Sclera reinforcement treatment and prevention of complications of progressive myopia in children

Elena TARUTTA
Elena IOMDINA
Elena VIADRO

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Introduction

Two facts make myopia a serious issue: 1) high prevalence in the population and 2) likelihood of complications, of which macular dystrophies and retinal detachments are the most severe. Peripheral vitreochorioretinal dystrophies (PVCRD) are known to be risk factors of the latter type of complications [2].

We have been observing patients with progressive myopia, both adult ones and children from the age of 1 year, for 30 years. From our studies into the natural course of myopia, we have established the following age-related development patterns of chorioretinal dystrophies. Whilst central chorioretinal dystrophies (CCRD) emerge as a rule at an age of 30 or older (with the exception of cases of congenital and early acquired myopia), PVCRDs are regularly found in myopic children. PVCRDs occur in myopia several times more often than in other refraction types, while their prevalence shows a statistically significant growth with the increase of myopia degree, its progression rate, and eyeball size. These facts definitely link the emergence and development of PVCRDs with myopia progression. In progressive myopia pathogenesis, changes in structural, biochemical, and biomechanical parameters of the sclera play the leading role [6, 8]. These changes bring about the distension of the sclera in the sagittal and frontal planes.

According to literary data, the many attempts to control myopia, including sustained instillations of atropine or hypotensive agents, using bifocal lenses, hypo- or hypercorrection of vision, wearing contact lenses, or sclera strengthening surgery, do not stop the progression of the disease. On the other hand, the same papers tend to report the slowdown of myopia progression or even temporary stabilization of refraction in some patients. The most expressed temporary effect is achieved by scleroplastic surgeries. Numerous reports from eye surgeons active in the former Soviet Union and our own data testify to the fact that myopia and the axial length of the eye (AL) remain stable for one year after surgery in 85 to 96% cases depending on the patients’ age and the initial rate of myopia progression [1]. Many authors also note that a concomitant inhibitive effect persists on the fellow eye.
unoperated eye for 6 to 10 months. However, in the longer term, in a considerable part of children the progression resumes (up to 60% over the period of 7 to 10 years), and the younger the child, the more likely the return of progression \([3, 5, 9, 12]\).

What conclusions could be drawn from this state of affairs? Does it imply that all our attempts are doomed, or the temporary effect can still affect the myopia degree and the state of eye fundus in the long run?

**Purpose:** to estimate the remote effect of repeated sclera reinforcement surgeries on myopia progression and development of its complications in children and adolescents.

**Material and Methods.** Children with rapidly progressing myopia were divided into two groups. The test group (200 patients, 400 eyes, average age at start 8.9±1.4 years, myopia degree 5.4±1.0 D, mean AL=25.3±0.2 mm, mean progression rate 1.3 D/year) received surgical treatment that included repeated sclera reinforcement interventions: low-invasive at the age of 8-9 and scleroplastic operations at the age of 10-12. The control group (105 patients, 210 eyes, average age at start 9.1±1.3 years, myopia degree 5.3±1.3 D, AL=25.1±0.3 mm, mean progression rate 0.98 D/year) did not receive such treatment. There were no changes in the eye fundus in either of the two groups at the start. Patients were examined every 6 months for 10 years with a thorough checkup of the periphery of the eye fundus and given argon laser photocoagulation (LC) of the retina if indicated.

In the main group, sclera reinforcement treatment involved repeated interventions: low invasive procedures (1 or 2 for each eye, given in turns on fellow eyes with a 6 months’ interval between interventions) and scleroplastic operations (given in turns on fellow eyes with a 12-18 months’ interval). Later on, another intervention could be administered if indications were present. From the first procedure, renewed progression of myopia was considered as indication to a repeated sclera reinforcement, the rates being higher than 0.75 D a year and higher than 1.25 D a year for low invasion and scleroplasty, respectively.
Low invasive intervention consisted in locating a biologically active synthetic graft in the form of a rectangle sized 6 by 12 mm under the Tenon’s capsule on the sclera surface in the area of superior lateral quadrant into a previously created tunnel directed toward the posterior pole of the eye (Fig. 1). The material of the graft is polyether knitted cellular-structure fabric with polymeric coating on the basis of copolyamide E-Caprolactam and hexamethylene diammonium adipinate, which contains panaxel, a germanium-containing medicine produced on the basis of selective varieties of ginseng, which accelerates proliferative and restorative processes in living tissues [12]. This medicine contributes to the overall biological activity of the graft (Fig. 2) as it stimulates collagen synthesis, the generation of cross links that stabilize the sclera, and blood supply of eye coats [7].
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Fig. 2: Experimental scleroplasty on rabbit eye with a biologically active synthetic graft. 4.5 months after surgery. Mature connective tissue is seen in the periphery and the center of the graft intertwined with it fibers. Hematoxylin and eosin staining. X250.

Scleroplasty was performed according to Avetisov - Tarutta [4]. The technique of the surgery is that the transplant (a strip of donor sclera broadening in the upper third) is guided under the inferior oblique and the superior rectus muscles and attached to the sclera along the vertical meridian, directly under the superior and the inferior rectus muscles (Fig. 3).
Fig. 3 Scleroplasty according to Avetisov-Tarutta. Graft guided under inferior oblique muscle.

As a rule, myopia progression rate in children is increased at the age of 10-12 (somewhat later in boys than in girls) and remains high for 2 to 3 years. We have revealed that the peak of PVCRD accumulation in the ocular fundus is observed during the same period (Fig. 4) [10]. Consequently, we performed at this time a more effective, if harder to repeat, scleroplasty according to Avetisov - Tarutta.
The patients were examined every 6 months over a period of 10 years. The follow-up included a thorough examination of the ocular fundus so that we could detect the emerging peripheral dystrophies and, in case of need, perform argon laser photocoagulation of the retina in good time.

It should be emphasized that the indications to laser coagulation were the same in both groups: any breaks, either isolated or associated with lattice dystrophy, as well as emerging areas of lattice dystrophy with thinning localized in the upper half of the ocular fundus were considered eligible.

**Results**

Our earlier experimental studies showed that low invasive interventions and, to a greater degree yet, scleroplastic surgeries not only provide a biomechanical effect but also cause vascular and tissue reactions that have a sustainable trophic effect on the eye coats over a period of several months [4, 6]. Approximately 1 year after the surgery, cellular and tissue reactions are followed by a restructuring of the transplant, which is gradually replaced by the patient’s own connective tissue. Later on, this newly formed tissue is partially reduced [6].

Repeated interventions recommence to activate collagen synthesis and connective tissue generation, while simultaneously inhibiting the reduction processes of the sclera-transplant complex that had been formed earlier.

By comparing the clinical parameters we were able to show that the average progression rate during the 10-year period was 0.36 D/year in the test group and 0.9 D/year in the control group (2.5 times as high); while the final degree of myopia was 9.1 ± 1.1 D and 13.0±1.4 D, respectively (p<0.05). The AL in the test group raised to 26.4±0.2 mm, in the control group - to 27.7±0.2 mm (p<0.05).
difference in the character of the clinical course of myopia reflected on the condition of the ocular fundus. Over the follow-up period, CCRDs emerged in 12 eyes (3.0%) of 9 patients of the main group and in 11 eyes (5.2%) of 7 control group patients. All of them had congenital myopia. No CCRDs were found in cases of acquired myopia by the age of 19±1.2 in either of the groups.

By the end of the follow-up period the occurrence of PVCRD was 32.5% (130 eyes) in the main group and 55.4% (117 eyes) in the control group, i.e. 1.7 times more frequently. In particular, the most severe forms - lattice dystrophy and breaks - claimed 9.8% and 19.7%, and breaks with subclinical retinal detachment claimed 1.1% and 2.3%, respectively, so that the prevalence in the control group was twice as high.

An indirect evidence of the severity of ocular fundus changes is the revealed need for laser coagulation. It was performed on 19 eyes (4.8%) of 13 patients (6.5%) of the main group, whereas the control group required the procedure for 29 eyes (13.8%) of 19 patients (18%), which is 2.5 times as many. In 2 eyes (0.5%) of the main group and 5 eyes (2.4%) of the control group, laser coagulation was performed because of breaks surrounded by an area of subclinical retinal detachment (all procedures were successful). Over the follow-up period, no clinical retinal detachment was observed in either group.

**Conclusions**

1. Sclera strengthening surgery inhibits the progression of myopia, elongation of the eye and the development of chorioretinal dystrophic changes. 2. For the prevention of complicated forms of myopia, surgery should be performed in childhood or adolescence - between the age of 8 and 15. 3. If myopia progression persists after scleroplasty, a repeated sclera strengthening intervention is advisable.

**Other reference:** [11]

**References**

