

Anophthalmic socket: choice of orbital implants for reconstruction

Cavidade anoftálmica: escolha de implantes orbitais para reconstrução

SILVANA ARTIOLI SCHELLINI¹, REGINA EL DIB¹, ROBERTO MURILLO LIMONGI², RICARDO MÖRSCHBÄCHER³

ABSTRACT

This literature review considers the treatment of an anophthalmic socket and the controversial aspects of the implants used to restore the lost volume after enucleation or evisceration, including the different materials employed and the main problems encountered during anophthalmic socket reconstruction. Since the 1980s, when integrated implants were proposed, there has been much controversy about what is the best implant for restoring the lost volume in an anophthalmic socket: integrated or non-integrated implants. Thus, we present this literature review to provide guidance to doctors and consumers

Keywords: Anophthalmic surgery; Ophthalmological surgical procedures; Orbital implants; Reconstructive surgical procedures

RESUMO

Esta revisão da literatura abrange o tratamento da cavidade anoftálmica, assim como os controversos aspectos relacionados com os implantes de cavidade utilizados para recompor o volume perdido após enucleações ou eviscerações, tais como os diferentes materiais utilizados e os principais problemas enfrentados na reconstrução da cavidade anoftálmica. Depois dos anos 80 do século passado, quando foram introduzidos os implantes integrados, há muitas controvérsias sobre qual seria o melhor implante para recompor o volume perdido na cavidade anoftálmica: implante integrado ou não integrado? Desta forma, apresentamos esta revisão da literatura, que procura melhor orientar médicos e consumidores.

Descritores: Anoftalmia/cirurgia; Implantes orbitários; Procedimentos cirúrgicos oftalmológicos; Procedimentos cirúrgicos reconstrutivos

DEFINING THE PROBLEM

An anophthalmic cavity or anophthalmic socket refers to an orbit that lacks an eye. This condition may be attributable to one of the following causes:

- 1) Congenital: related to a hereditary condition that causes no development of the optic vesicle. If remnants of the optic vesicle or underdeveloped eye structures are present, the condition is known as clinical anophthalmia and additional tests are required to define the situation⁽¹⁾.
- 2) Acquired anophthalmia: this occurs secondary to ocular or systemic diseases, which result in a blind and painful eye (chronic uveitis, absolute glaucoma, proliferative diabetic retinopathy, trauma, or unsuccessful eye surgery), or extensive intraocular tumors (melanoma or retinoblastoma)⁽²⁻⁵⁾.

The eye can be removed by enucleation or evisceration and both types of surgeries are indicated, except in the case of intraocular tumors where enucleation is mandatory⁽⁵⁾.

The absence of the eye or its contents leads to major changes in the physiology and dynamics of the orbit, and for cosmesis, it is necessary to replace the orbital volume using autologous or homologous tissues or implants made of haloplastic materials, which are usually in the form of spheres⁽⁵⁾.

The haloplastic implants can be made of different materials but the most common are polymethylmethacrylate (PMMA) and silicone^(4,6-8).

SIGNS AND SYMPTOMS

Patients with an anophthalmic socket often complain of secretion. Asymmetry and bad cosmesis may result in a lack of orbital volume, and changes in the positions of the eyelids may often lead to pseudoptosis, eyelid retraction, or reduced prosthesis motility in subjects

with anophthalmic cavities. They may also complain of pain in the missing eye^(5,8).

CLASSIFICATION

An anophthalmic socket can be classified into five categories depending on the degree of contraction of the conjunctiva and orbital tissues^(5,7). It is very important to differentiate the grade of contraction for the anophthalmic cavity to select the best treatment as follows:

- 1) Grade 1: there is no contraction of the tissues in the cavity and it is only necessary to replace the lost volume with implants in the orbital cavity.
- 2) Grade 2: the cavity exhibits scar retraction of the lower fornix, and the treatment should include a graft of skin or mucosa besides the use of implants in the cavity for volume replacement.
- 3) Grade 3: this occurs when the inferior and superior fornix are shallow, and the treatment requires even larger grafts and the placement of implants or dermal-fat grafts for volume replacement.
- 4) Grade 4: this involves the contraction of the entire fornix and the treatment is dermo-fat or skin grafts to expand the whole fornix.
- 5) Grade 5: besides the contraction of the entire fornix, micro-orbits are also present, which requires a complex treatment to expand the orbit bone walls^(5,7).

IMPLANTS AND RECONSTRUCTION OF THE ANOPHTHALMIC CAVITY

After enucleation or evisceration, it is necessary to replace the lost volume in the orbit, which is a condition that was recognized since the beginning of the 20th century⁽⁹⁾.

Submitted for publication: January 13, 2015
Accepted for publication: July 6, 2015

¹ Universidade Estadual de São Paulo "Júlio de Mesquita Filho" (UNESP), Botucatu, SP, Brazil.

² Universidade Federal de Goiás (UFG), Goiânia, Goiânia, GO, Brazil.

³ Universidade Federal do Rio Grande do Sul (UFRGS), Porto Alegre, RS, Brazil.

Funding: No specific financial support was available for this study.

Disclosure of potential conflicts of interest: None of the authors have any potential conflicts of interest to disclose.

Corresponding author: Roberto Murillo Limongi. Al. das Rosas, 501/2203, Setor Oeste - Goiânia - GO - 74110-060 - Brazil - E-mail: rmurillousp@hotmail.com

The first orbital implants were produced by Mules in 1885, who used hollow glass spheres to restore the anophthalmic cavity volume. Subsequently, diverse materials were used to manufacture orbital implants; however, the advances in this field progressed relatively slowly until the 1940s when various materials were suggested. The most successful were PMMA and silicone spheres, and the use of both has spread throughout the world⁽⁹⁾.

PMMA and silicone implants are both smooth, non-porous, and non-integrated implants, which are inert and they cause little reaction in the host. These are still the most popular implants⁽¹⁰⁾.

A revolution in anophthalmic cavity reconstruction occurred when integrated implants emerged in the 1980s to improve the results obtained during anophthalmic cavity treatment, particularly in terms of the mobility of the external prosthesis⁽¹¹⁾.

Conjugate movement with the contralateral normal eye is important for cosmesis, and the implant proposed by Perry⁽¹¹⁾, using the natural hydroxyapatite, can receive a screw that connects the implant to the external prosthesis to better transmit the movements of the extraocular muscles to the external prosthesis, thereby enhancing the overall cosmetic result for the patient⁽²⁾.

Thus, the main reason for using integrated implants with a coupling system between the implants and external prosthesis was to improve mobility. However, numerous complications have been described, which are caused by dehiscence and the exposure of the implants, and they necessitate the removal or extrusion of the integrated implants^(2,12-14). Therefore, the pegging system is rarely used at present⁽¹⁰⁾. However, if pegging is not planned, there is no advantage in terms of mobility when using porous orbital implants instead of solid silicone spheres⁽⁴⁾.

Many surgeons were encouraged to use the integrated implants as a new option to solve the problems of extrusion that occurred with the non-integrated implants.

Initially, some researchers were excited about the hydroxyapatite implant; however, the same complications that occurred with the non-integrated implants were reported soon after the use of these implants^(15,16).

The use of natural hydroxyapatite was followed by other integrated or porous implants, such as synthetic hydroxyapatite and porous polyethylene^(4,17-19).

The follow-up of patients was decisive for identifying problems that may occur with the integrated implants, which were at least as common as those with the non-integrated implants. Dehiscence of the conjunctiva and sclera were increasingly frequent, and the exposure rates ranged from 2.9% to 62%, which were influenced by many factors such as the surgical technique employed (enucleation or visceration), removal of the cornea or not⁽²⁰⁾, the use of wraps or not, the length of follow-up, and systemic diseases in the anophthalmic socket^(2,4,21,22).

Ultimately, it is impossible to state whether extrusion or the need to remove implants will not occur when using integrated implants. Exposure may favor the colonization of porous implants by bacteria and by dense inflammatory infiltration, thereby necessitating implant removal when spontaneous extrusion does not occur⁽²³⁾.

Previous studies provide no evidence that integrated implants are superior to non-integrated implants^(2,24,25). The superiority of porous polyethylene has been reported but others note that porous polyethylene has the same rate of complications as other porous⁽²⁶⁾ or non-porous implants⁽³⁾.

Several case reports indicate that complications have occurred with all of the different types of implants. Randomized studies and long-term follow-up are required to conclusively determine the performance of implants^(4,19).

Therefore, according to the current state-of-the-art and for the implants that exist in the market, it is possible to affirm that there is no ideal implant and that the integrated implants do not perform better than the non-integrated implant⁽²⁾.

For all patients, follow-ups should be performed with periodic examinations at least once a year to assess the signs of complications, such as thinning of the conjunctiva or the sclera, dehiscence, migration of the implant, or signs of extrusion. Extrusion can occur regardless of the type of implant used, and it may have many causes, such as a poorly adapted external prosthesis causing constant trauma on the conjunctival surface.

SHAPE AND SIZE OF IMPLANTS

In addition to the different materials employed, the shape and size of implants may also vary. The most widely used implant format is spherical but other formats may be available, such as conic, pear shaped, "ball-and-ring," and quasi integrated⁽⁴⁾. The main reason for changing the implant format depends on the movement of implants and researchers are aiming to develop an implant that facilitates a better transmission of extraocular muscular movements to the external prosthesis.

The size of the implant is also related to the orbit dimensions. Thus, in childhood, the implant must be appropriate for the size of the orbit, and it should be replaced according to the growth of the child's orbit until they reach the adult orbital size⁽⁸⁾. The use of porous implants in the pediatric population has been advocated; however, if implant exchange is required later, its removal is more difficult due to fibrovascularization. Therefore, non-porous implants are the preferred choice in children by the majority of surgeons⁽⁴⁾.

The size of the implant varies according to the extent of the orbit and the degree of contraction of the orbital tissue, where most spheres vary from 16 to 24 mm in diameter⁽⁵⁾.

A PMMA sphere with a diameter of 20 mm is the first choice for adults among the Brazilian surgeons⁽¹⁰⁾. In the UK, 55% of surgeons prefer to use spherical porous orbital implants and 42% prefer PMMA quasi-integrated implants with a diameter of 18 mm⁽²⁷⁾.

SHOULD ALL IMPLANTS BE WRAPPED?

The implant may be placed within the patient's own sclera after enucleation. After enucleation, the implant must be coated, where the donor's sclera was the first material used for this purpose and it is still the most common⁽²⁾.

Unwrapped PMMA implants may migrate into the orbital cavity, thereby leading to poor stability for the external prosthesis as well as yielding an anaesthetic effect. Thus, non-integrated implants must be wrapped, and the extraocular muscles can be sutured to the wrapping material in their normal anatomical positions.

Integrated implants were designed to allow greater mobility by the external prosthesis, and it was assumed that the vasculature needs to grow through the center of the implant. The wrapping material may reduce the contact between the host and the implant, so this scleral coating should either not be present or have discontinuities, thereby facilitating the vascularization of the implant.

Porous polyethylene implants are advantageous because surgeons can suture the extraocular muscles directly to the implant. Initially, polyethylene implants were frequently placed in the anophthalmic cavity without a wrapping. However, dehiscence of the conjunctiva and sclera increased with time, and thus surgeons decided to coat the anterior surface of the implant, thereby leaving the rear implant face free for vascularization. At present, this is the most common management method when making a decision to use a porous polyethylene implant. The coating is reinforced by Tenon's fascia and the conjunctiva, which remain intact after enucleation or visceration, thereby avoiding exposure and extrusion^(3,4).

In conclusion, there is no doubt that the implants must be coated, at least on their front face where they come into contact with the delicate conjunctival surface, which will reduce the chance of exposure to polyethylene or hydroxyapatite implants^(4,28).

IN ADDITION TO THE SCLERA, WHAT OTHER MATERIALS CAN BE EMPLOYED AS IMPLANT COATINGS?

The homologous sclera is a tissue that is used throughout the world for coating implants; however, other homologous materials have been suggested for this purpose, such as dura mater, fascia lata, or temporal fascia⁽²⁹⁾. All homologous materials may have a risk of disease transmission, and they must be subjected to rigorous evaluations to ensure that the transmission of infectious diseases does not occur^(5,8,29).

Autologous tissues may also be employed, such as fascia lata, temporalis fascia, auricular cartilage, rectus abdominis sheath, or even the autologous sclera. However, the use of autologous tissues can increase the surgical time requirements and the risk of morbidity.

High complication rates were observed when heterologous bovine pericardium was used as an implant wrap⁽³⁰⁾.

Haloplastic materials have been widely proposed such as meshes of absorbable threads like synthetic polymeric materials, e.g., polyglactin mesh, a composite of poly(lactic acid) and poly(glycolic acid)^(2,29). The use of synthetic meshes has also led to controversial outcomes.

Surveys have shown that the homologous sclera is the preferred wrapping material for 92% of Brazilian ophthalmologists⁽¹⁰⁾. However, 42% of UK ophthalmologists employ synthetic Vicryl or Mersilene meshes, 28% prefer to use the homologous sclera, and 20% prefer autogenous sclera⁽²⁷⁾.

EVOLUTION AND PROGNOSIS

The prognosis of an anophthalmic socket depends on the cause of the eye loss or its contents. Cicatricial diseases can lead to the reductions of the fornix and difficulties with the maintenance of the external prosthesis. Diseases with poor cicatricial responses, such as diabetes and collagen diseases, may lead to difficulties with the healing and extrusion of implants. Bone fractures with orbital trauma can result in extensive inflammatory processes, which affect the evolution of anophthalmic cavities.

After the replacement of the lost volume in the anophthalmic cavity using implants, the patient should use a scleral conformer to avoid contraction of the scarring on the superficial tissues. After the edema caused by surgical trauma has reduced, which occurs about 15 days after surgery, an external prosthesis must be adapted.

The care of the external prosthesis should be similar to that of contact lenses. The accumulations of secretions and mucous on the prosthesis surface mainly occur on old and scratched prosthesis, where this may lead to giant papillary conjunctivitis as also found with contact lenses. The external prosthesis must be removed every night and cleaned with soap and water.

ADVANCES IN THE TREATMENT OF ANOPHTHALMIC SOCKETS

Although many materials have been suggested for reconstructing an anophthalmic cavity, PMMA is still the preferred choice among 62.75% of Brazilian ophthalmologists⁽¹⁰⁾.

Recently, other implants have been developed by associating different materials, i.e., composites that combine PMMA, silicone, hydroxyapatite, porous polyethylene, aluminum, polytetrafluoroethylene, and other materials. These new implants should have a porous posterior portion to facilitate fibrovascular colonization and a smooth anterior surface. Some implants have barriers that protect the conjunctival surface from the roughness of the integrated implants⁽³¹⁾. Another possibility is using a non-integrated material implant coated with an integrated substance as the polyethylene/bioglass composite as well as porous quasi-integrated implants with hydroxyapatite-coated aluminum oxide or alumina covering the PMMA implants, which have been reported successful, with few complications^(32,33).

Orbital implant design continues to progress, which has been stimulated by a renewed interest in composites. Significant progress has been made, but the perceived theoretical benefits of porous

materials have not always been demonstrated clinically. In addition, comparing the available orbital implants is very difficult due to the lack of randomized controlled trials in this area, which was also confirmed by a rigorous systematic review⁽³⁴⁾.

Acrylic and silicone implants have the lowest rate of complications, particularly when used as the primary implant^(35,36).

In conclusion, despite progress in studies of new implants to correct anophthalmic sockets, it is possible to assume that porous polyethylene-coated implants are just as effective as non-porous implants⁽²¹⁾.

REFERENCES

- Souza Segundo P, Schellini SA, Padovani CR. Anoftalmia congênita clínica - alterações oculares e sistêmicas associadas. *Rev Bras Oftalmol.* 2006;65(5):269-72.
- Chalasan R, Poole-Warren L, Conway RM, Ben-Nissan B. Porous orbital implants in enucleation: a systematic review. *Surv Ophthalmol.* 2007;52(2):145-55.
- Deacon BS. Orbital implants and ocular prostheses: a comprehensive review. *J Ophthalm Med Technol.* <http://www.jomtonline.com/jomt/articles/volumes/4/2/orbital.pdf>.
- Baino F, Perero S, Ferraris S, Miola M, Balagna C, Verne E, Vitale-Brovarone C, Coggiola C, Dolcino D, Ferraris M. Biomaterials for orbital implants and ocular prostheses: Overview and future prospects. *Acta Biomaterialia.* 2014;10(4):1064-87.
- Hoyama E. Cavidade anoftálmica. In: Alves MR. *Órbita, sistema lacrimal e oculoplástica.* Rio de Janeiro: Cultura Médica; 2013. Chap 1. p.45-56.
- Levine MR, Fagien S. Enucleation and evisceration. In: Stuart WB. *Surgery of the eyelid, orbit and lacrimal system.* San Francisco: American Academy of Ophthalmology; 1995. Chap. 30. p.84-108.
- Fernandes JBVD. Cavidade anoftálmica. In: Matayoshi S, Forno E, Moura EM. *Manual de cirurgia plástica ocular.* São Paulo: Roca; 2004. p.287.
- Casillas G. Perda ocular. *México: Auroch Health Care;* 2008. p.279.
- Tonkelaar J, Henkes HE, Leersun GK. A short history of the artificial eye. *Doc Ophthalmol.* 1991;77(4):349-54.
- Sousa RL, Schellini SA, Zornoff DC, Padovani CR. Conduas para reparação da cavidade anoftálmica no Brasil. *Arq Bras Oftalmol.* 2012;75(6):394-7.
- Perry AC. Integrated orbital implants. *Adv Ophthalm Plast Reconstruct Surg.* 1990;8:75-81.
- Wang JK, Lai PC, Liao SL. Late exposure of the bioceramic orbital implant. *Am J Ophthalmol.* 2009;147(1):162-70.
- Cheng MS, Liao SL, Lin LL. Late porous polyethylene implant exposure after motility coupling post placement. *Am J Ophthalmol.* 2004;138(3):420-4.
- Yazici B, Akova B, Sanli O. Complications of primary placement of motility post in porous polyethylene implants during enucleation. *Am J Ophthalmol.* 2007;143(5):828-34.
- Shields CL, Shields JA, Potter P. Hydroxyapatite orbital implant after enucleation. *Arch Ophthalmol.* 1992;110(3):333-8.
- Shields CL, Shields JA, Potter P, Singh AD. Problems with the hydroxyapatite orbital implant-experience with 250 consecutive cases. *Br J Ophthalmol.* 1994;78(9):702-6.
- Karesh JW, Dresner SC. High-density porous polyethylene (Medpor) as a successful anophthalmic socket implant. *Ophthalmology.* 1994;101(10):1688-95.
- Jordan DR, Munro SM, Brownstein S, Gilberg S, Grahovac S. A synthetic hydroxyapatite implant: the so-called counterfeit implant. *Ophthalm Plast Reconstr Surg.* 1998;14(4):244-9.
- Schellini SA, Hoyama E, Padovani CR, Ferreira VL, Roça R. Complicações com uso de esferas não integráveis e integráveis na reconstrução da cavidade anoftálmica. *Arq Bras Oftalmol.* 2000;63(3):175-8.
- Alwitry A, West S, King J, Foss AJ, Abercrombie LC. Long-term follow-up of porous polyethylene spherical implants after enucleation and evisceration. *Ophthalm Plast Reconstr Surg.* 2007;23(1):11-5.
- Li T, Shen J, Duffy MT. Exposure rates of wrapped and unwrapped orbital implants following enucleation. *Ophthalm Plast Reconstr Surg.* 2001;17(6):431-5.
- Iordanidou V, De Potter P. Porous polyethylene orbital implant in the pediatric population. *Am J Ophthalmol.* 2004;138(3):425-9.
- Chuo JY, Dolman PJ, Ng TL, Buffam FV, White VA. Clinical and histopathologic review of 18 explanted porous polyethylene orbital implants. *Ophthalmology.* 2009;116(2):349-54.
- Custer PL, Kennedy RH, Woog JJ, Kaltreider SA, Meyer DR. Orbital implants in enucleation surgery: a report by the American Academy of Ophthalmology. *Ophthalmology.* 2003;110(10):2054-61.
- Quaranta-Leoni FM. Treatment of the anophthalmic socket. *Curr Opin Ophthalmol.* 2008;19(5):422-7.
- Jung SK, Cho WK, Paik JS, Yang SW. Long-term surgical outcomes of porous polyethylene orbital implants: a review of 314 cases. *Br J Ophthalmol.* 2012;96(4):494-8.
- Viswanathan P, Sagoo MS, Olver JM. UK national survey of enucleation, evisceration and orbital implant trends. *Br J Ophthalmol.* 2007;91(5):616-9.
- Tabatabaee Z, Mazloumi M, Rajabi MT, Khalilzadeh O, Kassae A, Moghimi S, Eftekhari H, Goldberg RA. Comparison of the exposure rate of wrapped hydroxyapatite (Bio-Eye) versus unwrapped porous polyethylene (Medpor) orbital implants in enucleated patients. *Ophthalm Plast Reconstr Surg.* 2011;27(2):114-8.

29. Yoon JS, Lew H, Kim SJ, Lee SY. Exposure rate of hydroxyapatite orbital implants a 15-year experience of 802 cases. *Ophthalmology*. 2008;115(3):566-72.
30. Arat YO, Shetlar DJ, Boniuk M. Bovine pericardium versus homologous sclera as a wrapping for hydroxyapatite orbital implants. *Ophthal Plast Reconstr Surg*. 2003;19(3):189-93.
31. Choi JC, Bstandig S, Iwamoto MA, Rubin PAD, Shore JW. Porous polyethylene sheet implant with a barrier surface—a rabbit study. *Ophthal Plast Reconstr Surg*. 1998;14(1):32-6.
32. Ma X, Schou KR, Maloney-Schou M, Harwin FM, Ng JD. The porous polyethylene/bioglass spherical orbital implant: a retrospective study of 170 cases. *Ophthal Plast Reconstr Surg*. 2011;27(1):21-7.
33. Brandão SM, Schellini SA, Moraes AD, Padovani CR, Pellizzon CH, Peitl O, Zanotto ED. Biocompatibility analysis of bioglass® 45S5 and biosilicate® implants in the rabbit eviscerated socket. *Orbit*. 2012;31(3):143-9.
34. Schellini S, El Dib RP. Integrated and non-integrated orbital implants for treating anophthalmic sockets [Protocol]. *The Cochrane Collaboration*. New York: Wiley Blackwell; 2013.
35. Nunery WR, Heinz GW, Bonnin JM, Martin RT, Cepela MA. Exposure rate of hydroxyapatite spheres in the anophthalmic socket: histopathologic correlation and comparison with silicone sphere implants. *Ophthal Plast Reconstr Surg*. 1993;9(2):96-104.
36. Shoamaneh A, Pang NK, Oestreicher JH. Complications of orbital implants: a review of 542 patients who have undergone orbital implantation and 275 subsequent pegg placements. *Orbit*. 2007;26(3):173-82.

American Academy of Ophthalmology

14 a 17 de novembro de 2015

Sands Expo/Venetian

Las Vegas - USA

Informações:

Site: www.aao.org

E-mail: meetings@aaao.org

Tel.: 415. 447-0320