ЕПИРЕТИНАЛЕН СРЕЩУ СУБРЕТИНАЛЕН ИМПЛАНТ ПРИ ХИРУРГИЧНОТО ЛЕЧЕНИЕ НА ПИГМЕНТЕН РЕТИНИТ – ОБЗОР

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РЕЗЮМЕ
Целта е да се представи развитието на ретиналните чипове при оперативното лечение на пигментна ретинолна дистрофия. Докладват се технологичните възможности, хирургичните техники и резултати по отношение на зрението при концептуално различните суб- и епиретинални импланти, както и технологичното развитие и очакваният бъдещ прогрес на база публикувани резултати от развойните центрове, произвеждащи този тип чипове. На този етап от развитието на медицината поставянето на ретинален имплант е единственият начин да се върне зрението при пациенти с пигментен ретинит в краен стадий на болестта. Все още е трудно да се определи кой от типовете импланти дава по-добри резултати в дългосрочен план, както и при кой нежеланите странични реакции биха били по-малко. Достъпната в литературата информация дава обнадежващи резултати и надежда за зрение при пациенти с пигментен ретинит в краен стадий на заболяването.

Keywords: пигментен ретинит, суб- и епиретинал имплант, хирургично лечение

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Pigment retinal dystrophy is a clinically and genetically diverse group of hereditary diseases of the retina affecting photoreceptor cells. It may occur sporadically or with an autosomal dominant, autosomal-recessive or X-linked inheritance model (1). More than 150 genetic mutations are known to lead to the production of defective proteins in photoreceptor cells, which disrupts their cellular metabolism and causes their lethal end. As a result, vision decreases over time, the field of vision narrows, nyctalopia ("night blindness"), color vision is disturbed, and in the final stages visual acuity is reduced. At present, two types of therapy are successfully applied. However, they are effective only in the early stages of the disease to slow down progression. These are: gene therapy that uses gene repair vectors, most often adenoviruses, but is of limited value since it is only suitable for patients with mutation in certain genes (PDE6β, PDE6ββ) (2,3); and transcorneal electrostimulation that activates neuroprotective growth factors and also has relevance only in the early stages of the disease (4). The only way to improve visual perception in patients with late-stage pigment retinitis with a lack of useful visual acuity and reduced light perception is to implant a retinal microchip. The retinal implant is a microelectronic microchip replacing the function of damaged sensory cells by electrically stimulating healthy retina neurons.

MATERIALS AND METHODS

The first application of an implantable stimulator to restore vision has been made by Dr. Giles Brindley in 1968 in England. He implanted 80 electrodes in the visual cortex of the right brain hemisphere of a 52-year-old blind man. Thereby, visual perceptions had been created (phosphenes) within the left visual field. At the end of the 1990s a portable system with a miniature camcorder has been introduced (mounted in the glasses frame) connected to a portable computer that processes images, and thus the image is perceived not only as a visual perception (phosphine) but also as a form (5).

The first retinal microimplant approved, in 2011 in Europe and in 2013 in the US, is Argus II (a chip produced by Second Sight) based on data from a large clinical study of 30 people with 60-month follow-up (6). Currently, in many reference centers in Europe and the United States, two types of micro-implants are successfully being placed - epiretinal and subretinal, differing by structure, pattern of action, surgical implantation technique, each having its own indications of placement, advantages and disadvantages.

The selection of patients suitable for surgical treatment is quite important: they must necessarily have the residual function of the inner retina - confirmed by an electroretinogram, preserved light perception, they should not have any additional ocular pathology and significant systemic diseases; to be over the age of 25, and have formal vision.

The epiretinal implant is made up of six parts: three intraocular and three extraocular. The vision field is scanned from a microcamera built into glasses. The visual information is processed and transformed by a video-processing portable device and transmitted wirelessly via a transmit antenna in the glasses to an antenna receiving part of the video-processing portable device, which converts their cellular metabolism and causes their lethal end. As a result, vision decreases over time, the field of vision narrows, nyctalopia ("night blindness"), color vision is disturbed, and in the final stages visual acuity is reduced. At present, two types of therapy are successfully applied. However, they are effective only in the early stages of the disease to slow down progression. These are: gene therapy that uses gene repair vectors, most often adenoviruses, but is of limited value since it is only suitable for patients with mutation in certain genes (PDE6β, PDE6ββ) (2,3); and transcorneal electrostimulation that activates neuroprotective growth factors and also has relevance only in the early stages of the disease (4). The only way to improve visual perception in patients with late-stage pigment retinitis with a lack of useful visual acuity and reduced light perception is to implant a retinal microchip. The retinal implant is a microelectronic microchip replacing the function of damaged sensory cells by electrically stimulating healthy retina neurons.

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Epiretinal vs. Subretinal Implant in Surgical Treatment of Retinitis Pigmentosa – a Review

The surgical procedure for implantation of the epiretinal chip requires general anesthesia and lasts several hours. The operation is carried out in one step, starting with a peritomy of 360 degrees, isolating the four rectus muscles and a superotemporal quadrant under the lateral rectus muscle. The receiving antenna and the microelectronic box are sewn to the sclera with a technique similar to a scleral buckle (Fig. 2). Next step is a pars plana vitrectomy, superotemporal sclerotomy, full-thickness choroidotomy and the implant is fixed to the surface of the retina, in the macular area by means of a retinal tack (Fig. 3), while remaining attached to the electronic box by means of polymer cable. The extra-ocular part of the cable is sewn with a mattress suture (Fig. 4) (7,8,9).

The subretinal implant consists of three parts: 1. a microchip consisting of 1600 photodiodes that transform directly the light on it into an electrical signal; from there, the signal reaches the healthy...
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60 electrodes, each with a diameter of 200 microns) stimulates the healthy layers of the retina, then the information is passed through the visual nerve to the brain. The surgical procedure for implanting the epiretinal chip requires general anesthesia and lasts for a few hours. It is performed in one stage, starting with a peritomy of 360 degrees, isolating the four rectus muscles and suturing the receiving antenna and microelectronic box to the sclera, similar to a scleral patch (Fig. 2). A pars plana vitrectomy is performed and a 41 G subretinal cannula with BSS is used to form a subretinal blister comprising a superotemporal retina and macula (Fig. 6). Linear sclerotomy and choroidotomy are created at the base of the scleral flap. The retinal implant is inserted into the subfoveal region with a flexible polyamide foil and the foil is removed.

Surgical intervention for insertion of the subretinal implant is done in two stages: extra-ocular - consisting of retro-auricular insertion of the coil by a cochlear implantologist; an intracochlear part in which the subretinal chip is placed under fovea centralis, between the pigment epithelium and the inner retina. An opening is created at the superotemporal orbital rim in order to convey the implant and the connecting cable behind the ear. A scleral flap is formed in partial thickness superotemporally. A pars plana vitrectomy is performed and a 41 G subretinal cannula with BSS is used to form a subretinal vesicle comprising a superotemporal retina and macula (Fig. 6). Layers of the retina are activated and passed through the visual nerve to the brain; 2. a transponder - microchip charging device, attached with a magnet behind the ear, connected to a coil which is built in superosteally; 3. a portable battery device which adjusts the brightness and contrast under the conditions of the environment (Fig. 5).
пигментния епител и вътрешната ретина. Създава се отвор в горен телескомпютърен дърър за преминаване на импланта и създаващия кабел от към ухото. Оформя се склорамо и бързо в частична дебелина горе – телескомпютърно. Извършва се парс плана бързопроекционен и с 41 G субретинална канюла и BSS се оформя субретинално междуре, обхващащо гората телескомпютърна ретина и макула (Фиг. 6). Създава се линейна склеротомия и хориотомия в основата на склералното ламбо. Чрез гъвкаво поламдионно фолио се въвежда ретиналия имплант в субретиналното пространство, след което ендотомно се извършва (Фиг. 7). Имплантът остава прикрепен към ретината с водоустойчива поламдионна фолио. Създаващият кабел се приви към склорама. Поставя се силиконова тампонада (10,11).

Според резултатите от две големи клинични проучвания на BvAта водещи представители на ретиналия импланти: Alpha AMS – субретинален имплант от 2017 г., с 12-месечно проследяване в Университетската клиника в Ройтлингер – Германия (10), и Argus II епиретинален имплант – от 2018 г., Университетската клиника – Бордо, Франция (6), пациентите подобряват качеството си на живот и дейността в ежедневието си с над 75%. Те разпознават големи букви, шифри, геометрични фигури, сърцата и прибори, определят посоката на движещо и източника на светлина.

**Обсъждане**

На този етап от развитието на ретиналия импланти и хирургичната методика на тяхното поставяне е трудно да се определи кои от вообшето импланти е по-надежден и улеснява телескомпютърно движение и източника на светлина.

DISCUSSION

At this stage of the development of retinal implants and the surgical method of their placement, it is difficult to determine which type of implants is more reliable in the long run, and in which side effects would be less. An advantage of the epiretinal implant over the subretinal is that it directly stimulates the ganglion cells as it is more superficially located. Thereby, it can be applied to patients in whom all other layers of the retina are damaged. The advantage of the subretinal implant is that the reception and processing of the visual information is done directly by the microphotodiodes from which the implant is built, unlike the epiretinal, in which the image is perceived by the micro camera embedded in the glasses. Thus, the subretinal implant allows patients to freely use the movement of their eyes. The drawback of the epiretinal is the limited eye movement of the patients, as the vision field is scanned from the video camera, which requires further longer training of the patients. It is possible postoperative rotation of the epithelial implant around its axis and the occurrence of retinal glisis between the surface of the retina and the implant (7,8,9). A disadvantage of the subretinal implant is its limited application in patients with lesions extending beyond the external photoreceptor layer, i. e. requires intact inner and middle layers of the retina. Cases of poor post-operative result due to microtrauma of the polyamide foil during implantation have been reported. Postoperative retinal detachment is not common with both types of implants. Cases of inferior temporal detachment with on macula have been reported and successfully treated (10,11).

**Заключение**

A newly invented photovoltaic implant that is fully powered by infrared light emitted by video glasses. From the beginning of 2018 a clinical study of patients has been initiated, with expectations for very good results and high resolution postoperatively, since the implant is made up of a large number of electrodes on a small area, and it does not require complicated surgical intervention as with implants until now fed with extraderronic electronics connected to the implant via a trans-scleral cable (12). At this stage of its development, medicine is in the process of searching for the perfect model of a retinal prosthesis to help blind people.

CONCLUSION

A newly invented photovoltaic implant that is fully powered by infrared light emitted by video glasses. From the beginning of 2018 a clinical study of patients has been initiated, with expectations for very good results and high resolution postoperatively, since the implant is made up of a large number of electrodes on a small area, and it does not require complicated surgical intervention as with implants until now fed with extraderronic electronics connected to the implant via a trans-scleral cable (12). At this stage of its development, medicine is in the process of searching for the perfect model of a retinal prosthesis to help blind people.
темпорално отлепване с лежаща макула, което са успешно лекувани (10,11).

Заключение
Тепърва навлиза нов фотоволтаичен имплант, който се захранва напълно безжично от инфрачервена светлина, излъчваща се от видеоочила. От началото на 2018 г. е стартирано клинично проучване на пациенти, като се очакват много добри резултати и висока разделителна способност постоперативно, тъй като имплантът е изстроен от голям брой електроди на малка площ и за поставянето му не е необходимо сложна хирургична интервенция, както при имплантите до момента, които се захранват с екстракуларана електроника, свързана с имплант чрез транссклерален кабел (12). На този етап от развитието медицината е в процес на търсене на съвършения модел ретинална протеза, в помощ на незрящите хора.

REFERENCES