The use of the Alloplant biomaterials in posttraumatic eyeball subatrophy surgery

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Abstract

There has been growth of subatrophy in the structure of serious posttraumatic complications. The existing surgery methods of treatment are effective at the onset of a disease and less effective at the middle stage of a disease and ineffective at far advanced forms of it. Meanwhile, subatrophy is the most frequent reason of eye enucleation after the trauma. There is a complex of operations with the use of Alloplant biomaterials for surgery treatment of posttraumatic eyeball subatrophy on the basis of the Russian Eye and Plastic Surgery Centre; they are revascularization of ciliary body and eyeball bandage. These operations increased eyeball in 66% of the patients and stabilized the form of it in 31,8% of the patients. Twelve patients with the 1-st stage of subatrophy (9%) and with slight changes in a vitreous body and retina underwent optic reconstructive operations (cataract extraction, vitreoectomy, iridoplasty, penetrating keratoplasty and others), which improved their visual acuity by 3,5 times as it used to be according to the range scale. As for the patients who had 2nd and 3rd stage of subatrophy the operation gave them a possibility for thin-walled cosmetic prosthetics.

Key words: Alloplant, biomaterials, surgery, posttraumatic subatrophy, revascularization, ciliary body, prosthetics.

For the last few years there has been growth of subatrophy in the structure of serious posttraumatic complications from 7-22% [2, 4, 11] till 29, 6-36, 9% [6, 7, 8]. The present day surgery methods of subatrophy treatment are effective mostly at the onset of the disease and less effective at the middle stage and non-effective at the far advanced form of the disease [1-4, 12-18]. Meanwhile, subatrophy is the most often reason of eye enucleation after the trauma and at present it reached 32,9 % [8], and more over most of the patients are under 40 years old – 78-92, 6 % [1, 4]. It is of paramount importance for this category of patients to preserve the eye both in the functional and cosmetic aspects. One should keep in mind that eye enucleation is a hard mental trauma for most patients, females and children in particular.

We have developed and introduced on a large scale a special complex of surgery treatment of posttraumatic ocular subatrophy with the use of the Alloplant biomaterials in clinical practice; this complex consists of the two following operations:

1) revascularization of ciliary body with the aim to restore trophism of a ciliary body, to normalize metabolism, and stimulate local immunity, to enlarge chamber humour producing, to increase intraocular pressure and to stop inflammatory process. For choroid revascularization an allograft is used; the process of its replacement is accompanied by the development of newly-formed vessels [9]. The operation is accompanied by an activation of macrophages;

2) eyeball bandage with the use of dermal allograft which is able to create a skeleton for sclera with the aim to prevent sclera shrinkage and deformation and to restore form and volume of an eyeball.

The use of dermal allograft for eyeball bandage is caused by its following advantages: 1) evident skeleton properties such as rigidity, elasticity, wound disruption strength [10] 2) sufficient thickness 3) good engraftment and gradual (not less than a year) replacement by its own connective tissue with dense regenerate formation [9].

The purpose of this work is to analyze findings of the given complex of surgical operations with the use of Alloplant biomaterials in the treatment of the eyeball posttraumatic subatrophy.

Materials and methods. According to the given method 473 patients were operated on; 134 cases were followed-up within three years and more. Most of the patients are under 40 years old -91, 04%, including children – 34, 33%. Case period lasted from 2 months till 12 years.

90 cases (67, 16%) of subatrophy development out of the whole number were caused by penetrating wound, 21 cases (15, 67%) occurred because of penetrating wound with foreign body, 23 cases (17, 16%) – eye contusion. The development of posttraumatic eye subatrophy after penetrating wounds was preceded by cornea wound which took place in 34 cases (25, 37%), scleral would – in 32 (23, 88%), corneoscleral – in 45 (33, 58%).

There were 43 patients (32, 1%) with the first stage of subatrophy, 59 patients (44, 03%) with the second stage of subatrophy, 32 patients (23, 9%) with the most apparent changes.

Preoperational examination included visometry, biomicroscopy, ophthalmoscopy, gonioscopy, Maclakov's tonometry, electrotonography, ultrasonic biometry, diagnostic ultrasonic scanning, electrophysiologic and immunologic methods of research.

Surgical treatment was applied to the mostly injured patients. The overwhelming majority of patients had evident organic and functional changes of visual analyzer: the most frequent cases (77, 7 – 24%) were (according to decreasing frequency): fibrosis of vitreous body, cornea changes, retinal detachment, changes of an iris, lens and their different combinations.

128 cases (95, 4%) had changes of indices of electrophysiologic studies of functional conditions of retina and optic nerve; these changes had a tendency to develop and to get spread; initial changes of retinal functions revealed themselves in 6 cases (4, 6%)

Practically all patients had low visual acuity. In 82, 8% of the cases there was a complete absence of light perception or wrong light projection. In 23 cases (17, 2%) there was correct light projection at a different stage of subatrophy.

The evident preoperative organic and functional changes of visual analyzer made it uncertain to radically restore in some way visual functions. That is why the basic purpose of our interference was 1) to save an eye as an organ, 2) to produce any possible functional effect, 3) to prepare the eyeball for any other possible optic-reconstructive operations, 4) to reach a cosmetic effect, 5) to prepare the eyeball for cosmetic prosthetics.

The techniques of operations. A circumferential incision of conjunctiva and tenon's capsule is made 7 millimeters from limbus, then they are elaborately separated till the limbus. Suture holders are put on four eye rectus muscles. Between the rectus eye muscles in the inferior outer sector an episcleral flap containing vessels is cut out 3-4 millimeters from the limbus; the flap is 6 millimeters wide and 8 millimeters long to 1/3-1/2 of sclera's depth. The flap is folded back to the limbus and a penetrating linear cut is made at its base and through this cut the flap is introduced into the supraciliary space (Fig. 1 A). The round part of the allograft is put on the flap of episclera. A duplication is formed for the projected from the wound the right-angle part of the transplant and fixed at the angles by four episcleral sutures (Fig. 1 G).

The last stage is an eyeball bandage. The eyeball bandage allograft has a form of a broken ring 6-8 millimeters wide with the inner diameter equaling 12 millimeters and from 0,5 till 3 millimeters thick (depending on the stage of subatrophy). With the preserved sensitivity of cornea of the eye liable to prosthetics, an eyeball bandage is made by a graft of such a thickness which makes its margins stick out a little over the level of the cornea; to have no contact between cornea membrane and prosthesis. The bandage allograft is put round the cornea and is fixed at the equator and at the limbus by the episcleral sutures so that it tightly fits to the sclera (Fig 1 D). Tenon's membrane and conjunctiva are sutured layer by layer.

Results and discussion. Surgical treatment of posttraumatic eye subatrophy with the use of the Alloplant biomaterial allowed to preserve an eye as an anatomic organ in 97, 8% of cases.

The analysis of treatment results by stages of subatrophy showed that with the help of this operation at all stages one could observe anterior-posterior axis (APA) increasing: at the first stage on the average by 0, 7 ± 0, 4 millimeters ($p<0, 01$); at the second stage the average increase of APA by three years of follow-up is 1,3 ± 0,3 millimeters ($p<0,05$); at the third stage APA increased by 1,3 ± 0,4 millimeters ($p<0,05$) (Fig. 2).

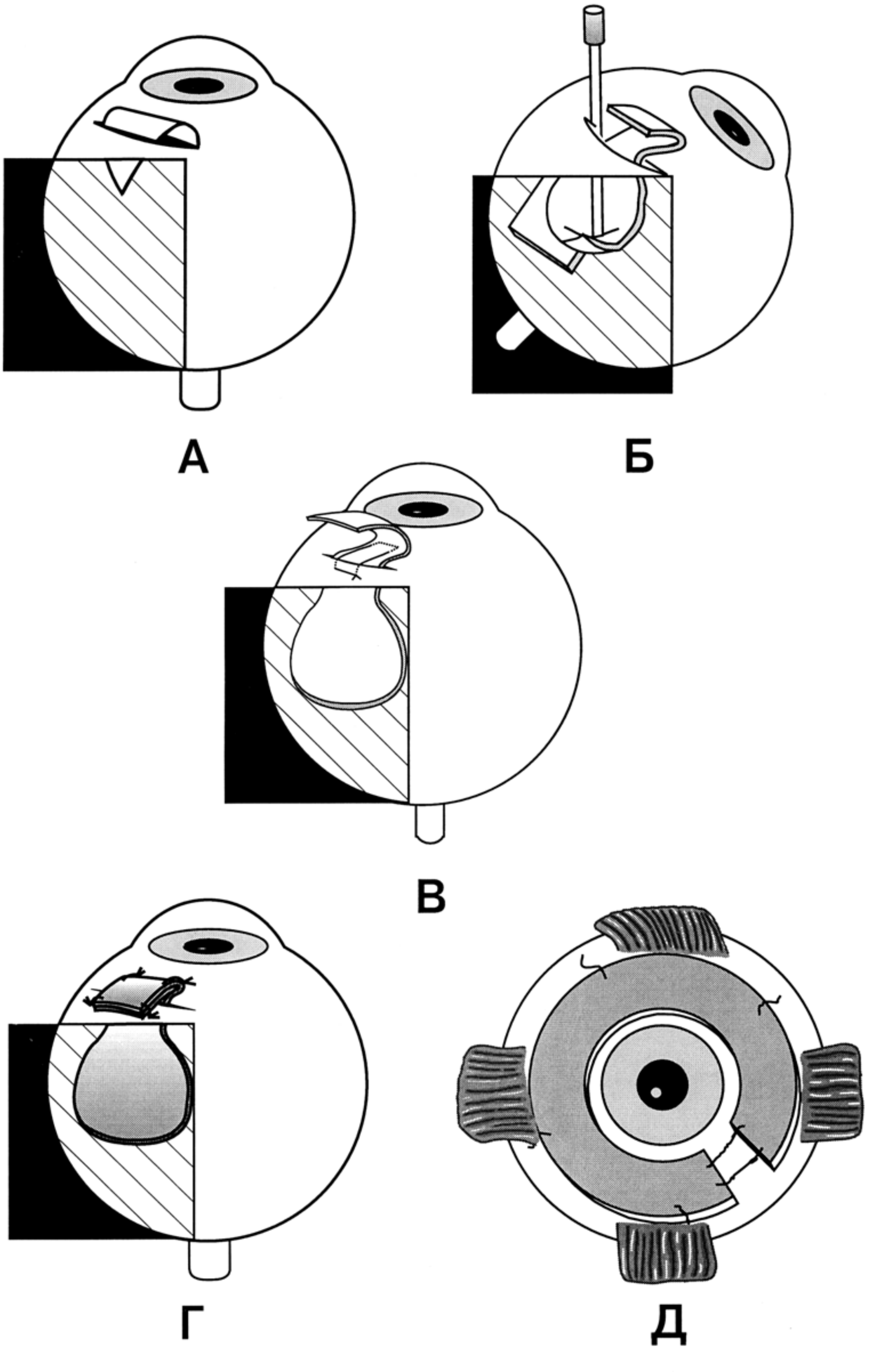

Fig.1. The scheme of the operation successive steps of the ciliary body revascularization and eyeball bandage with the use of the Alloplant biomaterials: A – introduction of an epithelial flap into the supraciliary space; B – introduction of allograft for choroid revascularization into supraciliary space; C – closure of an arch-form suture of a penetrating incision of the sclera and allograft; D – fixation of allograft duplication in episclera; E – fixation of allograft for eyeball bandage to episclera.

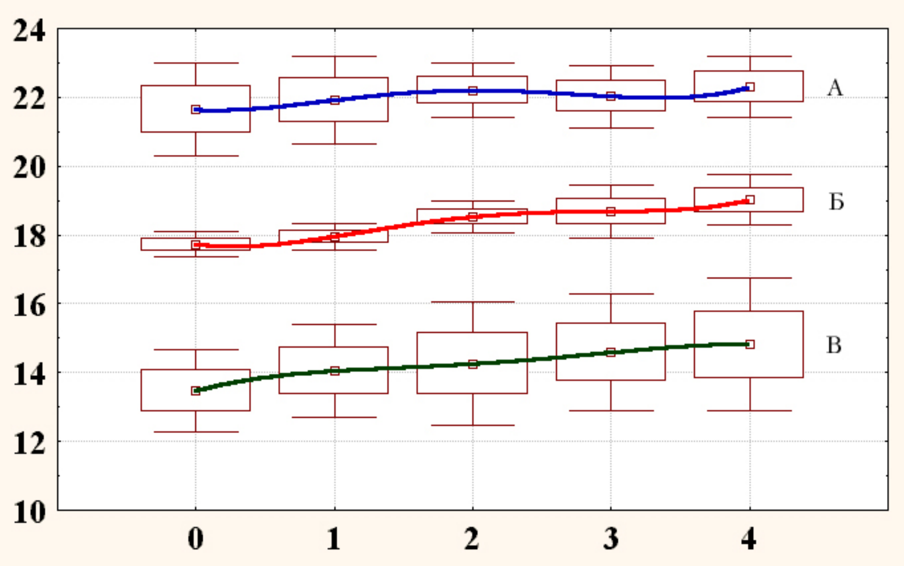

Fig. 2. Dynamics of APA changes by subatrophy stages. A - for the first, B - for the second, C - for the third stage of subatrophy. 0 - before operation, 1 - after operation, 2 - a year after operation, 3 - two years after operation, 4 – three and more years after operation. Along X-axis – mean group values in millimeters for APA. Confidential borderlines for mean values on each temporal section are marked: rectangles are for 63% of the level, horizontal lines are for 95% of the levels of confidential relativity.

The average increase of the intraocular pressure by three years follow-up made up: for the first stage of subatrophy – 3,5 ± 2,2 millimeters by mercury column ($p< 0,05$); for the second stage – 2±1,14 millimeters by mercury column ($p<0,01$); for the third stage -1,2±0,55 millimeters by mercury column ($p<0,05$) (Fig.3)

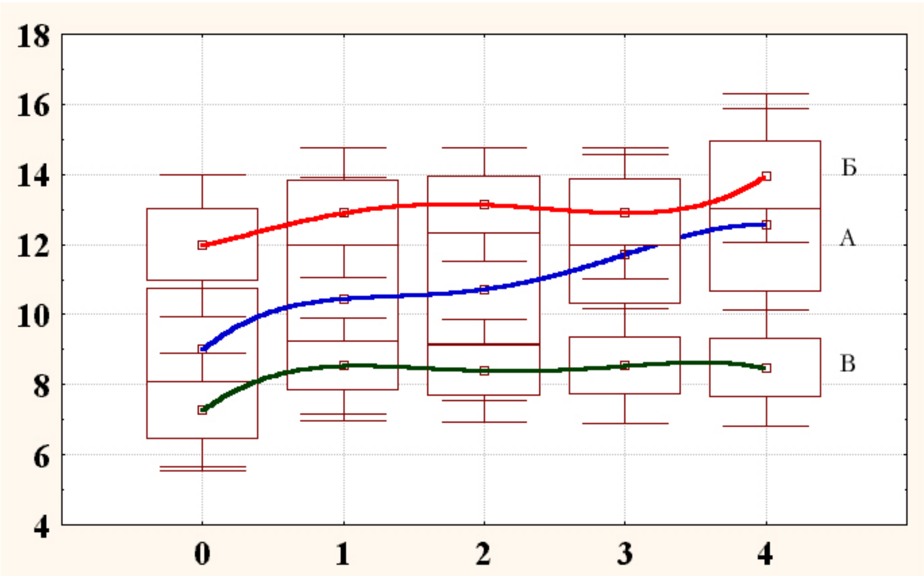

Fig.3. Dynamics of changes of intraocular pressure (IOP) in millimeters by mercury column as per subatrophy stages. A - for the first, B - for the second, C - for the third stage of subatrophy. All designations as they are given in Fig. 2.

Tonographic studies made on 24 patients with the 1-st stage of subatrophy, that had no changes of cornea or drainage zone of the eye anterior chamber angle, showed that three years after the operation there was observed statistically significant increase of the chamber humour production on the average of 0,7± 0,05 millimeters cubic min. ($p<0,05$).

As a result of the operation the eye volume increased in 66% of cases, including 4,5% of those whose eyes became healthy; stabilization occurred in 31,8% of cases. Children's eye volume increase went more rapid.

51,8% of the patients have increased their intraocular pressure, in 46% of cases IOP had a tendency to reduce on the average by 10% and three years later got stabilized on that level.

The eye volume growth was accompanied by the increase of IOP in 32% of cases, in 65,8% of cases there was discoordination of the eye volume and IOP.

Progressive course of subatrophy, which ended in enucleation, was found in 2,2% of patients (3 cases): two cases with the first stage a year after the operation because of unstoppable slow uveitis under the threat of sympathetic ophthalmia; in the third case with the third stage of subatrophy 1,5 years after the operation because of the exacerbation of uveitis after repeated dull trauma because of eye pain and the threat of sympathetic ophthalmia.

The operation itself has never caused uveitis exacerbation and subatrophy development.

Surgical interference practically did not influence residual visual functions because of severity of clinical manifestations of posttraumatic subatrophy. A year after the operation with the use of the Alloplant biomaterials 12 patients with the 1-st stage of subatrophy with slight changes of vitreous body and retina underwent optic-reconstructive operations (cataract extraction, vitreoectomy, iridoplasty, penetrating keratoplasty and others), which allowed to increase their visual acuity on the average by 3,5 times as it used to be according to the range scale.

The allograft applied in surgical treatment to create a skeleton for sclera in the anterior section of an eyeball, also allowed: to restore the natural color of sclera and hide its scar deformation; to repair the right form and to enlarge the eye volume thanks to its flexibility and thickness; the surgery procedures helped to achieve good cosmetic effect at the first stage of subatrophy.

With the advanced and far advanced forms of subatrophy the use of the allograft for eyeball bandage allowed to create optimal bed for a prosthesis and the possibility to manipulate its thickness allowed to use thick-walled prosthesis, which exert high cosmetic effect. The use of the allograft allows to exclude an irritable effect of a prosthesis on the eye in cases of sensitive cornea membrane and the presence of rough scar tissues of corneascleral localization; thus, it allows to extend indications for the cosmetic subatrophic eyes prosthetics. The prosthetics with the use of the individual thin-walled cosmetic prosthesis was made 4-6 weeks after the operation with the preliminary immunologic examination. Good cosmetic result took place in 97,3% of cases, good prosthesis mobility was achieved on the average in 82,2% of cases. The total average mobility in 4 directions made up 132,7± 8, 0 º and within longer follow-up increased up to 136,5± 8,2º.

Conclusions:

1. The developed complex of surgical operations with the use of the Alloplant biomaterials, including revascularization of ciliary body and eyeball bandage, is effective at all stages of eye subatrophy**.**
2. The given method of treatment gives optimal possibilities for thin-walled cosmetic prosthetics, excluding irritable effect of a prosthesis in cases of sensitive cornea membrane and (or) the presence of rough scar tissues of corneoscleral localization.

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