

Anterior Lamellar Keratoplasty Using Artificial Biotransplant in Veterinary Ophthalmology

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Abstract

The article describes a method for anterior lamellar keratoplasty with biological material from porcine small intestine submucosa (tunica submucosa) used to replace the damaged area of the cornea. The indications for surgery were deep ulcers caused by chronic irritation, septic ulcers with elements of keratomalacia, corneal sequesters, traumatic needle-shaped ulcers and xerotic ulcers in cats. Complete graft integration was achieved in 27 eyes (77,14 %) of 35. In 8 cases (22,86 %) complications occurred. Suture failures, partial graft integration and central thinning of the transplant were later corrected by repeated surgeries. Panophthalmitis developed in one eye required its enucleation. Observating the late postoperative period showed a minimal decrease in visual functions, which is not always possible to achieve through other surgeries.

Key words: lamellar keratoplasty, biological material, corneal graft, biotransplant, porcine small intestine submucosa.

Introduction

Corneal diseases are leading the list of eye disorders in animals. Today, many methods of conservative treatment, such as topical antibiotic therapy, instillation of autoserum or plasma enriched with platelets, pharmacological therapy are used to promote cornea regeneration. However, corneal diseases with stroma defects can be a serious threat to vision, thus, the surgical intervention is often needed.

The most commonly used surgical technique is conjunctival repair using an autoconjunctival graft to close the defect. The corneal flap can be total, pedicle (or rotational), bipedicle or hood. The main disadvantages of this technique are a rough scarring and deterioration

of cornea optical properties [1-3].

Corneo conjunctival and corneo scleral transpositions are considered to be the most progressive methods, using an autoflap from the cornea and conjunctiva or sclera, respectively as a graft. The pedicle permits to intensify scarring, but the use of the healthy part of cornea limits its application only to small defects of the cornea [2].

In comparison to other methods, keratoplasty do not have these disadvantages. Different materials are used as grafts in anterior lamellar keratoplasty: amniotic membrane, biological materials from the porcine small intestine submucosa or extracellular matrix of porcine urinary bladder, alloplants and donor cornea [4,5].

The amniotic membrane facilitates the migration and specialization of epithelial cells and enhances their adhesion, scar modulation and reducing inflammation. This relatively cell-free material is widely used in the reconstruction of corneal surface in human ophthalmic operations. Amniotic membrane transplant is used as bio-dressing, reducing the effect of microbial proteases

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on animal cornea [6].

The biomaterial from the extracellular matrix of porcine urinary bladder and those from the porcine small intestine submucosa consist of cell-free collagen matrix, it contains fibronectin, hyaluronic acid, chondroitin sulfate, heparin sulfate and growth factors. In the process of graft integration, fibroblasts grow into the matrix, forming a scar, which is subsequently replaced by corneal stroma cells [7-11].

Donor grafts are also common in lamellar keratoplasty. Due to their tectonic properties, they are perhaps the best transplants, but the challenge is to obtain and store donor material, as well as to dissect the graft at the required depth [12,13].

Thereby, the biomaterial “VetBioSIS” from porcine small intestine submucosa was used in the current study to restore the cornea thickness”.

Serious corneal injuries with a loss of more than half its normal thickness can be caused by various reasons and have poor prognosis [10]. Currently, there are several surgical techniques aimed at restoring the cornea thickness, such as penetrating keratoplasty, corneal-scleral transposition, and conjunctival grafting [7]. Anterior lamellar keratoplasty using bio material from the porcine small intestine submucosa is effectively performed after deep keratectomy in our clinic.

The aim of the study

To describe the technique of performing anterior lamellar keratoplasty using the biological material and assess its results in the early and late postoperative periods.

Materials and Methods

This interventional study comprised 35 eyes of 34 animals (20 dogs and 14 cats), which underwent 35 anterior lamellar keratoplasty. The age of the animals ranged from 9 months to 11 years.

During an ophthalmological examination using biomicroscopy, tonometry and fluorescein test, the following pathologies were diagnosed: deep corneal ulcers resulting from entropion (in 4 cats and 3 dogs), septic corneal ulcers with keratomalacia (in 8 cats and 10 dogs), deep corneal sequestration (in 2 cats, one of

them having both eyes damaged), needle-shaped corneal ulcers (in 6 dogs), deep corneal ulcer associated with keratoconjunctivitis sicca (in 1 dog).

The porcine small intestinal submucosa VetBioSIS was used in all cases. Operations were conducted under the surgical microscope Leica M220 F12.

Surgical techniques

The combined anesthetic support, including premedication, systemic anesthesia, induction, local and inhalation anesthesia was used. The eyelids and the area around them were thoroughly shaved. The skin around the eyes was cleaned with a 10% betadine solution, the conjunctival sac was treated with a 0.2% betadine solution. A sterile surgical field with an opening for the operation area was prepared. The palpebral fissure was dilated with the help of a blepharostat. Eyeball akinesia was achieved by the intravenous medication of a non-depolarizing muscle relaxant (Rocuronium bromide) and fixation sutures.

At the first stage, a necrosectomy is performed with a scarifier. At a minimum magnification of the microscope, trephine is installed perpendicular to the cornea surface marking the area of planned trepanation by light pressure on the epithelium. The trephine must be larger than the diseased area [8]. Cornea stripping is carried out by leucosapphire exfoliator installed parallel to the curvature of the cornea, without excessive pressure, to healthy tissues. The graft is cut out of the artificial cornea layer with a trephine or micro scissors, depending on the shape. After this, the graft is placed in the prepared bed and fixed to the cornea with knotted sutures at 3, 6, 9 and 12 o'clock position. Then, the graft is stitched to the cornea with single knots [12]. The number and frequency of sutures depends on the graft diameter and the corneal tissues condition (Fig. 1). In the end, the fixing ligatures and the eyelid speculum are removed and the palpebral fissure is closed by suturing the eyelids for 2 weeks (blepharoplasty) or tarsorrhaphy during simultaneous blepharoplasty (Fig. 2).

Figure.1. Lamellar keratoplasty in a pugdog with a needle-shaped ulcer of cornea

Figure.2. Lamellar keratoplasty with VetBioSIS. The simultaneous blepharoplasty led to a deep



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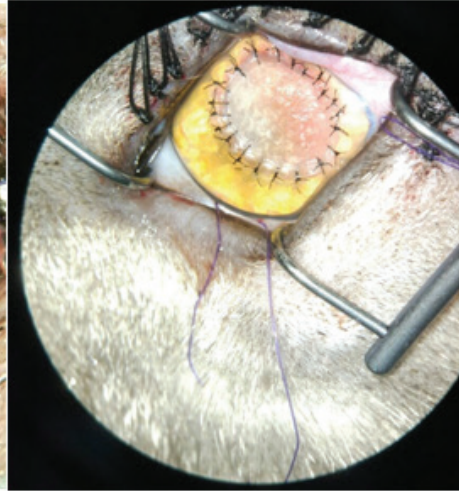


Figure.2. Lamellar keratoplasty with VetBioSIS. The simultaneous blepharoplasty led to a deep cornea ulcer in a british cat.

cornea ulcer in a british cat.

In the postoperative period, antibiotic therapy (local and systemic), drugs to stimulate corneal regeneration are administered. 10-14 days after surgery, the external sutures are removed. Removal of corneal sutures is carried out on 21st to 30th day under sedation.

Results

A complete recovery of cornea continuity and complete engraftment after lamellar keratoplasty was achieved in 27 cases (77.14%). Complications arose in 8 cases (22.86%) (Table 1).

Complications associated with graft fixation were the failure of sutures in 3 eyes with intense keratomalacia before surgery (8.571%). 1 eye received new stitches with non-absorbable material (Sterilon 7/0), and 2 eyes - with absorbable suture material (Tisorb 7/0). In all cases, complete engraftment was finally achieved.

Table 1. Types of complications

Types of complications		Number of cases
Associated with transplant fixation	Suture failure	3 (8,571%)
Changes in transplant	Unstable transplant integration	1 (2,857%)
	Central thinning	3 (8,571%)
Others	Panophthalmitis	1 (2,857%)

The complications associated with changes in transplant were the partial integration of biomaterial in 1 eye (2.857%) and the central thinning in 3 eyes (8.571%), Repeat keratoplasty was performed using biomaterial and additional fixation with Sulfacrylate bioglue in the case of partial implant integration. In 2 cases of central thinning after anterior lamellar keratoplasty in the eyes with total and subtotal corneal ulcers, a penetrating keratoplasty with defect replacement by the donor cornea was performed 14 days after lamellar keratoplasty (Fig. 3). The area of

repeated transplantation was smaller and corresponded to the diameter of graft thinning surface. In 1 eye with a slight thinning, a complete restoration of the cornea was achieved using therapeutic methods.

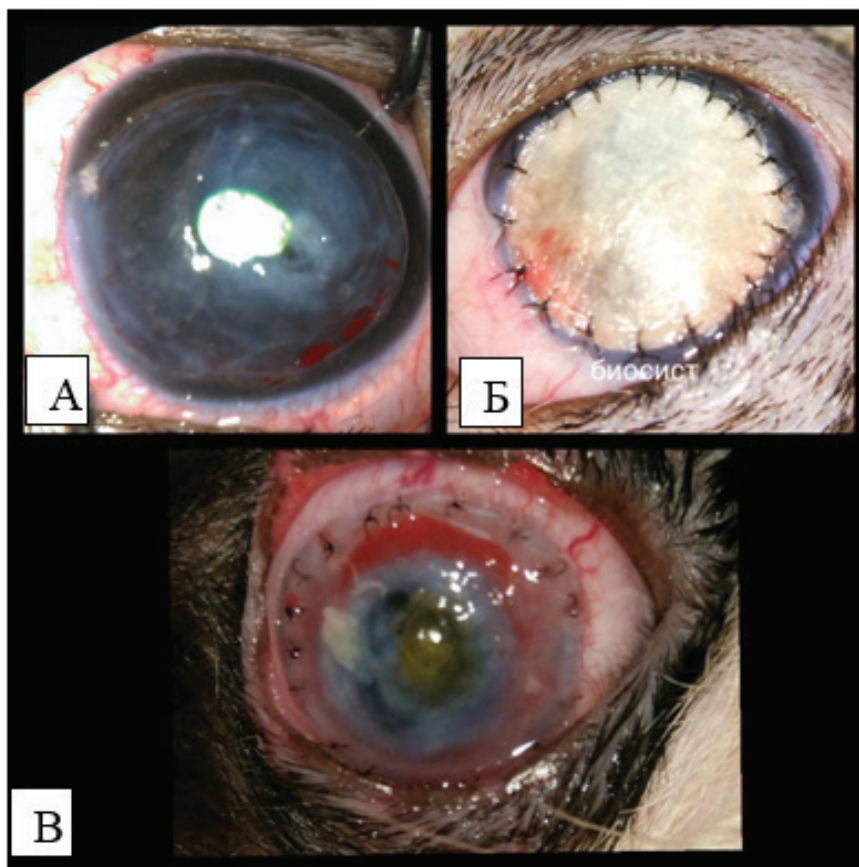


Figure.3. A - Japanese Chin with a deep corneal ulcer and keratomalacia elements. B – after a total anterior lamellar keratoplasty using VetBioSISt. C- eye condition 14 days after removal of blepharorrhaphy sutures. Early graft resorption, central thinning, risk of perforation. The dog was indicated for penetrating keratoplasty.

An eye was subjected to enucleating due to the development of panophthalmitis (2.857%).

A long-term monitoring (more than 10 weeks) allowed to observe the development of a fine discontinuous scar in 25 cases (71.43%) after surgery, (Fig. 4). In 9 cases (25.71%) there were thick scars in the postoperative period, 2 of which (5.71%) arose due to the followed penetrating keratoplasty using a donor cornea dried over silica gel. The remaining 7 (20%) scars were located on the peripheral part of the cornea, which did not significantly worsened the vision of animals.



Fig. 4. The result of anterior lamellar keratoplasty 10 weeks after surgery

Discussion

The biological material from the porcine small intestine submucosa consists of acellular collagen matrix, and contains fibronectin, hyaluronic acid, chondroitin sulfate, heparin sulfate and growth factors. In the process of graft integration, fibroblasts grow into the matrix forming a scar, subsequently replaced by cornea stromal cells [3].

A thick scar and pronounced conjunctival vessels can remain after plastic surgery with replacement of damaged area with a conjunctival flap. The corneo conjunctival transposition provides a more transparent cornea, but the healthy cornea is usually damaged during this surgery. This technique cannot be used in case of subtotal and total lesions of the cornea [4].

Conclusions

1. An analytical study of corneal transplantation

using biological material has shown a high efficiency in 77.14% of cases.

2. Anterior lamellar keratoplasty using corneal grafts allows preserving visual functions and restoring optical transparency in most cases.

3. For subtotal and total corneal ulcers, as well as for septic corneal ulcers with the elements of keratomalacia, it is recommended to use additional methods of transplant fixation in order to avoid complications in the postoperative period.

References

1. Chow D., Westermeyer H.D. Retrospective evaluation of corneal reconstruction using ACellVet™ alone in dogs and cats: 82 cases // *Veterinary Ophthalmology*. – 2015. – P.1-10.
2. Gimenez T.P., Inmaculada Morales Farina. Lamellar keratoplasty for the treatment of feline

- corneal sequestrum// *Veterinary Ophthalmology*. – 1998. - №1. – P.163-166.
3. Goulle F. Use of porcine small intestinal submucosa for corneal reconstruction in dogs and cats: 106 cases // *JSAP*. – 2012. - №53. –P.34-43.
 4. Pavlova T.N. Keratoplasty in veterinary ophthalmology: dissertation / T.N. Pavlova. - Moscow, 2013. – 155 p.
 5. Arenas E., Esquenazi S., Anwar M., Terry M. Lamellar corneal transplantation// *SurvOphthalmol*. – 2012. – №57.
 6. Barachetti L., Zanni M., Rampazzo A. Use of four-layer porcine small intestinal submucosa alone as a scaffold for the treatment of deep corneal defects in cats and dogs: preliminary data. – *ECVO*. – Hungary. – 2016.
 7. Maggs D.J., Miller P.E., Ofri R. *Slatter's fundamentals of veterinary ophthalmology*. – 4th edition. – St. Louis: Saunders Elsevier, 2008. – 482 p.
 8. Shilkin A.G., Kopenkin E.P., Averin M.A., Oleinik V.V. Technique and results of layered keratoplasty of the cornea using artificial grafts in dogs and cats // *XII Moscow International Congress on Diseases of Small Pets: Materials*. – 2004. – P. 153-155.
 9. Goulle F. The use of the submucosa of the small intestine of pigs for reconstruction of the cornea in dogs and cats: 106 cases // *JSAP*. – 2011. – №1. – P. 5-13.
 10. Pavlova, T.N. Advantages and disadvantages of all available materials for keratoplasty in veterinary ophthalmology today / Oleinik V.V., Rotanov D.A., Goncharov D.V., Lutsay V.I., Scientific Advisor Academician Usha B.V., Associate Professor Shilkin A.G. // *Abstracts of the II All-Russian Interuniversity Conference on Veterinary Surgery - Moscow, 2011.*- P.125-129.
 11. Dîrlea I.A., Muste A., Beteg F., Hodis L., Stroe T. Research Regarding Prelevation and Preparation of Porcine Small Intestinal Submucosa for Corneal Reconstruction in Dogs and Cats//*Bulletin UASVM Veterinary Medicine*. - 2016. - №73. – P. 21-25.
 12. Featherstone H. J., Sansom J., Heinrich C.L. The use of porcine small intestinal submucosa in ten cases of feline corneal disease // *Veterinary Ophthalmology*. – 2001. - №4 (2). – P.147-153.
 13. Godoy-Esteves C., Yazbek K. Lamellar keratoplasty in rabbits using human and rabbit amnioticmembrane grafts: a comparative study // *Veterinary Ophthalmology*. – 2015. - №18. –P. 191-197.