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Some Aspects of Complications of Congenital Cataract Surgery

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Abstract Cataract in children, which is one of the leading causes of primary blindness, is a clouding of the lens. The prevalence of cataracts in developed countries, as well as in Russia, is 1.6–2.4 per 100,000 children. Intraocular lens (IOL) implantation has become widespread in recent decades and is considered the most optimal method for correcting aphakia. Despite the introduction of new high-tech methods of surgical treatment of congenital cataracts, there is currently a fairly high percentage of complications. All of the above does not reduce the urgency of the problem of treating children with congenital cataract (CC) and requires further research.

Keywords Congenital cataract, Cataract extraction, Intraocular lens, Pseudophakic myopia, Pseudophakia, Secondary cataract, Cataract extraction complications, Posterior capsule fibrosis, Inflammatory reactions, Anterior chamber moisture, Often sick children

1. Introduction

Cataract in children, which is one of the leading causes of primary blindness, is a clouding of the lens. The prevalence of cataracts in developed countries, as well as in Russia, is 1.6–2.4 per 100,000 children [1,2,3,4]. Among the causes of blindness in children, congenital cataracts (CC) account for 7.5–8.0% (in economically developed countries) to 27.4% (in socially disadvantaged regions). Due to cataracts, the development of the visual analyzer is disrupted and amblyopia is formed, the treatment of which requires significant and prolonged efforts on the part of ophthalmologists and parents [2,5,6]. The main factor in determining the timing of surgical intervention, both in bilateral and unilateral cataracts, is the severity of lens opacities, determined by the form of CC, affecting the formation of visual functions of the child in the sensitive period. On the one hand, having operated on a child with partial lens opacity and high residual visual acuity in the first months of life, we deprive him of the possibility of normal physiological development of visual functions and accommodation, on the other hand, performing surgery at a late date with pronounced lens opacity, for example, the total form of CC leads to the development of high-grade obscuration amblyopia and gross, often irreversible changes in the visual analyzer. Implantation of an intraocular lens (IOL) has become widespread in recent decades and is considered the most optimal method of correcting aphakia, since IOLs are devoid of the disadvantages of eyeglass and contact correction [7,8]. When choosing a method for correcting aphakia in young children, the following main circumstances are taken into account: anatomical and functional features of the growing eye (the existence of a sensitive period, modeling of the refractive effect according to age), the constancy of correction [9,10]. Primary implanted IOL, unlike glasses and contact lenses, is the most optimal method of correction of induced aphakia, allowing to create all conditions for the completion of age-related organogenesis of the eye, morphological and functional development of the visual system. We believe that the principles of "medicine of the future" are quite acceptable for children with CC and their parents, which are based on four fundamental principles: personalization, prediction, prevention and participativeness (4P-medicine). Personalization is an individual approach to the patient. The latest scientific developments are used for this purpose: a thorough analysis and analysis of the genetic and physiological characteristics of a particular person. Based on genetic testing and the collection of parental (genealogical) analysis, biomarkers affecting the development of the disease are tracked. As part of the implementation of this principle, the creation of a patient's genetic passport is becoming widespread. Prediction is the identification of predispositions based on such a passport and the creation of a forecast health. Having knowledge about the individual characteristics of the human genome, it is possible to identify risk factors and determine the degree of probability

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of developing a particular disease. Prevention is the next step after determining the risk factors. Its essence is either to prevent or to reduce the risk of developing the disease. The forecasts made on the basis of genetic analysis allow us to develop a set of preventive measures, and a personalized approach allows us to make it the most effective. Participation, or involvement of the patient, in this case his parents, in the treatment process. The patient should be motivated to participate in prevention and treatment and take responsibility for their health. Popularization of a healthy lifestyle, awareness of risks and opportunities - this is the basis for the implementation of this principle in practice. The implementation of the principles of 4P medicine is possible thanks to fundamental scientific research and understanding of the pathogenesis of the disease based on the identification of functional, molecular and cellular changes that allow to assess the ongoing pathological processes, determine the degree of risk of developing the disease and develop a set of preventive measures. The creation of numerous databases on molecular biology, biochemistry, and genetics will allow analyzing the data of specific patients and developing accurate individual prevention and treatment strategies [11].

2. Materials and Methods

Complications of CC extraction. Intraoperative complications, complications of the early postoperative period (6-10 days from the moment of surgery) and late postoperative complications (up to 9 years after surgery) are distinguished, and complications associated with IOL implantation can also be singled out separately.

Intraoperative complications. The most dangerous complication that can occur during the removal of the CC is the loss of the vitreous body. The increased risk of this complication is due to age-related features of the lens and eye, among which the thinness of the posterior capsule and the anterior border membrane of the vitreous body, as well as the presence of the ligament of the Viger between them, are important [9,10,12,13]. In addition, during the operation, an exudative reaction may develop with the loss of fibrin threads in the pupil and on the iris. Analysis of the causes of exudative reactions that developed during the operation itself showed that all children had a virus-induced form of CC, the cause of which was infection of the mother during pregnancy with cytomegalovirus and herpes simplex viruses [14].

Complications of the early postoperative period include: hemorrhage into the anterior chamber or vitreous body, pupillary block, iritis, iridocyclitis, keratopathy, iridocorneal and vitreocorneal synechiaes. These complications are noted in 8.0-26.4% of cases [1,15]. An analysis of the literature shows that in the structure of all complications after CC aspiration, inflammatory reactions range from 5.5 to 48.1% of cases. More often an exudative reaction develops, less often anterior uveitis. At the same time, exudation with fibrin deposition on the IOL and iris in childhood develops more often and much more intensively than in adults due to the pronounced reactivity of the tissues of the child's eye, especially the iris and increased vascular permeability. Factors determining the occurrence of an exudative inflammatory reaction during IOL implantation may be a long duration of surgical intervention, traumatization of tissues during surgery, the use of a large number of viscoelastics, iris retractors, sphincterotomy, activation of latent infections [16]. Often, even after the least traumatic operation, a temporary inflammatory reaction is observed as a result of inevitable surgical trauma and damage to the blood-intraocular fluid barrier. The initial anatomical parameters have a significant impact on the nature of the course of the postoperative period. According to L.B. Kononov, the most common inflammatory reactions are observed in the eyes of children with anterior microphthalmos of I-II degree, as well as with posterior microphthalmos: with a decrease in axial length (AL) by 1.5-2.5 mm, the frequency of postoperative iritis increases by 2 times [17].

The risk factors for the development of complications in the early postoperative period also include allergic conditions and the presence of foci of chronic infection, and the risk group includes children who are often sick children (OSC). OSC is a group of dispensary observation of children of early and preschool age, mainly of the II-health group, with a polygenic hereditary predisposition to an increased incidence of acute respiratory infections due to immunological immaturity of the body, manifested by a decrease in IFN, IL2, IgG–antibody response [18]. The results of our studies of chamber moisture (CM), conducted in 54 children with CC, showed that there was a significant increase in the protein content of OSC in CM before cataract extraction, while a negative correlation was established between the protein content in CM and blood. At the same time, postoperative complications, in the form of a cellular reaction with exudation in the moisture of the anterior chamber, were noted more often in OSC [19].

3. Result and Discussion

It is necessary to note the peculiarity of inflammatory reactions in children - a tendency to exudation, a sluggish progressive fibroplastic process with the formation of synechiae, which are noted already on the 1st-2nd day after surgery and subsequently lead to pupil deformation, in severe cases - to pupil overgrowth, pupillary block, secondary glaucoma. Such characteristic signs of iridocyclitis in adults as precipitates on the posterior surface of the cornea, turbidity of the anterior chamber moisture in children with CC occur in isolated cases. It is also important that the inflammatory process often proceeds without external signs of inflammation - photophobia, pericorneal injection [7,10]. Anterior and posterior synechiae, according to the literature, account for 2.5 to 19.6% of cases. Pupillary block is a relatively rare complication of surgical interventions and most often occurs when the integrity of the

posterior capsule of the lens is violated. The pathogenetic essence of the complication is a violation of communication between the anterior and posterior chambers. Obturation of the pupil and colobus can be caused by exudate, blood, air, remaining lens masses, vitreous. The factors predisposing to the complication may also be wound filtration, detachment of the vascular membrane, posterior detachment of the vitreous body, rigid atrophic iris. Pupillary block can develop both in the early and late postoperative period [7]. Given the prevalence of post-inflammatory forms of secondary glaucoma in young children, reconstructive surgical interventions are more often required: dissection of splices and excision of fibrin films in the pupil and anterior chamber angle in combination with iridectomy and anterior vitrectomy. In older children, in most cases, fistulizing operations are required: trabeculectomy, deep sclerectomy. As a result of surgical intervention with a follow-up period of up to 5-6 years, compensation of intraocular pressure is achieved in 89.1% of children. In addition, the frequent complications of the postoperative period in children with CC, due to anatomical features, early surgical treatment of cataracts with IOL implantation, immaturity of their immune system, include proliferative reactions that cause the development of secondary cataracts, which reduces visual functions and requires repeated surgical intervention [20]. In the structure of this complication, fibrosis of the posterior capsule of the lens, regenerative secondary cataract and their combinations are distinguished. The frequency of secondary cataracts in the surgical treatment of CC, according to the literature, ranges from 20 to 90% of cases and, according to many ophthalmologists, prevails during operations at an early age [6,21,22].

The high frequency of inflammatory postoperative reactions after cataract removal often leads to the development of secondary glaucoma, leading to a decrease in the functional results of the operation [1,23]. Various methods of surgical treatment of secondary aphakic glaucoma in children do not provide long-term stabilization of intraocular pressure (IOP) and preservation of high visual functions [7]. According to our data, a comparative analysis conducted in 75 children aged 2 to 17 years with cataract, aphakia, pseudophakia, dislocation of IOL, as well as 12 healthy children, showed significant changes in the hydrodynamic parameters of the eyes of patients with pseudophakia: an increase in true IOP with dislocation of IOL and, conversely, its decrease in the normal position of artificial the lens. The development of secondary pseudophakic glaucoma was an indication for reoperations. In our opinion, the "hypotension" of the eye in pseudophakia requires further study [24].

Complications of the late postoperative period include: secondary cataract, secondary glaucoma, retinal detachment, subatrophy of the eyeball. The literature describes cases of secondary glaucoma in artificial eyes. Although a number of researchers believe that IOL implantation is a kind of prevention of the development of secondary glaucoma. In the structure of secondary cataracts, fibrosis of the posterior capsule of the lens, regenerative secondary cataract and their combinations are distinguished. The frequency of secondary cataracts in the surgical treatment of CC ranges from 20 to 90% of cases and, according to many ophthalmologists, prevails during operations at an early age [6,8,9,22,25]. It is generally believed that a large variation in the frequency of secondary cataracts depends on the age of the child, concomitant ocular and systemic diseases, features of microsurgical cataract extraction technique, the presence of IOL and its type, and the timing of postoperative follow-up. According to a number of authors, the important factors of high risk of secondary cataracts are childhood age, traumatic surgical technique. Fibrosis of the posterior capsule, secondary cataracts, immunologically determined inflammatory-proliferative reactions after cataract extraction are a characteristic feature of childhood [15]. There are clear age-specific features of the structure and timing of the formation of secondary cataracts in children: the younger the child's age, the faster and more often this complication is formed. In younger children, secondary cataracts are more often observed in the form of fibrosis of the posterior capsule, which occurs at an earlier time, while in older children regenerative secondary cataracts that occur at a later time predominate [26].

The main criteria determining the indications for the removal of secondary cataracts in infants and young children are the optical condition of the pupillary region, which makes it difficult to perform ophthalmoscopy, a change in the fixation of the gaze and the appearance of strabismus. In older children, the degree of visual acuity reduction compared to the maximum achieved as a result of surgical pleoptic treatment is also taken into account. Indications for the removal of secondary cataracts are: full forms without an optical opening or with small through holes that do not perform optical functions, translucent full forms, partially passable to light, but sharply reducing visual acuity (by more than 0.05 compared to the maximum achieved as a result of surgical pleoptic treatment of CC), in small patients with the impossibility of ophthalmoscopy is partial, but centrally located forms of cataracts. Currently, the most progressive method of treating secondary cataracts in children is YAG-laser destruction, the advantage of which is a minimum of side effects and possible complications. Instrumental surgical capsulotomy is used only in isolated cases when it is technically impossible to perform it [20].

A complication specific to implantation surgery is the dislocation of the posterior chamber IOL and the decentralization of its optics. The cause of this complication may be a mixed "Bag-sulcus" fixation as a result of a surgical defect during IOL implantation or as a consequence of deformation of the capsule bag with fibroplastic processes occurring in it. The cause of dislocation of the IOL during primary implantation is postoperative iridocyclitis. Dislocation of the lens by the type of "pupil capture" is accompanied by the development of "uvea touch" syndrome, in which there is chronic sluggish uveitis with periodic precipitation of fine-point pigment and non-pigment

precipitates on the posterior surface of the lens or clouding of the anterior layers of the vitreous body in the case of posterior capsulorhexis [10,12,15]. There may be such changes as: "tertiary cataract"- the spread of Elschnig balls over the surface of the hydrophobic IOL, fibrous deposits directly on the posterior surface of the artificial lens after dissection of the posterior capsule of the lens, a violation of the transparency of the lens due to the migration of giant cells of foreign bodies to its surface [27]. Therefore, to date, many issues of early intraocular correction in children with CC remain debatable, which is due to the peculiarities of children's eyes: the complexity of calculating the optical strength of the implanted IOL in young children, the technical possibility of performing a low-traumatic operation taking into account the age-related anatomical and optical parameters of the eye and the increased risk of developing exudative-proliferative reactions after surgery, especially in patients of the first months of life. The results of our own research indicate that abnormal refractive changes (pseudophacial myopia) may be a manifestation of an inadequately selected IOL associated with the calculation of its optical strength according to a single formula for all children - both with and without the risk of abnormal refractogenesis, as well as with the presence of obscuration or refractive amblyopia [28].

4. Conclusions

The above dictates the need to determine reliable (significant) risk factors for the development of pseudophacial myopia (the indicators of the ocular AL at the time of implantation of the IOL are higher than the age norm by more than 0.2 mm; a child from the first pregnancy; AL/CR ratio ≥3.0; myopia of the paired eye; strabismus more than 4, etc. dpt; hereditary burden; strain of phonocardiography: pressure ≤180 mmHg at the time of IOL implantation) [29]. A restrained attitude to intraocular correction in children after CC extraction is associated with a high risk (from 5.5 to 48.1% and from 4.5% to 100.0%) of developing an inflammatory reaction in the early postoperative period [5]. The specificity of the inadequate response to surgical trauma in children is due to the functional immaturity of the immune system [30]. The peculiarities of the topography of the ligamentous apparatus of the lens, increased motor activity of children, and as a consequence a high risk of eye injury, lead to dislocation of the IOL, significantly increasing the subsequent development of complications such as intraocular hypertension, which may raise the question of repeated surgical intervention [24,31].

The analysis of the conducted studies shows that secondary implantation of IOL into the aphakic eye of a child, compared with primary implantation, is more traumatic and requires a number of additional interventions in the form of separation of posterior synechiae and junctions in the capsule sac, vitrectomy, which in turn increases the duration of surgical intervention and intraocular manipulations [32-37].

Thus, the introduction of new technologies into the process of pediatric cataract surgery today, unfortunately, does not fully eliminate complications, and in some cases gives birth to new ones, which dictates the need for further search for rational solutions for the prevention and treatment of adverse outcomes.

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