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Monitoring, treatment and care of glaucoma

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Abstract. Glaucoma is a serious ophthalmic disease with extremely high blindness rates, second only to cataracts. Glaucoma can be divided into 3 types according to clinical practise: primary glaucoma, secondary glaucoma, and congenital glaucoma. If glaucoma is not treated in a timely manner, it can lead to irreparable results. Therefore, the prevention and treatment of glaucoma is particularly important, and it is necessary to emphasize early detection, diagnosis, and treatment. The main symptom of glaucoma is an increase in intraocular pressure caused by aqueous humor and excessive generation of blocked discharge, but intraocular pressure is controllable. When intraocular pressure increases, it can cause many irreversible damage in the eye, such as optic disc atrophy, visual field loss, visual loss, and severe pain. This article will review the monitoring, treatment, and care of glaucoma. Monitoring mainly includes traditional equipment and new equipment. Treatment can also be divided into traditional methods and new methods, and their advantages and limitations are compared. In the end, the article will provide some suggestions for daily care of glaucoma patients.

Keyword: glaucoma, intraocular pressure, monitor, treatment.

1. Introduction

Glaucoma is an irreversible blinding disease with serious consequences. 95% of people's intraocular pressure (IOP) is between 10 mmHg to 21 mmHg. But when stimulated by certain factors, the IOP will rise. It can cause depression atrophy of the optic disc accompanied by the visual field defect when the intraocular pressure exceeds the standard where the tissues cannot withstand it such as 21 mmHg. Its blindness rate is only second to cataracts and cannot be recovered. Many incentives can contribute to the paroxysm of glaucoma, such as high refractive error, family generic history, tiredness, bad temper, dark room and so on. And the outbreak of the glaucoma has hiddenness, so a regular examination is necessary. It is indicated by the statistics by the WHO, there were 66.8 million patients in 2000 but in 2020 the number rose to 76.5 million. It is speculated that the number will exceed 95.4 million in 2030 (Figure 1) [1]. It is a very large population and increasing every year. In modern society, due to the increased time on using electronic products, pressure, insufficient rest and other reasons, young people's eyesight has severely decreased [2], which cause a hidden danger of glaucoma in the future. At the early stage of glaucoma, it is hard to find the abnormalities. Because there is a greatly large overlap in the field of vision between two eyes, even if there is some damage in one eye, it can be compensated by the other eye. Thus, when the patient has symptoms and goes to the hospital, it is already in the late stage. Therefore, the prevention and early detection, diagnosis, and treatment of glaucoma are of great

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significance. This paper aims to summarize the methods for the monitoring and treatment of glaucoma, which all include traditional technologies and emerging technologies. At the end of this article, some suggestions are proposed for the care of glaucoma.

This paper provides a systematic understanding about glaucoma and a prevention awareness. This article will introduce the common knowledge of glaucoma and increase its popularity. Some constructive suggestions can be provided to high-risk groups for glaucoma to prevent disease outbreaks.

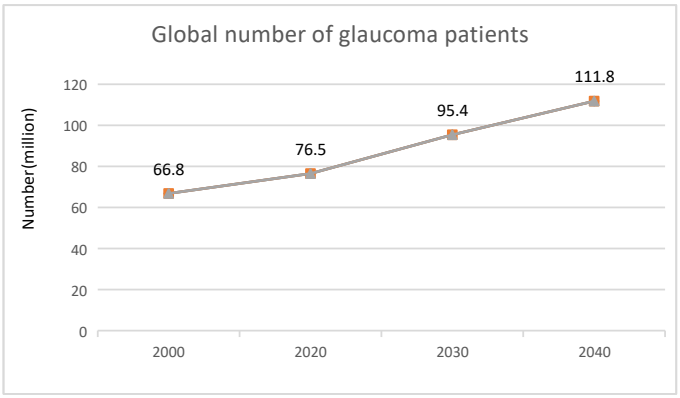

Figure 1. The tendency of glaucoma patients number (The statistic can be searched at http://apps.who.int/iris).

2. The monitoring of the glaucoma

At the early stage of glaucoma, it is hard to detect. So high-risk people should be examined timely. The IOP is the direct data to reflect the condition of the eyes. Because in this disease, pressure caused by the increased IOP can lead to damage to the optic disk. All of the measuring devices can be divided into traditional equipment and novel equipment.

2.1. Traditional equipment

When patients go to the hospital for examination, they are always inspected by the traditional tonometer. Most hospitals now use the Goldmann tonometer and the non-contact tonometer.

2.1.1. Goldmann tonometer. It is a standard intraocular pressure gauge accepted by people around the world. This device is minimally affected by the hardness of the eyeball wall. When using the tonometer, the doctor will put the gauge on the cornea, and then can acquire a result until the contact diameter reaches 3.06 mm. But accuracy can also be influenced by some factors, such as the patient's tizzy, corneal astigmatism, and the thickness and shape of the cornea [3].

2.1.2. Non-contact tonometer. Non-contact tonometer is also a commonly used device in clinical practice. It uses the air pulse as a flattening force. Compared to the Goldmann tonometer, it does not contact the cornea directly, so it can reduce the probability of cross-infection. The manipulation is easier. However, there may be significant errors when measuring patients with high intraocular pressure. The device is also influenced by the cooperation about the patient, tear film, and corneal state. But when implementing a nursing intervention on the patient, the result will be better and more accurate [4].

2.2. Novel equipment

With the development of modern science and technology, more and more advanced technologies are applied in measuring IOP. Now, the current popular technologies include non-invasive IOP monitoring devices and implantable IOP monitoring devices. The IOP changes constantly, so compared to the normal tonometer, the implanted devices can measure the IOP at any time.

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2.2.1. Non-invasive IOP monitoring devices. The operator puts the pressure sensor on the contact lens and the patient can wear a contact lens on the cornea. The contact lens can sense the change of corneal morphology by the highly sensitive detector to get the IOP, then send the message to the data recorder carry-on by the patient [5]. If the IOP exceeds the normal standard, it will sound the alarm. So the patient can notice the abnormal circumstance, then receive timely treatment through medication, surgery, and other therapies.

Another new apparatus is HOPES. It places the sensor on the fingertips of the gloves. Patients only need to touch the cornea with specialized gloves to obtain the IOP value. It can capture subtle eye movement and achieve continuous and accurate measurement of intraocular pressure. Patients feel more comfortable during the exam [6]. But this technology is still under development.

2.2.2. Implantable IOP monitoring devices. Limited by the disadvantages of the traditional tonometer, implantable devices are invented to solve the problem. This device can be implanted in the tissues of the eye to measure the IOP consecutively, such as the anterior chamber, vitreous body, choroid, lens capsule, etc. But some studies have found that placing the device in the vitreous body may cause infection, so the best places are the anterior chamber and lens capsule. Aqueous humor is located in the anterior chamber. The creasing pressure caused by the increased volume of the aqueous humor can directly act on the implantable device. So the IOP can be measured accurately. And compared to other devices, it can reduce the influence of factors such as corneal thickness [7]. But this technology is not mature enough and also faces many challenges such as signal drift, biocompatibility, external interference, intraocular infections, signal instability, etc [8].

The IOP changes constantly, so compared to the normal tonometer, the new device can measure the IOP at any time. And the data coming from the new device are more accurate because it suppresses the influences brought by some factors. So it is more suitable for household IOP monitoring instruments in real time. Therefore, purchasing one of these options for high-risk individuals with glaucoma is a good choice.

3. The treatment of glaucoma

The main clinical feature of glaucoma is high intraocular pressure. Therefore, reducing the IOP, protecting the visual function and preventing further damage are the main objectives during the onset of the glaucoma. It also can be divided into traditional treatment methods and novel treatment methods.

3.1. Traditional treatment methods

The traditional treatment methods include drug therapy, laser therapy and surgical therapy that are frequently used in clinics.

3.1.1. Drug therapy. At the early stage of glaucoma, most patients use drugs to control the IOP, such as eye drops, eye ointment, oral medication, etc. Regardless of the type of glaucoma, it is all caused by the excessive generation or discharge obstructed the aqueous humor. Therefore, various drugs can be divided into reducing aqueous humor generation and increasing aqueous humor excretion. The former includes brimonidine, timilol, acetazolamide, brinzolamide, etc. The latter includes the unoprpstone, mannitol, etc. Now the formula composite formulation is invented. Due to its good antihypertensive effect, high patient mobility and minimal adverse reactions, it has become a new trend in glaucoma treatment. But no matter which medical the patient chooses to use, it will cause damage to the eyes, such as cornea, conjunctive, tear film and so on [9]. So patients should use it scientifically. With the development of medical technology, some new drugs have been studied to reduce the damage caused by drugs to the eyes. For example, INO-8875, an EP2 receptor agonist, can be used by patients to protect the optic nerve while taking therapeutic drugs, such as calcium channel blockers and neurotrophins. Using them can protect the optic nerve and reduce damage.

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3.1.2. Laser therapy. Now surgery has become an important method for treating glaucoma in clinical practice. Laser mainly plays the role of photocoagulation, pore formation, and cutting through thermal solidification effects, photoionization effects, and photochemical effects. The commonly used laser surgical treatment methods include iridectomy, ALPA, ALT and cyclophotocoagulation, LPIP. This paper will give an example of laser peripheral iridoplasty (LPIP). It mainly uses the photocoagulation mechanism to cause the tissue between the small pores to contract centripetally, reducing the thickness of the iris, reopening the closed corner of the room, avoiding adhesion with surrounding tissues, increasing the outflow of aqueous humor, and reducing intraocular pressure [10]. And if proceed the LPIP after LPID, it can continuously contract the iris, further expand, widen, and release the angle, which is better than just undergoing LPID [11]. So it can make a significant effect on the glaucoma patient.

3.1.3. Surgical therapy. At the later stage of glaucoma, most patients will choose surgical therapy to reduce the IOP, and restore or rebuild the drainage channel for aqueous humor. The methods of this therapy become more and more popular. According to the mechanism, this therapy can be divided into relieving mechanical or physiological blockages and unblocking aqueous circulation pathways, such as peripheral iridectomy and trabeculectomy; A filtering surgery that reconstructs the outflow channel of aqueous humor and expels it from the eyeball to reduce intraocular pressure. By destroying ciliary epithelial cells with physical energy, the production of aqueous humor is reduced. For example, ciliary cryosurgery and ciliary photocoagulation. Although the surgical method mentioned above can alleviate the symptoms, it can also leave large wounds in the eyes. This damage can cause tissue damage, various complications and even lead to blindness. So now, some new methods such as minimally invasive glaucoma surgery (MIGS) are gradually being applied in clinical practice, such as Schlemm canaloplasty, and excimer laser trabeculectomy ab interno (ELT). It significantly enhances the safety and efficiency of the treatment. The common method of this surgery is drainage which will be introduced carefully in the next part. But the MIGS has been in the process of development and innovation, its long-term effects are still unclear. However, compared to this traditional surgical, the MIGS has a very promising future [12].

3.2. Novel treatment methods

The new treatment methods can be divided into minimally invasive drainage treatment, acupuncture treatment and stimulating ganglion cell regeneration method.

3.2.1. Minimally invasive drainage treatment. MIGS can reduce the damage to the eyes caused by traditional surgery, and provide a safe and effective treatment method for mild to moderate patients. It can minimize the influence caused by traditional surgery on the cornea and sclera, and also can realize aqueous humor outflow from the eye, and greatly reduce the possibility of blindness in glaucoma [12]. Its principle consists of reducing aqueous humor generation and increasing the discharge. The first one includes endoscopic ciliary body photocoagulation and the other includes trabecular meshwork bypass drainage, suprachoroidal drainage, subconjunctival drainage, and ocular surface drainage (Figure 2). There are various types of MIGS surgeries with different indications. Regardless of which surgical treatment is chosen, doctors should conduct a comprehensive preoperative examination and evaluation of the patient, and regular postoperative follow-up is also required [12]. MIGS has the advantages of small wound size, fewer complications, and good therapeutic effect. But there are also many drawbacks, such as the inability to reduce intraocular pressure to a certain level, which results in poor treatment effects for late-stage glaucoma patients [12]. With the in-depth research on MIGS, its safety and therapeutic effects are constantly improving.

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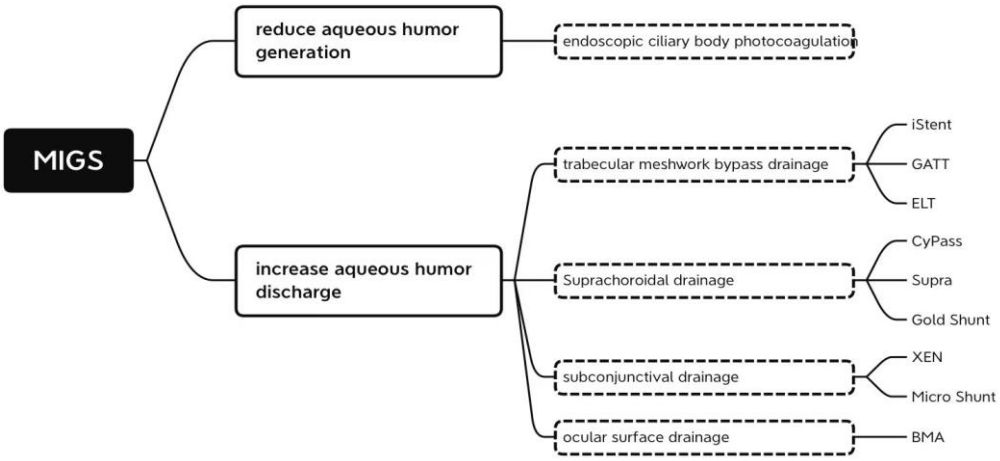

Figure 2. The classification of MIGS.

3.2.2. Acupuncture treatment. Glaucoma belongs to the category of traditional Chinese medicine's Pupil disease, known as five-colored glaucoma. Traditional Chinese medicine believes that this disease is mainly caused by disharmony of qi and blood, blockage of meridians, and accumulation of divine water [13]. The mechanism of acupuncture treatment includes lowering intraocular pressure, protecting the optic nerve and regulating blood flow [14]. The treatment methods can be divided into simple acupuncture therapy and a combination of acupuncture and medicine therapy. Simple acupuncture therapy includes routine acupuncture therapy, routine acupuncture combined with electroacupuncture therapy, routine acupuncture combined with bloodletting therapy and comprehensive therapy [14]. Experiments have shown that combined treatment like routine acupuncture combined with electroacupuncture therapy has better therapeutic effects than simple acupuncture treatment [14]. And combination of acupuncture and medicine therapy includes acupuncture combined with conventional Western medicine treatment, and acupuncture combined with traditional Chinese medicine oral treatment. The Western medicine latanoprostaglandin eye drops, brimonidine tartrate eye drops, timolol maleate eye drops and so forth. Traditional Chinese medicine includes chaihu, peony bark, gardenia, Chuanxiong, Poria cocos and so on. It can further mitigate the symptoms of the patients. In summary, simple acupuncture therapy is more commonly used in clinical practice, but combination therapy has better therapeutic effects [14].

3.2.3. Stimulating ganglion cell regeneration treatment. The methods mentioned above are all aimed at alleviating and controlling symptoms that have already occurred, but they cannot fundamentally solve the problem. Now construction of Glaucoma Treatment Based on Magnetic/Graphene Nanocomposite Stents provides a new idea [15]. This method aims to introduce magnetic nanoparticles into nitrogen-containing graphene nanofibers through various new synthesis routes. It also can stimulate the ganglion cells of the optic nerve to regenerate through this material. This irreversible visual field damage caused by glaucoma can be repaired. The implementation of this project will provide new ideas for the prevention and clinical treatment of glaucoma [15]. At present, this method is still under further research and development. It is believed that in the near future, this method can be applied in clinical practice and make significant contributions to glaucoma therapeutics.

4. Dalty care

For patients with glaucoma, their mental health should be cared. The patients should avoid excessive emotional fluctuations and long-term exposure to dark rooms. Family members and medical staff should provide care and guidance, and regularly monitor the progress of the disease. There is experimental

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evidence that timely care can improve the prognosis of patients [16]. In daily life, it is suggested that patients should avoid smoking and alcohol, strictly follow medical advice, exercise appropriately, eat more green vegetables and have a light diet, reduce eye use and rest more, and so on. And timely re-examine of intraocular pressure to understand the disease condition.

For high-risk groups of glaucoma, such as those with a glaucoma family history and high refractive error, going for a physical examination on time every year and paying attention to their intraocular pressure at any time should be emphasized.

5. Conclusion

Glaucoma is a serious blinding eye disease. Moreover, in modern society where excessive eye use occurs, refractive errors and the high pressure of nighttime eye use have also become triggers for glaucoma. And glaucoma is gradually showing a younger trend. But in the early and middle stages of the disease, the condition is completely controllable. Therefore, the treatment and nursing of glaucoma to reduce its incidence rate should be attached great importance to. This article comprehensively organizes the monitoring, treatment, and care of glaucoma, and provides a detailed introduction to certain methods. This article provides some understanding and cognition of glaucoma. Although the damage caused by glaucoma is irreversible, the development can be slowed down through timely monitoring, treatment, and daily care. However, the pathogenesis of some glaucoma is still unclear, so many treatments have limitations. Moreover, many novel methods lack clinical trials and cannot be used for large-scale treatment. But with the development of medical technology, it is believed more and more new technologies will be studied for detection and treatment. The harm of glaucoma to the eyes will be further controlled. For glaucoma patients, the monitoring and treatment of glaucoma have entered a new era: a progressive, promising and developmental era.

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