

# Diabetic retinopathy and ways of it's laser treatment

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**Abstract**— Diabetic retinopathy is a chronic medical condition characterized by damage to the retina caused by the presence of diabetes. It is a microangiopathy, which in the early stages is caused by vascular occlusion, and in its late stages is expressed in fibrovascular proliferation. Vascular occlusion, leading to increased vascular permeability and narrowing or blockage of vessels supplying the retina, is expressed by a blood-retinal barrier. Diabetic retinopathy is among the leading causes of blindness among the working population aged up to 75 years. Retinopathy is a common concomitant symptom in the presence of diabetes mellitus and develops in almost 90% of patients with diabetes mellitus regardless of the type of the disease. Since diabetic retinopathy is the basis of approximately 10-15% of newly diagnosed cases of blindness annually, its social importance requires the development of innovative methods for its treatment and cure.

**Keywords**— *diabetic retinopathy, laser treatment modern ophthalmological practice*

## I. SYMPTOMS OF DIABETIC RETINOPATHY

The diagnosis of the presence of diabetic retinopathy is carried out by a specialist ophthalmologist. Some of the symptoms indicating the presence of DR are blurred vision, difficulty seeing at night, the presence of cloudiness or specific spots in the eye, presence of an empty place in the center of the field of vision [1-7]. It is recommended that every person with diabetes consult an ophthalmologist (Fig.1) at least once a year, to prevent DR. [8,9]

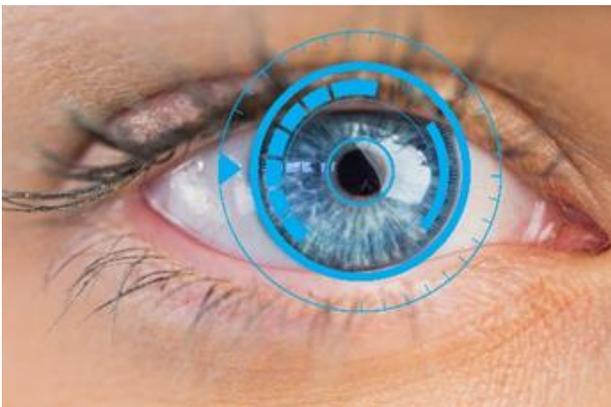


Fig1. Eye diagnostic procedure in progress

## II. TYPES OF DIABETIC RETINOPATHY

Two main types of DR are classified, namely non-proliferative and proliferative retinopathy

### A. Non-proliferative retinopathy

It's the early stage of the disease, it is often asymptomatic and passes through three stages (mild, moderate, and severe DR).

### B. Proliferative retinopathy

It's the advanced form of the disease, in which the vessels of the retina become thrombosed, which disrupts the supply of oxygen to the retina. At the same time, growth factors are released that stimulate the growth of new vessels in the retina and vitreous body as compensatory mechanisms, looking for a way to restore the blood supply and the normal delivery of the necessary oxygen. However, these new vessels are fragile and bleed easily, and can also cause retinal detachment due to the pulling they cause [10-13]

## III. THE POSSIBLE COMPLICATIONS AND LOGICAL CONSEQUENCES OF THE PRESENCE OF DIABETIC RETINOPATHY

These complications are very dangerous and are a major cause of reduced vision to complete blindness in people with diabetes. Most people with no proliferative retinopathy have no symptoms, leading to delayed treatment and further complications. Even with proliferative retinopathy, sometimes the symptoms appear too late, and the application of treatment methods does not bring the necessary effectiveness. [14]

## IV. METHODS OF TREATMENT OF DIABETIC RETINOPATHY

As with most medical conditions, the best treatment for DR is prevention, but if it comes to the need for treatment, it must be read promptly and performed with quality equipment (Fig.2). The timely inclusion of adequate forms of treatment prevents the further development of the disease especially its final phase expressed in partial or complete blindness.

Among the most applied methods for the treatment of DR are:



Fig.2 Equipment preparation for patient check

- **Photocoagulation.** In this method, with the help of a special laser, micro-burns are made on the retina, which stops the growth of new blood vessels. This is the method with the most serious potential, and its application reduces the risk of blindness by up to 90%.
- **Vitrectomy.** Surgery to remove the vitreous gel from the middle of the eye is used primarily in the presence of retinal detachment or hemorrhage.
- There is the development of macular edema, there are also two types of treatment: **focal photocoagulation**, through which the outflow of fluid in the macula is slowed down.
- **Injecting drugs into the eye.** These drugs block a growth factor (VEGF), which stimulates the growth of new blood vessels and plays a key role in the development of retinopathy. [15-17]

#### V. THE ADVANTAGES AND DISADVANTAGES OF THE TREATMENT OF DIABETIC RETINOPATHY BY LASER TECHNIQUE.

Laser photocoagulation as a treatment method for DR is one of the most effective practical solutions to this common medical problem.

In patients with **nonproliferative diabetic retinopathy**, laser photocoagulation significantly improves vision, and this is a serious prevention of vision loss, in almost 80% of all registered cases. In this form, only certain areas in the eye are treated, and vision does not always improve, but on the other hand, it does not allow further development of the disease.

In the presence of **proliferative diabetic retinopathy**, patients undergo a complete treatment of the retina. This type of treatment is also called **pan-retinal laser coagulation (PLC)**. This treatment stops the growth removes the newly formed blood vessels (**neovascularizations**) and seriously reduces the risk of vision loss (Fig.3). In severe forms of proliferative diabetic retinopathy, when the presence of newly formed vessels throughout the retina and/or hemorrhage in the vitreous body is observed, laser photocoagulation would hardly stop the process, but is applied before proceeding to vitrectomy, to reduce bleeding and additional complications of surgery.

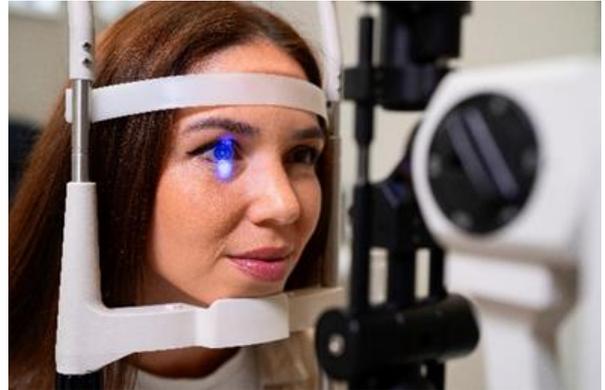


Fig.3 Laser treatment procedure

#### VI. TYPES OF LASERS USED TO TREAT DR

Among the most effective lasers applicable in the treatment of DR are **femtosecond lasers**. The technology guarantees perfect results and safety for the surgeon and the patient. It has some advantages over ordinary cataract surgery. Through computer control of the laser, the surgeon plans and operates, strictly following the individual characteristics of each patient, which cannot be achieved with other invasive surgical methods, or carries a serious risk of possible complications after the operative period.

Laser operations are bloodless, with the help of a computer, the patient's eye is scanned in a 3D image, thus reflecting the unique and strictly individual shape of both the eye and the phase of the disease for each patient. Upon establishing the necessary mode of operation, according to the individual characteristics of the patient, the laser beam is centered on the eye, making the incisions in seconds, without the surgeon ever touching the patient himself. The degree of precision is incommensurable with invasive surgery, making it the best for use in this diagnosis.

The most advanced **micropulse laser** - the so-called **"yellow" laser**. It works with a unique **wavelength of 577 nm**, which is not absorbed by the macular pigment. Which in turn eliminates the risk of damage to the patient's vision, in the event of an inadvertent error or misadjustment by the ophthalmologist. This laser works approximately 10 times faster than a standard "green laser" and is much gentler on the retina. When operating in its subthreshold mode of operation, or at about (50% below minimum power), the "yellow" laser does not destroy cells, it leads to their stimulation at the biochemical level. The effect of the performed procedures is reported between the 6th and 8th week of the therapy, with a gradual reduction of retinal swelling observed.

The series of laser procedures can of course also be performed with the **classic "green" laser** - with a **wavelength of 532 nm**. Its disadvantage is that it is not applicable in the presence of edema in the macula, and its action is destructive, that is, it affects not only the pathological fields but also the surrounding ones. For this reason, during treatment with this type of laser, in some cases, the appearance of the so-called scotomas (blind spots), as well as worsen patients' night vision.

In modern ophthalmological practice, combined lasers, such as those from the **Eye Lite system**, (Fig.4) representing a **combination of a diode and dual-frequency YAG laser**, are most often applied. Diode emission is a very efficient emission and has less thermal effect. The **dual-frequency YAG laser converts light from 1064 nm to 532 nm wavelength through the presence of a KTP crystal**. This laser has the possibility of longer application than ordinary diode or argon lasers.

The clinical impact of the combination laser is similar to that of the argon laser but with the **advantages of a 532-514 nm wavelength**. Due to the significantly lower absorption of these lasers by the xanthophyll pigment of the macula, their application is much safer and more successful. With this laser, there is increased absorption by hemoglobin and oxyhemoglobin, therefore it is not recommended to treat large hemorrhagic areas. The latest modern lasers are of the Pascal system, allowing one to make a group of coagulates with a certain arrangement in one shot.



Fig.4 Ophthalmological practice with Laser for curing DR

Laser techniques depend on the type of diabetic retinopathy:

Usually, in **non-proliferative DR**, either focal treatment (50-100 nm, 0.05-0.1 s) or temporal macular barrage is most often applied.

The latest innovations in ophthalmology include a new methodology in the therapy of DME (diabetic macular edema), which is carried out with the help of a micropulse and is accordingly called **Micropulse therapy**. It is performed using a **micropulse - a diode laser with a wavelength of 810 nm**, subthreshold power, and a short duration of pulses - microseconds, micropulse. In this method, only the RPE is affected, without additional damage to the other layers of the retina and the choriocapillaris. This avoids the complications of usual laser therapy, such as subretinal fibrosis, hemorrhages, and large cicatrixes. The method is much more gentle on the central areas of the retina and gives good results.

In **proliferative DR, pan-retinal photocoagulation** is used.

Panretinal laser coagulation aims to cover with laser coagulates the largest possible area of the middle and end retinal periphery. The goal is the destruction of ischemic areas to prevent neovascularization.

Panretinal coagulation is of two types: **non-confluent** or **confluent**.

The treatment is usually outpatient and requires the application of about 3 to 6 laser sessions, each lasting between 5 to 15 minutes. In some patients with intraocular hemorrhage, the procedure cannot be performed due to the inability of the laser beam to reach the fundus.

In the laser procedure, local anesthesia is used, the manipulation itself lasts no more than 20 minutes, and the patient does not feel the discomfort characteristic of invasive interventions, especially in a delicate organ such as the eye. Due to its sparing nature, surgery with a femtosecond laser is also successfully applied to many elderly patients with other co-morbidities.

**For these reasons, the treatment of diabetic retinopathy using laser technology is one of the modern and reliable methods.** This necessitates an increasing emphasis on expanding the application of the laser technique in the treatment of DR. As well as in the development of new and better laser devices applicable to the treatment of DR.

## VII. CONCLUSION:

**The societal impact of diabetic retinopathy is significant.** DR is a highly socially significant disease or concomitant symptomatology in the presence of diabetes. Since the disease itself is among the most common among the socially active population of working age, any successful method for its prevention and treatment would have a serious impact on preserving the quality of life of patients and on their ability to continue their normal rhythm of life. Every year, a huge percentage of people with type 1 and type 2 diabetes **develop some form of diabetic retinopathy.**

**For these reasons, the treatment of diabetic retinopathy using laser technology is one of the modern and reliable methods.** This necessitates an increasing emphasis on expanding the application of the laser technique in the treatment of DR. As well as in the development of new and better laser devices applicable to the treatment of DR.

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