· Original article ·

Analysis of the reconstruction of binocular visual function in 76 cases of pediatric ocular trauma

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Abstract

• AIM: To evaluate the effect of binocular visual function training in pediatric ocular trauma.

• METHODS: There were 76 patients (76 eyes) that were hospitalized with a primary diagnosis of ocular injury at the Affiliated Hospital of Medical College, Qingdao University between January 2006 and December 2009. Binocular visual function training was given after primary wound repair. Far stereopsis function were checked using AIT-1000 synoptophore fusion, and near stereopsis function was checked using Titmus stereogram. Binocular visual function was compared before and after training.

• RESULTS: Before binocular visual function training, 26 eyes (34%) had no binocular vision, after training there were only 16 eyes (21%) without binocular vision. Before undertaking binocular visual function training with fusion, only 27 eyes (36%) had binocular vision, after the training there were 48 eyes (63%) with binocular vision. Before undertaking binocular visual function training with far stereopsis , there were 23 eyes (30%) with binocular vision, after the training there were 29 eyes (38%). Before binocular visual function training with near stereopsis, there were 14 eyes (18%) with binocular vision, after the training there were 33 eyes (43%) with binocular vision. There was a significant difference in the number of patients with binocular vision before and after binocular visual function training.

• CONCLUSION: The training is useful for the reconstruction of binocular visual function in pediatric ocular trauma.

• KEYWORDS: ocular trauma; children; binocular vision; binocular visual function training

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INTRODUCTION

Pediatric ocular trauma not only causes vision in one or both eyes decreased, but also influences the patients' binocular vision. The treatment of pediatric ocular trauma is not just simply a case of treating eye injury itself, the subsequent treatment should also focus on the training of binocular visual function. Therefore, we analyzed 76 cases (76 eyes) of pediatric ocular trauma that were diagnosed and treated in the Affiliated Hospital of Medical College, Qingdao University, between January 2006 and December 2009. The training of binocular visual function was given after the primary wound had healed, and analysis of the reconstruction of the binocular visual function was undertaken.

MATERIALS AND METHODS

Materials Seventy-six eyes of 76 children who were diagnosed with ocular injury at the Affiliated Hospital of Medical College, Qingdao University, between January 2006 and December 2009 were included in this study. Of these children, 59 eyes were boys and 17 were girls, with a minimum age of 3 and a maximum age of 14, and a mean age of 6. 2 years old. The follow-up time was 14 months to 3 years, average 20 months. Inclusion criteria: pediatric ocular trauma (3 to 14 years old); every case sustained a monocular injury. An analysis of each patient's binocular vision was undertaken after the primary wound had healed, with resultant no binocular vision or degraded binocular vision to grade 1 or grade 2. Exclusion criteria: younger than 3 years old; monocular injury after the primary wound had healed had grade 3 binocular vision; eyeball was seriously ruptured and the contents of the eye prolapsed mostly and there was no light perception; binocular injuries were mostly burst injuries, which had serious damage in both eyes. Visual acuity was examined by an E vision acuity eye chart and recorded in decimal format. A total of 41 eyes (54%) were injured by open globe trauma, and 35 eyes (46%) by closed globe trauma. In more detail, specific diagnostics included corneal laceration (29 eyes, 38%), sclera laceration (7 eyes, 9%), corneoscleral laceration (5 eyes, 7%), hyphema (17 eyes, 22%), secondary glaucoma (4 eyes, 5%), traumatic cataract (9 eyes, 12%), vitreous hemorrhage (14 eyes, 18%), retinal injury (9 eyes, 12%), foreign bodies (9 eyes, 12%). Corrected vision of every non-corrected eye was

higher than 0.8, and the refractive status was -3.75- +1.00D. The examination of eye had no obvious abnormalities.

Methods

Perforating injuries Primary wound repair was given to perforate injuries. The wounds of the corneal and sclera laceration which were more than 2mm were sutured under the microscope. Uvea that was prolapsed for less than 48 hours was irrigated by gentamicin dilution and given back satisfied. Uvea which prolapsed more than 48 hours and the wounds were dirty and were not given back satisfied avoiding infection. The wounds that were less than 2mm and had closed well and no uvea incarcerated were not given suturing.

Hyphema Patients rest in semi-supine and at the same time were given hemostatic. The irrigation of the anterior chamber was given when the more conservative treatment had no obvious effect. Secondary glaucoma patients whose intraocular pressure(IOP) was controlled to normal level by medication were given conservative treatment. The eyes were operated upon with trabeculectomy when IOP was not sufficiently well controlled.

Traumatic cataract The patients who had traumatic cataract and rupture of the anterior lens capsule were given primary wound suture and crystal cortex aspiration. IOL was implanted when there were no signs of infection and the injured eyes were in a stable condition. When patients were without rupture of the anterior lens capsule, we firstly sutured the wound. If the lens opacity was serious and had no signs of infection, we gave the patients crystal cortex aspiration and IOL implantation.

Damage of posterior segment The patients who had vitreous hemorrhage were given vitrectomy after 2 or 3 months' patients. Conservative treatments were given to the penitents who had retinal injury. The patients who had retinal detachment were given the following treatment according to their condition, laser, scleral buckling, cryopexy, pneumatic retinopexy, *et al*. The patients who had intraocular foreign bodies were operated with vitrectomy and removing of foreign bodies.

Examination of binocular visual function The patients' fusion far stereopsis function were checked using AIT-1000 synoptophore , and the near stereopsis function was checked using Titmus stereogram.

Binocular visual function training After injured eyes had undergone their primary wound repair, the patients were given glasses if they had experienced a refractive change in optometry. During the training, we observed the vision, binocular stereopsis, refractive and eye conditions. The specific training methods were as follows: for the children whose vision of injured eyes were less than 0.3 or the difference between binocular vision was more than two lines, covered methods were used. Depending on the patients' age and vision, we decided the pattern of covering. Patients who were 3 years old had their non-injured eyes covered for 3 days, and exposed for 1 day. Patients who were 4 years old had their non-injured eyes covered for 4 days, and exposed for 1 day. Patients who were 4 to 6 years old had their non-injured eyes covered for 7 days, and opened for 1 day. Patients who were above 7 years old covered non-injured eyes every day. At the same time we matched up the visual stimulation training of family, such as color of rosary, the training atlas of visual, TV/reading instrument *etc*.

Table 1 Vision before and after primary treatment eye(%)

	≤0.1	0.2-0.4	≥0.5
Before treatment	53(70)	14(18)	9(12)
After treatment[b]	23(30)	27(36)	26(34)

[b]$P<0.01$ *vs*Before treatment.

Table 2 Vision before and after binocular visual function training eye(%)

	≤0.1	0.2-0.4	≥0.5
Before training	23(30)	27(36)	26(34)
After training[a]	10(13)	33(43)	33(43)

[a]$P<0.05$ *vs*Before training.

Table 3 Binocular visual function before and after binocular visual function training eye(%)

	Without	Fusion	Far stereopsis	Near stereopsis
Before training	26(34)	27(36)	23(30)	14(18)
After training[a]	16(21)	48(63)	29(38)	33(43)

[a]$P<0.05$ *vs*Before training.

Statistical Analysis In this paper, the data were analyzed by SPSS 17.0 software. We used a test of χ^2 and $P<0.05$ was considered to be statistically significant.

RESULTS

Vision Before and After Primary Treatment For the results of the vision of the 76 eyes with pediatric ocular trauma before and after primary treatment(Table 1). It can therefore be concluded that the difference between untreated and treated patients has statistical significance.

Vision Before and After Binocular Visual Function Training For the results of the vision of the 76 eyes with pediatric ocular trauma patients before and after binocular visual function training(Table 2). The difference between untrained and trained eyes had statistical significance. It can therefore be concluded that the patients' vision improved significantly after the binocular visual function training.

Binocular Visual Function Before and After Binocular Visual Function Training For the results of binocular visual function of the 76 eyes with pediatric ocular trauma patients before and after binocular visual function training (Table 3). It can therefore be concluded that after the training of binocular visual function, part of the children's binocular visual function had been reestablished.

DISCUSSION

Seventy-six children with ocular trauma were included in this

study, fifty-nine (78%) of these children were boys and 17 girls (22%), and the ratio of boys to girls was 3.47∶1. Most of the patients in the study group (54%) had open globe injuries. Liu *et al*[1] reported in 156 pediatric ocular traumas, the ratio of boys to girls was 2.1∶1, and the open globe injuries was 71.2%. Mela *et al* reported that the ratio of boys to girls was 2.0∶1-7.3∶1 in the pediatric ocular trauma [2-5]. These studies would infer that boys are more vulnerable than girls in the injury [3,4], which may be related with the general character of boys perhaps being more naughty, active and more likely to play with dangerous toys. Eye injuries mostly involved corneal and scleral wound, so eye injuries mostly were open globe ones[6,7].

In this study, the patients' vision was improved after primary repair treatments were given to the pediatric ocular trauma. And no patient encountered endophthalmitis and sympathetic ophthalmitis. The eyeball has a fine organizational structure and its physiological function is complex, especially as a child's eye tissue is fragile and it is in a developmental stage. Ocular trauma can damage the structure and function of the eyeball. It can not only cause vision decreased or lost, but also affect the appearance[4]. Therefore, considering the particularity of the pediatric ocular trauma, the primary repair treatment is very important. Emergency surgery should be given to open globe eye injuries, and recover anatomical structure of an injured eyeball as far as possible. In this study, 24% of the children's eye injuries needed subsequent treatment, such as IOL implantation, penetrating keratoplasty, treatment of retinal detachment, *et al*. Blomdahl and Norell[7] reported that 33% of the children's eye injuries need subsequent treatment. After the active treatment, the visual function of injured eyes improved obviously.

Children's eye injuries are not only related to the recovery of the vision, but also involving the reconstruction of binocular visual function. Binocular vision is divided into three grades, and it includes simultaneous perception, fusion, and stereopsis. Among the binocular function, the stereopsis is the highest. Stereo vision is the perception of various objects in three-dimensional distance, height, depth perception and ability to punch. It is a superior binocular vision, which is formative from a basis of simultaneous perception and fusion and it is an important indicator of whether binocular vision perfect or not [8]. A human's binocular vision begins to form after birth and gradually establishes. The binocular vision of child with an eye injury that was disturbed by the injury, due to the low vision or the different vision of both eyes[9]. Wolfe and Held[10] reported that the formation of stereopsis was pure binocular vision process, which could be compromised due to the retinal image blurring. Good corrected vision is the basis of obtaining binocular vision, so if the patients had refractive changes in optometry before the training, we gave patients corrective glasses. During the training, we observed the vision, binocular stereopsis, refraction and eye conditions. At the same time we treated the patient's complications. During the training, if the difference of vision between two eyes was more than two lines, we covered the superior eye to attain new balance. It is important to pay attention to the training of visual stimulation during the covering treatment. After the period of visual training, we found that the vision of injured eye had improved. We analyzed the reason for the improvements in vision, and it was found that the training of binocular visual function was an effective visual stimulation, and the wound of injured eye recovered further as the time extended.

Before the training, every one of 76 eyes with pediatric ocular traumas had no stereopsis function, after the training of binocular vision, 20 eyes (26%) regained stereopsis function, so it can be concluded that the effect of training was very satisfactory. Broadlbent and Westall[11] reported that the peak of the development of stereopsis was between the ages of 3 and 4 years old, and that it would continue until the age of between 7 to 10 years old. In the critical period of developmental plasticity, an abnormal environment may disturb the visual function. If an abnormal environment was eliminated, the development of visual cells could return to normal. But after the termination of critical plasticity, it was irreversible. Therefore, the patients who were treated in the sensitive period have an opportunity to obtain stereopsis. Our study selected the children with injured eyes from 3 to 14 years old, and most children were still in the plasticity period of development of visual function, so the binocular vision would reestablish with the effective and comprehensive measures.

With regard to the appropriate amount of time to be spent and the required vision of binocular visual function training, there is no unified view at present. Some scholars considered that it was more appropriate to carry on the training of binocular visual function when the vision was more than 0.8 in the amblyopic children[12]. We consider that the injured eye is different from the amblyopic one, and the recovery of the injured eye's vision is a gradual process. In other words, early binocular training can stimulate the vision of injured eye, which may improve the vision, so we can conclude that the training of the binocular visual function should be carried out as soon as possible. Horton[13] considered that the information of two eyes can stimulate the central visual cells produced depth and stereopsis perception. The obvious difference in vision between two eyes may due to reduce of stimulation of cell populations, and the information of this cell population delivering to the central would decrease. So the formative of stereopsis would be influenced. During the training, if the difference in vision of two eyes had a large difference, we covered the superior eye to attain new balance. In this study, the children whose vision was greater than or equal to 0.5 and the difference in vision between two eyes was less than two entrants, they would reestablish stereopsis after the training.

The children whose vision is between 0.2 and 0.4 can regain the stereopsis partly after the training. The children whose vision lower than or equal to 0.1 could not reestablish stereopsis. So a good corrected vision is the basis of obtaining binocular vision. In pediatric ocular trauma, the active and effective treatment of injured eye is very important, which is a requirement to enable the training of binocular vision.

The reestablishing of binocular vision is a long process, and at this age level, children have poor self-control, therefore parents should reinforce the actions required in the doctor's prescribed treatment proactively and diligently. Parents should have sufficient knowledge and pay attention to the possible damage caused by eye injury, at the same time understanding the meaning and purpose of this training, to ensure the effectiveness of the training. Binocular vision is a prerequisite for the fine and skilled work requiring detailed use of the eye, and is required by more and more people. Therefore, in the treatment of pediatric ocular trauma we should not only be confined to the improvement of the corrected vision in injured eye, but also focus on the recovery of binocular visual function.

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儿童眼外伤76例双眼视功能的观察

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摘要

目的:测定76例经治疗后的眼外伤儿童立体视训练前后双眼视功能,评价双眼视功能训练对眼外伤儿童立体视的影响。

方法:收集2006-01/2009-12期间在我院诊治的儿童眼外伤76例76眼,进行一期修复后,即进行双眼视功能训练。使用AIT-1000同视机检查眼外伤儿童训练前后融合和远立体视功能,使用Titmus立体图检查近立体视功能。

结果:训练前无双眼视功能者26眼(34%),训练后无双眼视功能者16眼(21%);训练前有融合功能者27眼(35%),训练后有融合功能者48眼(63%);训练前有远立体视功能者23眼(30%),训练后有远立体视功能者29眼(38%),训练前有近立体视功能者14眼(18%),训练后有33眼(43%)。经统计分析,双眼视功能在训练前后的差异具有统计学意义。

结论:对眼外伤儿童及时行双眼视功能训练,有助于重建患儿的双眼视功能。

关键词:眼外伤;儿童;双眼视功能;视功能训练