17].

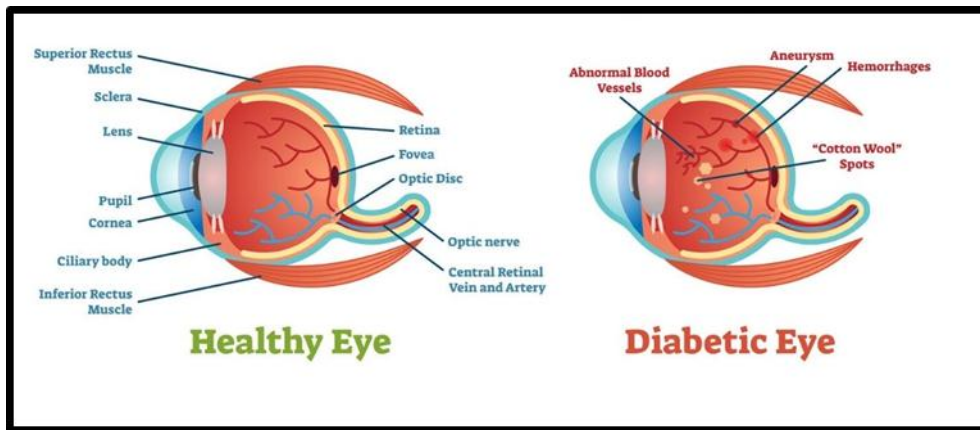


Figure (9): Eye anatomy [14]



Figure (8): Diabetic retinopathy [15]

Methods of treating the effect of diabetes on the eye

Increasing the chances of successful treatment depends on early detection of the case in addition to following prevention methods so that the situation does not worsen. Treatment methods vary according to the following:

- Treatments based on lowering diabetes and making it normal.
- Treatments that treat symptoms and complications.
- Treatments that treat diseases caused by the effect of diabetes on the eye [18].

Prevention of the effect of diabetes on the eyes

- Take a regular eye exam at least once a year controlling diabetes levels.
- Take the diabetes medication prescribed by the doctor, stop smoking and doing exercise.
- Seek medical advice promptly if you notice any change in your vision [19].

Subjects & Methods

This study is carrying out in Al-Kindi Governmental Hospital in the Iraqi capital, Baghdad, for the period November 2021 to March 2022. The study included forty patients with diabetes. The aim of this study is to reveal the effect of type 1 and type 2 diabetes on the retina and the difference between the two types in terms of their effect. The study also included cases of gender and age between 30 and 80 years, by knowing eye pressure (IOP) and DM types (1,2) and other clinical finding. Diabetes effects on all the organs of the body, especially organs with dense micro-capillaries, such as the retina of the eye, it weakens the walls of the capillaries, which leads to fluid accumulation and low vision in the patient. In advanced stages, this can lead to retinal detachment.

Subjects

At least 40 patients suffering from diabetic retinopathy in the city of Baghdad, Iraq (22 males and 18 females), ranging in age from between (30-80) years.

Method

- **First device**

Slit lamp: It is used for adults and older children. The device consists of a microscope, a telescope, lenses, and a light that reflects the eye's image of the disease from the inside. It is also include the testing of cornea, conjunctiva, optic nerve and retina. Therefore, we need to focus on the patient's retina to see the extent the impact of diabetes on it.



Figure (1): photograph of the Optometry device (finding in optometry unit of Al-Kindi Governmental Hospital in Baghdad city 2022).[20]

- **Second device**

Tonometer: Diabetes affects intraocular pressure, that leads sometimes to an increase or decrease on eye pressure. By using an eye pressure measuring device we can find out how diabetes effects on intraocular pressure.



Figure (2): photograph of the pressure measurement (Existing in the ophthalmology consultation at Al-Kindi Hospital in Baghdad 2022) [20].

- **Third device**

Refractive error: The Auto Refraction device measures the refractive error of the eye (far- and near-sighted), we can also find out the affects of diabetes on the patient's vision level.



Figure (3): Refraction error (Existing in the ophthalmology consultation at Al-Kindi Hospital in Baghdad 2022) [20].

Procedure steps

1. We put a dilating eye drop that dilates the pupil of the eye, and we ask the patient to wait around one hour to half an hour.



Figure (4): photograph of the eye drop(Existing in the ophthalmology consultation at Al-Kindi Hospital in Baghdad 2022) [20]

2. The patient places his eye in front of the lens of the device, where we sit behind the device to testing it, and then we moving to the other eye.



Figure (5): patient examination method(Existing in the ophthalmology consultation at Al-Kindi Hospital in Baghdad 2022) [20]

3. We need sometimes to use additional lenses to improve the inner vision of the eye.



Figure (6): used lenses(Existing in the ophthalmology consultation at Al-Kindi Hospital in Baghdad 2022) [20]

4. We diagnose the patient according to the results that appeared after the test and we give the appropriate treatment.



Figure (7): photograph for the patient diagnosis(Existing in the ophthalmology consultation at Al-Kindi Hospital in Baghdad 2022) [2]

Results

The (table 1, table 2) shows the differences between DM type I and DM type II by age group , and gender group (male, female). There were patients with DM type I ,type II more occurring in age (>50years) and in type II more in male than female. Also there was significant different between DM types and gender group.

		Age group		Gender group	
		≤50years %	>50years %	Males %	Females %
DM types	Type I	10 (39.1)	15 (44.1)	12 (42.5)	13 (46.3)
	Type II	2 (29.4)	13 (43.6)	10 (29.4)	5 (66.9)
Total		12 (42.5)	28 (66.5)	22 (55.6)	18 (50.9)

Table (1)

*DM (Diabetic Mellitus)

Table (2)

	Gender group	N %	Mean± Std. Deviation	P- value
DM types	Male	22 (63.4)	1.4545 ± 0.50965	0.042
	Female	18 (57.8)	1.2778 ± 0.46089	

*DM (Diabetic Mellitus), Std. Deviation (Standard Deviation)

This study shows the differences between I.O.P range and DM types there was significant differences between I.O.P range and DM types. Patients with DM type II were more in I.O.P range (<18mmHg) than to have type I , while patients with DM type I were more in I.O.P range (18-24mmHg) than type II), as in Table (3).

Table (3)

		DM types		x2	P-value
		Type I	Type II		
I.O.P range	<18mmHg	7 (25.4)	15 (44.1)	19.636 ^a	0.00
	18-24mmHg	18 (53.8)	0(0.0)		
Total		25 (77.30)	15 (46.5)		

*DM (diabetes mellitus), x2 (Chi-square), I.O.P range (intraocular pressure).

Table 4 show values of HbA1c , according to gender group, incidence of diabetic retinopathy (DR), and duration of diabetes mellitus (DM). There were significant different study group (without & with DR), DM duration and HbA1c (p<0.05)

Table (4): values of HbA1c , according to gender group, incidence of diabetic retinopathy (DR), and duration of diabetes mellitus (DM)

Variable	HbA1c		P Values	(95% C.I.)
	Normal (%)	Increased (%)		
Gender group				
- Males	4(66.7)	18(52.9)	>0.05	(0.58 – 0.352)
- Females	2 (33.3)	16 (47.1)		
Study groups	3 (50.0)	20 (58.8)	<0.05	(0.000.354)
- With DR	3 (50.0)	14 (42.5)		
- Without DR	1 (16.7)	10 (29.4)	<0.05	(0.58- 0.114)
DM	4 (66.7)	15 (44.1)		
duration/years	1 (16.1)	9 (26.5)		
- <5				
-5-10				
->10				

*DM (diabetes mellitus), HbA1c (hemoglobin A1c), DR (diabetes retinopathy), C.I (coefficient interval).

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