



Socket discomfort in anophthalmic patients—reasons and therapy options

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Abstract: A smooth and timely fitting of a visually appealing, custom-made eye prosthesis after the loss of an eye is not only essential from a cosmetic point of view but above all facilitates good social and psychological rehabilitation. Cryolite glass prostheses must be replaced at least once a year, PMMA prostheses polished once a year and renewed every five years. In children, especially in growth phases, the fit of the prosthesis should be checked at least every six months and adjusted, if necessary. Ocularists and ophthalmologists should determine an individual cleaning procedure together with the patient, which depends on both the prosthesis material and external factors. Complications such as allergic, giant papillary, viral, and bacterial conjunctivitis or even blepharoconjunctivitis sicca must be detected and treated at an early stage to avoid discomfort and to maintain the ability of prosthesis wear. In the case of inflammation-induced shrinkage of the conjunctival fornices or post-enucleation socket syndrome, surgical interventions are necessary. In summary, an early supply with an eye prosthesis, adequate treatment of complications, and attention to psychological aspects, form the basis for a successful long-term rehabilitation of anophthalmic patients.

Keywords: Cryolite glass; PMMA; prosthetic eye; eye prosthesis; anophthalmia

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Introduction

In Europe, 2.5 extirpations of an eye per 100,000 population are performed each year due to trauma, malignant tumors, severe infections, various congenital malformations, or other medical indications (1-5). A few weeks after the removal of an eye, the patient is fitted with a custom-made and handmade ocular prosthesis to assure fast rehabilitation (1-5).

However, the loss of an eye is a life-changing event for the affected patients, which is not only a purely physical but also a major psychological burden and can lead to reduced quality of life (1-11). In addition to functional disability (12) and cosmetic aspects, discomfort of the anophthalmic socket is one of the most important general complaints for these patients after eye loss. Socket discomfort has tremendous impact on the quality of life and influences also social

interaction in everyday life (1-12). Every ophthalmologist should have important basic knowledge of ocular prosthetic fitting (13,14). Furthermore, this knowledge is needed to ensure adequate and smooth rehabilitation of these patients in close cooperation with the ocularists. Also, an ophthalmologist should be able to advise these patients, identify complications and reasons for socket discomfort and, if necessary, initiate therapeutic interventions (1-14).

The purpose of this review article is to give an overview of typical complications resulting in socket discomfort and to present various therapeutic options for these issues reducing the quality of life in anophthalmic patients.

The appropriate orbital implant—the basis to avoid socket discomfort

The oculoplastic surgeons form the basis of each ocular prosthetic rehabilitation (5). To avoid postoperative as well as late complications resulting in socket discomfort, successful surgical treatment without significant postoperative complications is essential (5). Therefore, the choice of an adequate and suitable orbital implant is mandatory for every enucleation or evisceration (5,14-17). The orbital implant must take into account various aspects including adequate volume replacement in the orbit, good motility or transferability of implant motility to the prosthesis, simple implantation technique, good biocompatibility, low complication rates, and also a tolerable price (5,14-17).

Porous, coralline hydroxyapatite orbital implants are one of the most commonly used implants worldwide (5,14-17). Many studies demonstrated good tolerability and high biocompatibility. In addition, these implants seem to have very good motility with less postoperative complications (5,14-17). It is important for this type of implant that the rough surface of the hydroxyapatite implants is covered with another material, otherwise the extrusion rate increases significantly (5,14-18). Depending on the surgeon's preference, synthetic materials such as Vicryl mesh or biological, autologous materials such as sclera may be used (5,14-18). However, the properties of these coralline implants are very different compared to implants made of alternative materials. In many countries, implants made of porous polyethylene (Medpor) have now replaced coralline hydroxyapatite as the most commonly used material for orbital implants (19). The reasons for this include a good vascularization, the fact that the implant does not need a wrap and muscle fixation can be achieved directly at the

implant (5,6,14-18).

One complication after eye removal causing socket discomfort is an exposure of the orbital implant (5,6,14-18). A potential exposure may also lead to secondary infections of the implant (5,6,14-18). Strategies for the management of an exposed implant include also conservative treatment options with regular follow-ups, the use of artificial tears, and optimizing fitting of the prosthesis. Sometimes, spontaneous healing occurred during conservative treatment (6).

Surgical approaches to cover the exposed implant with vascularized flaps or non-vascularized patches are sometimes combined with implant volume reduction and implant exchange or implant removal (6).

Infections of the orbital implant is a dreaded complication resulting in heavy socket discomfort (6). Unfortunately, infected biomaterials have mostly biofilms in which bacteria seem to be much more resistant to antibiotics (6). Therefore, implant removal often is necessary to treat these infections successfully (6). However, after complete healing, the insertion of a dermis fat graft can be performed to correct the orbital volume defect.

Migration of the orbital tissue and of the orbital implant as well as atrophy of the orbital tissues occur mostly in long-term prosthetic eye wearers. These aspects result in post-enucleation socket syndrome (PESS), which is a typical complication after the removal of an eye and may result in socket discomfort (5). PESS is a complex of symptoms of variable severity, which may include various changes in eyelid contour, such as ptosis, lax lower eyelid or lower lid ectropion, and enophthalmos (4,5,14,15,20,21). While this complication does not generally play a major role in the first few years after enucleation, long-term wearers of ocular prostheses showed a very high rate of PESS (4,5,14,15,20,21). The ectropium and the laxity of the lower eyelid are caused by the mechanical stress on the tissue by the weight of the prosthesis. Other factors causing PESS are too large prostheses and frequent manipulation as well as rubbing of the lower eyelid (4,5,14,15,20,21). Therapeutically, the treatment of choice for pronounced findings is surgical intervention. However, before performing eye lid surgery, it is recommended to correct potential orbital volume defects surgically. Ectropion of the lower eyelid can be fixed for example by lateral tarsal strip surgery (4,5,14,15,20,21). Ptosis occurs either in the sense of ptosis *ex vacuo* or through mechanical stress by overstretching of the levator aponeurosis. This ptosis is comparable to age-related involutional ptosis

(4,5,14,15,20,21) and, likewise, treatment options include levator folding or resection (4,5,14,15,20,21).

However, oculoplastic surgeons can significantly minimize the risk of PESS. The choice of a suitable and well-tolerated orbital implant, as mentioned above, is essential (4,5,14,15,20,21). Together, the ocular prosthesis and orbital implant should compensate for the orbital volume loss completely (2,4,5,14,15,20,21). A larger volume of the orbital implant and the smaller and lighter the ocular prosthesis can be designed, the more the risk of PESS can be reduced (2,4,5,14,15,20,21). However, too large orbital implants also have a higher risk of extrusion through tenon and conjunctiva (2,4,5,14,15,20,21). Furthermore, over time some patients have significant atrophy of the orbital connective and fatty tissues resulting in enophthalmos despite an initially good postoperative volume replacement by the implant (2,4,5,14,15,20,21). An attempt to correct the enophthalmos with a larger, even heavier ocular prosthesis should be avoided because heavy prostheses increase the risk of lower lid laxity (2,4,5,14,15,20,21). However, if a correction is necessary to reduce socket discomfort, the orbital volume can be surgically increased by secondary orbital implants, grafts, or minimally invasive by injection of autologous fat (2,4,5,14,15,20,21).

Prosthesis-related problems—a wide range of potential reasons for socket discomfort

When wearing artificial eyes, a wide variety of causes can reduce the comfort of wearing, lead to pain, and cause further complications (5-29).

Globally, the most commonly used material for ocular prostheses is plastic (polymethyl methacrylate, PMMA). PMMA, which is also known for dental prosthetics and contact lens manufacturing, replaced cryolite glass as the most frequently used material for eye prostheses worldwide during the Second World War (2,3,5,23). At that time, cryolite glass was produced exclusively in Germany and was therefore no longer available for the majority of the world's eye prosthesis manufacturers for several years (2,3,5,23). Nevertheless, in Germany, Austria, and Switzerland, more than 90% of the ocularists still use cryolite glass for the production of custom-made eye prostheses (2,3,5,23). Prosthetic eye wearers are fitted with a placeholder (conformer) for about two weeks postoperatively to prevent scarring of the fornices (2,3,5,23). Due to major changes in the eye socket within the first six months after enucleation, it should have regular check-ups and if necessary, the

prosthetic eye has to be adjusted or replaced (2,3,5,23). The ocularists can not only take into account the changes in the anophthalmic socket but also the patient's wishes and experiences in order to optimize the prosthesis in terms of appearance and fit to avoid socket discomfort (2,3,5,23).

To produce a PMMA prosthetic eye, initially an impression is taken of the anophthalmic socket and a plastic button is trimmed to the diameter of the iris. The iris colors are matched directly to the patient's natural eye and applied to the button using finest grade oil paints and the smallest of sable hairbrushes. When dry, a clear acrylic cornea is processed over the top of the painted iris and an iris/corneal button is produced. Afterwards, this iris/corneal button is imbedded into a wax pattern made from the impression and the whole is inserted into the eye socket. The wax is shaped and molded until the direction of gaze, the size and the lid contour of the eye is established. Then, a plaster mould is made and the wax is replaced with PMMA. After colouring the sclera, a clear PMMA veneer is processed over the surface of the prosthesis and finished off with a high polish. PMMA prosthetic eyes are mostly replaced every 4–5 years.

Cryolite glass prosthetic eyes should be replaced regularly every 9-12 months while the PMMA eye should be polished in order to remove irregularities and maintain the gloss at least every 12 months (2,3,5,23,25). Children and adolescents represent a special case concerning the adjustment intervals (5). Due to the greater growth rate in children, there is a higher risk of an asymmetrical development of the two orbits. Therefore, a check-up should be carried out every six-months, regardless of the material of the prosthesis (5). If necessary, an adjustment or replacement of the prosthesis is recommended (2,3,5,23,25). Another new aspect, which should not be seen as a marginal note, is that only 7% of patients are concerned about defects of cryolite glass eye prostheses (22). A lower defect rate is often propagated as a great advantage of PMMA eye prostheses (30). However, it seems that defects only play a minor role and therefore do not represent a major disadvantage or decisive factor for socket discomfort for most patients wearing cryolite-glass eye prostheses (22,30).

Daily cleaning and care are very important factors to avoid socket discomfort. Anophthalmic patients can and should wear the ocular prostheses continuously, even at night (2,5,25,31-33). If permanent wearing is not tolerated in individual cases, overnight removal of the prosthesis usually does not have any major disadvantages, at least in adult patients and in patients with no tendency to conjunctival scarring (2,5,25,31-33).

General recommendations for the regular care and cleaning of artificial eyes are very difficult to formulate based on existing literature and are not consistent (2,5,24,25,31-33). Until today there are no evidence-based recommendations for ocular prostheses. However, it has now been shown for PMMA eye prostheses that less frequent removal (even at night) and cleaning reduces one of the major complications of socket discomfort, namely increased discharge, mucus secretion, and crust formation (2,5,24,25,31-33). Less frequent removal and cleaning, e.g., only monthly, promotes a constant environment in the conjunctival sac and reduces the risk of noxious agents transferred from the hands to the prosthesis and into the anophthalmic socket (2,5,24,25,31-33). This constant and physiological environment improves the wetting of the prosthesis and the socket comfort by reducing irritation and inflammation (2,5,24,25,31-33). Less frequent manipulation of the prosthetic eye seems also to reduce the mechanical stress on the conjunctival sac (2). Instead of uniform recommendations, the patient should, therefore, determine a cleaning frequency individually with his ocularist and ophthalmologist, which depends on the prosthesis material and, last but not least, on external factors such as the daily exposure to dust or air conditioners (2,5,24,25,31-33).

The biggest and most important prosthesis-specific problem causing socket discomfort is increased discharge, strong, visible mucus secretion, and crust formation (2-5,11,24,25,31-33). These symptoms occur in more than two-thirds of patients daily (2-5,11,24,25,31-33). There is no significant difference between cryolite glass and PMMA eye prosthesis wearers (2-5,11,24,25,31-33). The reason for this is conjunctivitis which is a typical complication of ocular prosthesis wearers. Most ophthalmologists are confronted with this issue in everyday practice (2-5,11,24,25,29,31-33). Acute allergic conjunctivitis occurs very rarely within 48 hours after the fitting of PMMA prostheses (2-5,11,24,25,31-35). Clinical signs are conjunctival hyperemia with massive chemosis and lid edema (5,34,35). Since PMMA monomers of the plastic prosthesis can act as an antigen, in this case, topical administration of steroids, mast cell stabilizers, and non-steroidal anti-inflammatory drugs, as well as a change to glass prosthetic, should be considered (5,34,35).

In contrast, giant papillary conjunctivitis (GPK), which is more common, is an immune-cell-mediated delayed allergic reaction to deposits on the prosthesis surface (5,34-37). These (giant) papillae are clinically mostly at the tarsal conjunctiva of the upper eyelid (5,34-37). Patients

suffer from itching, burning, significantly increased discharge and mucus secretion, and, less frequently, pain (5,34-37). Since a rough prosthesis surface is itself the cause of socket discomfort and also promotes protein deposits, a PMMA eye prosthesis should always be polished, while an older cryolite-glass prosthesis should be replaced (5). In addition, therapeutic tear substitutes and, under certain circumstances, a temporarily reduced wearing time can be considered (5,34-38). As in acute allergic conjunctivitis, topical medication includes topical steroids, mast cell stabilizers such as cromoglycate acid or non-steroidal anti-inflammatory drugs (5,34-38).

Viral and bacterial conjunctivitis can also occur in the anophthalmic socket, as in normal eyes (2,5,6,39,40). Bacterial conjunctivitis is most frequently caused by gram-positive pathogens such as staphylococci and streptococci in prosthesis wearers, also analogous to normal eyes (2,5,6,39,40). However, some atypical pathogens, such as *Escherichia coli*, are significantly more frequently detected in the anophthalmic socket (2,5,6,39,40). This can be explained by the regular removal of prostheses with insufficient hygiene, especially of the hands (2,5,6,39,40).

In cases of severe and therapy-refractory cases, a conjunctival swab should be taken for pathogen diagnosis including resistance testing. In principle, both viral and bacterial conjunctivitis is treated in the same way as normal eyes (2,5,6,39,40). For prosthesis wearers, both the prevention of inflammation and infections by optimal fitting, timely replacement of the prosthesis, regular care and hygiene, as well as adequate therapy of complications, is essential to avoid irreversible scarring resulting in socket discomfort (2,5,6,39,40). This scarring might result in the inability of the insertion of a prosthesis due to the shortening and shrinking of the conjunctival fornices (2,5). Only a surgical intervention can solve this problem (2,5).

Another very important and frequent complication causing socket discomfort is a dry anophthalmic socket syndrome (DASS) (5,6,29,41). A dry anophthalmic socket after enucleation, like a dry eye in general, is a disease of the tears and ocular surface leading to discomfort, and tear film instability with possible damage to the ocular surface (5,6,29,41). Overall, more than 50% of ocular prosthetic wearers suffer from dry socket complaints (5,6,29,41).

Depending on the age and surface of the prosthesis, the therapy may include the replacement of the prosthetic glass eye or the polishing of PMMA prostheses to increase the wettability and to improve the distribution of the tear film (5,6,33,41). Furthermore, the cleaning regime of the patient

should be checked, since too frequent cleaning destroys the physiological environment that ensures good wettability of the prosthesis and an even distribution of the tear film (5,6,33,41). In addition, regular morning eyelid care can be carried out to remove incrustations and to improve the function of the meibomian glands (5,6,33,41). The application of wetting eye drops, if necessary, in combination with anti-inflammatory topical therapeutics such as glucocorticoids (e.g., Loteprednol 0.5%) or calcineurin inhibitors (e.g., Ciclosporin A 0.05%) for at least 3 months can also be recommended (5,41,42). Less frequently, punctum plugs (5) or labial mucosal transplants are also used in cases of failure of conservative therapies (5,41-43).

In some very rare cases, patients report discomfort despite a normal physical examination. A potential reason for this could be phantom eye pain, which can be treated with systemic analgesics, antidepressants, anticonvulsants, antipsychotics, or opioids. However, sometimes it is necessary to remove the orbital implant and insert a dermis fat graft to treat chronic socket pain successfully (44).

Psychological factors—not only the cosmetic aspect matters

The loss of an eye is usually a life-changing event for these patients, which is primarily associated with a major psychological and emotional stress situation and can lead to depression, anxiety, stress, social problems and overall reduced quality of life (3-5,7-11,15). In addition to all these factors, the diagnosis of a potentially life-threatening malignant tumor may be required (3-5,7-9,11,15). Against this background, a good, smooth and fast rehabilitation of these patients by fitting a visually appealing, custom-made eye prosthesis seems all the more important (3-5,7-9,11,15). The prosthesis not only fulfills a purely cosmetic function but above all facilitates good social and psychological rehabilitation (3-5,7-11,15). However, psychological diseases, various prosthesis-related concerns, and socket pain might also lead to subjective socket discomfort (3-9,11,15). Ophthalmologists and ocularists should be aware of this factor when counseling patients (3-5,7-9,11,15). Therefore, a multidisciplinary approach including psychologists and if required, psych oncologists, is recommended (3-9,11,15).

Conclusions for the practice to avoid socket discomfort

A smooth and quick fitting of a visually appealing, custom-

made eye prosthesis after the loss of an eye is not only essential from a cosmetic point of view but above all facilitates good social and psychological rehabilitation. Cryolite glass prostheses must be replaced at least once a year, PMMA prostheses polished once a year and renewed every 5 years. In children, especially in growth phases, the fitting of the prosthesis should be checked at least every 6 months and adjusted, if necessary. Ocularists and ophthalmologists should determine an individual cleaning procedure together with the patient, which depends on both the prosthesis material and external factors. Complications such as allergic, giant papillary, viral, and bacterial conjunctivitis or even blepharoconjunctivitis sicca must be detected and treated at an early stage to avoid discomfort and to maintain the ability of prosthesis wear. In the case of inflammation-induced shrinkage of the conjunctival fornices or post-enucleation socket syndrome, surgical interventions are necessary.

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References

1. de Gottrau P, Holbach LM, Naumann GO. Clinicopathological review of 1146 enucleations (1980-90). *Br J Ophthalmol* 1994;78:260-5.
2. Koch KR, Trester W, Muller-Uri N, et al. Ocular prosthetics. Fitting, daily use and complications. *Ophthalmologe* 2016;113:133-42.
3. Rokohl AC, Koch KR, Adler W, et al. Concerns of anophthalmic patients-a comparison between cryolite glass and polymethyl methacrylate prosthetic eye wearers. *Graefes Arch Clin Exp Ophthalmol* 2018;256:1203-8.
4. Rokohl AC, Koch KR, Trester M, et al. Concerns of Anophthalmic Patients Wearing Cryolite Glass Prosthetic Eyes. *Ophthalmic Plast Reconstr Surg* 2018;34:369-74.
5. Rokohl AC, Mor JM, Trester M, et al. Rehabilitation of Anophthalmic Patients with Prosthetic Eyes in Germany Today - Supply Possibilities, Daily Use, Complications and Psychological Aspects. *Klin Monbl Augenheilkd* 2019;236:54-62.
6. Bohman E, Roed Rasmussen ML, Kopp ED. Pain and discomfort in the anophthalmic socket. *Curr Opin Ophthalmol* 2014;25:455-60.
7. Pine NS, de Terte I, Pine KR. An investigation into discharge, visual perception, and appearance concerns of prosthetic eye wearers. *Orbit* 2017;36:401-6.
8. Pine NS, De Terte I, Pine KR. Time Heals: An Investigation into How Anophthalmic Patients Feel about Eye Loss and Wearing a Prosthetic Eye. *J Ophthalmol and Vis Sci* 2017;2:1018.
9. Pine NS, De Terte I, Pine KR. The Impact of Eye Loss and Prosthetic Eye Wear on Recreational, Occupational and Social Areas of Functioning. *J Ophthalmol and Vis Sci* 2017;2:1016.
10. Chin K, Margolin CB, Finger PT. Early ocular prosthesis insertion improves quality of life after enucleation. *Optometry* 2006;77:71-5.
11. Pine K, Sloan B, Stewart J, et al. Concerns of anophthalmic patients wearing artificial eyes. *Clin Exp Ophthalmol* 2011;39:47-52.
12. Hughes MO, Hughes N. Visual Field Deficits After Eye Loss: What Do Monocular Patients (Not) See? *Insight* 2015;40:11-7.
13. Hintschich C, Baldeschi L. [Rehabilitation of anophthalmic patients. Results of a survey. *Ophthalmologe* 2001;98:74-80.
14. Thiesmann R, Anagnostopoulos A, Stemplewitz B. Long-term results of the compatibility of a coralline hydroxyapatite implant as eye replacement. *Ophthalmologe* 2018;115:131-6.
15. Rokohl AC, Koch KR, Trester M, et al. Cryolite glass ocular prostheses and coralline hydroxyapatite implants for eye replacement following enucleation. *Ophthalmologe* 2018;115:793-4.
16. Norda AG, Meyer-Rusenberg HW. Long-term results of implantation of hydroxylapatite as artificial eye. *Ophthalmologe* 2000;97:91-9.
17. Custer PL, Kennedy RH, Woog JJ, et al. Orbital implants in enucleation surgery: a report by the American Academy of Ophthalmology. *Ophthalmology* 2003;110:2054-61.
18. Meyer-Rusenberg HW, Kasperski S, Althoff R. Sclera silicone implants of the orbit. *Fortschr Ophthalmol* 1983;79:555-6.
19. Cleres B, Meyer-Rusenberg HW. Porous orbital implants. *Ophthalmologe* 2014;111:572-6.
20. Hatt M. Orbitoplasty in patients with artificial eyes. *Klin Monbl Augenheilkd* 1992;200:424-7.
21. Bailey CS, Buckley RJ. Ocular prostheses and contact lenses. I--Cosmetic devices. *BMJ* 1991;302:1010-2.
22. Rokohl AC, Trester M, Pine KR, Heindl LM. Risk of breakage of cryolite glass prosthetic eyes. *Graefes Arch Clin Exp Ophthalmol* 2019;257:437-8.
23. Rokohl AC, Trester M, Mor JM, et al. Customizing a Cryolite Glass Prosthetic Eye. *J Vis Exp.* 2019;(152). doi: 10.3791/60016
24. Rokohl AC, Adler W, Koch KR, et al. Cryolite glass prosthetic eyes-the response of the anophthalmic socket. *Graefes Arch Clin Exp Ophthalmol.* 2019;257:2015-23.
25. Pine KR, Sloan BH, Jacobs RJ. A proposed model of the response of the anophthalmic socket to prosthetic eye wear and its application to the management of mucoid discharge. *Med Hypotheses* 2013;81:300-5.
26. Pine KR, Sloan B, Stewart J, et al. The response of the anophthalmic socket to prosthetic eye wear. *Clin Exp Optom* 2013;96:388-93.
27. Pine KR, Sloan B, Jacobs RJ. The development of measurement tools for prosthetic eye research. *Clin Exp*

- Optom 2013;96:32-8.
28. Pine KR, Sloan B, Jacobs RJ. Deposit buildup on prosthetic eyes and implications for conjunctival inflammation and mucoid discharge. *Clinical Ophthalmology* 2012;6:1755-62.
 29. Rokohl AC, Trester M, Guo Y, et al. Dry anophthalmic socket syndrome - Standardized clinical evaluation of symptoms and signs. *Ocul Surf* 2020;18:453-9.
 30. Rokohl AC, Trester M, Hinkelbein J, et al. Implosion of prosthetic eyes-Significance of type and material. *Ophthalmologie* 2020. [Epub ahead of print].
 31. Pine KR, Sloan B, Stewart J, Jacobs RJ. The response of the anophthalmic socket to prosthetic eye wear. *Clin Exp Optom* 2013;96:388-93.
 32. Pine KR, Sloan B, Jacobs RJ. Deposit buildup on prosthetic eyes and implications for conjunctival inflammation and mucoid discharge. *Clin Ophthalmol* 2012;6:1755-62.
 33. Pine KR, Sloan B, Han KI, et al. Deposit buildup on prosthetic eye material (in vitro) and its effect on surface wettability. *Clin Ophthalmol* 2013;7:313-9.
 34. Patel V, Allen D, Morley AM, Frcophth RM. Features and management of an acute allergic response to acrylic ocular prostheses. *Orbit* 2009;28:339-41.
 35. Meisler DM, Krachmer JH, Goeken JA. An immunopathologic study of giant papillary conjunctivitis associated with an ocular prosthesis. *Am J Ophthalmol* 1981;92:368-71.
 36. Srinivasan BD, Jakobiec FA, Iwamoto T, DeVoe AG. Giant papillary conjunctivitis with ocular prostheses. *Arch Ophthalmol* 1979;97:892-5.
 37. Swann PG. Giant papillary conjunctivitis associated with an ocular prosthesis. *Clin Exp Optom* 2001;84:293-5.
 38. Bischoff G. Giant papillary conjunctivitis. *Klin Monbl Augenheilkd* 2014;231:518-21.
 39. Christensen JN, Fahmy JA. The bacterial flora of the conjunctival anophthalmic socket in glass prosthesis-carriers. *Acta Ophthalmol (Copenh)* 1974;52:801-9.
 40. Vasquez RJ, Linberg JV. The anophthalmic socket and the prosthetic eye. A clinical and bacteriologic study. *Ophthalmic Plast Reconstr Surg* 1989;5:277-80.
 41. Han JW, Yoon JS, Jang SY. Short-term effects of topical cyclosporine A 0.05% (Restasis) in long-standing prosthetic eye wearers: a pilot study. *Eye (Lond)* 2014;28:1212-7.
 42. Ko JS, Seo Y, Chae MK, et al. Effect of topical loteprednol etabonate with lid hygiene on tear cytokines and meibomian gland dysfunction in prosthetic eye wearers. *Eye (Lond)* 2018;32:439-45.
 43. França IS, Medrado J, Franca VP, et al. Treatment of dry anophthalmic cavities with labial salivary glands transplantation. *Arq Bras Oftalmol* 2011;74:425-9.
 44. Shams PN, Bohman E, Baker MS, et al. Chronic anophthalmic socket pain treated by implant removal and dermis fat graft. *Br J Ophthalmol* 2015;99:1692-6.

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