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A comparative study between foldable Iris Claw Lens and ICL (Implantable Collamer Lens) Phakic iols in correcting moderate and high Myopia

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ABSTRACT

Objective: The purpose of this study is to compare between implantation of anterior chamber iris-fixated foldable phakic IOLs and posterior chamber phakic IOLs in patients with moderate to high myopia. *Patients and Methods:* The study included forty eyes with high myopia. Twenty eyes, with spherical error ranging from -9.0D to -15.0D, were implanted with VeriFlex. Other twenty eyes, with

spherical error ranging from -8.0D to -18.0D, were implanted with ICL, followed up for one year postoperative. *Results:* The BCVA improved one to two lines from the preoperative values in both types and the refractive results of both types were stable. In VeriFlex no postoperative rise in IOP, while in ICL, only one eye developed acute rise of IOP in the first day postoperative, this was due to insufficient size of PI. VeriFlex led to 5.4% decrease in the mean endothelial cell count, while ICL led to a much less decrease (1.53%) in the mean endothelial cell loss at the end of the follow up period with statistically highly significant difference (P <0.001). Postoperative uveitis in VeriFlex disappeared after one month, while in case of ICL; it disappeared after one week. Pupil ovalization was reported only in one eye in case of VeriFlex group. One eye only with ICL developed lens opacity which was due to low vault. *Conclusion:* This study proved that regarding the post-operative visual acuity, glare, halos and complications both types of pIOLs had similar results, but the ICL was superior over the foldable anterior chamber PIOL as regards the corneal endothelial cell loss.

1. INTRODUCTION

For hundreds of years efforts have been made to correct, and in some cases cure refractive errors. Methods as familiar as spectacles have been used. Leonardo da Vinci proposed the idea of a contact lens as early as 1508. Due to the inherent risks of ocular surgery, operative techniques for the correction of refractive errors have been slower to develop. Sporadic attempts in refractive surgery have included the removal of crystalline lens in the treatment of myopia in Italy in late 1700s, and incisional surgery for the correction of astigmatism by Faber in the 1800s (Hashem et al., 2009). In the mid to late 1800s, von Graefe, Bates, Faber, Luciola, and Lans reported on the effects of corneal incision on corneal curvature and astigmatism (Sideroudi et al., 2018).

There was a subsequent hiatus of almost 50 years in the development of surgical correction of refractive errors. Barraquer developed the lamellar techniques of keratophakia and microkeratome freeze keratomileusis (MKM). It was Fyodorov who introduced radial keratotomy (RK) in Russia in the 1960s, and Bores who imported RK to the United States in 1978, where it rapidly became a popular technique for the correction of myopia. RK was the first refractive surgery technique to gain widespread popularity, and many patients still equate refractive surgery with RK (Reinstein et al. 2012).

The choice of the proper refractive surgical technique for correction of myopia depends on many parameters, the first of which is its degree (Bhatt et al., 2013). Ideal candidates for refractive surgery are people with healthy eyes who are not satisfied wearing eye glasses or contact lenses (CL). So, the goal of any refractive surgery is to decrease dependence on eye glasses and or CL. Most people who undergo refractive surgery achieve this goal; about 95% do not need corrective lenses for distance vision (Chung et al., 2018).

Lens based refractive surgery is certainly a growing segment of refractive surgery for last few years. It has gained worldwide acceptance and popularity. Refractive surgery is usually classified in two categories: corneal based refractive surgery and lens based refractive surgery (Kim et al., 2019). In corneal based refractive surgery, corneal reshaping using excimer laser has proven to be very useful in the correction of a wide spectrum of visual defects. However, common options like LASIK, PRK, LASEK and more recently Epi-LASIK have shown their limitations for the correction of higher degrees of myopia (Seven et al., 2017). A variety of IOLs have been designed to be used in pIOLs, with the purpose of managing these extreme cases pIOLs offer a promising alternative, particularly for high error correction up to -20D (Yesilirmak et al., 2016).

This study aimed to compare between implantation of Veriflex anterior chamber iris-fixated foldable phakic IOLs and implantable collamer lens posterior chamber phakic IOLs (ICL) in patients with moderate to high myopia.

2. METHODS

This is a prospective randomized comparative study included (40) eyes of 22 patients with moderate to high myopia, (20) eyes of (11) patients where the Foldable iris-fixated AC pIOL ([VeriFlex] by AMO) was implanted (group A) and (20) eyes of (12) patients where the PC pIOL (Implantable Collamer Lens [ICL V4] by STAAR Surgical) was implanted (group B).

Inclusion criteria included the patient age (20-40) years, not suitable for LASIK, refractive error over -6.00 Diopters. Anterior chamber depth is 3.2 mm or more in group A (Veriflex), 2.8mm in group B (ICL). Endothelial cell count (ECC) of 2800 cells/mm^2 or more.

Exclusion criteria include abnormal cornea such as keratoconus, opaque cornea or endothelial dystrophy, DM, anterior and posterior segment pathology, abnormal pupil as fixed pupil or pupil in mesopic light greater than 6.5 mm. IOP greater than 21 mmHg, previous ocular surgery.

A written informed consent was given by the patients for their clinical records to be used in this study.

Surgical Technique

Patients were anesthetized by general or peribulbar and topical anesthesia. After opening the eye with speculum, two vertical paracenteses made by MVR 20G directed toward the enclavation area are performed at 2 o'clock and 10 o'clock (9.0 mm apart). In VeriFlex group, the pupil was constricted by injecting acetylcholine (Miochol) in the AC at the beginning of the procedure, then AC was filled with a cohesive OVD (Healon GV, Sodium hyaluronate 1.4%) injected through the side port to fully inflate the AC. A clear corneal tunnel incision was done by an angled keratome 3.2mm centered at 12 o'clock which corresponds to the width of the PMMA haptics.

Loading the lens: VeriFlex was inserted at the apex of the spatula with the optic preesed to position the next haptic, then insedrted in the AC then rotated 90º into a horizontal position. The pIOL was fixated with an enclavation needle that has a bent shaft and a bent tip that pushes the iris into both claws till automatically grasp the iris. The needle is introduced through one paracentesis and holds the fold of iris while the pIOL is grasped with the implantation forceps at the base of the haptic instead of at the edge of the optic in PMMA type. Removal of the OVD from the AC was done and self-sealing of incision by intrastromal hydration.

In ICL group, the pupil should be dilated to implant the ICL in the ciliary sulcus. Correct loading of the ICL in the cartridge and the injector is essential for correct and easy implantation. Staar foam tip is positioned to protect the ICL from contact with the plunger of the shooter. The ICL has two tiny holes on the footplates (distal right and proximal left) that allow correct anterior-posterior orientation. The front-loading forceps Aus der Au was inserted through the cartridge tip and the forward haptic of the ICL was grasped so that the lens positioning mark is aligned with the jaws. The ICL was held in this position and carefully pulled the cartridge with the other hand over the ICL and Forceps. The cartridge is pulled over the ICL and forceps till the lens is completely folded in the cartridge tip. Two paracenteses made by MVR 20G were performed at 12 o'clock and 6 o'clock, AC is filled with a dispersive (Hydroxypropyl methyl cellulose 1.4%) was injected through the side port to partially inflate the AC to protect the corneal endothelium and crystalline lens from surgical trauma. A clear corneal tunnel incision was done by an angled keratome 3.2mm centered temporal, the ICL is carefully injected slowly using the MicroSTAAR injector (STAAR Surgical). The injection should be slow enough to allow the leading footplate to unfold in the AC before the trailing footplate is pushed out of the cartridge. Once the lens unfolds, the marks on the footplates are checked for proper orientation. OVD is injected on top of the ICL. Finally, the haptics are gently pushed under the iris with a blunt spatula. Acetylcholine (Miochol) is injected into the AC to induce pupil constriction after removal of the OVD. A peripheral iridectomy should be performed with scissors to prevent pupillary block. Initial postoperative examination for both groups A & B was done on the first day postoperative, first week, then after one month and three months.

Statistics

Analyses of the data were performed using SPSS for Mac, version 23. Data are expressed as the mean values (with standard deviations [SDs]), and all statistical tests are 2-tailed. Non-parametric tests were applied to the data. Chi-square tests (χ^2), paired t-test and student-t-test were used to identify differences between groups. Values of $p < 0.05$ were considered significant.

3. RESULTS

Group A included 4 males (36.4%) and 7 females (63.6%), the mean age of which was 26.3 years ±6.1 ranged from 20 to 36 years. Group B included 3 males (25%) and 9 females (75%), the mean age of which was 27.7 years ±4.1 ranged from 20 to 33 years. The difference between the two groups was statistically non-significant (P=0.667) (Table 1-6 & chart 1-3).

Table 1 UCVA (pre-operative and post-operative) in both groups

	Group A	Group B	P value
UCVA pre-operative	0.02±0.007	0.03±0.025	0.265
UCVA 1st week	0.6±0.2	0.5±0.2	0.043
UCVA 1st month	0.7±0.2	0.5±0.2	0.004
UCVA 6thmonth	0.7±0.2	0.6±0.2	0.030
UCVA 1st year	0.8±0.2	0.6±0.3	0.023

P > 0.05 was considered insignificant

Table 2 BCVA (pre-operative and post-operative) in both groups

	Group A	Group B	P value
BCVA pre-operative	0.6±0.2	0.5±0.2	0.211
BCVA 1st week	0.6±0.2	0.6±0.2	0.341
BCVA 1st month	0.8±0.1	0.7±0.2	0.002
BCVA 6 th month	0.9±0.1	0.8±0.2	0.011
BCVA 1st year	0.9±0.2	0.8±0.2	0.002

P > 0.05 was considered insignificant

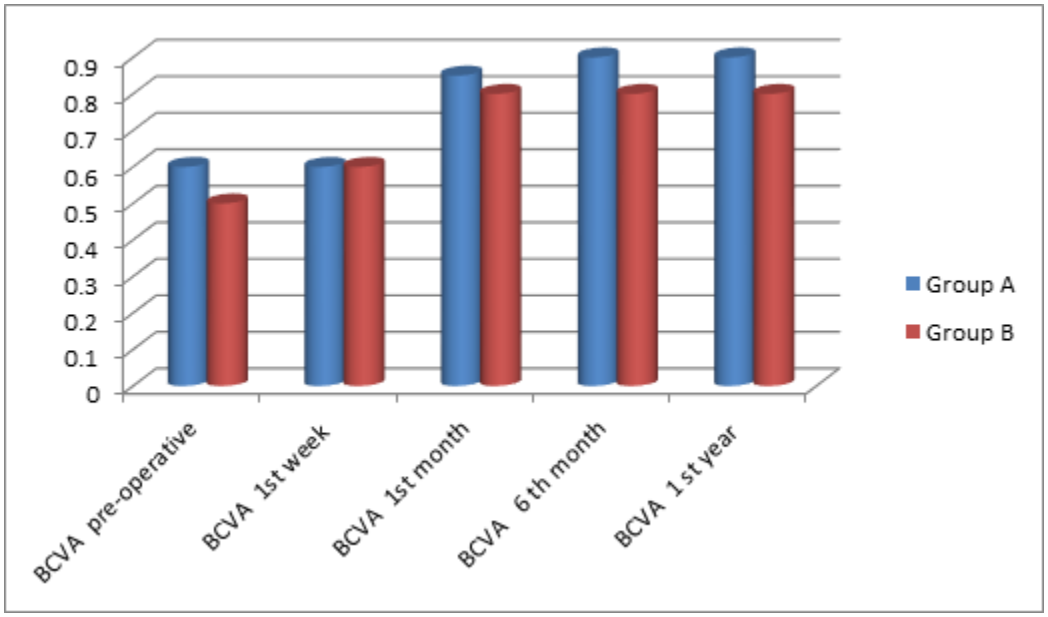

Chart 1 BCVA (pre-operative and post-operative) in both groups.

Table 3 Spherical equivalent SE (pre-operative and post-operative) in both groups

Sph. equivalent SE	Group A	Group B	P value
pre-operative	-12.3 ±1.5D	-16.9 ±3.6D	0.6
1 week post-operative	+1.0 ±1.6D	-0.5 ±2.5D	0.77
1month post-operative	+0.3 ±1.3D	-0.6 ±2.0D	0.73
6month post-operative	+0.5 ±1.0D	-0.9 ±2.0D	0.87
1year post-operative	+0.5 ±1.1D	-1.0 ±2.4D	0.58

Table 4 Cylindrical (Cyl) error (pre-operative and post-operative) in both groups

	Group A	Group B	P value
Cyl error pre-operative	-2.9 ±1D	-1.8 ± 0.9D	0.004
Cyl error 1st week	-1.6 ±0.8D	-2.1 ±0.9D	0.301
Cyl error 1st month	-2.0 ±1.2D	-2.0 ±1.0D	0.698
Cyl error 6th month	-1.8±0.9D	-2.1±1.2D	0.355
Cyl error 1st year	-1.8 ±0.9D	-2.2 ±1.3D	0.565

Table 5 Intraocular pressure (IOP) (pre-operative and post-operative) in both groups

	Group A	Group B	P value
IOP pre-operative	14.8±1.4 mmHg	16.3 ±2.6 mmHg	0.380
IOP 1st week	16.1 ±5.5 mmHg	18.8 ±5.0 mmHg	0.006
IOP 1st month	15.1 ±2.3 mmHg	20.2±6.2 mmHg	0.003

IOP 6th month	16.0±2.4 mmHg	19.3±7.8 mmHg	0.398
IOP 1st year	14.0 ±2.6 mmHg	16.1±2.3 mmHg	0.578

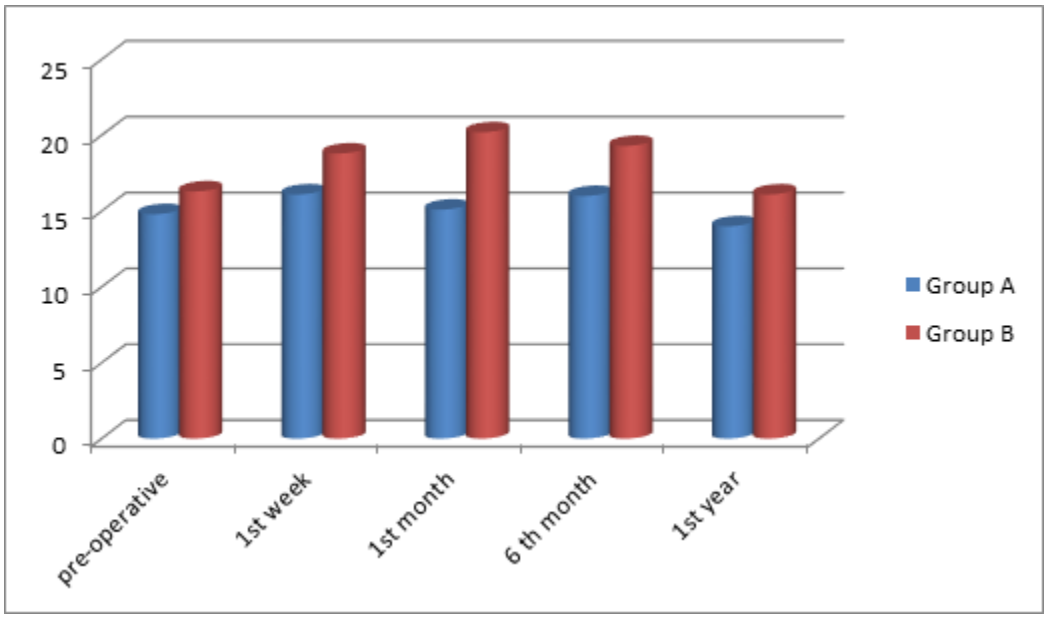

Chart 2 Intraocular pressure (IOP) (pre-operative and post-operative) in both groups.

Table 6 Endothelial Cell Count (ECC) (pre-operative and post-operative) in both groups

	Group A	Group B	P value
ECC pre-operative	2683.4±340.6 cell/mm²	2732±322.8 cell/mm²	0.718
ECC 1st week	2605.9±308.9 cell/mm²	2698.7±311.0 cell/mm²	0.495
ECC 1st month	2605.6±308.6 cell/mm²	2697.8±311.2 cell/mm²	0.512
ECC 6th month	2537.3±277.7 cell/mm²	2691.4±307.9 cell/mm²	0.165
ECC 1st year	2537.7±277.8 cell/mm²	2690.0±305.5 cell/mm²	0.165

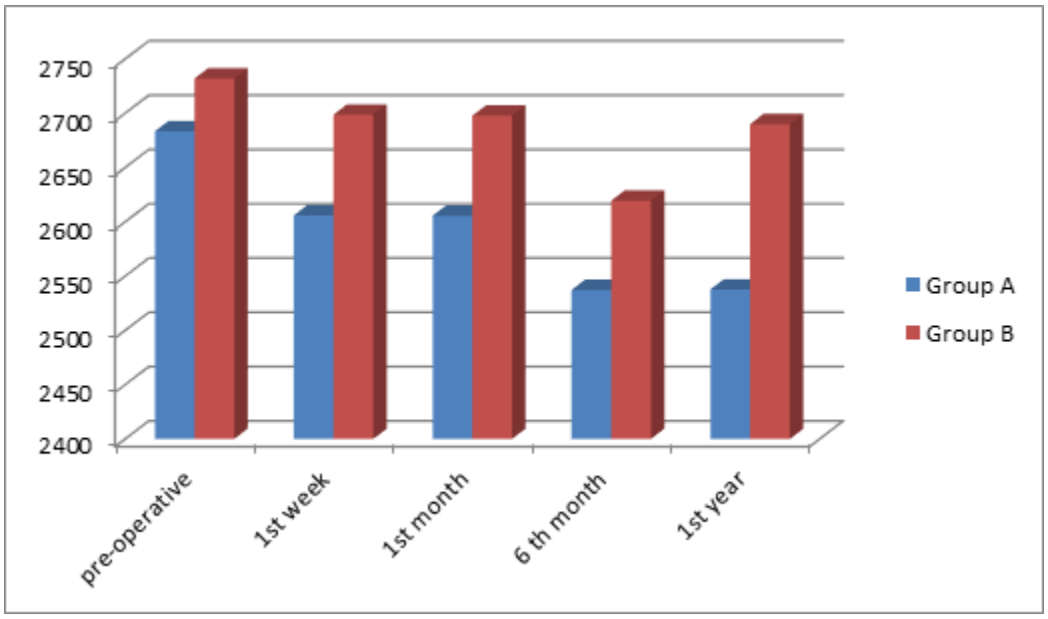

Chart 3 Endothelial Cell Count (ECC) (pre-operative and post-operative) in both groups.

4. DISCUSSION

The results we got in our study concerning effectiveness, predictability, stability and improvement in visual acuity were similar to many previous studies of pIOLs. After one year follow up, 34 eyes (85%) in both groups had an UCVA of 6/12 (0.5) or better. Regarding final refraction; 11 eyes (27.5%) were emmetrope with UCVA of 6/9 (0.8-0.9), 23 eyes (57.5%) were within ± 0.5D, 5 eyes (12.5%) were within ±1.00D and only one eye (2.5%) in group B had complicated as anterior uvietis and high IOP controlled after 1month of surgery. The refractive results were stable and the BCVA improved one to two lines from the preoperative values. Similarly; in a United States FDA study showed that the ICL pIOL had good safety, efficacy and functional results with a low complication rate (Sanders et al., 2004).

Regarding glare and halos; night glare was the complained in VeriFlex group in three eyes (15%) after 1 month of the surgery that was minimized to only 1 eye (5%) after 3 months. This might be attributed to pupil dilatation in darkness rather than pupil ovalization. In ICL group, it was complained in two eyes (10%) till one month after surgery that was minimized to only one eye (5%) after two months. This was related to slightly central PI in one eye and in the other eye due to pupil dilatation after the acute attack of glaucoma rather than pupil ovalization. By the end of the follow up period; glare and halos were not complained by any patient in both groups. This might be due to relatively small mesopic pupil diameter (3.0 mm) of almost all selected subjects (the optic diameter VeriFlex: 6.0mm and ICL 4.5-5.0mm). This was the same explanation as (Senthil et al., 2006); who reported no glare and halos after implantation of the Artisan pIOL in 60 myopic eyes.

On the contrary; other authors reported different results; (Maroccos et al., 2001) explained the presence of glare and halos at the end of their study to the fact that the optic diameter of both pIOLs (VeriFlex: 6.0mm and ICL 4.5-5.0mm) was larger than the mesopic pupil diameter (4.5mm) of the selected subjects.

Similar results regarding AC pIOL were described by (Kohnen & Shajari, 2016) and (Moshirfar et al., 2014); which was explained by permanent wide dilation of the pupil. The glare reported in ICL; (Kohnen & Shajari, 2016); attributed it to decentration of pIOL greater than 1.0 mm. (Stulting et al,. 2008); reported mild to moderate glare in 18 eyes (13.8%) of 130 eyes. In the ICL FDA study, a larger incidence of glare and halos, approximately 8.5%, was reported. The authors concluded that the incidence of glare and halos decreased or remained unchanged from before the operation after ICL surgery (Sanders et al., 2004).

Regarding the cylindrical error; our results reported no significant increase in postoperative cylindrical error with both VeriFlex and ICL. We attributed this to the small incision of 3.2mm required for the VeriFlex and ICL implantation. Similar results were reported by (Awadein and Habib 2013); after AC pIOL. Moreover, a decrease in the preoperative cylindrical error in 14 eyes (70%) in group A (VeriFlex) and in 10 eyes (50%) in group B (ICL) in our study occurred when the incision was coinciding with the axis of the steepest meridian. This was also reported by (Stulting et al., 2008); after AC pIOL.

In a study comparing two AC pIOLs (VeriFlex and Artisan), the mean refractive cylinder power of the Veriflex pIOL was significantly lower than that of the Artisan pIOL (Coullet et al., 2007). Other Authors studied the post-operative cylindrical error after different pIOLs as (Coullet et al., 2007); who found a cylindrical error of 0.42D after VeriFlex. (Stulting et al., 2008); reported a change of more than 2.0D in 3.5% of eyes three years after Artisan/Verisyse. (Dick et al., 2009); found that the mean cylindrical error two years after Veriflex pIOL was 0.33D. On the other hand, the cylindrical error after ICL implantation was 0.45D (Kamiya et al., 2009).

The major statistically significant finding in our study was the decrease in the endothelial cell count (ECC) in both groups. The total endothelial cell loss was 5.4 % in group A (VeriFlex) and 3.53% in group B (ICL) at one year postoperative. There was statistically highly significant difference between the two groups in percentage endothelial cell loss ($P < 0.001$), with more loss in group A This might be attributed to the damage of the corneal endothelium by direct close contact between the VeriFlex AC pIOL and the inner surface of the cornea either during implantation or from postoperative changes in VeriFlex position with leaning forward or eye rubbing. Moreover, chronic postoperative subclinical inflammation, which was more with the VeriFlex AC pIOL, might cause direct toxicity to the endothelium and led to further damage. However the less decrease in the ECC in the ICL group was mainly attributed to direct trauma to the endothelium during surgery.

Natural loss of corneal endothelial cells is about 0.6% per year, as reported by (Gasser et al., 2014). They showed similar results with iris fixated AC pIOL but in longer follow up period. Also (Kamiya et al., 2010) reported similar endothelial cell loss after ICL implantation. In contrast to our results; (Igarashi et al., 2009); reported more corneal endothelial cell loss of 17.6%, 24 months after Artisan implantation and (Silva et al., 2018); reported a decrease of 14.05% corneal endothelial cells after five years following implantation of Verisyse pIOL. As for ICL; a more endothelial cell loss of 5.2% - 5.5% was documented after 12 months by (Edelhauser et al., 2004); reported an endothelial cell loss of 8.4-9.7%, three years postoperative.

Researchers therefore considered surgery to be the cause of the early corneal endothelial cell loss for both types of pIOL. This is also affected by the learning curve of the surgeon (Gonnermann et al., 2014). Factors leading to corneal endothelial cell loss after

pIOL implantation, were studied by many authors who reported a yearly corneal endothelial cell loss of 1.0% for a mean minimum distance of 1.43mm between the edge of the pIOL and the corneal endothelium; the loss was 1.7% for a mean minimum distance of 1.20mm and 0.2% for a mean minimum distance of 1.66mm. They also expected that a critical corneal endothelial cell level of 1500 cells/mm^2 would be reached 18 years after Artisan/Artiflex implantation (Doors et al., 2010).

On the other hand; a less decrease in ECC than our results was revealed by (de Vries et al., 2009) who reported a loss of 0.7% three years after Verisyse, (Güell et al., 2001) who described a decrease of 5.11% four years after Artisan, (Stulting et al., 2008) showed a mean change of 4.8% three years after Verisyse and (Dick et al., 2009) reported a loss of only 1.1% two years after Veriflex implantation.

Ironically; (de Sanctis et al., 2008) reported no change in corneal endothelial cells six months postoperatively after iris fixated AC IOL implantation, also, (Senthil et al., 2006) reported no significant change in corneal endothelial cells two years after Artisan implantation. No cases, of neither pigment dispersion nor lens deposits in both groups had been reported in our study. This might be due to the fact that the optic of the VeriFlex has an anterior vault to prevent iris chaffing and the Collamer of the ICL inhibits protein adhesion and deposition. (Pop et al., 2002) and (Baykara et al., 2007) performed postoperative UBM of the haptics of myopic iris claw AC pIOLs and found no evidence of irritation of the iris pigment epithelium by the pIOL haptics during a one year follow-up. However, if the distance between the crystalline lens and PC pIOL is increased, the PC pIOL is closer to the iris with the consequent risk for pigment dispersion (Kohnen& Klaproth 2010).

On the contrary; (Stulting et al., 2008) reported a long-term incidence of 6.6–6.9% pigment dispersion after Artisan implantation. Also, (Dick et al., 2009) described pigment precipitates in 4.8% of eyes, non-pigment precipitates in 1.4%, and synechiae formation in 1.4% two years after VeriFlex. Pigmentary reaction was frequently associated with elevated IOP as reported by (Den Beste & Okeke, 2017). Also, (Zaldivar et al., 1998) reported that two of 124 eyes showed IOL-related IOP spikes and one of these eyes, with a decentered ICL, had excessive pigment deposition on the pIOL surface. Chronic postoperative subclinical AC inflammation in our study has been a major concern in 20% of eyes in group A (VeriFlex). This was because this pIOL is fixated directly to the iris tissue and causes pressure or shear forces when the eye is moving or patients rub their eyes. This may lead to injury or increased permeability of the iris vessels with breakdown of the blood–aqueous barrier and chronic release of inflammatory mediators, on the other hand; no cases of chronic intraocular inflammation have been reported in group B (ICL).

Similarly; (Hedayatfar et al., 2017) reported elevated flare levels after Artisan. In contrast with us; (Tahzib et al., 2006) and (Doors et al., 2012) described development of severe cell deposition one week after Artiflex implantation. (Moshirfar et al., 2014) described a case of toxic anterior segment syndrome (TASS), also known as sterile endophthalmitis, in a patient who presented with severe corneal edema one day after Verisyse pIOL surgery. The TASS resolved after a two months course of topical steroids. However, corneal endothelial cells decreased by 69% one year after surgery. One case (5%) of slight pupil ovalization occurred after VeriFlex implantation in group A which might be due to slight unequal enclavation, while, no any case of pupil ovalization was reported with ICL in group B.

In comparison to our study; (Bootsma et al., 2006) reported pupil irregularities the first day after Artisan/ Verisyse pIOL implantation, (Stulting et al., 2008) report an incidence of 13.0% of asymptomatic oval pupil one day postoperative, after iris fixated pIOL. No cases of IOP elevation after VeriFlex were reported in our study, this might be due to the anterior chamber angle which is not generally thought to be affected by the haptics of the iris-claw AC pIOL.

On the contrary; (Yamaguchi et al., 2008) reported that after implantation of an Artisan/Verisyse pIOL, partial narrowing of the AC angle of more than 5º occurred in the area where the pIOL haptics pinched the iris. This did not affect IOP. On the other hand; one case of acute pupillary block glaucoma occurred in our study after ICL with IOP spike to 40 mmHg on the first day postoperative, in this case the PI was small, and the patient went for another surgical iridectomy 2 days after the surgery after which the IOP was normalized. Many authors stated that, a peripheral iridectomy or iridotomy was necessary to prevent acute pupillary block glaucoma (39). Similarly; preoperative iridotomies become non-permeable over time because they are too small or the haptic of the PC pIOL blocks them. This may cause acute pupillary block glaucoma. A second iridotomy has to be performed in these cases (Edelhauser et al. 2004).

On the other hand; (Kamiya et al., 2009); did not report a statistically significant IOP increase after ICL implantation. We reported one case with VeriFlex implantation developed steroid induced glaucoma in the early postoperative period. However; IOP was normalized after replacement of steroids with NSAIDs eye drops and use of antiglaucoma eye drops. Similarly; cases of elevated IOP in the early postoperative period that were probably related to steroid medication had been found by (Stulting et al., 2008). Postoperative decentration is possible in AC pIOLs if the enclavation is not sufficient. This can lead to difficulties if the pupil itself is decentered and the optical axis is not in the middle of the pupil that not happens in our cases. In contrast to our results; (Tahzib et

al., 2008) reported decentration of pIOL with respect to the pupil center at an incidence of 13.5% decentration, but in only one case was a second intervention necessary because of double vision.

Regarding pIOL rotation or dislocation; the present study described one case (5%) of postoperative dislocation of VeriFlex. It was not preceded by any trauma. This may was due to enclavation of inadequate iris tissue. Re-enclavation was done immediately on the same day. Also, spontaneous postoperative dislocations or dislocations due to blunt ocular trauma were described by (Peng et al., 2018). Using Scheimpflug photography, (Baumeister et al.2004) reported that the iris-fixated pIOL had the best positional stability compared with AC and PC pIOLs. Therefore, the iris-fixated pIOL is particularly interesting for toric pIOL designs.

Although; one of the most common expected complications after pIOLs is cataract formation, yet; we did not report any case of cataract formation after VeriFlex over the follow up period. This could be attributed to its insertion in the AC over a miotic pupil and its far location from the crystalline lens which was also explained by (Kohnen et al., 2010). On the other hand; one case (5%) with ICL developed anterior sub capsular cataract 3 months postoperative which was due to low ICL vault (¼CCT). This occurred due to improper measuring of white to white distance which was measured using a caliper with indistinct appearance of the limbus due to contact lens wear. The reason why these cataracts develop is not well established, although it is widely believed that it depends mainly on the space (vault) between the IOL and the natural lens. When this space is too narrow or even nonexistent (the IOL touching the natural lens) the aqueous humor cannot flow freely around the lens, causing changes in metabolism responsible for the opacities (Khokhar & Mahabir, 2018). On the contrary; (Chen et al., 2008) reported that the incidence of cataract was 8.5% for the ICL pIOL and 1.1% for the myopic Artisan/Verisyse pIOL while no cataracts with the Artiflex pIOL. No cases of retinal detachment (RD) occurred in our study, with both types. Mostly this was due to thorough preoperative and postoperative fundoscopic investigation. On the contrary; (Stulting et al., 2008) reported a RD rate of 0.3% per year after Artisan/Verisyse implantation.

The present study revealed the ICL vault (distance from the anterior lens surface and the center of ICL optic from the posterior surface) was within the ideal range [from ½ CCT to 1 ½ CCT (250 µm to 750µm)] in 19 cases (95%). In just one case (5%) it was about ¼ CCT (125 µm) by the end of follow up period. This case is considered to have a low vault as a high vault is considered when the vault is more than 750µm while a low vault if less than 250µm. Similar to our study; (Hashem et al., 2009) found that the ICL sits further away from the corneal endothelium than AC pIOLs and he concluded that ACD of 2.7mm from the endothelium to the anterior surface of the crystalline lens is estimated as the lower limit for safe ICL implantation**.**

Also, in the study of (Choi et al., 2007) in the UBM method group, ICL vault was within the ideal range in all 13 eyes (100%) at one and six months postoperatively, whereas in the conventional method group, 10 eyes (58.8%) showed ideal vault at one month postoperatively (P=0.01) and 9 eyes (52.9%) showed ideal vault at six months postoperatively (P=0.01). Other complications of iris-fixated pIOL implantation are ischemic blown pupil (Urrets-Zavalia syndrome), early postoperative hyphema, and ischemic optic neuropathy (Park et al., 2008).

5. CONCLUSION

Regarding the post-operative visual acuity, glare, halos and complications both types of pIOLs had similar results, but the ICL was superior over the foldable anterior chamber PIOL as regards the corneal endothelial cell loss.

Conflict of interest and financial resources
All authors declare no conflict of interest or any financial resources.

REFERENCE

1. Hashem AN, El Danasoury AM, Anwar HM. Axis alignment and rotational stability after implantation of the toric implantable collamer lens for myopic astigmatism. J Refract Surg. 2009 Oct; 25 (10 Suppl): S939-43.
2. Sideroudi H, Lazaridis A, Roth MA, Labiris G, Kozobolis V, Sekundo W. Corneal Irregular Astigmatism and Curvature Changes After Small Incision Lenticule Extraction: Three-Year Follow-Up. Cornea. 2018; 37(7):875-880.
3. Reinstein DZ, Archer TJ, Gobbe M. The history of LASIK. J Refract Surg. 2012; 28(4): 291-8.
4. Bhatt UK, Sheppard AL, Shah S, Dua HS, Mihashi T, et al. Design and validity of a miniaturized open-field aberrometer. J Cat. Ref. Surg. 2013; 39(1):36-40.
5. Chung H, Sanders E, Bhamra J. Can J Ophthalmol. Opinions on corrective refractive surgery. 2018; 53(3):278-283.
6. Kim TI, Del Barrio JLA, Wilkins M, Cochener B, Ang M. Refractive surgery. Lancet. 2019; 393(10185):2085-98.
7. Seven I, Vahdati A, Pedersen IB, Vestergaard A, Hjortdal J, et al. Contra-lateral eye comparison of SMILE and flap-based corneal refractive surgery: Computational analysis of biomechanical impact. J Refract Surg. 2017; 33(7):444-53.

8. Yesilirmak N, Davis Z, Yoo SH. Refractive Surgery (SMILE vs. LASIK vs. Phakic IOL). Int Ophthalmol Clin. 2016; 56(3):137-47.
9. Sanders DR1, Doney K, Poco M; ICL in Treatment of Myopia Study Group. US Food and Drug Administration clinical trial of the Implantable Collamer Lens (ICL) for moderate to high myopia: three-year follow-up. Ophthalmol 2004; 111(9): 1683 - 92.
10. Senthil S, Reddy KP, Ravisankar, Srilakshmi R. A retrospective analysis of the first Indian experience on Artisan phakic intraocular lens. Indian J Ophthalmol. 2006; 54(4):251-5.
11. Maroccos R, Vaz F, Marinho A, Guell J, Lohmann CP. Glare and halos after phakic IOL. Surgery for the correction of high myopia. Ophthalmologe. 2001; 98(11): 1055-9.
12. Kohnen T, Shajari M. Phakic intraocular lenses. Ophthalmol. 2016; 113(6):529-38.
13. Moshirfar M, Imbornoni LM, Ostler EM, Muthappan V. Incidence rate and occurrence of visually significant cataract formation and corneal decompensation after implantation of Verisyse/Artisan phakic intraocular lens. Clin Ophthalmol. 2014; 8:711-6.
14. Stulting RD, John ME, Maloney RK, Assil KK, Arrowsmith PN, Thompson VM; U.S. Verisyse Study Group. Three-year results of Artisan/Verisyse phakic intraocular lens implantation. Results of the United States Food and Drug Administration clinical trial. Ophthalmol. 2008; 115(3):464-472.e1.
15. Awadein A, Habib AE. ICL versus Veriflex phakic IOL for treatment of moderately high myopia: randomized paired-eye comparison. J Refract Surg. 2013; 29(7):445-52.
16. Coullet J, Gontran E, Fournié P, Arné JL, Malecaze F. Refractive efficacy and tolerance of the foldable phakic iris-supported Artiflex lens in the surgical correction of moderately high myopia: a 2-year follow-up. J Fr Ophtalmol. 2007; 30(4):335-43.
17. Dick HB, Budo C, Malecaze F, Güell JL, Marinho AA, et al. Foldable Artiflex phakic intraocular lens for the correction of myopia: two-year follow-up results of a prospective European multi-center study. Ophthalmol. 2009; 116(4): 671-7.
18. Kamiya K, Shimizu K, Aizawa D, Igarashi A, Komatsu M. surgically induced astigmatism after posterior chamber phakic intraocular lens implantation. Br J Ophthalmol. 2009; 93(12):1648-51.
19. Gasser L, Daniel M, Reinhard T, Böhringer D. Long-term tracking of the central corneal endothelial mosaic. PLoS One. 2014 Mar 13; 9(3):e88603.
20. Kamiya K, Shimizu K, Igarashi A, Aizawa D, Ikeda T. Clinical outcomes and patient satisfaction after Visian Implantable Collamer Lens removal and phacoemulsification with intraocular lens implantation in eyes with induced cataract. Eye (Lond). 2010; 24(2):304-9.
21. Igarashi A, Kamiya K, Shimizu K, Komatsu M. Visual performance after implantable collamer lens implantation and wavefront-guided laser in situ keratomileusis for high myopia. Am J Ophthalmol. 2009; 148(1):164-70.e1.
22. Silva L, Najafi A, Suwan Y, Teek-hasaenee C, Ritch R. The iridocorneal endothelial syndrome. SurvOphthalmol. 2018; 63(5):665-676.
23. Edelhauser HF, Sanders DR, Azar R, Lamielle H; ICL in Treatment of Myopia Study Group. Corneal endothelial assess-ment after ICL implantation. J Cataract Refract Surg. 2004;30(3):576-83.
24. Gonnermann J, Amiri S, Klamann M, Maier AK, Joussen AM, et al. Endothelial cell loss after retropupillary iris-claw intraocular lens implantation. KlinMonblAugenheilkd. 2014; 231(8):784-7.
25. Doors M1, Berendschot TT, Webers CA, Nuijts RM. Model to predict endothelial cell loss after iris-fixated phakic intraocular lens implantation. Invest Ophthalmol Vis Sci. 2010; 51(2):811-5.
26. de Vries NE, Tahzib NG, Budo CJ, Webers CA, de Boer R, Hendrikse F, Nuijts RM. Results of cataract surgery after implantation of an iris-fixated phakic intraocular lens. J Cataract Refract Surg. 2009; 35(1):121-6.
27. Güell JL, Vázquez M, Gris O. Adjustable refractive surgery: 6-mm Artisan lens plus laser in situ keratomileusis for the correction of high myopia. Ophthalmol. 2001; 108(5):945-52.
28. de Sanctis U, Mutani B, Grignolo FM. Long-term endothelial cell loss after traumatic dislocation and repositioning of Artisan phakic IOL. J Refract Surg. 2008; 24(5): 546-8.
29. Pop M, Payette Y, Mansour M. Ultrasound biomicroscopy of the Artisan phakic intraocular lens in hyperopic eyes. J Cataract Refract Surg. 2002; 28(10): 1799-803.
30. Baykara M, Ozcetin H, Yilmaz S, Timuçin OB. Posterior iris fixation of the iris-claw intraocular lens implantation through a scleral tunnel incision. Am J Ophthalmol. 2007; 144(4):586-91.
31. Kohnen T, Klaproth OK. Three-year stability of an angle-supported foldable hydrophobic acrylic phakic intraocular lens evaluated by Scheimpflug photography. J Cataract Refract Surg. 2010; 36(7):1120-6.
32. Den Beste KA, Okeke C. Trabeculotomy ab interno with Trabectome as surgical management for systemic fluoroquinolone-induced pigmentary glaucoma: A case report. Medicine (Baltimore). 2017; 96(43):e7936.
33. Zaldivar R, Davidorf JM, Oscherow S. Posterior chamber phakic intraocular lens for myopia of -8 to -19 diopters. J Refract Surg. 1998; 14(3):294-305.

34. Hedayatfar A, Hashemi H, Asghari S, Badie N, Miraftab M. Chronic subclinical inflammation after phakic intraocular lenses implantation: Comparison between Artisan and Artiflex models. J CurrOphthalmol. 2017; 29(4):300-304.
35. Tahzib NG, Eggink FA, Frederik PM, Nuijts RM. Recurrent intraocular inflammation after implantation of the Artiflex phakic intraocular lens for the correction of high myopia. J Cataract Refract Surg. 2006; 32(8):1388-91.
36. Doors M, Budo CJ, Christiaans BJ, Luger M, Marinho AA, Dick HB, Güell JL, Nuijts RM. ArtiflexToric foldable phakic intraocular lens: short-term results of a prospective European multicenter study. Am J Ophthalmol. 2012; 154(4):730-9.
37. Bootsma SJ, Tahzib NG, Eggink FA, de Brabander J, Nuijts RM. Evaluation of pupil dynamics after implantation of artisan phakic intraocular lenses. J Refract Surg. 2006; 22(4):367-71
38. Yamaguchi T, Negishi K, Yuki K, Saiki M, Nishimura R, Kawaguchi N, Tsubota K. Alterations in the anterior chamber angle after implantation of iris-fixated phakic intraocular lenses. J Cataract Refract Surg. 2008; 34(8):1300-5.
39. Toh T, Nguyen DQ, Ruddle JB, Crowston JG, Coote MA. Bilateral acute severe intraocular pressure elevation requiring filtration surgery after implantation of toric Artisan phakic intraocular lenses. Clin Exp Ophthalmol. 2012; 40(2):212-3.
40. Tahzib NG, MacRae SM, Yoon G, Berendschot TT, Eggink FA, Hendrikse F, Nuijts RM. Higher-order aberrations after implantation of iris-fixated rigid or foldable phakic intraocular lenses. J Cat Ref Surg. 2008; 34(11):1913-20.
41. Peng RM, Guo YX, Qiu Y, Hao YS, Hong J. Complications and outcomes of descemet stripping automated endothelial keratoplasty with artisan aphakia intraocular lens implantation. Int J Ophthalmol. 2018; 11(4):607-611.
42. Baumeister M, Bühren J, Kohnen T. Position of angle-supported, iris-fixated, and ciliary sulcus-implanted myopic phakic intraocular lenses evaluated by Scheimpflug photography. Am J Ophthalmol. 2004; 138(5):723-31.
43. Khokhar S, Mahabir M. Phaco-emulsification in phakic iris-claw lens with cataract. Indian J Ophthalmol. 2018; 66(11):1609-1610.
44. Chen LJ, Chang YJ, Kuo JC, Rajagopal R, Azar DT. Metaanalysis of cataract development after phakic intraocular lens surgery. J Cataract Refract Surg. 2008; 34(7):1181-200.
45. Choi KH1, Chung SE, Chung TY, Chung ES. Ultrasound biomicroscopy for determining visian implantable contact lens length in phakic IOL implantation. J Refract Surg. 2007; 23(4):362-7.
46. Park SH, Kim SY, Kim HI, Yang SW. Urrets-Zavalia syndrome following iris-claw phakic intraocular lens implantation. J Refract Surg. 2008; 24(9):959-61.