Алтернативна филтрираща процедура при хронична първична закритоъгълна глаукома

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Alternative filtrating procedure in terms of chronic angle closure glaucoma

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Резюме

Цел

Да се представи нашият опит с алтернативна филтрираща процедура при пациенти с хронична първична закритоъгълна глаукома, извършена с помощта на плазма генератор Plexr (GMV, Италия).

Материал и метод

Наблюдаваната група, включва пациенти със закритоъгълна глаукома, която се състои от 10 пациенти (10 очи). Пациентите са на максимална локална терапия и вътреочно налягане, по-високо от 25mmHg.

Резултати

Представяме постигнатото вътреочно налягане (на първи ден, 1 седмица, 2 седмица, 1 месец, 3 месеца и 6 месеца). Представена е морфологията на филтрационния път чрез предносегментно ОСТ (AS OCT).

Заключение

Трансцилиарният дренаж притежава някои преимущества при селектирани пациенти с минимално инвазивен характер.

Ключови думи: *Филтрационна глаукомна хирургия, трабекулектомия, митомицин-Ц, плазма, трансцилиарен отток.*

Abstract

Purpose

The aim of the study is to present our experience with alternative fitration procedure in patients with chronic angle closure glaucoma (CACG) using plasma Plexr (GMV, Italy).

Methods

This prospective, interventional case series included patients with CACG (IOP ≥25mmHg) on maximal local therapy. We present the surgical steps of the procedure. Our study group consisted of 10 eyes of 10 patients with open-angle glaucoma patients.

Results

The achieved intraocular pressure (IOP) has been presented (fist day, fist week, 2 weeks 1 month, 3 months and 6 months). The fitration way has been shown by using the anterior-segment OCT (AS OCT).

Conclusion

Transciliary drainage is a minimal invasive procedure and has some advantages for selected patients.

Keywords: *fitering glaucoma surgery, trabeculectomy, mitomycin-C, plasma, transciliary flow.*

Introduction

The main goal of glaucoma treatment is lowering the patient's intraocular pressure. The development of industry and pharmaceuticals is constantly adding more and more new strategies to facilitate this. Trabeculectomy is one of the most popular and modified filtering techniques for lowering the intraocular pressure in glaucoma patients [1 2 3]. For years it has been widely believed that the aqueous humour should be evacuated from the eye through the anterior pathway which includes the trabecular apparatus, the Schlemm's canal and evacuation through the collector channels to the subconjunctival space where it is drained by diffusion. The main goal of this surgical technique has remained the same since it was first introduced by Cairns[4] , i.e. formation of a drainage network between the anterior chamber and the sub-Tenon's space, known as a filtering bleb (FB). A number of classifications have been proposed to characterize FB with regard to the surgical procedure outcome[5,6,7]. The successful outcome of the procedure depends on the FB functionality. The „ideal FB"according to Pollak[8] is mildly *ischemic*, has slightly *thin walls* and is moderately elevated positioned comfortably for the patient under the upper eyelid, IOP 6–12 mmHg. Fibrotic tissue reaction control takes place by medications, i.e. Mitomicyn C (MMC) and 5-fluoracil (5-FU)[9]. The studied filtration surgical procedure is based on carving a transciliary filtration track (TCF). TCF allows the flow of aqueous humor from the posterior chamber, through the ciliary body, suprachoroid lamina, the sclera and reaching the sub-Tenon's space. The formation of this network is performed by a PLEXR® plasma generator (GMV, Italy). Similar techniques have been described by Singh, using the Fugo blade for tissue ablation [10]. The use of the PLEXR® plasma generator (GMV, Italy) in ophthalmology was promoted in 2019 [11,12].

Patient Selection

Angle closure glaucoma usually affects the 45^{+}-age group. The angle closure glaucoma major predisposing factor is the specific anatomy of the anterior ocular segment. The changes associated with the angle closure glaucoma are: a smaller anterior to posterior diameter of the eye, shallow anterior chamber, large or spherical lens, etc. All of these result in blockage of the irido-corneal angle (the junction where the aqueous humor normally drains). At first, the so-called pupillary block is observed where the lens seals against the iris and obstructs the flow of the aqueous humor from the posterior to the anterior chamber. Because of this pupillary block, the flow of the aqueous humor from the posterior to the anterior chamber is delayed. This results in elevation of the intraocular pressure in the posterior chamber and decrease of the intraocular pressure in the anterior chamber. The periphery of the iris is pushed forward, it fills in the narrow irido-corneal gap and blocks the trabecular apparatus of the eye. The quick blockage of the irido-corneal gap causes a sudden elevation of the intraocular pressure ≥ 35 mmHg depending on its severity.

The selected group of patients are pseudophakic, on a maximum local medical therapy, surgical iridectomy and IOC >25 mmHg.

Material and Methods

The TCF was performed on 10 eyes in 10 patients (8 female and 2 male), with a pre-operative administration of MMC at a dose of 0,2 mg/0,1 ml. All of the patients had been diagnosed with angle closure glaucoma. The average age of the patients in the group was 53-65 years.

The average pre-operative IOC was 25–40 mmHg. All of the patients take twice a day the beta-blocker and pilocarpine combination, carbonic anhydrase inhibitors, alphagonists and once a day - Prostaglandin analogues.

There was evidence for visual field defects such as nasal step, paracentral scotomas and early arcuate scotoma, detected by 30–2 SITA (Humphrey).

All of the patients underwent identical TCF. There were no significant intraoperative complications calling for a change of the Surgeon's plan.

PLEXR Plasma Generator (GMV, Italy) Description

Plasma, along with solid, liquid and gas, is one of the four fundamental states of matter. The plasma generator uses the 4th state of matter, plasma. From a Physics point of view, this is ionized gas in which ions roam freely, i.e. a highly volatile structure of electrons and ions which are generally neutral. There are different methods for plasma generation depending on the position of the electrodes, the atmospheric conditions and the electrical potentials. In the general case, there are thermal and non-thermal plasmas depending how they are generated. A requirement for the generation of thermal plasma is the high atmospheric pressure and high temperature allowing the formation of electrons and heavy corpuscles (neutrons, ions and radicals), which have a temperature reaching tens of thousands degrees Kelvin. On the other hand, the electrons in non-thermal plasma are hotter than the heavy particles and the temperature does not exceed the room temperature (30–60 ° C)[13]. Given the difference in the electromagnetic potential between the tip of the medical device and the human tissue, decomposition takes place by sublimation. Sublimation is the transition of a substance directly from its solid to its gaseous state, without passing through the transilitional aqueous state of matter. Plasma generators are widely used in the esthetic medicine, dermatology, oculoplastic procedures, dental medicine and gynecology [14].

The PLEXR® plasma generator is manufactured by GMV, Italy, and its technology is protected by and international patent.

The plasma generator has three applicators – red, green and white corresponding to the calibrated power in continuous and pulse operation mode (Fig. 1). The red applicator features the highest output power (700V, 2W, 75 kHz), and is followed by the green applicator (600 V, 1W, 75 kHz) and the white one which has the lowest output power (500V, 0.7W, 75 kHz).

Settings are changed by tapping the screen (Fig. 2)

Description of the Surgical Technique

The TCF is performed under standard sub-Tenon's anaesthesia. As the patient is introduced to the OR, they are administered an intra-Tenon's injection of 0,2ml/0,02% MMC at 6 mm from the corneal limbus tangentially. In the chosen area of the upper quadrant the conjunctiva is drawn sidewards using tools without sharp edges as to avoid its damaging.

Fig. 1. PLEXR® plasma generator (GMV, Италия). The applicators are attached to the console. In an operation mode, the handles connect wirelessly to the console

Fig. 2. Applicator settings display.
The selected option is a fractional mode
100 ms in an operational mode and a pause of 90 ms

Using transillumination, the region of the ciliary body is visualized and then with an ink marker the desired application area is marked (Fig. 3). The calibrated green applicator is used (Fig. 4a) with a 19G nozzle to perform a layered sublimation.

The sclera is sublimated in the form of the

Fig. 3. Using transillumination, the region of the ciliary body is visualized and then with an ink marker the desired application area is marked.

19 G nozzle adjacent to the ciliary body, following this, using a 300 μm tip fitted on the white applicator, a canal is made through the ciliary body to the posterior chamber (Fig. 4b).

The procedure ends with ensuring the free flow of aqueous humor and the formation of a cavity with entrapped gas bubble in the anterior chamber. The conjunctiva opening is sutured using a single strand of 10/0 nonresorbable monofilament thread.

Results

TCF was performed on 10 eyes in 10 patients (8 female and 2 male), with a pre-operative administration of MMC. All patients had been diagnosed with an angle closure glaucoma.

The average age of the group was 60,7 ± 7,05 years. One of the patients was suffering from an advanced perimetric damage and nine were with a moderately pronounced perimetric damage. The IOP was 25–40 mmHg (31,7 ± 8,46 mmHg). The achieved IOP was between 12–22 mmHg (17,4 ± 5,6 mmHg). The IOP reduction was 54,5% ± 16,5%. The data were analyzed using the Wilcoxon signed rank test ($p < 000.1$), suitable for small data sets. The patients were tested on day 1, week 1, week 2, month 1, month 3 and month 6 (Table 1). In the therapy of 4 patients the antihypertensive drug Oftantimolol 0,5% (Santen) was included. It was chosen for the fact that it is well tolerated by patients prior to operation.

Remark: highlighted in grey in the Table are the patients in whose therapy Oftantimolol 0,5% (Santen) was included in month 6.

The anterior segment OCT evaluation allows visualization of the morphological structure of the filtration zone. Making of an opening enables the aqueous humor to flow back.

Most probably this is the reason for a more flattened FB, situated backwards. The structural image is presented on Fig. 5 and Fig. 6.

a b

Fig. 4. The sclera is sublimated in the form of the 19G nozzle adjacent to the ciliary body, following this using a 300 µm tip fitted on the white applicator, a canal is made through the ciliary body to the posterior chamber

Table 1: Patient Group Test Results, Wilcoxon, p < 000.1.

Patients	Pre-operation IOP	Day 1	Week 1	Week 2	Month 1	Month 3	Month 6
53,♀	28 mmHg	8 mmHg	12 mmHg	16 mmHg	14 mmHg	15 mmHg	14 mmHg
60, ♂	25 mmHg	4 mmHg	6 mmHg	12 mm Hg	18 mm Hg	20 mm Hg	19 mm Hg
67,♀	38 mmHg	10 mmHg	12 mm Hg	12 mm Hg	16 mm Hg	16 mm Hg	19 mm Hg
60, ♀	28 mmHg	10 mmHg	15 mm Hg	14 mm Hg	17 mm Hg	15 mm Hg	16 mm Hg
62,♀	34 mmHg	15 mm Hg	17 mm Hg	18 mm Hg	17 mm Hg	20 mm Hg	19 mm Hg
58,♀	40 mmHg	6 mmHg	8 mm Hg	13 mm Hg	15 mm Hg	14 mm Hg	12 mm Hg
60,♀	34 mmHg	12 mm Hg	12 mm Hg	14 mm Hg	14 mm Hg	20 mm Hg	22 mm Hg
68,♀	32 mmHg	18 mmHg	20 mm Hg	22 mm Hg	21 mm Hg	22 mm Hg	21 mm Hg
60,♀	30 mmHg	10 mmHg	14 mm Hg	16 mm Hg	14 mm Hg	16 mm Hg	17 mm Hg
59, ♀	28 mmHg	12 mm Hg	10 mmHg	14 mm Hg	12 mm Hg	14 mm Hg	15 mm Hg

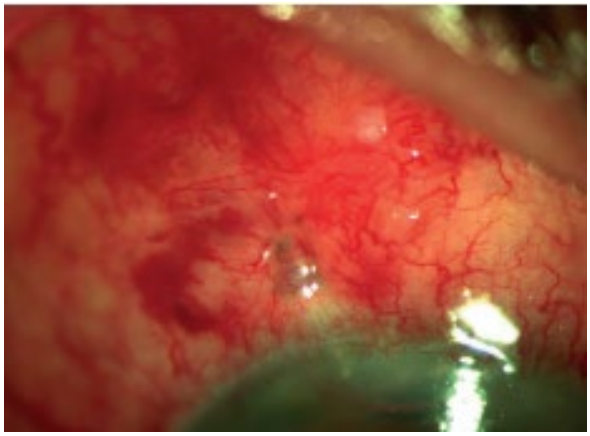

Fig. 5. TCF biomicroscopy image, day 1.

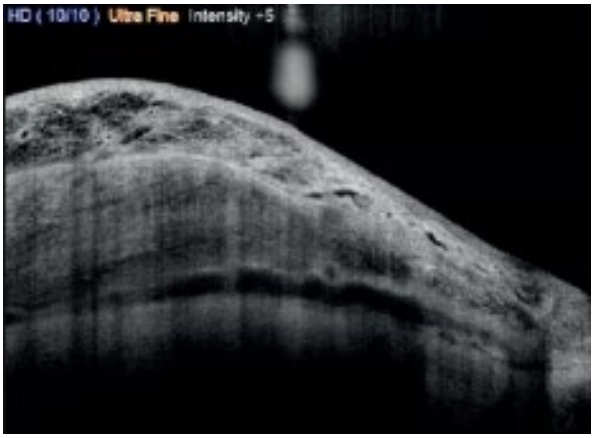

Fig. 6. AS OCT longitudinal section image of the TCF filtration route. Visualized is the carved drainage route and flow. Month 3

Discussion

The main reason for a failure of the trabeculectomy in angle closure glaucoma is the phenomenon of uncommon filtration and a shallow anterior chamber[15 16].

One of the major causes for this failure is the formation of a subconjunctival fibrosis or sub-Tenon fibrotic encapsulation[17]. Multiple manipulations on the conjunctiva (surgical dissection, diathermy, etc.) can increase the risk of rupture or fibrosis induction[18].

The limited manipulations in the subconjunctival space lessen the risk of fibrocyte activation. TCF has a sparing effect on the conjunctiva since tissue sublimation is properly dosed given the advantages of the plasma generator. The high voltage and the high frequency generation ensures low heat propagation and low penetration. Balancing of parameters enables layered tissue sublimation with no spread of heat. This is how the subconjunctival outflow canals remain relatively intact opposed to the disadvantages of the conventional trabeculectomy. The risk of induced fibrosis is smaller and the conditions for the formation of a subconjunctival outflow are better.

The heat spreads at some 25 µm around the tip of the instrument which does not cause a thermal damage to the surrounding tissues and does not cause burns and cicatrices. The filtering bleb is formed by the hydrostatic pressure onto the intact conjunctiva. This is a potential advantage of the procedure. Conjunctiva repositioning resulting from the sclera sublimation reduces compression (similarly to trocar insertion in vitrectomy).

Using plasma for the formation of filtering canals in glaucoma surgery was reported as early as 1979[19]. The main disadvantages of these early techniques are associated with the necessity of multiple repetitions due to the fibrosis formation. The activation of collagen synthesis by the fibroblasts in the Tenon's membrane and the conjunctiva forms cicatricial tissue. The inclusion of MMC and other antimetabolites during surgery has changed dramatically the results observed.[20]. Using low temperature plasma at normal atmospheric pressure allows reducing the risk of induced fibrosis. Low temperature plasma features low hemostatic activity and eventually poses a higher risk of bleeding.

No serious intraoperative complications such as bleeding or thermal burns were observed in any of the patients.

It is a certain disadvantage that for plasma generation, dry surface and a particular distance are required.

When the tip of the instrument contacts the conjunctiva or the sclera, no plasma is generated.

Conclusion

The presented alternative procedure shows a good correlation with the results from the conventional trabeculectomy with regard to reduction of the IOP and reducing the number of the glaucoma medications.

However, it is necessary that the results are analyzed over a longer period of time and in larger data sets which is to some extent a disadvantage of the study.

Transciliary drainage is a minimal invasive procedure and has some advantages for selected patients.

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