

# ANOPHTHALMIC CONJUNCTIVAL SAC PLASTIC SURGERY USING THE MODIFIED CUL-DE-SAC METHOD

Krásný J.

Department of Ophthalmology,  
Královské Vinohrady University Hospital,  
Prague, Head prof. MUDr. P. Kuchynka,  
CSc.

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MUDr. Jan Krásný  
Oční klinika FN Královské Vinohrady  
Šrobárova 50,  
109 34 Praha 10  
e-mail: jan.krasny@fnkv.cz

## SUMMARY

**Aim:** The author refers about the plastic surgery technique of deepening the conjunctival sac in acquired anophthalmos without the orbital implant. The condition without the implant was caused primarily or secondarily after the enucleation or evisceration. The principal of the cul-de-sac technique is the fixation of the lower fornix conjunctiva to the orbital periosteum.

**Material and methods:** The modification of the original surgery technique applied by the author is from the nineties of the last century. It consists of the use of long-term resorbable suturing material for vascular sutures made from polydioxanone (PDS 6-0) and the suture primarily fixated to the orbital periosteum. Only in the second phase, the tarsal and bulbar part of the conjunctiva of the lower fornix is fixated to the orbital rim. The result is the deepening of the conjunctival sac making possible better positioning of the eye prosthesis in the interpalpebral fissure from the cosmetic and functional point of view.

**Results:** The author presents the successfulness of this surgical technique in six patients operated on during the period from 2009 to 2014, presenting photographs of four of them in the child and adult age. Shallow of the lower fornix was caused by spontaneous elimination of the implant at the school age after the enucleation due to the inborn malformation of the eye globe in three years old boy. Extrusion of the implants occurred also in two young men after previous enucleation due to the malignant intraocular tumors in infant age. In these cases, the influence of the growth to the physiognomy of the conjunctival - palpebral area was evident. Among included adults were: Eighty-three years old female patient, twelve years after the enucleation without the implant due to the endophthalmitis of unknown etiology; 62 years old man after the evisceration of the eyeball at the age of seven years due to the endophthalmitis after the perforating injury; and 55 years old male patient five years after the enucleation of the eye globe with adjacent fat tissue removal without implant due to the malignant intraocular tumor with the suspicion of its extrascleral growth. Always, the co-occurrence of the involution process in the conjunctival sac itself took its part.

**Conclusion:** The surgical technique of deepening the conjunctival sac using the cul-de-sac method and using the suturing material made from polydioxanone (PDS 6-0) may be applied in shallow anophthalmic conjunctival sac in the lower fornix. At the same time, with this method, the possible ectropion of the lower eyelid is treated as well. To prevent the occurrence of the conjunctival sac not suitable for the orbital prosthesis application, it should be used the orbital implant during enucleation or evisceration surgery.

**Key words:** anophthalmos, plastic surgery of the conjunctiva, polydioxanone

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## INTRODUCTION

Enucleation brings a range of problems through the change in the alignment of the soft structures of the orbit following evisceration of the eyeball, into which the position of the lower eyelid is also projected due to frequent affliction of the Lockwood's ligament, within the framework of the slackening of the lower direct muscle. Sufficient depth of both fornixes is of decisive significance for the implantation of a prosthetic implant. Scarring processes of the conjunctiva, as well as traumas or surgical interventions, have a fundamental and decisive influence. Nevertheless, shallowing of the conjunctival sac relates primarily to the lower fornix, where a role is also played by the influence of the gravitation of the soft structures of the eye socket, and primarily by its shallower character, as determined by the vertical position of both eyelids. As far back as the beginning of the 20th century, ophthalmologists sought out the possibility of a plastic surgical solution. A solution was found, enabling a deepening of the lower fornix by means of a tractional suture from its apex, via the periosteum of the orbital rim, fixed on a bead above the skin of the face beneath the lower eyelid (fig. 1A), which was published in an ophthalmology

textbook from the 1920s (7). Further therapeutic procedures developed from this surgical technique, to which operations with the implantation of various biological materials were classified.

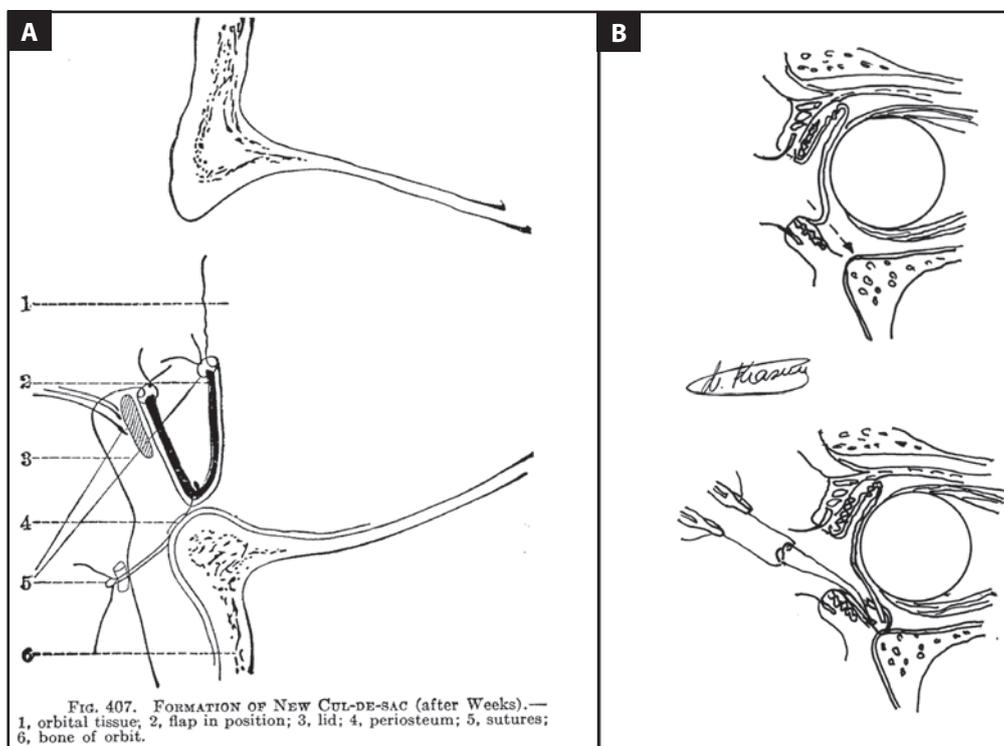
## METHOD AND OWN CONFIGURATION

We have always performed plastic surgery on the conjunctival sac under general anaesthesia for the reason of better orientation within the operating field, thus we avoided the local application of anaesthetics, which would generate its edematous saturation. Following the incision of the conjunctiva in the apex of the lower fornix or in the place of envisaged maximum deepening, we bluntly prepared the subconjunctival tissue up to the orbital rim (fig. 1B above) in a width of 10 mm (fig. 4B). First of all we implemented two knotted PDS 6-0 sutures into the periosteum of the uncovered orbital rim. To these sutures we first of all attached the external lobe of the (tarsal) loosened conjunctiva. We subsequently fixed an internal lobe of the (bulbar) loosened conjunctiva (1B below) with the same suture, separately on each edge of the incision (fig. 4D). This traction created a sacciform deepening. After the operation we

applied drops of a separate antibiotic, and at an interval of one week we supplemented the therapy for a further two to three weeks with fluorometholone. We recommended the actual application of the new prosthesis only after an interval of three months, at the time of the full healing of the newly formed fornix, conditional upon the practical resorption of the used long-term resorbable suturing material. An integral component of the good cosmetic effect of the operation was the work of the optician – prosthetist, who always had to adapt the shape of the prosthesis. The lower rim had to have a curvature greater than the upper rim, to be regularly symmetrically rounded and convexly rotated in the direction towards the newly created lower rim of the conjunctival sac. Within the period of the last five years, from September 2009 to June 2014, we have operated on a total of 6 patients, comprising five men and one woman aged from 13 to 83 years. The shallowing of the lower fornix was a manifestation also of the influence of growth on the development of the physiognomy of the conjunctival lid area, following loosening of a silicon implant in a thirteen year old boy. The indication for surgery was congenital malformation of the eyeball. This influence was also projected in another two young men, in whom spontaneous expulsion occurred before the end of school attendance, following previous enucleation with an implant due to a malignant intraocular tumour (retinoblastoma) at infant age. Older patients were also included due to the co-occurrence of the involutinal process of the conjunctival sac: an 83 year old female patient twelve years following enucleation of the eyeball without an implant for endophthalmitis, a 62 year

old male patient following evisceration of the eyeball at the age of 7 years due to endophthalmitis as a consequence of a perforating injury and a 55 year old male patient following enucleation of the eyeball with the surrounding fat tissue without an implant due to the suspicion of extrascleral growth of a malign intraocular tumour (melanoma).

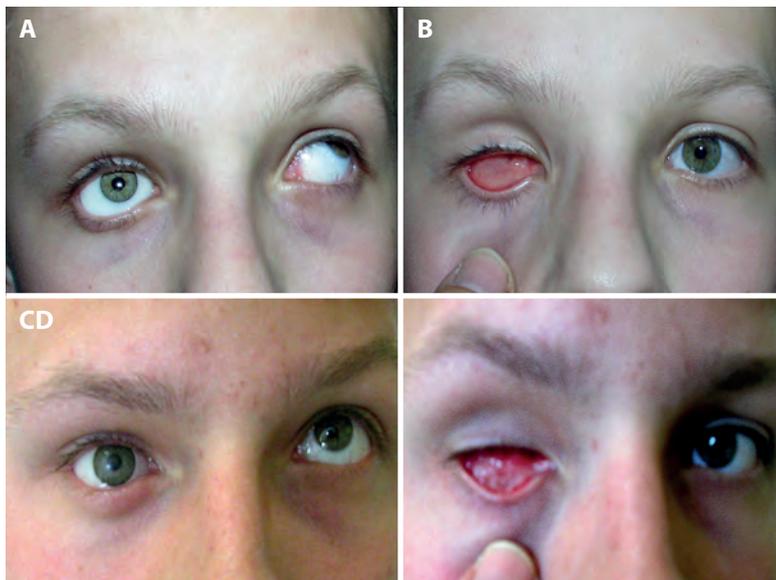
**Case study no. 1** A thirteen year old boy underwent plastic surgery on the conjunctival anophthalmic sac in the right eye by means of the cul-de-sac method in September 2009. The reason for enucleation was secondary glaucoma in the blind eye due to mesodermal dysgenesis of the iris. Plastic surgery on the conjunctival sac was performed repeatedly at our centre after June 2000 due to a preclusive silicon orbital implant, since the muscle fixation cross was functional. In 2007 we had to definitively eviscerate the implant, since the muscles relaxed from the fixation cross in the silicon implant. We resolved the situation by suturing the muscle ends of four external direct muscles together, and filling the created cavity with fibrin foam. Subsequently, in April 2009 we resolved the newly detected pathological situation of the left eye, which was rotated slightly inwards and accompanied by an inclination of the head towards the right shoulder, caused by rotation nystagmus. We had not addressed this finding before this time, since we had concentrated on the issue of plastic surgery of the orbital region of the right eye. We chose the technique of “Kestenbaum’s rotation”, in reinforcement of the limbal portion of the upper sloping muscle according to Harada-Ito and weakening primarily of the limbal portion of the lower sloping muscle by means of electrocautery incisions according to Hugonier. Following



**Fig. 1 Surgical techniques**

A – cul-de-sac operation according to Weeks (taken from H.E. Fuchs & A. Duane: Text-Book of Ophthalmology, 1923)

B – schema of operation: incision on orbital rim (above) and fixation sutures into periosteum (below)



**Fig. 2 Case study no. 1**

- A – spontaneous loosening of prosthesis in right eye upon upward gaze
- B – cause is shallowed lower fornix
- C – good fixation of prosthesis following plastic surgery operation even after five years
- D – postoperative “beaked” deepening of lower fornix

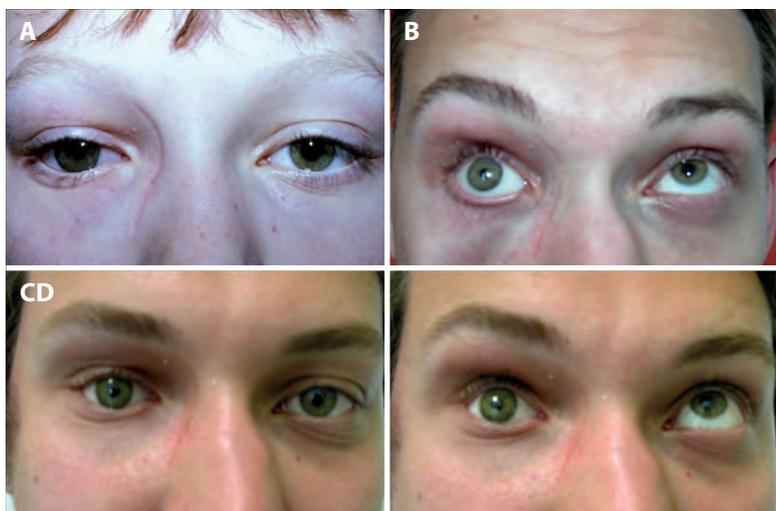
realignment of the head, falling out of the prosthesis was manifested in an upward gaze (fig. 2A) due to the influence of softening of the lower fornix (fig. 2B). In the years following the plastic surgery operation on the conjunctival sac in the region of the lower fornix, the prosthesis was minimally mobile, but in the conjunctival sac maintained a good position also in an upward gaze, even after an interval of practically five years (fig. 2C) on the basis of a “beaked” deepening of the lower fornix (fig. 2D).

**Case study no. 2** A twenty two year old man requested the option of plastic adjustment of the conjunctival sac in the right eye, since in the last two years the prosthesis had begun to fall out with increasing frequency, again due to the influence of a softened lower fornix (fig. 3B). The patient underwent enucleation with implantation of a silicon orbital implant at the age of almost one year old due to retinoblastoma, in the following years the prosthesis was fully cosmetically suitable (fig. 3A). At the age of thirteen years (nine years ago), the implant in the region of the lower and internal direct muscle spontaneously loosened, and as a result we replaced only the cadaverous sclera filled with fibrin foam. Following plastic adjustment using the cul-de-sac method, in March 2014 the fornix was now sufficiently dee-

pened and the prosthesis well anchored, again the symmetrical shape of the interpallebral fissures had been renewed (fig. 3C). In upward gaze the prosthesis remained well fixed (fig. 3D).

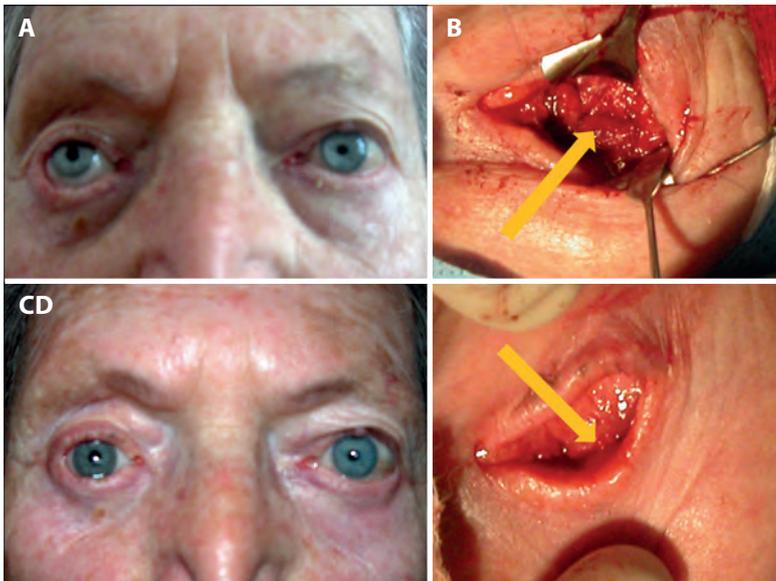
**Case study no. 3** In February 2013 we indicated an eighty three year old female patient for plastic surgery on an anophthalmic conjunctival sac due to ectropion of the lower eyelid at the patient’s request, since spontaneous falling out of the prosthesis in the right eye was causing her psychological discomfort (fig. 4A), in which the interpallebral fissure was markedly widened, despite the fact that the left eye was slightly conditioned by indicated endocrine exophthalmos. The basis for enucleation without an implant at another centre in the year 2001 was endophthalmitis of unclear etiology. Any relation to the last intraocular procedure (cataract surgery) in 1991 is improbable. The cosmetic effect of conjunctival plastic surgery by the cul-de-sac method was symmetrical, even with the indication of bilateral exophthalmos (fig. 4C). The position of the prosthesis was also well fixed in the sufficiently modelled conjunctival sac of the right eye.

**Case study no. 4** A sixty two year old male patient requested plastic adjustment of the region of the eyelids of



**Fig. 3 Case study no. 2**

- A – normal fixation of prosthesis at age of eight years (7 years after enucleation)
- B – falling out of prosthesis due to softened lower fornix in right eye at age of 22 years
- C – renewal of fixation of prosthesis following plastic surgery at age of 22 years
- D – prosthesis remains well fixed even in upward gaze



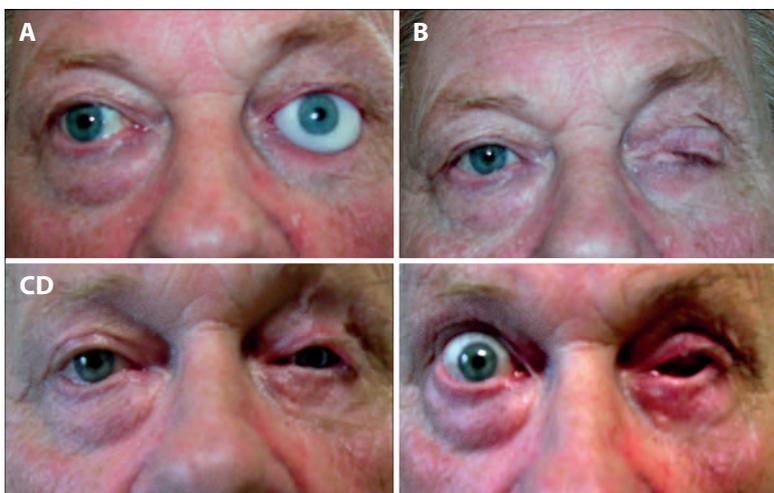
**Fig. 4 Case study no. 3**

- A – ectropion of lower eyelid with loosening of prosthesis in right eye
- B – uncovered orbital rim following preparation (perioperative photo)
- C – symmetrical position of both interpallebral fissures, with good fixation of prosthesis in right eye
- D – newly fixed lower fornix to orbital rim (perioperative photo)

the left eye in April 2014, since the prosthesis was constantly falling out. This was fixed only by the pressure of the upper eyelid, and was only partially anchored on the outer edge of the lower eyelid (fig. 5A). Furthermore, the lower eyelid had been covered in the outer corner by the upper eyelid (fig. 5B) since tarsorrhaphy performed ten years previously, in an endeavour to improve the fixation of the prosthesis. The onset of the complaints was linked to an injury at the age of 7 years, following perforating trauma from a shot of an air gun pellet, complicated by endophthalmitis, when the eyeball was eviscerated. The prosthesis was cosmetically functional for approx. 40 years, after which problems began with falling out. In addition to plastic surgery of the lower fornix by the cul-de-sac method, we performed disruption of the tarsorrhaphy and the plastic adjustment of the outer corner. The interpallebral fissure became symmetrical in the position of the eyelids together with deepening of the fornix (fig. 5D). The newly modelled prosthesis did not fall out, but was rotated slightly inwards by the lower edge, with regard to its smaller size it did not perform a full cosmetic function (fig. 5C), but this was tolerated by the patient.

## DISCUSSION

In general, it applies that all surgical techniques reconstructing the interpallebral fissure aim to create sufficient depth of both fornixes and appropriate modelling of the eyelids for fixation of the ocular prosthesis (5). Our proposed surgical procedure is based on the surgical technique presented by R.W. Neuhaus and M.J. Hewes in 1992 (21), which we have modified essentially in three aspects. Unlike the American authors, we have always performed the procedure under general anaesthesia. The main difference in the techniques resided in the fact that foreign authors fixed the bulbar part of the conjunctiva with a single knotted suture to the periosteum, and at the same time to the tarsal part of the prepared conjunctiva. We primarily implemented sutures into the periosteum, where we left them. Only afterwards did we fix the individual parts of the conjunctiva in the periosteum of the orbital rim separately, by which we attained a better attachment of the conjunctiva in the lower fornix. We replaced the originally used Dexon mono-filament resorbable fixation suturing material (21) with also reso-



**Fig. 5 Case study no. 4**

- A – sufficient fixation of prosthesis in left eye by pressure of upper eyelid
- B – deformation and closure of interpallebral fissure in left eye by external tarsorrhaphy
- C – renewed fixation of prosthesis following plastic surgery, smaller size constricts interpallebral fissure
- D – practical normalisation of shape of interpallebral fissure in left eye with deepening of fornix following plastic surgery

bable monofile suturing material from polydioxanone due to its increased tensile strength, which is still 40% after one month, and has a resorption period of three months (31). This factor is beneficial in this surgical indication. After one annual quarter the experimental model confirms its biodegradation without granulation reaction (23), with good clinical effect e.g. in cardiosurgery in children (2). In the 1970s, suturing material made from polyglycolic acid (Dexon) was already successfully used in ophthalmological surgery (10), including strabology (3). After 50 days Dexon was no longer detectable in the tissue (27).

For the selection of plastic surgery of the conjunctival sac, a range of techniques are available upon its retraction or scarring, with the use of various materials supplementing the reduced surface of the anophthalmic sac. Plastic surgeons primarily choose an autogenous skin graft (13) with subsequent insertion of a pressure forming insert as compensation. This method has been used successfully on a patient upon cosmetic solution of cryptophthalmos (17). This procedure is also used in the case of retractions of the conjunctiva following enucleations due to retinoblastoma, with subsequent actinotherapy of the orbital region. Slovak authors have referred to the successful use of the buccal mucosa in an older female patient for retraction of the upper fornix, and have also described plastic surgery and enlargement of the conjunctival sac by a lyophilised amniotic membrane in a male patient of similar age. Both patients had undergone enucleation of the eyeball without an implant several years earlier due to a serious ocular injury (9). The fact that no contraction during healing has been described speaks in favour of an amniotic membrane (9, 19). There is no discomforting secretion of the saliva glands from a buccal transplant, with its certain contraction upon healing (13). Transplantation of the amnion is also applied in the reconstruction of conjunctival fornices in the case of Stevens-Johnson syndrome, as a solution of symblepharon following chemical or traumatic damage (26) and in the case of scarry ocular pemphigoid (1, 26). Autogenous mucosa is also applied in the solution of chemical and thermal burns to the eyes (18). Contractions following enucleations may occur upon damage to the orbital tissues, pronounced haemorrhage during the period of performance of the procedure and subsequent infection (9). The issue of correct modelling of the conjunctival sac following enucleations is linked to the correct choice of technique of fixation of the external muscles. If the procedure is supported by the insertion of an orbital implant, the problem of falling out of the prosthesis declines, since the lower direct muscle is fixed, thereby ensuring that the Lockwood's ligament, which helps maintain the lower eyelid in the correct position, is not affected. A decisive role is played by the "retarding ligaments" from the Tenon's fascia – fibrous connections between the external surfaces of the muscular sheaths. It is precisely the Lockwood's ligament that has a securing function for the retarding mechanism in vertical movement. This concerns a streaked thickening of the fascia between the sheaths of the lower direct and sloping muscle. This is more important for this retarding mechanism than the superior transverse

(Whitnall's) ligament between the upper muscles. Excessively large retropositioning of the lower direct muscle then leads to ptosis of the lower eyelid, and thereby also to a widening of the interpalpebral fissure (6), which is a parallel to damage to the Lockwood's ligament or lack of securing of the lower direct muscle during enucleation. At a later age, the incidence of ectropia is also influenced by involutional mechanisms through the slackening of elasticity of the skin. An endeavour not to damage the Lockwood's ligament was confirmed by the development of a weakening technique on the lower direct muscle by the cul-de-sac method in various strabological indications, which prevented the preparation of the Tenon membrane in the region of the affected muscle (20). Further causes of falling out of the prosthesis include ectropion of the lower eyelid due to its slackening, indicated as "lower eyelid ptosis" (29). In anophthalmic eyes this has been resolved with the help of suspension of the fascia lata, guided subcutaneously between the medial internal epicanthus and external orbital rim (29, 30). It is precisely plastic surgery by the cul-de-sac method which resolves the problem of ectropion together with deepening of the conjunctival sac in the region of the lower fornix in a single surgical procedure. Various substitutes suitable for implantation of an orbital insert substituting the eyeball were sought for the possibility of mobility of the prosthesis, and from a cosmetic perspective also for the symmetrical creation of the shape of the interpalpebral fissure. In our region an acrylic orbital insert (18, 28) was used in the 1950s and 60s. Later the hydrophilic gel Methacrylate – Hydron (22) was used. Inflammatory symptoms appeared 24 years after its implantation, which were the reason for its extirpation. Its biodegradation by histiocytic proliferation was demonstrated (8). In Czechoslovakia the most commonly used implants included one developed in Prague from silicon rubber (11), produced in Ruben Náchod. Its quality also deteriorated over time. The authors attributed expulsion of up to 10% in adult patient to erroneous technique, whilst by contrast they viewed the 60% rejection of the implant in children as probably linked to biological reactions of the growing organism (KK). Our experience confirms only its isolated expulsion in our two young men out of a total number of more than forty long-term observed patients, in whom enucleation was performed at infant age due to retinoblastoma. Subsequent chemotherapy had no direct impact on the state of growth development of the conjunctival sac, as can be substantiated by case study no. 2. It is only the loosening of the orbital implant after a time interval that resulted in ptosis of the lower eyelid and softening of the conjunctival sac. We specially adjusted the silicon implants by cleaning the overflow edges from the generated fraying, with subsequent polishing before sterilisation and use. Our view was that expulsion could occur on the basis of a biological reaction to micro-imbalances and erosion of the surface of the implants. The subsequent minimisation of explantations confirmed our assumption. At present silicon implants are usually packaged into the cadaverous sclera, as a parallel to their insertion into the scleral sac following evisceration. Other materials used as substitution of the eyeball have included hydroxyapatite, in the

case of which the growth of fibrovascular tissue assisting its integration has been described (25). In the last twenty years porous polyethylene (MEDPOR) has begun to be used (4, 12). In a comparison of both implant materials it ensues that hydroxyapatite has manifested extensive mature fibroproliferation, whereas in the case of porous polyethylene there was higher porosity, similar to the spongy bone matrix (24). MEDPOR can be used without packing into the cadaverous sclera, fixation using PDS 6-0 sutures following drilling into the implant is suitable. In order to prevent postoperative dehiscence of the conjunctiva it is necessary to affix the implant at the end of the procedure with an embedded suture to the apex of the implant. This method prevents the opening of the surgical wound, since fixation ensures the synkinesis of the bulbar conjunctiva with the implant. The

resulting convex shape of the base of the anophthalmic conjunctival sac conditions the adjustment of the production of the ocular prosthesis produced from acrylate (16).

## CONCLUSION

The surgical technique of cul-de-sac to deepen the conjunctival sac in the region of the lower fornix also simultaneously resolves present ectropion of the lower eyelid, mainly in adult patients. The optician – prosthetist must then prepare a new special prosthesis. This work is an integral component of the good cosmetic effect of the operation. Acrylate is a suitable material. The prevention of these conditions, if a mutilating procedure is necessary, is to perform enucleation and evisceration with the use of an orbital implant.

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