

POLYMETHYLMETHACRYLATE WITH INTERCONNECTING CHANNELS AS ORBITAL IMPLANT IN RABBITS

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ABSTRACT

Evaluate the polymethylmethacrylate (PMMA) in the form of spheres, provided with interconnecting channels, such as orbital implants in rabbits. Six New Zealand rabbits underwent enucleation of the left eye, with subsequent implantation of a 12mm diameter PMMA spheres fitted with interconnecting channels. Clinical evaluation was performed daily during the first 15 days after surgery and every 15 days until the end of the study period (45 days). For histopathological analysis three animals per experimental period were submitted to exenteration at 15 and 45 days after implantation. There was no wound dehiscence, signs of infection or implant extrusion in any animal throughout the study period. On macroscopic examination, there were several outbreaks of tissue invasion into the implant, forming beams. This type of implant allows migration of fibrovascular tissue, providing more support and no complications.

KEYWORDS: Artificial eye, enucleation, eye, orbital implants, polymers

POLIMETILMETACRILATO MUNIDO DE CANAIS DE INTERCONEXÃO COMO IMPLANTE ORBITÁRIO EM COELHOS

RESUMO

Avaliar o polimetilmetacrilato (PMMA) na forma de esferas, munido de canais de interconexão, como implantes em órbita de coelhos. Seis coelhos da raça Nova Zelândia foram submetidos a enucleação do olho esquerdo, com posterior implantação da esfera de PMMA munida de interconexões com 12 mm de diâmetro. A avaliação clínica foi realizada diariamente nos primeiros 15 dias após a cirurgia e em intervalos de 15 dias até o final do período de estudo (45 dias). Para análise histopatológica três animais por período experimental foram submetidos à exenteração aos 15 e 45 dias após a colocação do implante. Não foi observada deiscência da ferida, sinais de infecção ou extrusão do implante em nenhum dos animais durante todo o período do estudo. À macroscopia, observaram-se vários focos de invasão tecidual no implante, formando traves. Tal modalidade de implante

permitiu a migração de tecido fibrovascular e conferiu maior sustentação com ausência de intercorrências.

PALAVRAS-CHAVE: Enucleação, implantes orbitários, olho, olho artificial, polímeros

INTRODUCTION

Enucleation is the most common orbital surgery in animals (SPIESS, 2007), it is indicated for cases of blind and painful eyes, severe glaucoma, endophthalmitis or extensive ocular trauma. This procedure is also indicated for the treatment of intraocular tumors not eligible for other forms of medication or surgical therapy (SPIESS, 2007; PARK et al., 2010; NARIKAWA et al., 2011; FOSSUM, 2013).

Even without presenting major complications enucleation usually leads to an orbit concave and cosmetically unacceptable appearance. Alternatively biologically inert substances can be used to fill dead orbital space (ARAF et al., 2010; BRANCO et al., 2012; GOMES JUNIOR, 2012; SORANZ FILHO et al., 2012; MIYASHITA et al., 2013).

Notably in the human medical field, different types of materials were tested to fill anophthalmic cavities such as glass, cartilage, bone, ivory, polymethylmethacrylate, porous polyethylene, hydroxyapatite, and others (CUSTER & REISTAD, 2000; SU & YEN, 2004; SPIESS, 2007; BRANCO et al., 2012; GOMES JUNIOR, 2012; SORANZ FILHO et al., 2012; MIYASHITA et al., 2013). However, the implantation of silicone and polymethylmethacrylate are routinely used in veterinary medicine (NASISSE et al., 1988; TALIERI et al., 2004; SPIES, 2007; ORÍA et al., 2012) and hydroxyapatite and porous polyethylene in human medicine (YOON et al., 2008; SORANZ FILHO et al., 2012), aiming the improvement of cosmetic appearance after surgical procedures such as exenteration, enucleation or evisceration of the eyeball.

Considering prosthetic surgery as a significant procedure in ophthalmology, we aimed in this research the investigation of an alternative form of implant made of polymethylmethacrylate with interconnecting channels to fill anophthalmic socket in rabbits.

MATERIALS AND METHODS

The spheres of PMMA (Acrílico auto-polimerizante JET, Clássico artigos odontológicos Ltda, Brazil) are made mixing the powder (polymer) to liquid (monomer) in a 1:1 ratio in sterile bowl until obtaining liquid slurry, according to manufacturer's directions. The paste was then injected into the 12 mm silicon ball mold using a 3 ml syringe. After 20 minutes (time required for hardening and cooling) the ball was removed from the mold.

Subsequently, ten equidistant channels were made around the implant with a conversion center. To this end, the points for the holes were previously measured and marked, then, the implant was drilled using a bench drill with drill bits of 1.5 mm (Figure 1). Immediately thereafter, the implants were washed, individually packaged and sterilized by autoclaving, at 132 °C for 20 minutes (NASISSE et al., 1988).

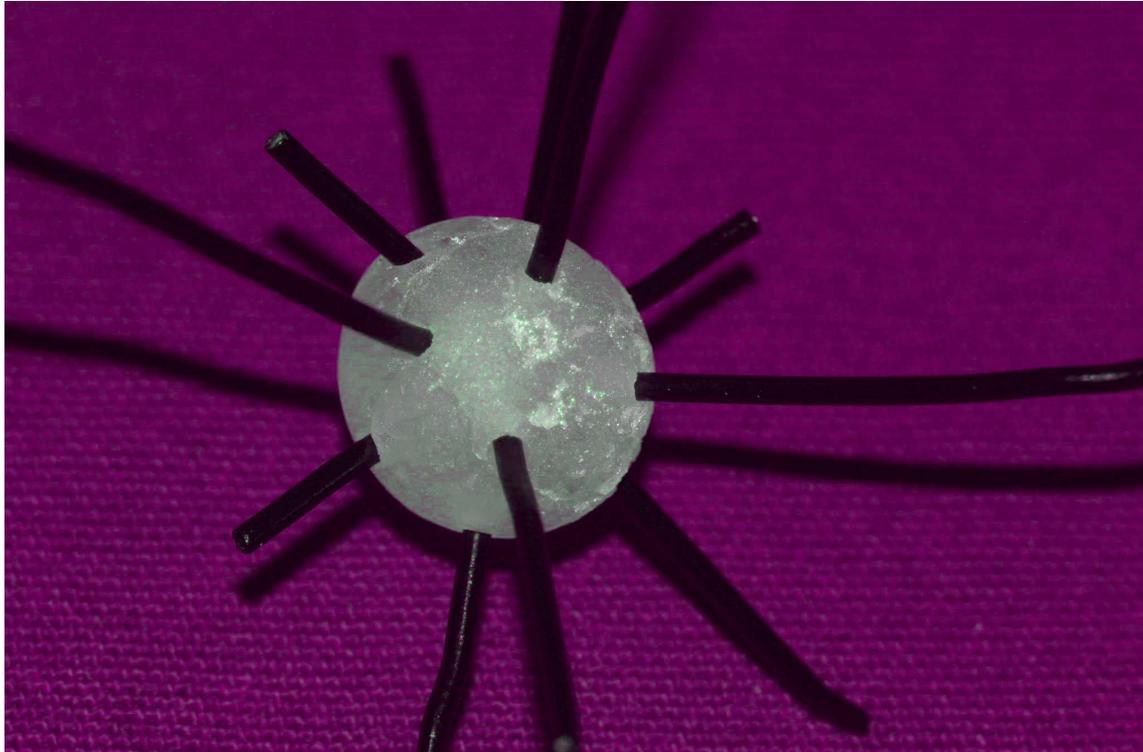


FIGURE 1. Photographic image of the polymethylmethacrylate implant fitted with interconnecting channels. Note the channels with central convergence evidenced by the insertion of black metal poles.

Fonte: arquivo pessoal

Six adult New Zealand rabbits (*Oryctolagus cuniculus*) males, weighing 2.0 to 3.5 kg, obtained from a breeding center were used. Seeking to use healthy individuals, the animals were evaluated prior to inclusion in the study, following the clinical and ophthalmic routine examination, particularly regarding the evaluation of the anterior segment by means of light source and magnifying visor, direct ophthalmoscopy and fluorescein stain. The healthy rabbits were identified and kept in individual cages with dimensions of 60x60x40cm in length, width and height, respectively, with appropriate water and food ad libitum.

The research protocols were approved by the Ethics and Animal Welfare (Protocol: 26716). Also following guidelines recommended by the bioethical ARVO - Association for Research in Vision and Ophthalmology (National Institutes of Health Publications In 85-23: Revised, 1985), according to the Nuremberg Code.

For the surgical procedure a two hour fasting period was adopted. The rabbits were premedicated with atropine sulfate at a dose of 0.1 mg / kg subcutaneously. After 15 minutes, the animals underwent anesthesia induction with ketamine hydrochloride (Vetanarcol, König S.A., Argentina) and xylazine (Virbaxil, Virbac, Brazil) at doses of 35mg/kg and 5mg/kg, respectively, in the same syringe and administered intramuscularly. Immediately thereafter a retrobulbar block was done

using lidocaine with epinephrine (Xylestesin, Cristália, Brazil) at a dose of 5mg/kg. All surgical procedures were performed by the same surgeon with the animals on general halothane inhalatory anesthesia (Halothane, Cristália, Brazil).

The left eye of each animal was enucleated. Subconjunctival surgical technique was adopted. The implant was placed in the space formerly occupied by the bulb and fixed by suturing the remnants of the conjunctiva and extraocular muscles with the use of simple interrupted suture pattern followed by intradermal suture both wired polyglactin 910 4-0 (Ethicon, United States of America). For the skin suture a monofilament nylon thread was used 4-0 with simple interrupted suture pattern.

Immediately after surgery, the rabbits received ketoprofen (Profenid, Sanofi-Aventis, Brazil) at a dosage of 1 mg/kg per body weight, subcutaneously, and then at regular 12-hour intervals for the first 3 postoperative days. As a prophylactic measure, each animal received enrofloxacin (Baytril, Bayer, Brazil) at a dose of 10mg/kg, intramuscularly, at intervals of 24 hours during the first three days after surgery. To provide postoperative comfort to the animals, 10 mg/kg pethidine hydrochloride (Dolosal, Cristália, Brazil) was administered subcutaneously immediately after surgery. The ocular surface was cleaned daily with 0.9% saline solution and a polyvinylpyrrolidone solution was applied every 24 hours for five consecutive days. No protective collar was needed at any time during the experiment.

Clinical evaluation was performed daily for the first 15 postoperative days and then at 15-day intervals until the end of the experimental period. All ocular manifestations considered to be abnormal during postoperative evolution were recorded. Postoperative complications and other ocular manifestations were investigated.

Three animals were exenterated at 15 and 45 days after the initial surgery. The contents were immersed in buffered 10 % formalin solution and sent to the pathology center of the Veterinary College of Federal University of Bahia, to macro and microscopic analysis.

RESULTS AND DISCUSSION

The removal of the eye or its internal content requires the insertion of a solid implant for the maintenance of orbital volume and its cosmetic appearance (SPIESS, 2007; ARAF et al., 2010; BRANCO et al., 2012; GOMES JUNIOR, 2012; SORANZ FILHO et al., 2012; MIYASHITA et al., 2013). Therefore we aim with this study to evaluate the behavior of polymethylmethacrylate provided with channels such as interconnections intraorbital implant in rabbits submitted to enucleation.

This study did not aim to evaluate the biocompatibility of PMMA as a material option once it is well tolerated by the animal organism. Instead, the study identified a new type of implantation of PMMA, ie, filled with interconnecting channels, for use as an orbital implant in order to allow tissue migration. It should also be noted that this new design of implant is inexpensive, easy processing and can be manufactured by hand.

The weight of the ball was on average 2.37 grams. The outer surface of the implant was solid, compact and irregular, with clear evidence of channels/holes. Central communication interconnections were present on the inner surface.

Despite many options, there is no consensus on the preferred type of implant to be adopted to fill anophthalmic cavities. Even with the many benefits reported, for

the porous implants, such as lower rates of infection and extrusion, some surgeons have advocated use acrylic and silicone spheres considering the low complication rates (CUSTER & REISTAD, 2000; SU & YEN, 2004; ORIÁ et al., 2012). The success in the use of a biomaterial to fill anophthalmic cavities depend on the physical, chemical and biological properties of the implants, the condition of the receiver and the surgeons expertise to introduce and monitor the progress of the patients (JORDAN et al., 2002).

PMMA is a material that does not allow tissue incorporation, except the covering of the corneoscleral intraocular implant (ORIÁ et al., 2012), however this experimental work has showed the migration of tissue towards the center of the PMMA implant, through the interconnection channels, which was observed in other types of integrable implant described in the literature as hydroxyapatite and porous polyethylene (TABATABAEE et al., 2011) and non integrable (GOMES JUNIOR, 2012; MIYASHITA et al., 2013).

Systemic events were not observed in any of the animals that received the implants. Suture dehiscence and signs of infection were not identified and there was no implant extrusion. It was noted, only postoperative edema was observed in the orbital region in all animals, which remitted within 120 hours.

Clinical evaluation of the rabbits in this study showed that the material was well tolerated, unlike what was reported by authors with other materials, in reporting migration, suture dehiscence and spherical implant extrusion a main complications (RUBIN et al., 1994; SCHELLINI et al., 2003; TABATABAEE et al., 2011). The postoperative edema observed in our experiment is common and well reported by others as coming from hemorrhage (SLATER & BASHER, 2007). The same disappeared in 5 days.

In the macroscopic evaluation at 15 days the presence of tissue between the implant was observed in the form of conjunctival proliferation without definite arrangements, with irregular surface, firm and yellowish-white color, molded to the implant and presenting infiltration in some areas.

At 45 days the implants were completely covered by thick and pale fibrous connective tissue. It was possible to see several tissue migration into the implant, forming beams (Figure 2).

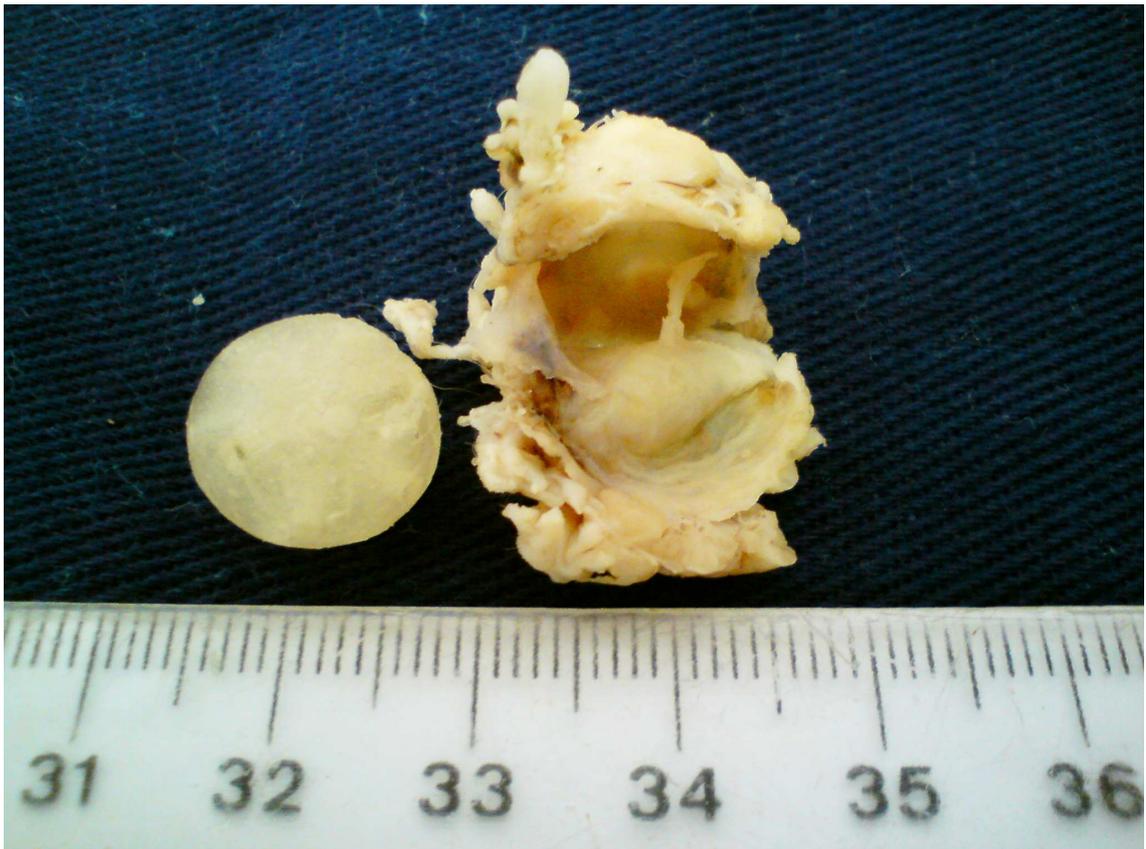


FIGURE 2. Macrophotography of the implant and fibrocellular cap that surrounded it at 45 days after surgery. Note various signs of tissue invasion to the implant creating beans and the surrounding smooth areas.

Fonte: Arquivo pessoal.

Microscopically it was observed leaving the fibrocellular cap that connects the implant to the host tissues; a focal exophytic growth consisted of immature fibrovascular tissue associated with mild lymphocytic infiltrate (Figure 3).

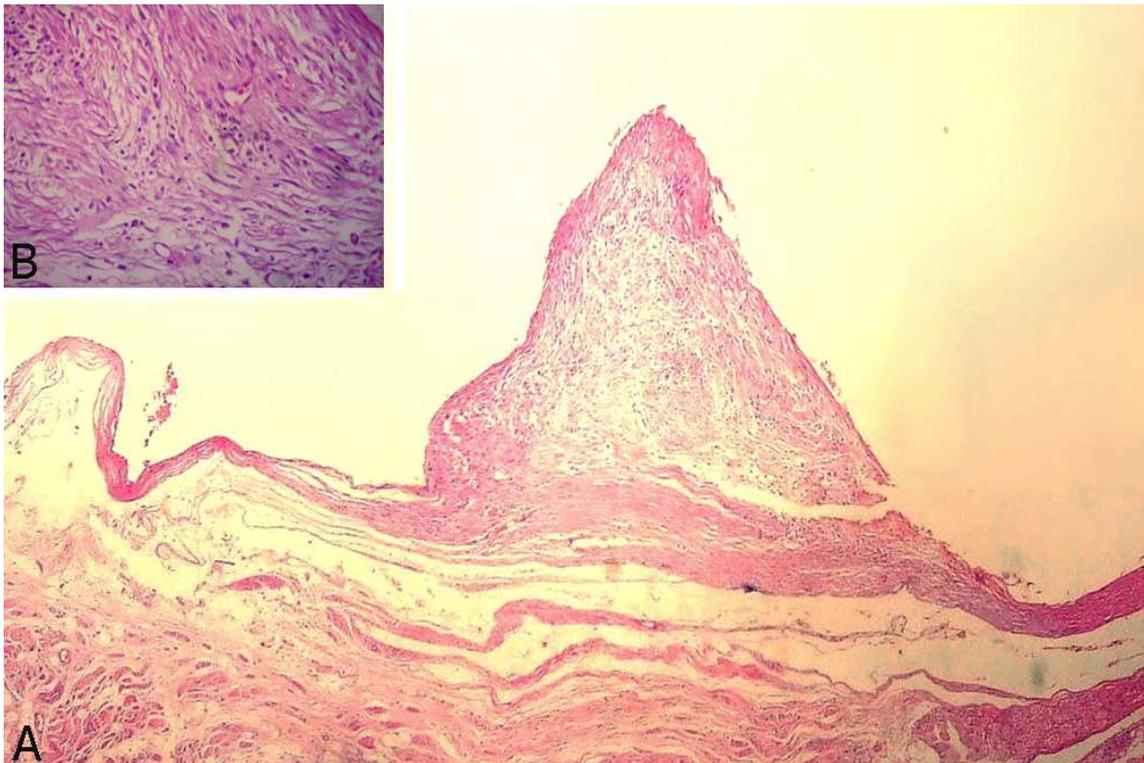


FIGURE 3. Section obtained 45 days after intraorbital insertion of a polymethylmethacrylate sphere fitted with interconnecting channels. Note (A) focal exophytic growth - HE 40X; (B) Detail of Figure A: granulation tissue associated with mild inflammatory infiltrate.

Fonte: Arquivo pessoal

CONCLUSION

The making of polymethylmethacrylate implants with interconnecting channels, with predefined numbers of holes and size, allowed the migration of fibrovascular tissue, providing more support and absence of complications such as infection, implant exposure and extrusion. Thus further research concerning the behavior of such implants considered non-integrable in the form of intraocular implant should be performed.

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