·Clinical Research·

Multiple methods of surgical treatment combined with primary IOL implantation on traumatic lens subluxation/ dislocation in patients with secondary glaucoma

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Received: 2013-05-07 Accepted: 2014-03-06

Abstract

• AIM: To describe clinical findings and complications from cases of traumatic lens subluxation/dislocation in patients with secondary glaucoma, and discuss the multiple treating methods of operation combined with primary intraocular lens (IOL) implantation.

• METHODS: Non–comparative retrospective observational case series. Participants: 30 cases (30 eyes) of lens subluxation/dislocation in patients with secondary glaucoma were investigated which accepted the surgical treatment by author in the Ophthalmology of Xi´an No.4 Hospital from 2007 to 2011. According to the different situations of lens subluxation/dislocation, various surgical procedures were performed such as crystalline lens phacoemulsification, crystalline lens phacoe – mulsification combined anterior vitrectomy, intracapsular cataract extraction combined anterior vitrectomy, lensectomy combined anterior vitrectomy though peripheral transparent cornea incision, pars plana lensectomy combined pars plana vitrectomy, and intravitreal cavity crystalline lens phacofragmentation combined pars plana vitrectomy. And whether to implement trabeculectomy depended on the different situations of secondary glaucoma. The posterior chamber intraocular lenses (PC–IOLs) were implanted in the capsular –bag or trassclerally sutured in the sulus decided by whether the capsular were present. Main outcome measures: visual acuity, intraocular pressure, the situation of intraocular lens and complications after the operations.

• RESULTS: The follow –up time was 11 –36mo (21.4 ± 7.13). Postoperative visual acuity of all eyes were improved; 28 cases maintained IOP below 21 mm Hg; 2 cases had slightly IOL subluxation, 4 cases had slightly tilted lens optical area; 1 case had postoperative choroidal detachment; 4 cases had postoperative corneal edema more than 1wk, but eventually recovered transparent; 2 cases had mild postoperative vitreous hemorrhage, and absorbed 4wk later. There was no postoperative retinal detachment, IOL dislocation, and endophthalmitis.

• CONCLUSION: To take early treatment of traumatic lens subluxation/dislocation in patients with secondary glaucoma by individual surgical plan based on the different eye conditions would be safe and effective, which can effectively control the intraocular pressure and restore some vision.

• KEYWORDS: crystalline lens; subluxation; dislocation; secondary glaucoma; surgical treatment

DOI:10.3980/j.issn.2222–3959.2014.02.13

Wang R, Bi CC, Lei CL, Sun WT, Wang SS, Dong XJ. Multiple methods of surgical treatment combined with primary IOL implantation on traumatic lens subluxation/dislocation in patients with secondary glaucoma. *Int J Ophthalmol* 2014;7(2):264–272

INTRODUCTION

Crystalline lens subluxation or dislocation caused by eye blunt trauma is common in clinical practice, and blunt trauma is the major cause of crystalline lens subluxation or dislocation [1]. To the crystalline lens subluxation/ dislocation caused by eye blunt trauma, a few questions need to be made clear: whether the visual acuity is influenced severely and what the main factors should be; whether it is accompanied by increased intraocular pressure and what the possible reasons should be; whether the structural damage of the anterior and posterior section of the eye in addition to the subluxation/dislocation crystalline lens co-exists. If the visual acuity is not significantly affected and not accompanied by other structural damage of the anterior and posterior section of the eye, the surgery is not considered, and the increased IOP can be controlled by drugs firstly. If the visual acuity is significantly affected and apparently correlated with the abnormal crystalline lens position, no matter whether accompanied by other structural damage or the increased

intraocular pressure, most of them require surgical treatment, and other structural damage can be dealt with at the same time. If the crystalline lens position is extremely abnormal and the lens position-induced glaucoma co-exists, the significance of the surgical treatment will become more apparent. In fact, with improvements in surgical technology and requirements of people to improve the quality of life, the attitude about the treatment of lens dislocation has become relatively positive, unlike the earlier period that the drug therapy is considered firstly and the surgical treatment is considered secondly [2]. At present, there are many surgical methods to treat the lens subluxation/dislocation combined with secondary glaucoma, but no matter what kind of surgical method is performed, we will have to face four issues: how to deal with the subluxation or dislocation crystalline lens; whether to perform the trabeculectomy to decrease the elevated intraocular pressure; whether to deal with other structural damage of the anterior and posterior section of the eye at the same time; how to deal with the aphakia state after the subluxation/dislocation crystalline lens is removed. We believe that because the position of the subluxation/dislocation crystalline lens, the degree of the crystalline lens subluxation/dislocation and the hardness of the crystalline lens nuclear is different, the surgical plan should be different. Individual surgical plan based on the different eye conditions is the key point to get good results. We took this as the principle to treat 38 patients with traumatic crystalline lens subluxation/dislocation with secondary glaucoma from 2007 to 2011, and retrospectively summarized 30 cases with complete clinical data as follows.

SUBJECTS AND METHODS

Subjects Eyes of traumatic crystalline lens subluxation/ dislocation with secondary glaucoma which accepted the surgical treatment by author in the Ophthalmology of Xi'an No. 4 Hospital from 2007 to 2011 were included. The preoperative indications were traumatic lens subluxation/ dislocation with secondary glaucoma and the eyeballs were integrate. Patients who were lost to follow-up were excluded. There were totally 30 cases (30 eyes) in this study whose clinical data were retrospectively analyzed. Twenty-three patients were male and 7 were female; aged from 28 to 72 (50.1±11.952). Crystalline lens were subluxation in 11 cases ranging from 1 quadrant to 3 quadrants, and totally dislocation in 19 cases, of which 4 cases had the crystalline lens dislocated into the anterior chamber, and 1 cases incarcerated in the pupil area, and 14 cases dislocated into the vitreous cavity. Twenty-three cases had cataract, in which the nuclear hardness was grade II in 7 cases, grade Ⅲ in 10 cases, and grade Ⅳ in 6 cases. One case combined anterior lens capsule rupture, and 5 cases combined partial iridodialysis, 7 cases hyphema, 1 case anterior chamber angle recession, 18 cases various degrees of traumatic mydriasis, 20 cases vitreous hernia, 4 cases vitreous hemorrhage, 3 cases choroidal rupture, and 2 cases were after the operation of suturing scleral rupture near the limbus. 8 cases had elevated preoperative IOP which can not be controlled below 30 mm Hg by at least three drugs combined application. The follow-up time ranged from 11mo to 36mo with an average of 21.4±7.13mo. All patients with crystalline subluxation/dislocation were caused by blunt ocular trauma, including fist injury in 4 cases, elastic belt injury in 6 cases, wood injury in 10 cases, stone wound in 5 cases, firecrackers injury in 5 cases. The preoperative IOP of all cases after injury were higher than 28 mm Hg at least three times. Preoperative visual acuity without correction was less than 0.01 in 17 eyes, 8 eyes from 0.01 to 0.05, 5 eyes from 0.05 above to 0.1. A/B ultrasound, corneal curvature and eye axial length measurement was done before the operation to determine the required IOL by SRK-Ⅱ or SRK-T formula and emmetropia was targeted. A reduction of IOL power of 0.5D was been done to compensate for the more anterior IOL location than the IOL in the capsular[3].

Equipment The main equipment included the phacoemulsification instrument (LEGACY 20000, Alcon, USA), vitrectomy machine (Millennium, Bausch & Lomb, USA), and ophthalmic surgical microscope (Leica 841, Germany). The foldable IOLs were the AMO AR40e (Santa Clara, California, USA). The unfoldable IOLs were AMO unfoldable IOLs (Santa Clara, California, USA). The suture was 10-0 Blue Polypropylene 12″ D/A, AUM-5, SC-5(Fort Worth, Texas, USA).

Methods

Crystalline lens subluxation Five cases had less than two quadrants subluxation range, and phacoemulsification and intraocular lens (IOL) implantation through clear corneal incision was performed. In these 5 cases, 1 case had grade Ⅳ crystalline lens nucleus, 3 cases had grade Ⅲ crystalline lens nuclei, 1 case had rade II crystalline lens nucleus. All were performed with the aid of 2 iris hooks, which hooked the anterior capsulotomy edge within the subluxation range after the continuous curvilinear capsulorhexis, then performed the crystalline lens nuclear phacoemulsification and removed crystalline lens cortex and implanted three-piece foldable IOL, then removed the iris hooks. Three cases were performed successfully without expanding the zonulysis. During the rest 2 case operation, the subluxation range of lens zonular expanded respectively to 270° and 210° from preoperative 180° after crystalline lens nuclear phacoemulsification, then implanted capsular tension ring into the lens bag, and prosperously completed the subsequent operation steps. Six cases had more than two quadrants subluxation range, 2 cases had nuclei grade Ⅳ, 2 cases had nuclei grade Ⅲ, 1 case had nucleus grade II, 1 case had nucleus less than grade II. Those with nuclei harder than

grade Ⅲ underwent the intracapsular cataract extraction through the scleral tunnel incision combined anterior vitrectomy, then implanted the unfoldable single-piece IOL and sutured the IOL haptics in the ciliary sulcus transsclerally under the condition of continuous anterior chamber irrigation. The procedure to suture the IOL in the ciliary sulcus: separately made a triangle lamellar scleral flap on inferior temporal and superior nasal or inferior nasal and superior temporal exactly 180° diagonally apart just behind the cornea limbus, and lens suture needle penetrated the eye wall vertically 2 mm posterior to the limbus just under the superior temporal or superior nasal scleral flap into the center of the eye, and then maintained parallelly with the iris plane and penetrated the eye wall vertically 2 mm posterior to the limbus under the inferior nasal or inferior temporal scleral flap just *via* the pupillary center. Drew out the intraocular part of the suture through the main incision, then cut this suture part in the middle of it. The part from inferior binded the inferior IOL haptic just between the middle and the lateral 1/4 of the haptic, and the part from superior binded the superior IOL haptic as the inferior one. Implanted the IOL through the main incision and pulled the superior and inferior sutures to positioned the IOL centrally and without obliquity, then separately tied the superior and inferior sutures on the lamellar sclera just beneath the triangle lamellar scleral flap. Finally, we respectively sutured the superior and inferior triangle lamellar scleral flaps. The rest two cases with grade II and less than grade II nucleus underwent the lensectomy with the continuous intracapsular irrigation though peripheral transparent cornea incision, then underwent the anterior vitrectomy though peripheral transparent cornea incision with the continuous anterior chamber irrigation, then implanted the three-piece foldable IOL through transparent cornea incision and sutured the IOL haptics in the ciliary sulcus under the condition of continuous anterior chamber irrigation. The fixation method was as follows: 3.2 mm transparent corneal incision was performed at 11:00 cornea limbus. Separately made a triangle lamellar scleral flap on inferior temporal and superior nasal or inferior nasal and superior temporal exactly 180° diagonally apart just behind the cornea limbus, and lens suture needle penetrated the eye wall vertically 2 mm posterior to the limbus just under the superior temporal or superior nasal scleral flap into the center of the eye, and then maintained parallelly with the iris plane and penetrated the eye wall vertically 2 mm posterior to the limbus under the inferior nasal or inferior temporal scleral flap just via the pupillary center. Drew out the intraocular part of the suture through the main incision, then cut this suture part in the middle of it. The three-piece foldable intraocular lens was set in a IOL injector and push forward to only expose 1/4 of the inferior haptic, and the suture from inferior binded the inferior IOL haptic just between the middle and the lateral 1/4 of the haptic, then injected the three-piece foldable IOL through transparent cornea incision and the superior haptic was exposed out of the cornea incision, and the suture from superior binded the superior IOL haptic as the inferior one. Then pulled the superior and inferior sutures to positioned the IOL centrally and without obliquity, then separately tied the superior and inferior sutures on the lamellar sclera just beneath the triangle lamellar scleral flap. Finally, we respectively sutured the superior and inferior triangle lamellar scleral flaps. The trabeculectomy was not performed in all these 11 cases.

Crystalline lens dislocation into the anterior chamber and pupil incarcerated There were 5 cases in this group. One case had grade Ⅳ crystalline lens nucleus, 2 cases had grade Ⅲ crystalline lens nuclei, 2 cases had less than grade II crystalline lens nuclei. Three cases with nuclei harder than grade Ⅲ underwent the intracapsular cataract extraction through the scleral tunnel incision combined anterior vitrectomy, then implanted the unfoldable single-piece IOL and sutured the IOL haptics in the ciliary sulcus through sclera incision under the condition of continuous anterior chamber irrigation. The procedure was as same as before. While 2 cases had less than grade II crystalline lens nuclei, and 1 case had the anterior capsular ruptured, then underwent the lensectomy with the continuous intracapsular irrigation though peripheral transparent cornea incision, then underwent the anterior vitrectomy though peripheral transparent cornea incision with the continuous anterior chamber irrigation, then implanted the three-piece foldable IOL through transparent cornea incision and sutured the IOL haptics in the ciliary sulcus under the condition of continuous anterior chamber irrigation. The procedure was as same as before. The trabeculectomy was not performed in all these 5 cases.

Crystalline lens dislocation into the vitreous There were 14 cases in this group. 2 cases had grade Ⅳ crystalline lens nuclei, 3 cases had grade Ⅲ crystalline lens nuclei, 5 cases had grade II crystalline lens nuclei, 4 cases had less than grade II crystalline lens nuclei. Those with nuclei harder than grade Ⅲ underwent pars plana vitrectomy combined intravitreous cavity phacofragmentation, then implanted the three-piece foldable IOL through transparent cornea incision and sutured the IOL haptics in the ciliary sulcus. At first, used the vitrectomy knob to exsect the central vitreous and the surrounding vitreous of the dislocated crystalline lens, and fully free crystalline lens, and used the phacofragmentation knob to suck the crystalline lens to the anterior vitreous cavity and phacofragmented and removed it. Then, the vitrectomy knob was used to exsect the peripheral residual vitreous. At last, implanted the three-piece foldable IOL through transparent cornea incision and sutured the IOL

loops in the ciliary sulcus as the method mentioned above, due to infusion head was fixed in inferior temporal quadrant, separately made a triangle lamellar scleral flap on inferior nasal and superior temporal exactly 180° diagonally apart just behind the cornea limbus. Examine the retina carefully, and decide whether to implement laser or cryotherapy and gas injection into the vitreous cavity. Those with nuclei less than grade Ⅱ underwent pars plana vitrectomy (PPV) combined pars plana lensectomy (PPL), then implanted the three-piece foldable IOL through transparent cornea incision and sutured the IOL haptics in the ciliary sulcus. In all the 14 cases, 3 cases combined with trabeculectomy, in which 2 patients were younger than 50y with application of mitomycin C for 2min during the operation. Three cases combined with retinal tears, and 2 cases were treated by laser while the rest one was treated by cryotherapy, then injected 100% C_2F_6 0.8 mL after gas-liquid exchange. Three cases combined with choroidal rupture without any special treatment.

Postoperative treatment Compound tropicamide eye drops, compound tobramycin and dexamethasone eye drops and levofloxacin eyes drops were given alternately 4 to 6 times a day after the operation. Implemented daily examinations included visual acuity, slit lamp examination of cornea, the situation of anterior chamber and the intraocular lens, fundus examination and monitoring of intraocular pressure.

RESULTS

The follow-up time lasted 11mo to 3y with an average of 21.4±7.13mo. There were no intraoperative complications in our case series. There was no significant postoperative macular edema and no uveitis or retinal detachment in the subsequent follow-up. There was no pigment deposition on the IOL optic surface.

Visual Acuity The visual acuity without correction of all cases at the last follow-up time were as follows: 22 cases among 0.2-0.5, 8 cases above 0.5. All cases were improved to different degree compared with the preoperative [Paired samples t-test, t=-18.441, P<0.001, the pre-UA such as CF and HM were treated as 0.01, analyses were carried out using SPSS (version 13.0, SPSS Inc., Chicago, Illinois,USA)].

Intraocular Pressure Twenty-eight cases intraocular pressure maintained between 11-21 mm Hg, while 1 case IOP was 28 mm Hg at 2wk follow-up, and dropped to 18mmHg after carteolol eye drops treatment for 1 week, at last the IOP was 16 mm Hg after 4wk eye drops withdrawal. One case IOP was 32 mm Hg at 3wk follow-up (5wk after eye blunt trauma), and UBM displayed anterior chamber angle recession about 360° , then the trabeculectomy combined mitomycin C was performed, and the follow-up IOP stabled between 12-15 mm Hg.

Situation of Intraocular Lens This examination was performed after the pupil was dilated adequately. In all cases, 2 cases IOL position were good in 3 cases of phacoemulsification assisted by iris retractors without using capsular tension ring (CTR) and intraocular lens implantation without ciliary sulcus suture fixation, 1 case IOL was slight decentration with no symptoms detected 2mo after surgery; the IOL (lens zonulysis expanded to 270° from preoperative 180° , using CTR) position was slightly subluxation toward inferior temporal (right eye) detected 4mo after surgery, while the other IOL (lens zonulysis expanded to 210° from preoperative 150° , using CTR) position was good. The remaining 25 cases were treated with suture fixation of intraocular lens, and the IOL were central, while 4 cases IOL optics area were slightly obliquity.

Complications One case had postoperative choroidal detachment after the PPV and crystalline lens phacofragmentation and IOL suture fixation and trabeculectomy combined mitomycin C, and was recovery after topical and systemic application of corticosteroids for 5 days. Four cases had the postoperative corneal edema lasting more than 1 week in which 2 cases combined with choroidal rupture. These two cases corneal edema were probably relevant with the greater blunt force than the others. One patient was 72y who was the oldest in all patients, and the corneal edema lasted for 10d. The corneal endothelial counts were 806/mm^2 when the cornea recovered completely transparency, so the cause of severe corneal edema was probably relevant with the natural reduce of corneal endothelial counts along with age. One case corneal edema lasted for 8d happened after gas injection, and the possible reason was relevant with the postoperative prone position and transient elevation of intraocular pressure caused by postoperative slightly expansion of the gas. All 4 cases corneal edema recovered completely transparency eventually. Two cases had a little hemorrhage in the vitreous cavity after intracapsular cataract extraction combined with anterior vitrectomy and intraocular lens implantation with suture fixation, and the blood was absorbed completely 4 weeks later.

DISCUSSION

About the Choice of Surgical Approach Traumatic crystalline lens subluxation/dislocation is often associated with secondary glaucoma, its basic clinical manifestations are various degrees of crystalline lens subluxation/dislocation and elevated intraocular pressure. The choice of surgical approach is also tightly determined by the two major clinical manifestations.

There are many literatures about the methods to extract the subluxation/dislocation crystalline lens, such as subluxation crystalline lens phacoemulsification assisted by iris retractors[4,5], capsular tension ring (CTR)[6,7], modified CTR

with single or double fixation point [8,9], capsular tension segment (CTS)[10] and capsular anchor device[11], subluxation crystalline lens phacoemulsification combined anterior vitrectomy [5,12], intracapsular cataract extraction combined anterior vitrectomy [13], lensectomy combined anterior vitrectomy, vitrectomy and intravitreal cavity lens phacoemulsification [14,15], pars plana vitrectomy combined with intracapsular cataract extraction through corneal limbus incision assisted by perfluorocarbon liquid [16], vitrectomy combined lensectomy [17,18], vitrectomy and intravitreal cavity crystalline lens phacofragmentation[19]. The choice of surgical approach is closely related to the nuclear hardness degree and the position of the subluxation/dislocation lens. The subluxation/dislocation crystalline lens of this group of 30 cases were extracted just according to the different degree of lens position and nuclear hardness, respectively by crystalline lens phacoemulsification with iris hooks or capsular tension ring assistance, crystalline lens intracapsular extraction, lensectomy, intravitreal cavity crystalline lens phacofragmentation. The short-term results showed that the four methods were effective with few complications, and also showed the rationality of individual crystalline lens processing approach. But it should be paid attention to that 1 case IOL was slight decentration detected 2mo after surgery in 3 cases of phacoemulsification assisted by iris retractors, It indicated that phacoemulsification assisted by iris retractors be feasible, but not perfect. Furthermore, some techniques should be perfectly used during the operation to prevent the further damage to compromised zonule such as usage of dispersive viscoelastics, bimanual method of capsulorhexis using forceps and cystitome, careful cortical cleaving hydrodissection as described by Fine, Osher's slow-motion phacoemulsification technique, and more utilization of chopping techniques to make the harder nuclei become smaller to minimize capsular stress, tangential stripping motion, and usage of foldable acrylic IOL[20-23]. And it should be noted that the IOL is the best to be a three-piece foldable type because of its stronger tension and one of the IOL haptic should be placed in the midpoint of the subluxation district, another haptic in the opposite position, thus can reduce expandation of the zonulolysis although it reduces support for one haptic. There was another important case should be mentioned here. The lens zonulysis of this case expanded to 270° from preoperative 180°, and the CTR was used, while the position was slightly subluxation toward inferior temporal (right eye) detected 4mo after surgery. It indicated that if the range of zonulolysis is larger than 180°, the implantation of standard CTR could not prevent the postoperative IOL subluxation/dislocation, and suture the modified CTR maybe useful [8]. About the lensectomy combined the anterior vitrectomy though peripheral transparent cornea incision, we used a 23G noodle which connected with the irrigation bottle to insert into the crystalline lens and maintained the continuous intracapsular irrigation though a peripheral transparent cornea incision. This noodle can assist to fix the subluxation/dislocation crystalline lens and the continuous intracapsular irrigation can make sure that the nuclear and the cortex is exsected while the capsular bag is kept as more as possible, thus can prevent the fragments of the lens drop to the posterior vitreous cavity as less as possible, then the capsular bag was removed by the vitrectomy knob with the continuous anterior chamber irrigation. Although the selection principle can not be generalized, the choice of procedure based on the following understanding: iris hooks assistance crystalline lens phacoemulsification is the preferred choice when the range of subluxation is less than 180° before the operation. Because it does exist some difficulty to perform the aspiration of peripheral residuary cortex and posterior capsule opacification (PCO) is the most common long-term complication after the CTR was used [24], the standard CTR has not the advantages over the iris hooks. After the IOL implanted assisted by the iris hooks, it is suggested to test IOL stability by performing a bounce-back test described by Cionni and Osher [6]. If the IOL fails to spontaneously recentrate after gentle decentration and release or the zonulolysis is larger than 180°, it is preferred to implant the modified CTR and suture it in the sulus where the zonulysis exists other than suture the haptic of the IOL because suturing the haptic may be difficult and increase the risk to expand the zonulolysis. When the range of subluxation is more than 180° and the nuclear is grade Ⅲ and above, intracapsular cataract extraction is the preferred choice, thus the possible thermal damage by phacofragmentation to the corneal endothelial can be avoided although the scleral tunnel incision is larger. When the subluxation is more than 180° or totally dislocation to the vitreous cavity while the nuclear hardness is grade II and below, lensectomy is the preferred choice which can avoid the larger scleral tunnel incision of intracapsular cataract extraction. When the crystalline lens dislocates into the vitreous cavity and the nuclear hardness is grade Ⅲ and above, it is the preferred choice to phacofragment the crystalline lens in the anterior vitreous cavity other than to use perfluorocarbon liquid floating crystalline lens and extract it from the scleral tunnel incision, despite those reports of perfluorocarbon liquid is safe and effective [16,25,26]. But special attention should be paid to the phacofragmentation which required a distance at least 6mm above the retina to ensure that the retina is away from the phacofragmentation energy damage. As Movshovich's[26] study has shown that if the phacofragmentation head keep distance away from retinal 2 mm at the corresponding energy 50% for 45s, the energy can lead to retinal hole formation, and if the phacofragmentation head keep distance away from

retinal 4 mm at the corresponding energy 100% for 155s, the energy can lead to retinal hole formation, while the distance is more than 6 mm, electron microscope reveals no retinal injury.

Secondary glaucoma is another major clinical manifestation after the eye blunt trauma. Whether to implement trabeculectomy depends on the damage of the anterior chamber angle, but it is very difficult to know the accurate damage degree of the anterior chamber before the operation because of cornea edema and the abnormal structure of the anterior chamber impeding the gonioscopy examination and the image by UBM is also difficult to be used to judge the damage degree of the anterior chamber. So the deviation of inadequate treatment or excessive treatment is not evitable. Whether to implement trabeculectomy in this group of patients with secondary glaucoma is based on the following considerations: the possible pathogenesis of elevated IOP, the degree of the lens subluxation/dislocation, the effect of eye drops to drop the elevated IOP and the duration of the elevated IOP, *etc*. Although in 1 case the IOP was 32 mm Hg at 3wk follow-up (without trabeculectomy at the first operation), and UBM displayed anterior chamber angle recession about 360° , then the trabeculectomy combined mitomycin C was performed, and the follow-up IOP stabled between 12-15 mm Hg. It indicated that the deviation does exist between the preoperative assessment and postoperative results, but most of the patients had the postoperative intraocular pressure controlled. As it is known that the reason of the IOP elevation in crystalline lens subluxation/ dislocation after eye blunt trauma may be related to the following factors: crystalline lens dislocats into the anterior chamber or incarcerats in the pupil leading to pupillary block; vitreous hernia caused by crystalline lens subluxation/ dislocation leading to pupillary block; crystalline lens subluxation forward leading to the corresponding quadrant anterior chamber angle tending to be narrow; with the coexistence of hyphema and vitreous hemorrhage the blood cells and their detritus blinding the anterior chamber angle; coexistence of injury of the anterior chamber angle, the recession of the anterior chamber angle, trabecular meshwork inflammation, edema and so on. Most of the secondary glaucoma with crystalline lens posterior dislocation is due to vitreous hernia in the pupillary area leading to pupillary block, less than 1% of patients with increased intraocular pressure are caused by traumatic anterior chamber angle recession [27]. It is generally believed that the secondary glaucoma could be controlled without drugs after subluxation/dislocation crystalline lens is extracted [28-31]. If the crystalline lens subluxation is mild or there are a obvious pupillary block factors or hyphema and vitreous hemorrhage is combined or the course after the trauma is relatively short or the IOP is slightly elevated or the IOP increased significantly but can be effectively controlled after the preoperative drug therapy, the trabeculectomy is suggested not to be combined with. While the crystalline lens dislocates into the vitreous cavity and the preoperative intraocular pressure can not be effectively controlled after drug treatment, the trabeculectomy may be combined with. As the elevated intraocular pressure caused by traumatic anterior chamber angle recession may have a certain lag, the postoperative follow-up of intraocular pressure appears particularly important in order to prevent the missed-diagnosis of the traumatic anterior chamber angle recession associated with the lens dislocation. UBM combined with gonioscope will be useful to make earlier diagnosis after the first operation.

In addition, traumatic crystalline lens dislocation may also be associated with other complications which should be dealt with carefully.

About the Primary Intraocular Lens Implantation

About whether the IOL is implanted in primary surgery for crystalline lens subluxation/dislocation once was controversial [32]. With the improvement of technology and constant updates of equipments, the feasibility and safety of the primary IOL implantation combined multiple operations were verified again and again[33-36]. Particularly, Senn *et al* [37] reported that combined surgery in selected patients was a safe and effective approach compare with sequential surgery by a well-controlled, random compare study. Sometimes it is difficult to suture intraocular lens in the sulus during the subsequent surgery because the vitreous cavity is filled with aqueous instead of the vitreous body and the stable intraocular pressure is hard to be maintained in a stable level, and the risk of the suprachoroidal hemorrhage is increased, while the primary IOL implantation is implemented under the condition of maintaining the anterior/posterior perfusion and the stable intraocular pressure is easy to be maintained in a stable level with less operative risks, less operative times and less operative costs. Primary intraocular lens implantation can early improve visual acuity, early restore binocular single vision, and the intraocular pressure is better maintained during the operation and the complications such as the eyeball collapsing and intraocular hemorrhage *etc*. can be avoided as least as possible. It can restore useful vision as soon as possible after the one-time operation, and can reduce the economic burden of the patients. Therefore, we tend to suture the posterior chamber intraocular lens during the first operation. But primary implantation must be based on the preoperative expectation that postoperative visual acuity can be improved to different level, if the macular injury or optic nerve contusion and other factors to prevent the enhancement of visual acuity does exist, primary IOL implantation is inappropriate. And it also should not be performed when the traumatic ocular situation is complex and the intraocular

inflammation is severe because postoperative intractable uveitis will occur more possibly in this situation. Due to longer operative time and more severe inflammation than two-step surgery, the postoperative treatment are very important including the anti-inflammation and mydriatic drops to ensure that synechiae of iris do not happen to interfere the fundus examination. The cases of this group were sutured IOL based on the following judgments: preoperative examination of visual electrophysiology revealed no serious optic nerve diseases; those who underwent PPV did not have severe macular injury identified by the careful examination during the operation; those who underwent anterior vitrectomy were often hit by a smaller power without obvious disturbance of the posterior segment. The results showed that the best visual acuity of all cases at the last follow-up time was improved to different degree compared with the preoperative.

There are many kinds of IOL fixation methods that can be used in the absence of the crystalline lens capsule or zonular support such as the anterior chamber intraocular lens (AC-IOL) with closed loop or rigid open 'C' loop or flexible open loop supported by the anterior chamber angle, the iris claw IOL and the iris-sutured posterior chamber intraocular lens (PC-IOL), transsclerally PC-IOL. The AC-IOLs with closed loop or rigid open 'C' loop could easily lead to corneal endothelial cell decompensation, secondary glaucoma and refractory uveitis complications *etc*., and has been nearly eliminated[38]. The flexible open loop AC-IOLs are relatively commonly used currently, which have a lower rate of complications than the earlier closed loop or open 'C' loop lenses [39]. The iris claw IOL is another kind of AC-IOL[40]. These two kinds of fixation have the advantages of less technical demanding and less operational time, but their long-term effects on corneal endothelium and blood aqueous barrier are still not clear, and cannot be used in the cases of marked iris tissue loss or in the cases where the anterior chamber is shallow. While the iris-sutured PC-IOLs and transsclerally PC-IOLs possess the inherent advantages of having a position more closer to the normal anatomical location of the crystalline lens [41-43]. Apart from the optical benefit of minimal aniseikonia, the complications due to improper location of the intraocular lens including the damage of the corneal endothelium and the trabecular meshwork can be avoided. Furthermore, the PC-IOLs can provide a mechanical barrier against diffusion of vasoactive substances or vitreous movement that could lead to cystoid macular edema or retinal detachment [44]. The iris-sutured PC-IOL possesses the advantages of posterior chamber fixation with less technically demanding than scleral fixation. But they cannot be used in the case of marked iris tissue loss. Moreover, the place where the haptics are sutured may give some restriction of pupillary dilation. They are thus not ideal if postoperative good fundus visualization is required. Currently the suture fixation IOL in the ciliary sulcus is still the mainstream choice of lens crystalline subluxation/dislocation surgery. Documents have showed that the visual acuity is slightly better than the anterior chamber intraocular lens [45-47]. Moreover such a lens has a optical diameter of 6mm, and can also be used safely in patients with moderate pupil dilation. But it is said that the suture fixation IOL in the ciliary sulcus has poor stability, and is easy to deviate from the axis center, and the incidence rate of hemorrhage during the operation or after the operation is high [48]. These complications can be reduced by the continuous improvement of the operational skills. In our study, 25 cases were treated with suture fixation of intraocular lens, and the IOL were central，while 4 cases (16%) IOL optics area were slightly obliquity. Two case (8%) had a little hemorrhage in vitreous cavity after intracapsular cataract extraction combined with anterior vitrectomy and intraocular lens implantation with suture fixation. There were no intraoperative hemorrhage seen in our case series. In order to overcome the disvantages that the final sutured position is not entirely predictable because that the intraocular exit point of the needle is unseen, Olsen *et al* [49] described a novel technique for posterior chamber intraocular lens implantation with endoscope-guided sutured, which maybe a reasonable option, but it still had the disadvantages including the learning curve, increased operative time, long-term suture stability issues, and limited availability of intraocular endoscopes. We used the 10-0 Blue Polypropylene 12″ D/A, AUM-5, SC-5 (Fort Worth, Texas, USA) suture noodle which can pass directly out of the eye from the superior corneoscleral wound to the superior corneoscleral wound, thus the sulcus positioning of the suture may be more predictable by knowing the entry point. Recently, more and more scholars pay attention to the late IOL dislocation due to breakage of 10-0 polypropylene sutures long-term after the operation. In our study, there were no IOL dislocation due to breakage of 10-0 polypropylene sutures, maybe our follow-up time was to short. There are no reports in the literature of a sutured IOL dislocation secondary to breakage of a 9-0 polypropylene suture. Price *et al* [50] and Stewart and Landers [51] recommended that 9-0 polypropylene suture be used as an alternative to 10-0 polypropylene may reduce the IOL dislocation due to breakage of polypropylene sutures, because it has a 60% greater tensile strength, 50% greater diameter, and a 125% greater cross-sectional area. Kumar *et al* [52] presented glued intrascleral fixation of PCIOL without suture, the mean duration of follow-up after surgery was 17.5 ±8.5mo (range 12-36). Short-term results in children after glued IOL were favorable, with a low rate of complications and low rate of the clinical decentration

(4.8%). However, regular follow-ups are required since long-term risks are unknown.

In short, the particularity of each case should be fully considered to treat crystalline lens subluxation/dislocation associated with secondary glaucoma, and it is the key point to chose reasonable operation time and surgical methods according to the degree of crystalline lens subluxation/dislocation, the crystalline lens nuclear hardness and the coexisted complications to obtain better effect to improve the visual acuity and reduce the complications of the operation.

ACKNOWLEDGEMENTS

Conflicts of Interest: Wang R, None; **Bi CC,** None; **Lei CL,** None; **Sun WT,** None; **Wang SS,** None; **Dong XJ,** None.

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