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Retropupillary Iris-Claw Intraocular Lens in Ectopia Lentis Due to Marfan Syndrome

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Abstract

Background: Surgical treatment of ectopia lentis in Marfan syndrome cases represents a great challenge for ophthalmic surgeons due to zonular weakness, capsular instability and postoperative aphakia correction. We report three cases of surgical treatment of ectopia lentis due to Marfan syndrome and our approach to aphakia correction by implantation of the retroiridally fixated iris-claw intraocular lens.

Methods: Prospective interventional case series. All patients underwent extraction of the subluxated lens with or without combined vitrectomy. Aphakia correction was performed using the Iris-claw intraocular lens, positioned retroiridally by traditional enclavation of both haptics into iris midperiphery. Patients were followed-up for 6 months. Intraocular lens power was calculated using the SRK-T formula.

Diagnosis of Marfan syndrome was confirmed in all cases by molecular diagnosis. Genomic DNA from peripheral blood samples of the patients and their relatives was isolated and screened for fibrillin-1 gene mutations by PCR.

Results: In all cases Iris-claw intraocular lens implantation was carried out uneventfully. In the postoperative period intraocular lens was stable and correctly centered. There were no signs of excessive or prolonged inflammation or any other complications. Intraocular pressure was normal.

Conclusion: Our results suggest that the retroiridally fixated Iris-claw intraocular lens is a very attractive alternative in cases lacking capsular support. It is safe and offers maximal aesthetical and functional results since visual acuity was significantly improved in all patients. However, further evaluation with longer follow-up of a bigger population is desirable.

Keywords: Aphakia correction; Ectopia lentis; Marfan syndrome; Retroiridally fixated Iris-claw intraocular lens; Posterior Iris-Claw IOL; Dislocated crystalline lens; Subluxated cataract

Abbreviations: AC: Anterior Chamber; ACIOL: Anterior Chamber Intraocular Lens; BCVA: Best-Corrected Visual Acuity; CTR: Capsular Tension Ring; EL: Ectopia Lentis; FBN1: Fibrillin-1; IOL: Intraocular Lens; IOP: Intraocular Pressure; MFS: Marfan's Syndrome; PC: Posterior Chamber; PCIOL: Posterior Chamber Intraocular Lens; RD: Retinal Detachment; TA: Triamcinolone Acetonide; VA: Visual acuity; WNL: Within Normal Limits

Introduction

Marfan Syndrome (MFS) is a disorder of the connective tissue. In 1876, E. Williams and Antoine Marfan, described the disease for the first time [1]. The incidence of classic MFS is approximately of 2 to 3 per 10,000 individuals [2]. It is found in all races and it affects both sexes equally. The syndrome has an autosomal dominant inheritance pattern with variable expressivity and is caused by a mutation of the extracellular matrix (ECM) protein fibrillin1, in 15q21.1 [3-6]. There are more than 1,000 mutations in the human fibrillin-1 gene (*FBN-1*) that can result in Marfan syndrome. Most of the mutations are caused by a single amino acid change in this large glycoprotein. *FBN1* gene mutations in MFS reduce the amount of fibrillin-1, leading to a severe reduction in the capacity to form microfibrils which in turn alters the structure and integrity of the ECM. Moreover, fibrillin-1 plays a major role in the regulation of growth factors sequestering circulating growth factor complexes. Hence, in the presence of *FBN1* mutations, the reduction in the number of microfibrils in combination with and excessive amount of activated growth factors, lead to a diminished elasticity and tissues instability with the resulting clinical features of MFS, characterized by defects in multiple organs. Affected areas include the cardiovascular, ocular and skeletal systems. Involvement of the central nervous system and lungs is also frequent. More than 30 different signs and symptoms, with a wide range of expressions, are associated with this syndrome. Most of signs related to the skeletal system include dolichostenomelia with arachnodactyly. Other signs may be scoliosis, abnormal joint flexibility and pectus excavatum or pectus carinatum. However, the most serious symptoms in MFS are associated with the involvement of the cardiovascular system. Such symptoms result of an inadequate circulation due to cystic medial degeneration causing prolapse of the mitral or aortic valves; a dilated

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aorta or an aortic aneurysm. Aortic dissection is the most feared complication and represents a surgical emergency.

Ocular abnormalities are divided into major and minor criteria. The major criteria are ectopia lentis of any degree present in about 80% of patients. The minor ocular criteria involves: abnormally flat cornea, increased axial length of globe, hypoplastic iris or hypoplastic ciliary muscle [7-9]. Other secondary manifestations include cataract, lens coloboma (which can be accompanied by other ocular colobomas of eyelids, iris, choroid or optic disc), displacement of Schlemm's canal, other changes of the anterior chamber angle and extensive liquefaction of the vitreous. Nearsightedness and retinal detachment (RD) are also common features. The incidence of RD ranges from 5% to 25,6% [10-13] and it is bilateral in 30-42% of MFS cases [14,15]. Glaucoma will also develop in about 35 percent of individuals with MFS.

Ectopialentis (EL) is typically superotemporal, usually bilateral, symmetric and may appear during early childhood. In fact, it is present in approximately 50% of patients [5,7,16]. Indications for surgery in cases of EL include decreased visual acuity (VA) due to progressive lens subluxation or cataract development and luxation of the lens into the anterior chamber (AC) or vitreous cavity. In cases of MFS surgical procedures in EL represent a great challenge to surgeons since the ideal implantation of a posterior chamber intracapsular intraocular lens (IOL) after cataract extraction is usually unfeasible. This is due to frequent complications of the surgical procedure caused by zonular weakness, capsular instability or the combination of inborn abnormalities of the lens and AC typical of these patients. These features usually lead to posterior capsule rupture or insufficient remaining capsular support for either intracapsular IOL implantation or posterior chamber sulcus placement of an IOL. In such cases additional methods of IOL placement must be contemplated.

Our purpose was to evaluate the efficacy and safety of the retroiridally Iris-claw IOL in patients with ectopia lentis due to Marfan's Syndrome. To the best of our knowledge this procedure has not been previously described for this pathology as a primary approach.

Materials and Methods

Prospective interventional case series

All participants were informed about the scope and purpose of the surgery and informed consent was obtained.

Diagnosis of Marfan syndrome was confirmed by molecular analysis in all cases. Peripheral blood samples from all consented members were collected. DNA extraction was performed by commercial DNA extraction kits. In cases #1 and #2, molecular analysis of exon 52 of the FBN1 gene showed heterozygosity for the c.6388 G>A (p. Glu 2130 Lys) mutation. In case #3, exon 4 of the FBN1 gene was amplified by PCR. The sequence of FBN1 was determined with an automated direct sequencing (ABI 3130 × l) and sequencing analysis (software "sequencer 4.8", Gene Code Corporation). The results showed the presence of the p.Cys136Ser mutation in exon 4.

The Artisan posterior chamber iris-claw aphakic IOL (Ophtec BV, Groningen, The Netherlands) is a single piece polymethyl methacrylate (PMMA) lens with an overall diameter of 8.5 mm, an optic diameter of 5.4 mm and haptics containing fine fissures to capture a fold of midperipheral iris stroma.

IOL power calculation was performed with A-scan ultrasonic biometry (Tomey UD-6000,Nagoya, Japan) using theSRK/T formula and an A constant of 115.0.

The surgical procedures were performed by one of the authors (CF) using Stellaris® Phaco Phacoemulsifier (Bausch & Lomb, Saint Louis, MO) for cataract surgery; Millennium® Vitrectomy Enhancer (MVE, Millennium Microsurgical system, Bausch & Lomb, Saint Louis, MO) for vitrectomy in case #1, and Constellation® Vision System (ALCON® MIVS, Micro-Incision Vitrectomy Surgery, Alcon, USA) for vitrectomy in case #2 and case #3.

Three patients with ectopialentis due to MFS underwent surgery. In all cases the lens was dislocated inferiorly. Examination did not reveal any associated retinal pathology. Intraocular pressure (IOP) was within normal limits (WNL) in all cases.

Case Series

Case 1

A 40-year-old female patient with inferior dislocation of her crystalline lens and vitreous prolapsed into the anterior chamber (Figure 1) was operated on under local anesthesia. After nucleus and cortex removal (Figure 2), a capsular tension ring (CTR) was inserted in order to stabilize the capsular bag and to continue with cortex removal. Unfortunately, despite the CTR, the capsular bag was greatly decentered due to a zonular dialysis of about 120°, therefore the CTR was removed and triamcinolone acetonide (TA) assisted anterior vitrectomy via corneal incision was performed (Figure 3). As a great amount of the vitreous body prolapsed into the anterior chamber TA-assisted vitrectomy with posterior hyaloid removal and peripheral vitrectomy was carried out in order to prevent retinal breaks and/or

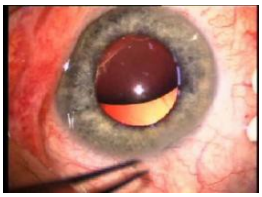

Figure 1: Preoperative photograph of the subluxated crystalline lens (case #1).

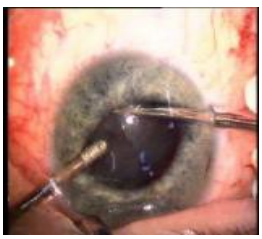

Figure 2: Irrigation – Aspiration cortex removal via limbus.

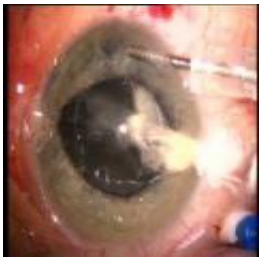

Figure 3: TA-assisted anterior vitrectomy via limbus.

detachment. The Iris-claw IOL was later inserted intothe AC via corneal incision enlarged to 5.5 mm (Figure 4). The lens was slipped through the pupil and maintained horizontally. Having achieved successful control of retropupillary centration, the haptics were positioned at 3 h and 9 h and midperipheral iris tissue was grasped applying gentle pressure on it through the slotted center of the lens haptics. The iris-claw IOL was thus perfectly centrated.

One week after surgery the patient best-corrected VA (BCVA) was 20/40 and there was no evidence of inflammation in her OS.

Case 2

A 46 year-old male patient was operated on under local anesthesia. A 2.2 mm clear corneal incision was performed and then we proceeded with capsulorhexis. After nucleus removal the CTR was inserted (Figure 5). Unfortunately, despite the CTR, the capsular bag was greatly decentrated due to zonular dialysis, hence the CTR was removed (Figure 6) and TA-assisted anterior vitrectomy via limbus was performed. We inserted the Iris-Claw IOL through an enlarged 5.5 mm corneal incision in the anterior chamber and the lens was later fixed retroiridally as previously described (Figure 7).

On his last visit the patient's BCVA was 20/30 OS and the iris-claw IOL was perfectly centered.

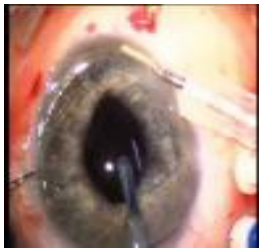

Figure 4: Insertion of the retropupillary iris-claw IOL into the AC through a 5.5mm corneal incision.

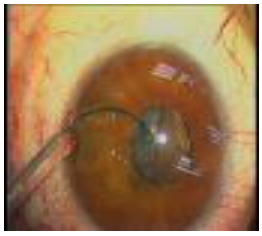

Figure 5: Insertion of the CTR.

Figure 6: CTR removal.

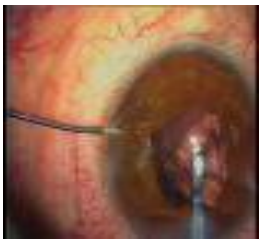

Figure 7: Enclavation of the iris-claw IOL's haptics to the posterior surface of the midperipheric iris.

Case 3

A 12-year-old female patient was operated on under general anesthesia. Anterior chamber was maintained through a 25G infusion (Figure 8). Injection of TA did not reveal presence of vitreous in the AC. Continuous curvilinear capsulorhexis was attempted, however, at 6 o'clock the flap went near the equator and capsulorhexis had failed to be completed (Figure 9). Lens aspiration through the corneal incision followed. After removal of the visible cortical mass, the CTR was inserted in the capsular bag. Once the capsular bag was stabilized and more centered, we proceeded to remove cortical remnants. Next TA injection was repeated to ensure that the vitreous barrier was maintained. Once again, no vitreous was seen in the AC. The capsulorhexis was completed with 23G scissors (Figure 10). Despite having an intact posterior capsular bag, we decided to implant the retro pupillary Iris-Claw IOL to avoid suturing the capsular bag-posterior chamber IOL-CTR complex to the sclera for their centration. Thus, surgical time was reduced and further complications were prevented. The IOL was fixed retroiridally as previously described.

One week after surgery the patient's BCVA was 20/25 and the Iris-claw IOL remained well centered (Figure 11).

Peripheral iridectomy was not performed in any case. After surgery a subconjuctival injection of gentamicin and betamethasone was administered in all patients. Topical combination drops of tobramycin-dexamethasone (Tobradex, Alcon, USA) and of loxacin (Ocuflox, Allergan, Irvine, CA, USA) four times daily were prescribed. In all cases postoperative follow-up was 6 months. The Iris – claw IOL remained stable and correctly centered and there were no signs of excessive or prolonged inflammatory reaction. The IOP was WNL.

Discussion

Removal of the dislocated crystalline lens in MFS presents two main challenges. The first one is the removal of the crystalline lens with preservation of the capsular bag avoiding corneal endothelium damage and vitreous disturbance, which is arduous since zonular weakness and capsular instability complicate the procedure. Surgical management includes pars plana or limbal approach lensectomy; intracapsular cataract extraction; intracapsular, bimanual lens irrigation and aspiration technique and phaco emulsification with a capsular tension ring (CTR), Cionni- modified CTR or the capsule anchor. The second challenge is aphakia correction. The choice of the intraocular lens (IOL), include anterior chamber open loop IOL, anterior chamber iris-claw IOL, posterior chamber sclera-fixed or posterior iris fixed IOL. However, the selected approach depends on the clinical and surgical situation.

In cases with preserved capsular bag, it is always advisable to implant the IO Lin the bag. In patients with limited zonular dehiscence, IOL

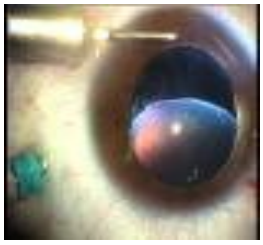

Figure 8: Anterior chamber maintenance through a 25G infusion cannula(Case #3).

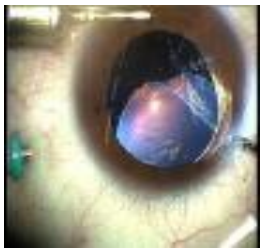

Figure 9: Incomplete capsulorhexis due to anterior capsule tear towards the equator at 6 o'clock position.

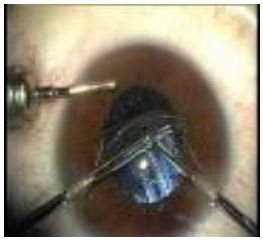

Figure 10: Capsulorhexiswas completed with 23G scissors.

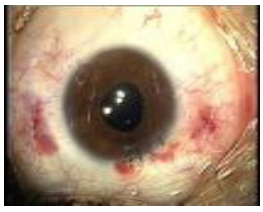

Figure 11: Final result. Perfectly centered Iris-claw IOL.

placement in the capsular bag with, for example, a stabilizing CTR may be possible. Unfortunately, in many cases, due to the characteristics of patients with MFS and the generalized weakness of the lens zonules, this is not possible. In our case series, it was feasible in one patient. However, in case #3, despite the preserved capsular bag, we decided to implant the Iris-Claw IOL as well. The main argument for this decision was the possibility of achieving a good centration of the lens' optic without the need of the capsular bag-IOL-CTR complex fixated to the scleral wall, a procedure which is usually more traumatic for the eye.

In these situations of inadequate capsular support, surgical options for IOL implantation consist of angle-supported or iris-fixed AC IOLs or posterior chamber IOL (PCIOL) implantation with sclera or iris-suture fixation.

At present the most commonly used models are flexible open loop ACIOLs [17]. Regarding anterior chamber IOL (ACIOL) some authors do not recommend using any type of ACIOLs in patients with MFS since they usually present abnormally deep anterior chambers and standard ACIOL results too small [6]. In addition, complications related to ACIOL in general, include excessive movement of the lenses, corneal decompensation, iritis, uveitis, glaucoma, Uveitis-Glaucoma-Hyphema (UGH) syndrome, iris tuck, lens dislocation and cystoid macular edema. Furthermore, ACIOL are usually contraindicated or not advised in patients with a long life expectancy like the patients in this report.

Large posterior chamber intraocular lenses (PCIOL) are more commonly used in patients with MFS and can be often sutured to the iris or to the scleral wall [18]. In the literature many techniques of transsclerally sutured rigid or foldable PCIOL are described. However, this procedure may result in IOL placement in the ciliary muscle, iris root or pars plana. On the other hand, iris-sutured PCIOLs are also employed. Common complications related to this type of IOL include erosion of suture knots through the conjunctiva in case of scleral-sutured lenses; iris chafe in case of iris-sutured lenses; chronic iris inflammation; lens tilt and decentration; iris capture of the IOL optic; and worsening of a preexisting glaucoma [2,19]. Additionally, late dislocation of the sclera-fixated IOL, due to suture breakage, has been reported in up to 24% of pediatric cases [20]. Other complications include hyphema, vitreous hemorrhage, graft failure, cystoid macular edema and retinal detachment.

Taking into consideration all the disadvantages of the above mentioned IOLs and the expectations of our patients, we decided to perform retropupillary fixation of the Iris-Claw IOL, as reported by Mohr and Eckardt in 2002.A 5,5 mm corneal incision or cornea-scleral tunnel [21] are needed to implant this type of lens. The hapticsof the Artisan aphakic IOLs have fine fissures to capture a fold of midperipheral iris stroma. Enclavation in the midperipheral is convenient since this portion of the iris is almost immobile, less vascularized, less reactive and guarantees pupil movement. Both haptics of the Iris-claw IOL must be well enclavated into the iris for long-term stability and centration [22].

The implantation of the Iris-Claw IOL is also technically less demanding, reduces the operative time and resembles physiological crystalline lens position. Moreover, it allows a reversible-adjustable fixation with a relatively low rate of complications. However, it requires an intact iris diaphragm and concern exists regarding long-term effects on corneal endothelium and blood aqueous barrier [17].

In our opinion, the Iris-Claw IOL with retropupillary fixation is a very attractive alternative in cases without capsular support compared to angle-supported or iris-fixated ACIOL or posterior chamber scleral-fixated IOL. During the follow-up period no chronic uveitis, corneal decompensation, haptics exclavation or IOL dislocation were observed in any of the patients and all patients achieved better final VA than recorded pre-operatively. Anyhow, future observations are mandatory to evaluate postoperative course and possible complications.

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