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Original research

Implantation of multiple suprachoroidal electrode arrays in rabbits

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Abstract

Purpose: Epiretinal and subretinal prosthesis have been shown to be a valid way to provide some vision to patients with advanced outer retinal degeneration and profound vision loss. However, the field of vision for these patients is markedly limited by the area occupied by the electrode array. In this study, we aimed to evaluate the feasibility of implantation of multiple suprachoroidal electrode arrays in a single eye in order to increase the field of vision in patients implanted with retinal prosthesis.
Methods: The right eye of seventeen Dutch rabbits (age range, 5−6 months) was used for the study. Multiple inactive custom-made electrode arrays were inserted into the suprachoroidal space (SCS) and animals were followed up for up to 6 months using fundus photography, optical coherence tomography (OCT), and fluorescein angiography (FA).
Results: It was possible to surgically implant up to 8 electrode arrays in a single eye. None of the rabbits showed any major complications. The electrodes were well tolerated and remained in position in all rabbits. There was no evidence of retinal damage on follow-up exams and FA throughout the study.
Conclusion: Multiple suprachoroidal electrode array implantation is feasible and may provide a novel approach to increase the field of vision in subjects implanted with retinal prosthesis.

Keywords: Suprachoroidal; Electrodes; Array; Retinal prosthesis; Retinal implant

Introduction

Retinitis pigmentosa (RP) is an inherited degenerative retinal disease that leads to specific loss of photoreceptors and retinal pigment epithelium (RPE) ending with severe vision impairment.[1] Using the existing visual pathway to create visual percepts (‘phosphenes’) by electrical stimulation of the surviving inner retinal neural elements can restore some vision in these patients.[2,3]

Different locations have been proposed for implanting a stimulating array currently under development. These arrays may be placed on the surface of the retina,[4−11] in the subretinal space,[12−15] within the suprachoroidal space (SCS),[16−19] within the scleral tissue,[20] or on the surface of the sclera. With all approaches, the visual field is limited by the surface area of the implanted array.[21] Implantation of a large electrode array can increase visual field; however, this requires large scleral incision and associated complications. A wide-field, round, epiretinal electrode array, 10 mm in diameter, that can be implanted through a similar size sclerotomy as that for Argus II implantation, has been developed and successfully implanted in canines.[22] Similarly, a wide-field suprachoroidal electrode array, 19 × 8 mm, has been successfully implanted in cats.[19] However, even with these wide-field electrode arrays, a large portion of the retina remains uncovered. Implantation of multiple electrode arrays could potentially allow

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placement of electrode arrays in all quadrants of the eye, dramatically increasing the visual field in patients implanted with retinal prosthesis.

The purpose of this study is to evaluate the feasibility of implantation of multiple electrode arrays in the SCS in rabbits.

Methods

All animal experiments were conducted in accordance with the Association for Research in Vision and Ophthalmology (ARVO) Statement for the Use of Animals in Ophthalmic and Vision Research.

For all animal procedures, the rabbits were anesthetized with a subcutaneous injection of a mixture of ketamine hydrochloride (25 mg/kg) and xylazine hydrochloride (6 mg/kg).

Animal groups

Seventeen Dutch rabbits, weighing 2—3 kg, (age range, 5—6 months) were used in the study. Only the right eye of each animal was used for the study, and the follow-up period was 6 months. The pupils were dilated with topical application of phenylephrine hydrochloride 2.5% and tropicamide 0.5% eye drops.

Test material

Inactive custom-made electrode arrays of 15—25 μm thick, 2 mm wide and 8 mm long, attached to a cable of the same width were used for implantation. The arrays were made of parylene (Fig. 1).

Surgical procedure

A speculum was used to hold the eyelid open and the periorbital area of one eye was cleaned with a drop of 5% povidone-iodine solution instilled into the fornix.

A limited fornix-based conjunctival peritomy was created using Westcott scissors in the quadrant planned for the implantation. A sclerotomy 2 mm in width, 4 mm behind the limbus, was created using Beaver Blade No. 15 (Beaver-Visitec International Inc, Waltham, MA). Counter-traction was provided by gripping or supporting the limbus, directly opposite to the incision. In some cases, in which there was bulging of the choroid following scleral incision, anterior chamber paracentesis was required to prevent choroidal rupture using a 30° supersharp blade (Katena Products, Inc., Denville, NJ).

The SCS was opened up by injection of Goniosol GONAK® (Hypromellose ophthalmic solution 2.5%, Alcon, Inc., Lake Forst, IL), immediately under the sclera followed by advancing the array in the created space for 8—10 mm using blunt conjunctival forceps. The redundant array cable was then cut about 2 mm from the sclerotomy site. Each electrode array was inserted through a separate scleral incision. Fundus exam was then performed to ensure that the array was not misplaced in the subretinal space or perforating into the vitreous cavity. Then the sclerotomy site and the conjunctival peritomy were closed with 6/0 vicryl and 8/0 nylon sutures, respectively.

Analgesia in the form of buprenorphine (Buprenex) IM injection of 0.01—0.05 mg/kg was administered immediately after surgery and 24 h later followed by test article. Gentak (Gentamicin Sulfate Ophthalmic ointment USP, 0.3%,

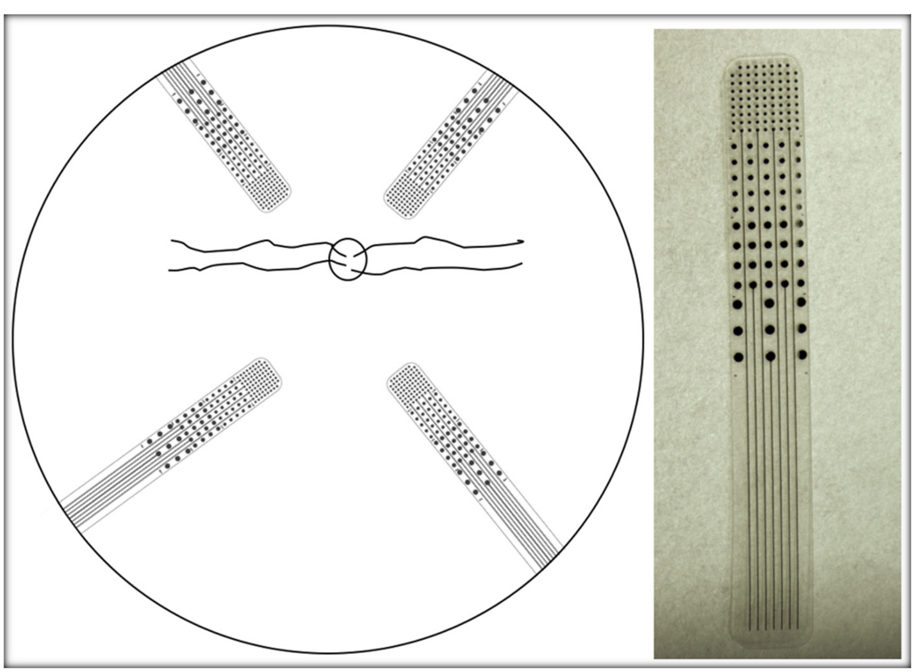

Fig. 1. Suprachoroidal electrode array. Left: Schematic illustration of the posterior segment of a rabbit eye with 4 electrode arrays in 4 different quadrants. Right: Microphotograph of the electrode array.

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