FEMTOSECOND LASER-ASSISTED KERATOPLASTY IN A CHILD WITH CORNEAL OPACITY: CASE REPORT

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SUMMARY

Corneal opacities are the fourth cause of blindness world-wide. Over the past two centuries, various corneal transplantation (i.e., keratoplasty) methods have been developed and improved. Nowdays, femtolaser-assisted keratoplasty is one of the most promising techniques. Femtosecond lasers have several advantages that provide additional surgical benefits. Among them, no thermal injury, the ability to cut deeply on a single plane and to perform various corneal profiles should be mentioned.
In children, corneal disorders are of special importance while femtosecond-assisted keratoplasty case reports are rare. Here, we describe femtosecond laser-assisted penetrating keratoplasty in a girl with a rough central corneal opacity.

Keywords: cornea, keratoplasty, femtolaser, children

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According to WHO data, corneal diseases take the forth place among causes of blindness [1].

Keratoplasty techniques have been improving for more than two centuries. The first surgeon who suggested replacement of opacified cornea with glass was Guillaume Pellier de Quengsy, who implanted glass disk mounted in a silver ring in place of opacified cornea, but the surgery was unsuccessful [2]. Since that transplantology knew many triumphs and despairs.

In Russia from 4 to 8 percent of children blindness cases are caused by corneal opacifications [3]. These significant numbers to the large extent result from increased injury rate, susceptibility to infections and imperfectness of immune responses peculiar to children.

Treatment of corneal opacity in children is challenging. Variety of clinical forms of the disease, age-specific peculiarities of the eyeball tissues and post-surgical reparation often question efficacy and reasonability of yet limited set of treatment procedures.

At the same time, postponed surgical operation may lead to amblyopia development and progression. With corneal opacities typical for children, in most cases penetrating keratoplasty is the surgery of choice. Other surgeries in children corneal opacification (rotational autokeratoplasty, excimer laser photoablation and, finally, optical iridectomy) have quite narrow clinical use while conservative treatment is either ineffective (proteolytic enzymes phonophoresis, tissue therapy) or palliative (instillation of hypertonic drug solutions, soft bandage lenses) [3, 4].

Recent achievements in corneal transplantology (identification of the main factors responsible for the donor graft transparency, introduction of new modern immunosuppressants and intraocular pressure-controlling medications, continual improvement of surgical techniques) decreased age of patients [3–5].

The abilities and advantages of femtosecond laser are due to the extremely short tissue exposure (1 femtosecond is 10^{-15} second) which minimizes thermal effect and allows employing higher laser energy to achieve local tissue destruction and to form numerous microbubbles of plasma. In place of plasma, water and carbon dioxide are generated and then being absorbed in the neighboring tissue. After that, tissue interface remains in place of microbubbles. Modern femtosecond machines allow forming profile of any complexity at a given depth keeping outer layers intact [6].

With femtosecond laser (FL) ability to form ideal cuts with almost complete edge adaptation one may expect increased surgery safety and optimization of reparation processes which are especially important in children [7].

Though FL use for keratoplasty in children is just breaking new ground there are some scattered reports on its successful employment in pediatric practice. Thus, according to Luca Buzzonetti deep lamellar femtolaser keratoplasty in children leads to significantly lesser post-surgical astigmatism than conventional lamellar keratoplasty [8].

In 2013 Morozov Children’s Hospital acquired femtosecond laser machine. It means that laser surgery in pediatric ophthalmology in our country achieves qualitatively new and more advanced level of treatment in children. Femtosecond laser machine FS-60/iFS is currently one of the most advanced laser surgical systems in the world. It is based on diode laser with wavelength of 1053 nm, pulse width of 600–800 fs, frequency of 60–150 kHz, gas bubble size of less than 3 µm and power of 100 MW. Computer programming allows complete control over a surgical procedure. High precision of computations ensures absolute match of profiles of donor’s and recipient’s cornea. The ability to create any profile complexity enables use of FL in lamellar, intrastromal and penetrating keratoplasty as well as for forming of tunnels in stroma for subsequent implantation of intrastromal rings.

CLINICAL CASE

Girl N, 12 years. Diagnosis: OS — corneal opacification, the outcome of corneal ulcer, the patient previously underwent Kuhnt's autoconjunctival grafting. OU high myopia.

Admission diagnosis:

- dev 10–15° div OS by Hirschberg
- visus OD = 0.06 sph —6.5 = 0.9–1.0
- visus OD = 0.015 sph —6.5 = 0.08 (best corrected visual acuity)
- OD — the eye is healthy
- OS — thin scars on the external and internal margins of the upper and lower eyelid (after previous tarsorrhaphy). No signs of eye inflammation. Conjunctival scars in bulbar, tarsal and inferior forniceal conjunctiva. An upper-temporal segment of the cornea including the pupil zone is covered by vascularized conjunctival flap adherent to cornea. Under the flap there is polymorphous full-thickness corneal opacification. Outside the opacification zone the cornea is transparent. Anterior chamber is of medium depth; pupil is round, 2.5 mm; light-stimulus response is normal. Underlying optical media are not discernible in details. The fundus reflex is normal. The eye fundus is not discernible in details (pic. 1).

Tonometry (J-care): OD = 21 mm Hg, OS = 18 mm Hg.

Echobiometry: OD = 25.74 mm, OS = 25.36 mm.

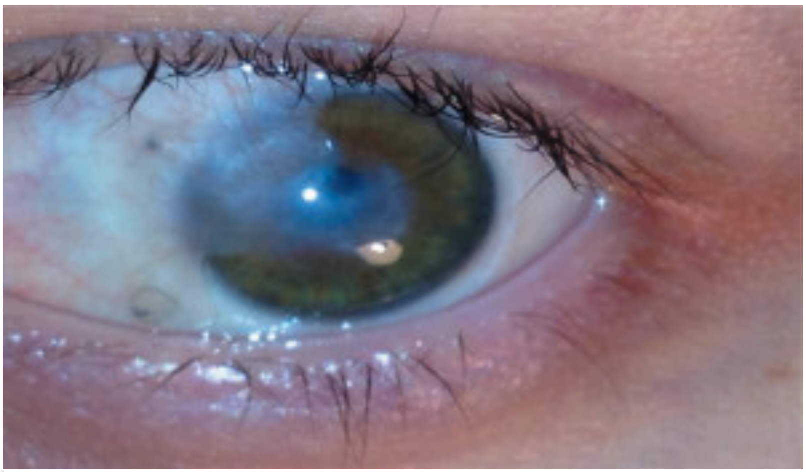
Ultrasonic scanning: thin drifting opacifications in the vitreous.

Spectral OCT of the anterior segment: severe central cornea opacification.

Scheimpflug camera: OD — corneal thickness 500 μm (apex), OS — corneal thickness is more than 700 μm, the thickness profile is irregular with maxima 1200-1300 μm.

Severe opacification of the central cornea in OS was an indication for a keratoplasty with the Intralase femtosecond laser machine.

Planning the surgery we kept in mind that lamellar keratoplasty poses less risk of intraoperative and postoperative complications. Additionally, according to the literature data, femtosecond laser cut quality and accuracy in deep layers of cornea is limited by the severity of opacification [9–11].



Pic. 1. Patient N. OS — corneal opacification, the outcome of corneal ulcer, the patient previously underwent Kuhnt’s autoconjunctival grafting.

Pic. 2. First day postoperative after penetrating FL keratoplasty OS.

Pic. 3. 2.5 months postoperative after penetrating FL keratoplasty OS. The transparent graft is accepted.

The certified donor material was obtained from the bank of cornea.

As it was hard to determine the lesion depth of the inner stromal layers, in the first stage of surgery we cut out the disk of preselected size in recipient's cornea (7.0 mm in diameter, 350 μm in depth). Laser energy was 2.2 μJ for the vertical cut and 1.6 μJ for the layer-wise tissue removal. After the corneal disk removal lesions in corneal bed were uncovered such as residual opacifications and microperforation. Areas of imperfect cuts of cornea were also found in the most opaque regions. Thus in spite of our initial intentions for lamellar keratoplasty we continued the surgery as penetrating keratoplasty. The inner layers of cornea were cut manually with corneal scissors.

We fixated the donor corneoscleral flap in an artificial anterior chamber and created a graft of corresponding diameter (7 mm) with FL. The graft was fixed with knotted retention sutures and then with a running suture 10–0. Anterior chamber was filled with physiological saline.

The first day postoperative: OS — there is some conjunctival injection; the graft is transparent; a slight descemetitis; the running suture keeps the graft well attached. Anterior chamber is of medium depth; the pupil is up to 2.5 mm in diameter, its light-stimulus response is weak. The lens and vitreous are transparent; the eye fundus has no pathological changes. The intraocular pressure was estimated by digital palpation to be normal (pic.2)

Post-surgery treatment included topical antibacterial, anti-inflammatory and epithelizing therapy. Taking into account the severity of pre-surgery condition, we strengthened treatment with intravenous dexasone (4 mg, 3 injections) and oral administration of antihistaminic drug and NSAIDs. On day 5 after the surgery topical therapy was supplemented with subconjunctival administration of dexasone (0.2 mg, 5 injections).

On discharge: Visus OS = 0.015 sph –6.5 = 0.2 (best corrected visual acuity)

Scheimpflug camera: OS — graft thickness in the central zone — 783-799 µm, graft thickness in the zone of suture — 754-1010 µm, corneal density in the optical zone is irregular (from 43% to 68%).

2.5 months postoperative: Visus OS = 0.015 sph –6.5 = 0.3-0.4 (best corrected visual acuity)

OS — no signes of inflammation, the transparent graft is accepted (pic. 3).

Development and introduction of FL technologies brings ophthalmic transplantology to qualitatively new level minimizing the risk of complications specific for corneal grafting. The list of indications for keratoplasty increases and more patients including children can be treated. Lack of heating due to ultrafast laser action and ability to form profiles of any complexity in the cornea allow significant improvement in keratoplasty outcomes justifying employment of femtolaser machines in pediatrics. Surely, keratoplasty in children has its own traits in patient preparation, anaesthetic management and post-surgical treatment.

In spite of the severity of the initial cornea condition of our patient, the uneventful early postoperative period inspires optimism. We realize that it is too early to state the stability of the outcome achieved but it is clear that our patient's quality of life has totally improved.

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