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Management of complications of sutureless intrascleral intraocular lens fixation

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Abstract:

PURPOSE: The purpose of the study was to report the complications of sutureless intrascleral (SIS) intraocular lens (IOL) fixation and its management.

MATERIALS AND METHODS: A multicenter, retrospective, consecutive interventional case series of patients with intra or postoperative complications after SIS IOL fixation during the technical learning curve of vitreoretinal surgeons from three Taiwanese referral hospitals. The used surgical techniques were the Scharioth technique for intrascleral tunnel fixation, Yamane technique (double-needle scleral fixation), and modified Yamane technique (double-needle flanged haptic scleral fixation). The IOL models and surgical instruments used as well as each patient's ocular characteristics and complication management were recorded.

RESULTS: Of the eight included patients, the complications of 3 (37.5%) and 5 (62.5%) were noted intraoperatively and postoperatively, respectively. Haptic-related complications, including haptic breakage, slippage, and haptic disinsertion, occurred in six eyes. Other complications included uveitis–glaucoma–hyphema syndrome, retinal detachment, and IOL tilt. For the two patients with haptic slippage, repositioning was achieved using a modified cow-hitch technique that resulted in favorable IOL centration and restored visual acuity.

CONCLUSION: Most complications surgeons encountered during their early exposure to SIS IOL fixation were haptic related. Surgeons should be aware of such complications to prevent and manage them during surgery. Our modified cow-hitch technique could be used to reposition IOLs with unilateral haptic slippage.

Keywords:

Cow-hitch technique, intrascleral intraocular lens fixation, sutureless

Introduction

Intraocular lens (IOL) implantation within the lens capsule after successful cataract extraction is anatomically preferable. However, in eyes with inadequate zonular support, including those with ocular trauma, Marfan syndrome-induced lens dislocation, pseudoexfoliation syndrome, and phacoemulsification-related intraoperative complications, an alternative location for IOL implantation must be identified. In patients with these conditions, possible treatments include anterior chamber IOL implantation, iris-fixated IOL implantation, and transscleral IOL fixation.[1,2]

Conventional transscleral fixation involves suturing specifically designed IOLs through the ciliary sulcus or pars plana.[3] In 2007, Gabor and Pavlidis[4] first reported an alternative technique for IOL implantation, sutureless intrascleral (SIS) fixation. SIS fixation has since rapidly gained popularity because of its association with favorable anatomical and functional outcomes, and several modified SIS fixation techniques

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have been developed.[5-8] SIS fixation has an advantage over anterior chamber IOL implantation because of its low corneal decompensation rate. Compared with scleral fixation, SIS fixation has less knot exposure and recurrent dislocation and demonstrates no suture erosion issues.[9] However, SIS fixation is a technically dependent procedure and therefore requires a longer learning curve. Although most extant studies have reported favorable outcomes for SIS fixation,[4-8] intra- and postoperative complications include haptic disruption,[10] IOL subluxation,[6] uveitis-glaucoma-hyphema (UGH) syndrome, and retinal detachment[11] remain possible. In addition, the management of such complications has often been overlooked.

In the present study, we examined the intra- and postoperative complications of SIS IOL fixation reported by different surgeons during early exposure to the technique. Herein, we also detail on the management of each complication and discuss potential preventions of such complications.

Materials and Methods

Patient population

In this multicenter, retrospective, consecutive case series, we reviewed all patients who underwent SIS IOL fixation performed by three vitreoretinal surgeons at three referral hospitals in Taiwan – namely National Taiwan University Hospital, Taipei Veterans General Hospital, and Taipei City Hospital Heping Branch – between February 2017 and December 2019. All patients underwent complete pars plana vitrectomy before the SIS IOL fixation. We included patients who experienced intra- or postoperative complications within the initial ten cases performed by each surgeon during our study's timeframe. Complications occurring beyond the first 10 cases were not part of our study series. All patients provided informed consent before surgery. The study was approved by the institutional review board of all three participating hospital and followed the tenets of the Declaration of Helsinki (approval number: 202006013RINC).

All patients received complete ophthalmic evaluation before and after the surgery, including slit-lamp biomicroscopy, indirect ophthalmoscopy, and best-corrected visual acuity (BCVA) examination. We reviewed each patient's chart, which contained the following information: age, sex, preoperative conditions (e.g. visual acuity, preexisting ocular conditions, and previous ocular surgery), surgical approach (as described later), intra- and postoperative complications, postoperative BCVA, IOL centration, and complication management.

Sutureless intrascleral intraocular lens fixation methods

Three approaches of SIS IOL fixation were used. The procedures were described in detail in the original reports and are summarized as follows.[4,7,8]

The Scharioth technique for intrascleral tunnel fixation[4]

As Gabor and Pavlidis[4] described in 2007, sclerotomy positions in the ciliary sulcus were confirmed intraoperatively through an indirect viewing system. Using 24G needles (Neopoint Luer #17), two straight ab externo sclerotomies were made 1.5–2 mm from the limbus, 180° apart. Two partial-thickness limbus-parallel tunnels were made, starting from the sclerotomies and ending with externalizing the needle. A 3-piece IOL was injected, and the leading haptic tip was grasped and externalized through sclerotomy, followed by the trailing haptic. The leading haptic was pulled into the intrascleral tunnel with end-gripping forceps (Janach J383825), and the trailing haptic was fixed into the opposite limbus-parallel tunnel in a similar fashion, with the IOL centered through adjustment of the two haptics.

Yamane technique (double-needle intrascleral fixation)[7]

This technique was introduced by Yamane *et al.*[7] in 2014. In brief, SIS fixation was performed by docking the haptics of a 3-piece IOL into 27G needles that were inserted intrasclerally. The haptics were externalized by withdrawing the needles and then tucked into the scleral tunnels, adjacent to a partial-thickness scleral groove.

Modified Yamane technique (double-needle flanged-haptic intrascleral fixation)[8]

Under this modified technique of flanged intrascleral haptic fixation, two 30G thin-walled needles (TSK ultra-thin wall needle; Tochigi Seiko, Tochigi, Japan) were passed transconjunctivally (each 2 mm posterior to the limbus and 180° apart), tunneled through sclera, and passed into the vitreous cavity. The haptics were docked into the needles, which were later withdrawn simultaneously. The externalized haptic ends were melted using a low-temperature cautery (Accu-Temp Cautery; Beaver Visitec, Waltham, MA), creating bulb-shaped flanges pushed back under the conjunctiva and nudged into the scleral tunnels.

Modified sliding cow-hitch technique

For patients complicated with haptic slippage slipping into the eye through the tunnels, the modified sliding cow-hitch technique was used [Supplementary Video 1]. The procedure for the technique is as follows: (1) A partial-thickness corneoscleral pocket, as described by Hoffman *et al*.[12] or a partial-thickness scleral flap was created 180° from the remaining fixated haptic. (2) Two needles threaded with 10-0 polypropylene (PP) sutures were introduced through a corneal incision and the Hoffman pocket/partial-thickness scleral flap through docking into a 27G needle, leaving an adequate length of suture outside of the corneal incision. (3) A cow-hitch tie was formed and loosely looped over the shaft of end-grasping intraocular forceps (Alcon, Fort Worth, TX, USA). (4) The forceps were introduced through the corneal incision to grasp the subluxated haptic under a wide-angle viewing system. (5) After the forceps secured the subluxated haptic, the cow-hitch tie was slid onto the haptic from the forceps shaft. After tightening the thread, the cow-hitch suture was secured to the haptic. (6) The subluxated haptic was pulled toward the desired position using the cow-hitch suture and fixated through the Hoffman pocket/partial-thickness scleral flap, with the suture knot buried into the pocket. Favorable postoperative IOL centration with restored visual acuity was noted in these two patients.

Results

We reviewed a total of 24 cases within the learning curve of four vitreoretinal surgeons, among which eight cases exhibited complications. Of these eight complicated cases (seven men and one woman), the average age was 71 ± 12 years (range: 55–91 years). Table 1 shows the preexisting causes of aphakia, including posterior capsule rupture and trauma. The mean uncorrected preimplant logarithm of the minimum angle of resolution (logMAR) visual acuity was 1.36 ± 0.43, and the mean preimplant best-corrected logMAR visual acuity was 0.683 ± 0.62. Mean postimplant best-corrected logMAR visual acuity improved to 0.633 ± 0.65.

Of the 8 patients with complications, 2, 4, and 2 underwent SIS IOL fixation with the Scharioth technique for intrascleral tunnel fixation, Yamane double-needle intrascleral fixation technique, and Yamane double-needle flanged-haptic intrascleral fixation technique, respectively. In all three centers, the same type of 3-piece IOL, the MA60AC (Alcon, Fort Worth, TX, USA) was implanted. Tan forceps (ASICO, Westmont, IL, USA), end-grasping forceps (Alcon, Fort Worth, TX, USA), and serrated forceps (Alcon, Fort Worth, TX, USA) were used as listed in Table 1.

During surgical manipulation, three patients had intraoperative complications involving IOL haptic damage. For one patient, haptic disinsertion was noticed; in the other 2, the haptic broke in the middle. The other five patients suffered from postoperative complications, including UGH syndrome, IOL tilt, postoperative haptic disinsertion [Figure 1a], retinal detachment, and haptic slippage-related IOL subluxation [Figure 1b].

Table 1: Summary of patients with complications during sutureless intrascleral intraocular lens fixation

Age	Sex	Laterality	Etiology	Preoperative UCVA	Preoperative BCVA	Final BCVA	Surgical method[a]	Needle	Forceps model	Complication	Management
64	Female	OS	Trauma	20/400	20/50	20/50	2	27G	Tan forceps	Postoperative haptic slippage-related IOL subluxation 4 weeks later	Modified sliding cow-hitch suture
81	Male	OS	PCR and lens drop	-	20/63	20/50	2	27G	Tan forceps	RD 3 weeks later; haptic slippage-related IOL subluxation 4 months after RD	Modified sliding cow-hitch suture
65	Male	OD	IOL subluxation	20/500	20/25	20/20	2	27G	Tan forceps	IOL haptic disinsertion 3 days later	Exchange 3-piece IOL
73	Male	OS	Loosen zonule and PCR	20/800	20/63	20/40	2[b]	27G	End-grasping	Intraoperative haptic break	Exchange 3-piece IOL
55	Male	OS	IOL subluxation	20/50	20/25	20/20	1[b]		End-grasping	UGH syndrome 9 weeks later	IOL removal
79	Male	OS	Spontaneous lens dislocation	20/800	20/32	20/40	1[b]		End-grasping	Intraoperative haptic disinsertion	Exchange 3-piece IOL
60	Male	OS	Phacodonesis	20/800	20/800	20/800	3	26G	Serrated I.O. forceps	Haptic break	Exchange 3-piece IOL
91	Male	OS	IOL dislocation	20/800	20/800	20/800	3	26G	Serrated I.O. forceps	Tilting IOL	observation

[a]Surgical techniques: 1=Scharioth, externalize plus scleral tunnel (J Cataract Refract Surg, 33 (2007), pp. 1851-854); 2=Yamane, double-needle plus scleral tunnel (Ophthalmology 2014;121:61-66); 3=Yamane, double-needle plus flanged haptic (Ophthalmology 2017;124:1136-1142), [b]First case of the surgeon. BCVA=Best-corrected visual acuity, IOL=Intraocular lens, OD=Right eye, OS=Left eye, PCR=Posterior capsular rupture, RD=Retinal detachment, SIS=Sutureless intrascleral fixation, UCVA=Uncorrected visual acuity, UGH=Uveitis–glaucoma–hyphema syndrome

Intraoperative complication management

All intraoperative complications involved damaged IOL haptics (haptic break or haptic disinsertion). Therefore, direct IOL exchange was performed in all three patients with intraoperative complications. In one patient, the broken haptic dropped onto the macula and was removed with forceps after complete vitrectomy without causing further damage. The implanted IOL remained stable throughout the follow-up period in all three patients.

Postoperative complication management

Haptic disinsertion

Three days after surgery, another patient experienced haptic disinsertion. IOL exchange was performed with the damaged IOL cut and externalized through the corneal incision, followed by implantation of a new 3-piece IOL using the same technique. The haptics of the new IOL were inserted within the original scleral tunnel tract. The new IOL remained stable after 13 months.

Retinal detachment

One patient developed rhegmatogenous retinal detachment on postoperative day 20. The patient underwent pars plana vitrectomy, encircling buckling, and intravitreal flush of 15% octafluoropropane and was placed in a prone position for 2-week postoperation. The retina was reattached after vitrectomy, and the intravitreal gas was completely absorbed 7 weeks after surgery. However, 15 weeks after vitrectomy, haptic slippage-related IOL subluxation, i.e. one haptic slippage slipping into the vitreous cavity through the scleral tunnel, was noted. The management for this complication is described subsequently.

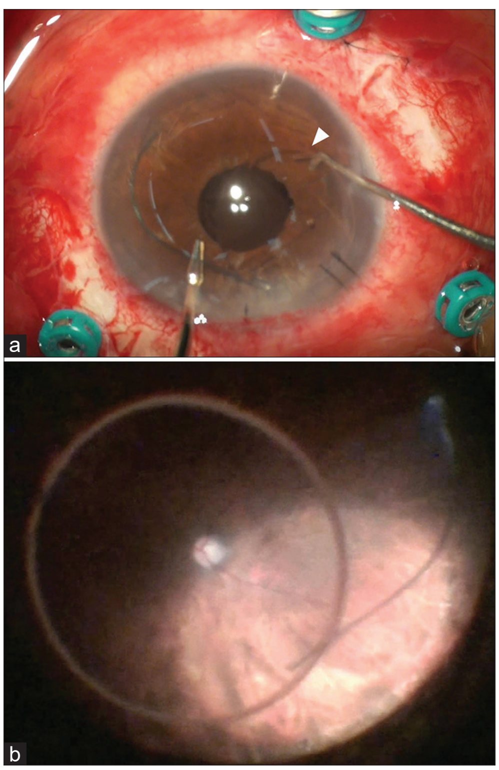

Figure 1: Postoperative complications involving IOL haptics: (a) Haptic disinsertion was noted on postoperative day 3. The rupture point (indicated by the white arrow) was seen during intraocular lens (IOL) removal using forceps. (b) Postoperative IOL haptic subluxation noted 1 month after implantation. One of the haptics had dislodged from the scleral tunnel and subluxated into the vitreous cavity

Haptic slippage-related intraocular lens subluxation

Two patients experienced haptic slippage-related IOL subluxation. The aforementioned patient experienced this complication after vitrectomy for retinal detachment and another patient experienced spontaneous haptic slippage-related IOL subluxation 1 month after initial implantation. We used a modified cow-hitch technique involving a sliding knot in combination with Hoffman's corneoscleral pocket or partial thickness scleral flap for IOL repositioning in these two patients [Figure 2 and Supplementary Video 1].

Uveitis–glaucoma–hyphema syndrome

One patient developed UGH syndrome 9 weeks after IOL implantation, with elevated intraocular pressure and intermittent vitreous hemorrhage despite treatment with topical antiglaucomatic agents and steroids. Because of preexisting high myopia, the patient continued to experience aphakia and near emmetropia after the eventual IOL removal. No recurrent hemorrhage or intraocular pressure elevation was observed after IOL removal.

Intraocular lens tilt

IOL tilt was determined with slit-lamp examination and was noted in one patient immediately after implantation. The patient was placed under close observation without surgical intervention because he had limited visual potential related to his retinal condition.

Discussion

The complication rate was 33% in the current study, higher than that compared with previous studies,[6-10] possibly a result of only including patients who underwent the surgery during the surgeons' learning curve. Most complications, including haptic breakage or slippage, were haptic related. For the two patients who experienced haptic slippage-related IOL subluxation, we applied our modified cow-hitch technique for IOL recentration and restabilization.

The favorable IOL centration and lack of suture-related complications associated with SIS IOL fixation have made it an emerging first-line treatment option for patients with aphakia and inadequate capsular support.[2,9,13] It has become increasingly popular since 2007. Nevertheless,

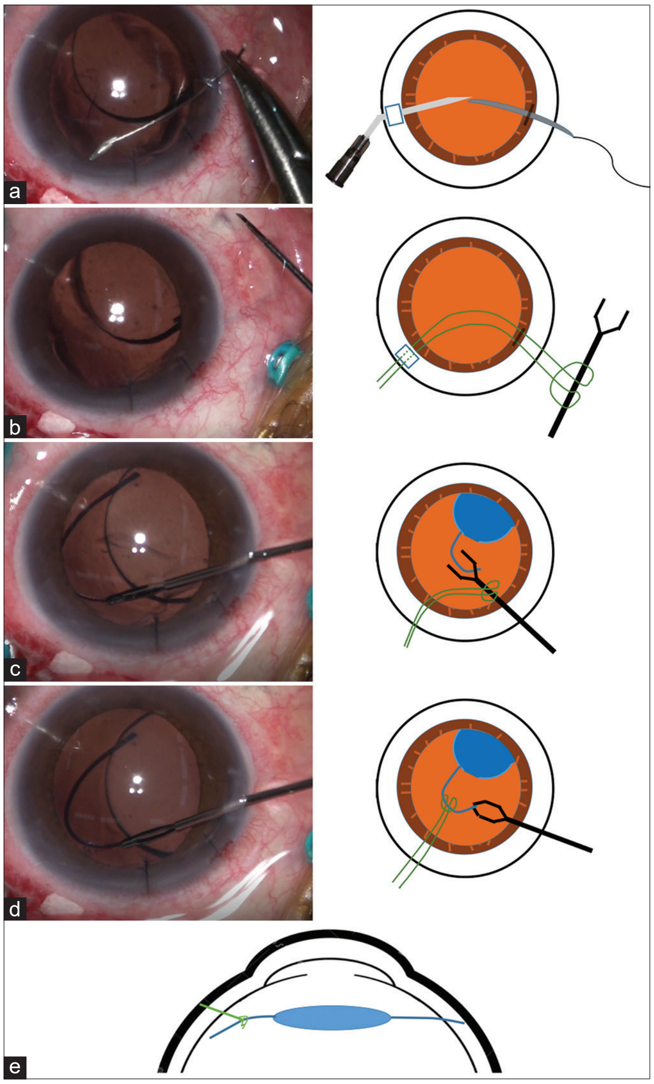

Figure 2: Modified sliding cow-hitch technique for repositioning a subluxated intraocular lens. (a) Two needles threaded with 10-0 polypropylene sutures were introduced through a corneal incision and the partial-thickness scleral flap through docking into a 27G needle. (b) A partial-thickness corneoscleral pocket was created 180° from the remaining fixated haptic. A cow-hitch tie was formed and loosely looped over the shaft of intraocular forceps. (c) The forceps were introduced through the corneal incision to grasp the subluxated haptic under a wide-angle viewing system. (d) After the forceps secured the subluxated haptic, the cow-hitch tie was slid onto the haptic from the forceps shaft. After tightening the thread, the cow-hitch suture was secured to the haptic. (e) The subluxated haptic was pulled toward the desired position using the cow-hitch suture and fixated through the partial-thickness scleral flap, with the suture knot buried into the partial-thickness scleral flap

multiple modifications to this technique have been recently developed, indicating its technical difficulty and that the optimal method by which to perform SIS IOL fixation remains to be found. In addition, as Turnbull and Lash[14] mentioned, SIS fixation involves an "ultrathin line between success and failure;" any modification in the surgical technique or instruments used could lead to complications. Thus, before adopting this technique, its related complications, along with their prevention and management, must be carefully considered, particularly in the case of surgeons unfamiliar with the technique.

Different scleral fixation techniques present varying risks of complications. The Scharioth technique[4] involves more forceps-haptic manipulation and greater straightening of the haptic during haptic externalization, thus theoretically has a higher risk of haptic-related complications. In contrast, the Yamane *et al.*'s techniques[7] minimize the risk of such complications by simultaneously externalizing haptics with 27G needles, reducing the need for extensive forceps manipulation. Furthermore, the Modified Yamane *et al.*'s technique,[8] which includes a flange in addition to a scleral tunnel, offers improved haptic stability and significantly lowers the chance of haptic slippage into the eye. These distinctions underscore the importance of selecting the most appropriate technique based on patient factors and surgeon proficiency to optimize outcomes while minimizing complications.

As mentioned, most complications in our case series were haptic related, including haptic breakage, slippage, and haptic disinsertion. Such complications have been frequently reported previously.[5,6,9,10,14-16] Other than the surgeon's technique, the design and material of the IOL may contribute critically to these complications.[10,17] Polyvinylidene fluoride (PVDF) haptics have superior shape recovery ability compared with PP or poly (methyl methacrylate) (PMMA) haptics.[18] McKee *et al*. suggested using IOLs with PVDF haptics rather than PMMA or PP haptics to prevent haptic kinking or breakage during manipulation.[10] In the original reports from Yamane *et al.*,[7] four different three-piece IOLs were used, including X-70 (Santen, Osaka, Japan), Tecnis ZA9003 (Abbott Medical Optics, Santa Ana, CA), PN6A (Kowa, Tokyo, Japan), and MA60MA (Alcon, Fort Worth, TX), of which the former three IOLs used PVDF haptics. The PMMA haptics of the MA60AC (similar to MA60MA except for slight differences in haptic angulation and the available IOL powers) used in our series are considered more fragile than PVDF haptics, which may have contributed to the high haptic-related complication incidence in our series. However, three-piece IOLs using PVDF haptics are not available in Taiwan. The modified J-loop design of the MA60AC could also result in a higher haptic-related complication rate compared with that of other three-piece IOLs with modified C-haptics such as the CT LUCIA 602 (Carl Zeiss Meditec, Jena, Germany) and the AR40e (Abbott Medical Optics, Santa Ana, CA, USA). C-loop haptics, which is less curved, undergo less deformation during sclerotomy externalization or docking into 27G needles, reducing the chance of breakage. As Todorich *et al*.[19] demonstrated, the lesser degree of haptic deformation or stretching also causes less strain on the optic–haptic junction, thereby reducing the risk of dislocation.

The use of properly designed intraocular forceps may also reduce the risk of haptic breakage during manipulation. Beiko and Steinert suggested that the use of forceps with ridged tips can result in crinkling or breakage of the haptics.[17] In two of the patients who experienced haptic breakage, we used end-grasping forceps (Alcon, Fort Worth, TX, USA), which applied a concentrated grasping force on the haptic, resulting in haptic damage at the grasping point. In one of the hospitals in our study, the forceps were replaced with Tan forceps (ASICO, Westmont, IL, USA), which provide a smooth platform and a larger contact area with the haptic during manipulation. No haptic breaks occurred after the switch to Tan forceps. Forceps without ridged tips that apply a "platform-grasping" force are preferable for haptic manipulation; however, additional studies are warranted to determine the most suitable type of forceps for haptic manipulation during SIS IOL fixation.

In the cases of the two patients with haptic slippage-related IOL subluxation, both haptics had been inserted into the scleral tunnels without the creation of a haptic flange or the use of tissue glue. Stem *et al*. demonstrated that the stability of flanged haptics was superior to that of unflanged haptics, with considerably greater disinsertion force required for IOLs with flanged haptics.[15] In addition, one patient underwent vitrectomy and encircling scleral buckle with gas tamponade after the initial implantation. We suspect that surgical manipulations and intraocular gas are risk factors for IOL subluxation after SIS fixation. In the other case, the IOL subluxation may have been due to the patient's long axial length (29.23 mm) and large white-to-white distance (12.32 mm). Both axial length and white-to-white measurement are used to estimate the sulcus-to-sulcus distance.[10,20] However, no direct preoperative measurement method of sulcus diameter has been found. Large sulcus diameter can lead to insufficient tucking power on the junction between the haptic end and the scleral fixation site and eventually lead to IOL subluxation.[10] A larger sulcus-to-sulcus distance may also result in a greater optic–haptic angle, thereby increasing the risk of haptic disinsertion.[19] Although the criteria regarding axial length or white-to-white measurement for patient selection for SIS IOL fixation have yet to be determined, alternative IOL fixation methods should be considered in patients with larger eyeballs.

We effectively repositioned the two subluxated IOLs using the modified sliding cow-hitch technique, without causing further postoperative complications in either patient. This technique has the advantage of minimizing manipulation of remaining secured haptics. Pugazhendhi *et al*. reported a case of pigment dispersion syndrome and IOL subluxation after SIS IOL fixation. The subluxated IOL was later repositioned using the double-needle Yamane technique.[21] The IOL haptic was composed of PVDF and was shortened for repositioning. Due to the relative fragility of the subluxated PMMA haptics in our case series, the Yamane technique may not be the preferable technique to reposition the haptic to prevent haptic damage during manipulation. Under the modified sliding cow-hitch technique, by holding the subluxated haptic, the intraocular forceps maintained the IOL position, which in turn served as a counterforce to suture tightening. The IOL position maintained stable until the subluxated haptic was secured with sutures. Thus, damage to the haptics was minimized.

Our study's limitations included the small case number and retrospective nature. In addition, because the surgical procedures were performed by different surgeons using different techniques rather than one standard procedure, concluding the best procedure for SIS fixation is challenging. By contrast, this variety of procedures also increased the external validity of our study. In addition, the wide range of complications observed in the patients should serve as a reminder to all surgeons, regardless of their experience with SIS IOL fixation, to be aware of the details of the surgical procedure and to optimize the instruments for this technique.

Conclusion

In this case series, SIS IOL fixation resulted in various complications, mostly haptic related, during the learning curve for surgeons unfamiliar with this technique. We described a modified sliding cow-hitch technique used to reposition subluxated IOLs. Furthermore, we provided comprehensive information regarding the IOL, instrument, and patient selections for SIS IOL fixation to prevent complications. Through our findings, we hope to minimize the chance of patient complications encountered by surgeons new to SIS IOL fixation.

Data availability statement

The datasets generated during and/or analyzed during the current study are not publicly available, but are available from the corresponding author on reasonable request.

Financial support and sponsorship

Nil.

Conflicts of interest

Dr. Yu-Bai Chou and Dr. Tso-Ting Lai, the editorial board members at *Taiwan Journal of Ophthalmology*, had no roles in the peer review process of or decision to publish this article. The other authors declared no conflicts of interest in writing this paper.

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