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USE OF ALLOPLANT BIOMATERIAL IN LAYER-BY-LAYER BARRIER KERATOPLASTY OF VASCULAR CORNEAL LEUKOMA

E.R.Muldashev, R.Z.Kadyrov, E.M.Gareev

The Russian center of eye and plastic surgery

The abstract

Use of Alloplant biomaterial layer-by-layer barrier keratoplasty of vascular corneal leukoma has been analyzed. This operation was carried out as a preparatory stage for through keratoplasty. It is shown, that the performed operation carries out “barrier” function and reduces neovascularization of the cornea. In the postoperative period there was an increase in transparency of a cornea and some visual acuity improvement.

We have analyzed efficiency and perspectivity of application of this technique and this biomaterial in curing corneal diseases and made proper conclusions.

Key words: Alloplant, layer-by-layer barrier keratoplasty, surgical treatment of vascular corneal leukomas.

There are certain difficulties in treatment of neovascularization of the cornea. It is connected with the fact that through keratoplasty makes a transplant turbid because of immune reaction of rejection, and keratoprosthetics gives rather high possibility for complications connected with keratoprosthetics denudation and with formation of retroprosthetic membrane [13]. In these cases, layer-by-layer barrier keratoplasty is frequently applied. As transplant materials we used dehydrated cornea [2, 12], amnion, solid cerebral tunic [7], tracheal cartilage and still-born children's bronchi [6], otic autocartilage[3] with the purpose to create a "barrier".

Alloplasty of corneal-scleral- conjunctival flap is carried out[9]. Such a big variety of transplants proves that the problem is very urgent.

The purpose of our researches was to study the possibility of using Alloplant biomaterials for layer-by-layer barrier keratoplasty.

MATERIALS AND METHODS

Alloplant biomaterials for layer-by-layer keratoplasty, applied in the Russian center of eye and plastic surgery [10], consists of white colored round-shaped parts of the tendon, with the diameter 5-10 mm for typical keratoplasty and ring-formed ones of 100 and 200 microns wide for barrier keratoplasty (fig. 1).

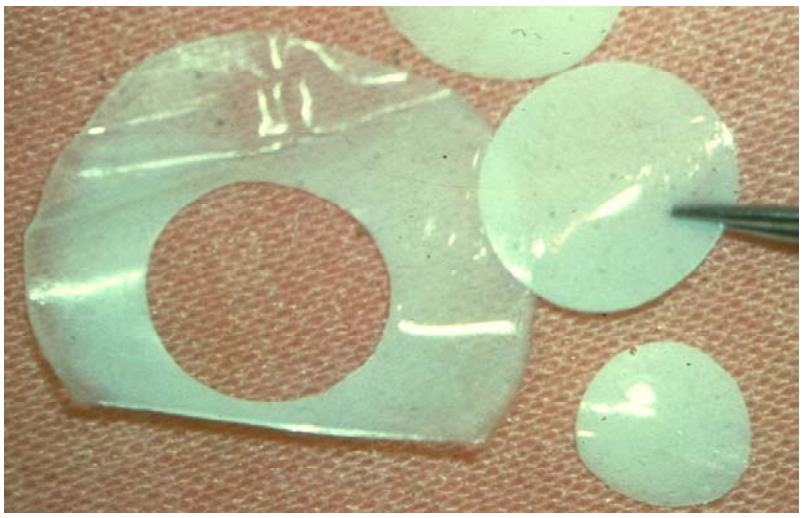

Fig. 1. Alloplant transplants for layer-by-layer barrier keratoplasty.

After the leukoma is dissected, when defected zones of the cornea are dissected deep in 150-200 microns, either peripheral layer-by-layer keratoplasty according to the Putchkovskaya methods [11] with Alloplant Biomaterial is carried out or the bared cornea is completely covered by the same transplant, thus its thickness and area well fit. As Alloplant biomaterial can be easily modeled it is possible to effectively keep parts of the cornea

transparent and choose a various forms of an alloplant according to the size of a pathological focus (fig. 2 and 3).

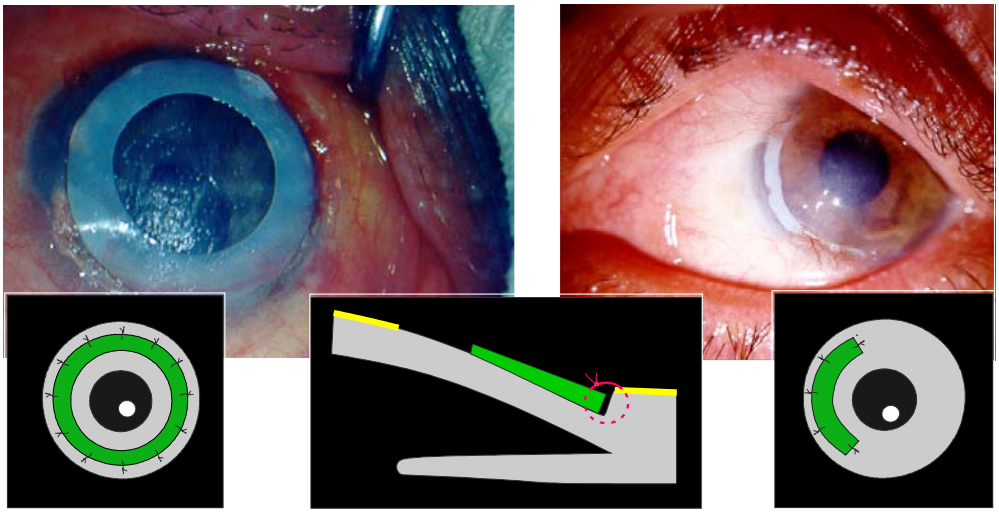

Fig. 2. Kinds of layer-by-layer barrier keratoplasty.

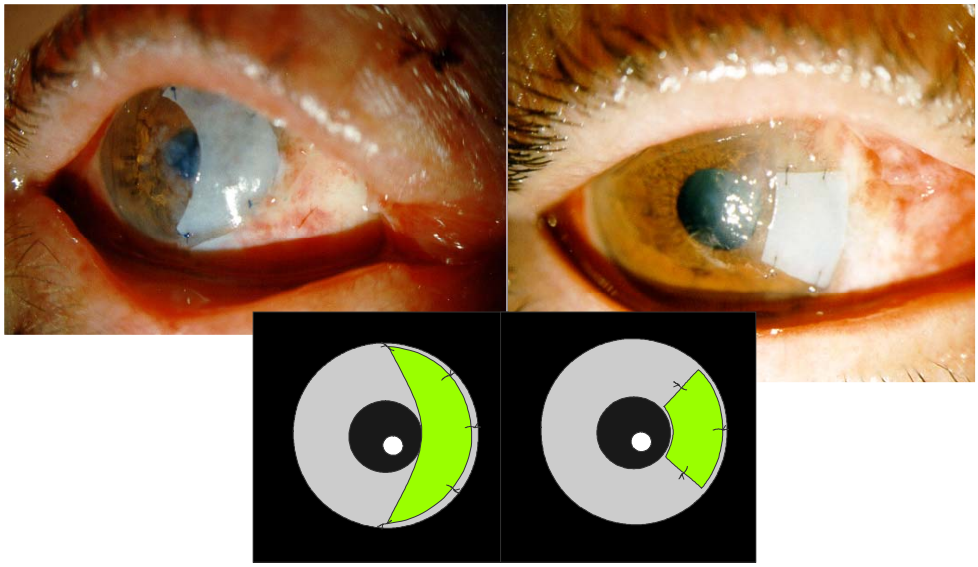

Fig. 3. Kinds layer-by-layer barrier keratoplasty.

We performed layer-by-layer barrier keratoplasty with Alloplant biomaterial for vascular leukomas as a preparatory operation for through keratoplasty (fig. 4) or for preventing corneal neovascularization (fig. 5).

Results of the operation were analyzed in patients with leukoma categories III and IV according to Filatov-Bushmich classification. Most of the examined patients had burns (43 %) and postherpetic (35 %) vascularized leukomas.

All patients were operated on not earlier, than a year after the burn.

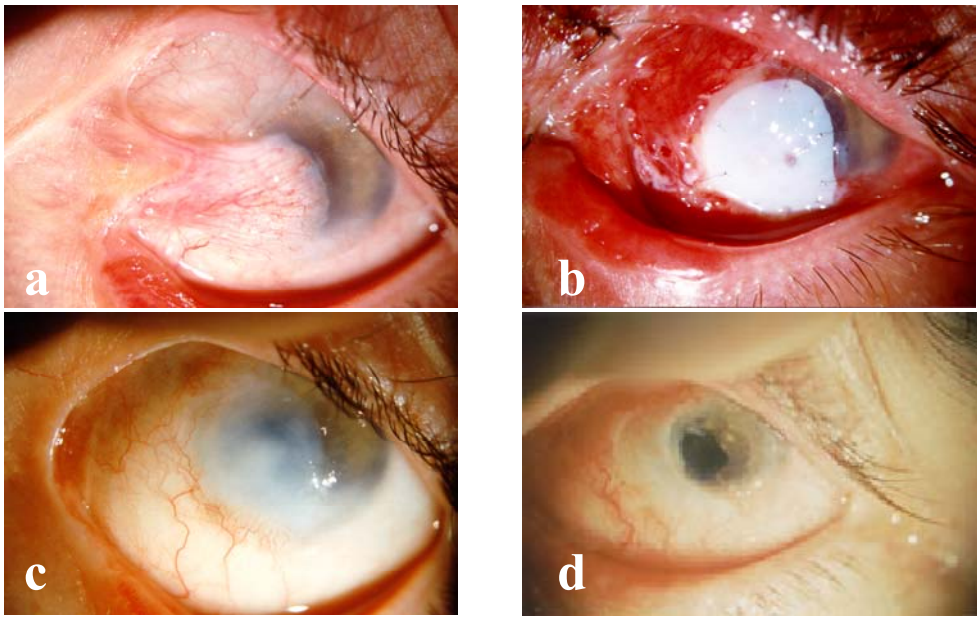

Fig 4. Patient B's eye, 17 years old, diagnosis: post-burn vascularized corneal leukoma of category IV: a -preoperatively; - the same eye, 2-nd day after layer-by-layer barrier keratoplasty, b - the same eye, 1 year after operation; c - the same eye, 1 month after through keratoplasty.

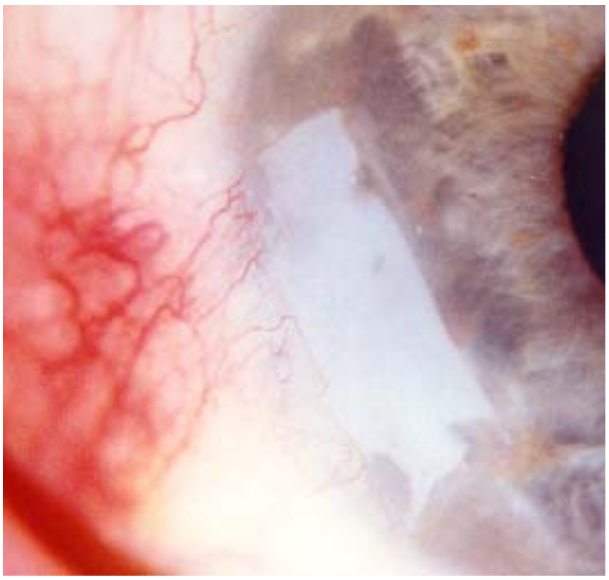

Fig. 5. Alloplant creates a "barrier" across the way of vessels growing into a cornea.

Efficiency of operation was estimated according to the three parameters: reduction of corneal revascularization level, increase corneal membrane transparency and improving eyesight acuity (EA).

In connection with that, 3 blocks of researches have been carried out.

The 1-st block. We have introduced a coefficient of corneal vascularization to estimate corneal vascularization level which showed dependence of EA on the area and a zone of vascularization. Computer scheme of corneal system consisting of 10 parallels and 36 meridians was conditionally divided into zones (fig. 6).

Influence of vessels = 1.710 standard units. A transparency =51.572 percent

Large vessels	-	Opaque cornea
Middle vessels	-	Semi-transparent cornea
Fine vessels		Almost transparent cornea
Conjunctival outgrowth	-	Translucent cornea

EA was better influenced by neovascularization and conjunctival outgrowth when optical zone of the cornea was defected [5,10]. Blood vessels course and both preoperative and remote conjunctival outgrowth on the cornea were schematically shown on the display.

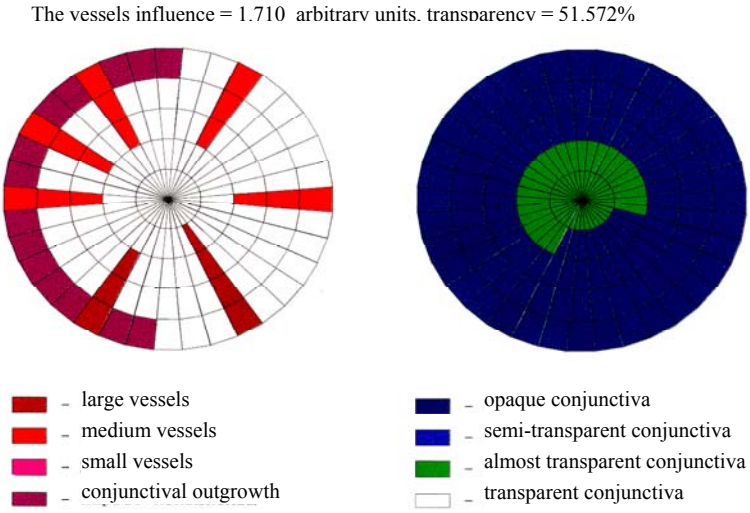

Fig. 6. An example of computer scheme of the cornea.

A special program made calculations of factors [4].

Preoperative and remote cases of negative difference of coefficients denoted decrease of vascularization and vice versa. Such calculations were made both for the basic group (51 patients with corneal leukoma, with vascularization of superficial and deep layers, operated with the help of Alloplant), and for the control group — 18 patients (19 eyes) operated with the use of native cornea. All patients had vascularized corneal leukoma of category III-IV according to the Filatov-Bushmich classification.

The second block. The transparency of a cornea was estimated. The same computer program was used (fig. 6), which estimated level of a transparency of the cornea in percentage (normal cornea - 100 %). In the right side of the display, scale of different colours specified the level of transparency of a cornea before operation and in the remote period. Differentiation of almost transparent and translucent cornea was carried out on a biomicroscopic picture. Biomicroscopy of almost transparent cornea showed that lacunas and iris crypts were visible in “fluora”. In cases of semitransparent cornea only contours of a pupil were visible. Details of the front chamber were not visible in turbid cornea. Increased

transparency of a cornea was a favorable outcome. Calculations were made in the same group of patients as in the first block of researches.

The third block. Changes of visual acuity was estimated before operations and during the remote period (1-8 years). There were changes of visual acuity in 23 patients with category III leukoma and in 20 patients with category IV.

The received results have undergone mathematico-statistical processing with use of methods of parametrical and the nonparametric analysis [I].

RESULTS AND DISCUSSION

The analysis of layer-by-layer barrier keratoplasty with the help of

Alloplant biomaterial has given the following results. In cases of category III leukoma there was an analysis of prevention of vessels from growing into the cornea with the help of Alloplant when vascularization was limited and occupied only a certain site, and there was no outgrowth on the cornea. In remote postoperative period coefficient of corneal vascularization considerably decreased in the basic group in comparison with the control one. Distinctions are statistically trustworthy ($t=3,7$; $p<0,002$). That is, the Alloplant showed more expressive barrier functions in cases of vascular leukomas, creating good conditions for through keratplasty (fig. 7).

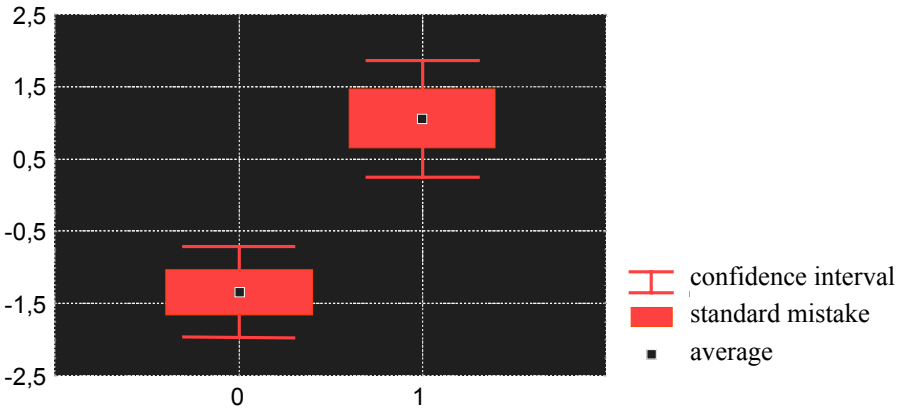

Fig. 7. Different coefficients of corneal vascularization before and after barrier keratoplasty in patients of the basic (0) and control (1) groups with vascular corneal leukoma with category III. Groups indices are shown on the absciss axis. Average difference of indices of corneal vascularization are on the axis of ordinates.

Patients with category IV leukoma had lower average coefficients of corneal vascularization (-1,6) than category III patients (-1,4) in spite of the fact that category IV is more troublesome. That happens because of decreased conjunctival outgrowth on a cornea after operation, as this group contained patients with conjunctival outgrowth placed no more than on the half of all surface of a cornea. Comparing the basic and control groups, coefficient distinctions appeared to be statistically trustworthy ($t=3,98$; $p<0,002$). Thus, Alloplant

created “barrier” to prevent vessels from growing into a cornea, and across the way of conjunctival outgrowth on a cornea as well (fig. 8).

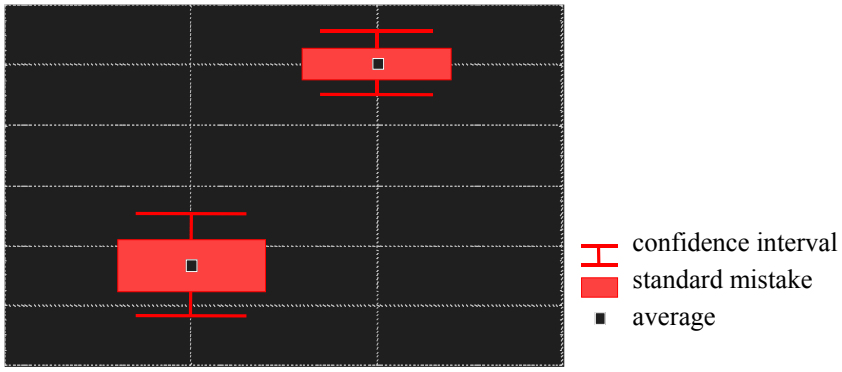

Fig. 8. Different coefficients of corneal vascularization before and after barrier keratoplasty in category IV patients of the basic (0) and control (1) groups with vascular corneal leukoma. Indexes of groups are shown on the absciss axis. Average difference of coefficients of corneal vascularization are shown on the axis of ordinates.

The analysis of changing transparency of a cornea revealed increaseof transparency in both (control and basic) groups with vascular leukomas without conjunctival outgrowth in remote period (category III leukoma) (fig. 9). However, the difference in percentage of transparency in the basic group appeared to be doubtful (p> 0,38).

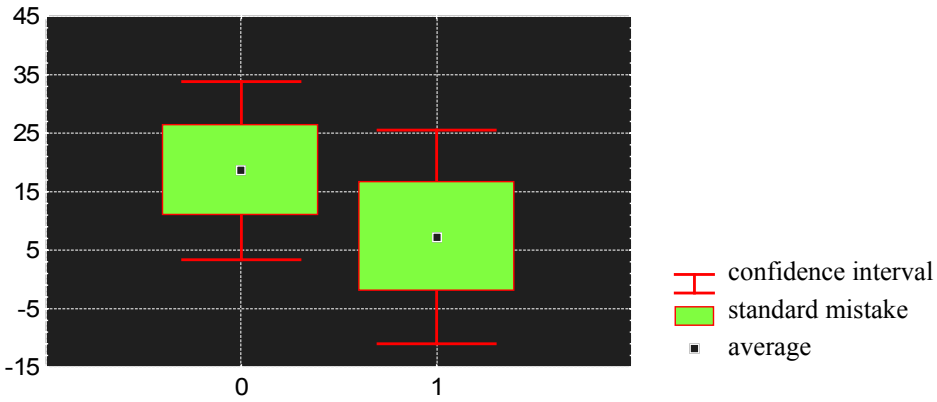

Fig 9. Changes of corneal transparency before and after layer-by-layer barrier keratoplasty in patients with category III leukoma. Indexes of groups are shown on the absciss axis (basic -0, control-1).Average difference of percentage of corneal transparency.

In patients with category IV leukoma with conjunctival outgrowth the difference of average percentage of transparency in groups appeared to be more essential though these distinctions are statistically also doubtful (p> 0,15) (fig. 10).

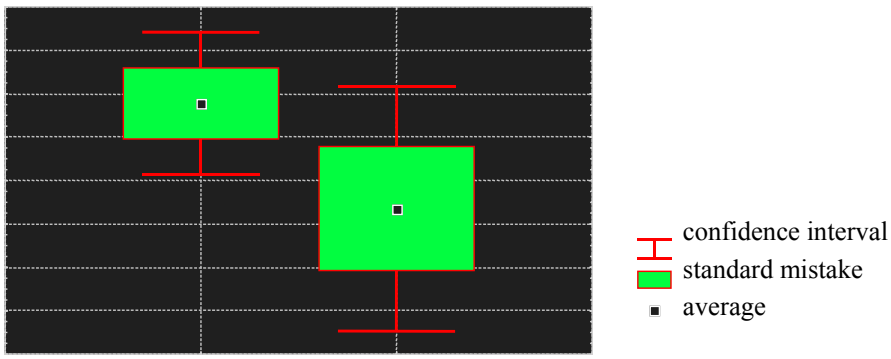

Fig 10. Changes of corneal transparency before and after layer-by-layer barrier keratoplasty in patients with category IV leukoma. Indexes of groups are shown on the absciss axis (basic—0, control-1). Average difference of percentage of corneal transparency in a group.

Alloplant used for layer-by-layer keratoplasty consists of white coloured opaque biological material. In spite of that, it is replaced by translucent tissue of corneal membrane during 1-6 months.

The transparency of a regenerated cornea straightly depended on how transparent the receiving bed of the cornea was (fig. 11).

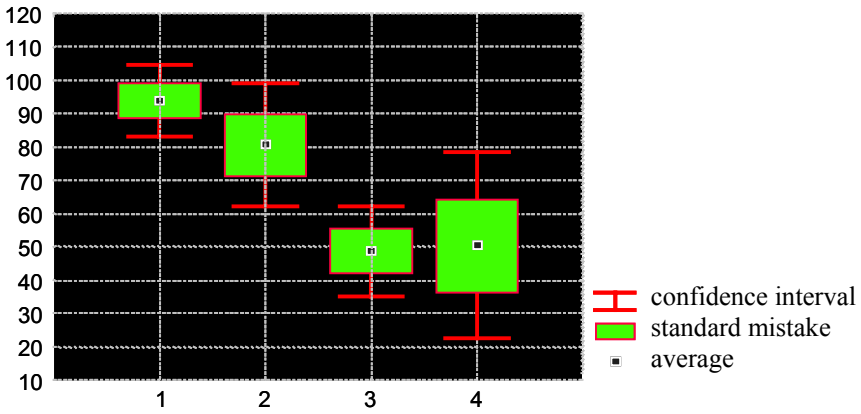

Fig. 11. Transparency of the regenerated cornea depending on the state of receiving bed of the cornea. State of transparency of the cornea (receiving bed). Percentage of transparency of the regenerated cornea with indication confidential borders/

Therefore while performing operations, whenever possible, we tried to reach transparent layers.

In the third block of researches dynamics of visual acuity was studied. (fig12,13) It is visible on the diagrams, that increase of average values appeared to be statistically insignificant.

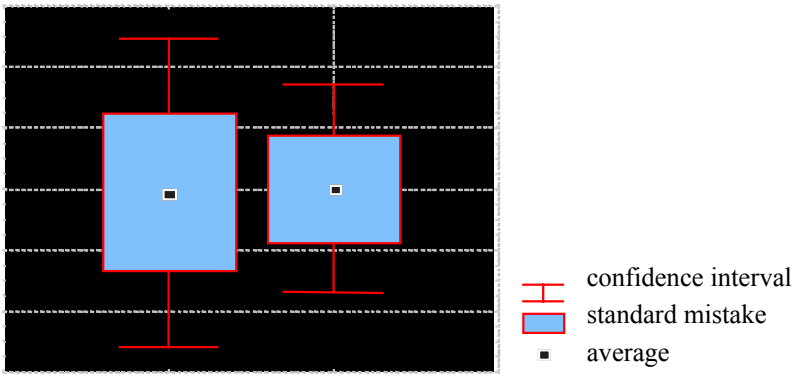

Fig. 12. Dynamics of visual acuity in those patients who underwent barrier later-by-layer keratplasty with Alloplant biomaterial in patients with category III leukoma. Time interval is shown on the absciss axis. Visual acuity is on the axis of ordinates.

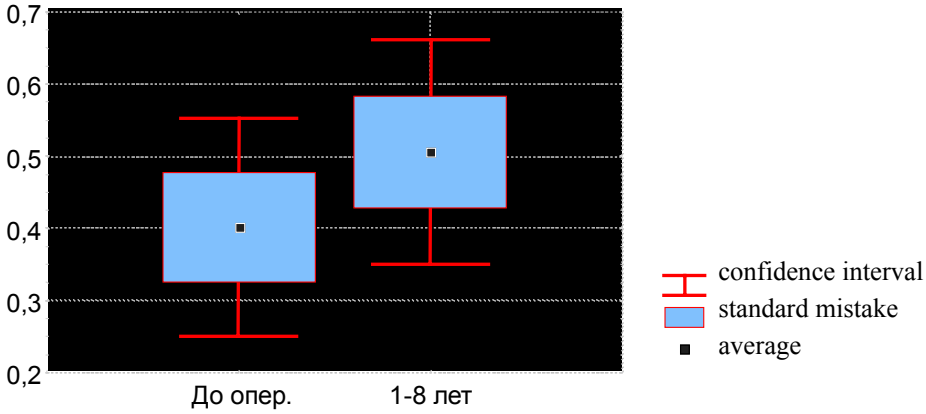

Fig. 13. Dynamics of visual acuity in patients after barrier layer-by-layer keratoplasty with Alloplant biomaterial in patients with category IV leukoma. Time interval is shown on the absciss axis. Visual acuity is on the axis of ordinates.

Most likely, it is connected either with often vascularization of peripheral parts of a cornea which do not influence visual acuity or with the influence of other poorly studied factors. To exclude those factors we used a special statistical processing according to the range test of paired comparisons suggested by Wilcoxon. It showed that distinctions are significant ($p < 0,05$) in patients with category III leukoma and on the border of the significance ($p < 0,08$) in patients with category IV.

There was postoperative inflammation which occurred after barrier keratoplasty with the use of Alloplant, that is confirmed by the examination of Ig G in lacrimal liquid.

Dynamics of Alloplant replacement after barrier keratoplasty is shown in fig. 14.

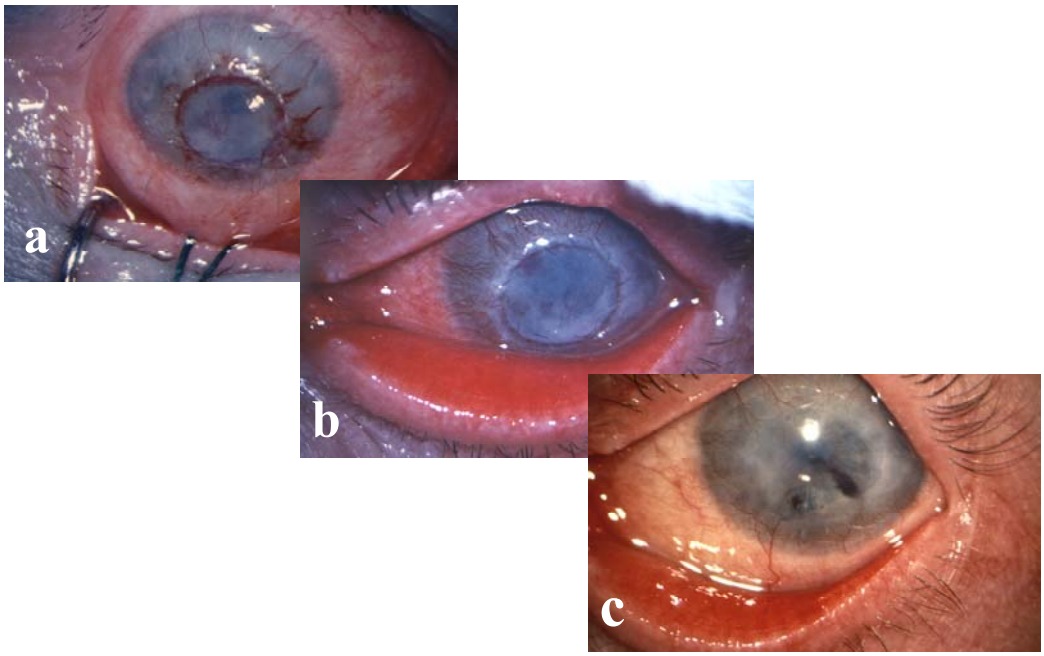

Fig14. An eye of patient named P., 40 yeas old., diagnosis: post-burn vascular a corneal leukoma of category IV: a - the terminal stage of layer-by-layer barrier keratoplasty; b - the same eye, 10-th days after operation; c - the same eye, 2 years after operation.

The received results evidently show that layer-by-layer keratoplasty with application of Alloplant biomaterial carries out barrier function, thus creating conditions for consecutive restoration of visual capability of the eye. It allows us to consider this technique, method of operation together with the applied biomaterial to be an effective and perspective means for repairing the given type of organic injure in an organ of vision.

Conclusions

1. Barrier layer-by-layer keratoplasty with the use of Alloplant biomaterial allows to reduce corneal vascularization in patients with vascular leukomas of categories III and IV according to the Filatov-Bushmich classification that gives an opportunity to carry out optical operations (through keratoplasty) in future.

2. The offered operation raises transparency of the regenerated operation during the remote period and increases visual acuity.

3. Transparency of a regenerated cornea straightly depends on the ‘receiving bed’ of a cornea at the moment of operation. That is why it is necessary, whenever possible, to stratify a cornea up to transparent layers.

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