NATIONAL INSTITUTE FOR HEALTH AND CARE EXCELLENCE

INTERVENTIONAL PROCEDURES PROGRAMME

Interventional procedure overview of artificial iris implant insertion for aniridia

Aniridia is when the iris (the coloured part of the eye) is incomplete or missing. This causes sensitivity to light and sight problems. In this procedure, an artificial iris implant is inserted through a cut in the eye. The aim is to decrease sensitivity to light, improve sight, and improve the appearance of the eye.

Contents

Introduction

The National Institute for Health and Care Excellence (NICE) prepared this interventional procedure overview to help members of the interventional procedures advisory committee (IPAC) make recommendations about the safety and efficacy of an interventional procedure. It is based on a rapid review of the medical literature and specialist opinion. It should not be regarded as a definitive assessment of the procedure.

Date prepared

This overview was prepared in August 2019 and updated in January 2020.

Procedure name

Artificial iris implant insertion for aniridia

Professional societies

The Royal College of Ophthalmologists

Description of the procedure

Indications and current treatment

Aniridia is when the iris is missing or underdeveloped. The amount of iris tissue missing varies from person to person. Aniridia can be congenital or acquired.

Congenital aniridia is a rare condition that affects both eyes. Many people with congenital aniridia also have a part of their retina that is not fully developed. Many also have nystagmus, which is a constant and involuntary movement of the eyes.

Acquired aniridia may be a result of trauma or damage during surgery or laser treatment.

People with aniridia may be very light sensitive (photophobic) and report symptoms of glare. They may develop other eye problems such as glaucoma, cataract and corneal opacification. The degree of vision loss varies.

Treatment includes contact lenses with iris prints and tinted spectacle lenses.

Surgical implantation of an artificial iris device may be an option for some people with complete or partial aniridia. There are different devices available, including a customised, flexible implant that has recently been developed.

What the procedure involves

Artificial iris implants can be solid acrylic rings or segments, or flexible silicone discs. The silicone discs are available in standard colours or custom-made for each patient.

The implant has a defined pupil size, which offers a compromise between day and night vision.

The artificial iris implant is inserted under local or general anaesthesia. The exact details of the procedure vary according to the type of implant being used.

Flexible implants are rolled up and inserted through a cut about 3 mm long at the edge of the cornea, into the posterior chamber of the eye. They are then unfolded and fixed in the eye. If sutures are needed to hold the implant in place, a larger cut may be necessary. The implant insertion can be done on its own or at the time of cataract or lens fixation surgery.

Solid ring implants are typically inserted during cataract surgery along with an intraocular lens. In some patients, an iris reconstruction lens containing both an artificial iris and a lens is implanted. Depending on the condition of the eye, the lens and iris device may need to be sutured to the sclera.

The aim of artificial iris implant insertion is to improve visual acuity, reduce photophobia and glare, and improve the eye's appearance.

Efficacy summary

Acquired aniridia

Visual acuity

In a case series of 34 patients with congenital, traumatic or iatrogenic aniridia who had a flexible silicone artificial iris implanted, 47% (16/34) of patients gained 2 or more lines at final follow up (mean 50 months). Visual acuity was stable in 44% (15/34) of patients and 9% (3/34) of patients lost 2 or more lines.[1]

In a second case series of 34 patients with traumatic aniridia who had a flexible silicone artificial iris implanted, 41% (14/34) of patients had an improvement of 0.2 logMAR or greater at 12-month follow up; 32% (11/34) of patients had a

change of less than 0.2 logMAR and 27% (9/34) had a deterioration of 0.2 or more logMAR.[2]

In a case series of 51 patients with acquired iris defects who had a flexible silicone artificial iris implanted, 42% (19/45) of patients gained 2 or more lines of best-corrected visual acuity using a Snellen projection chart. In 29% (13/51) of patients the best-corrected visual acuity remained unchanged and in 29% (13/51) there was a statistically significant decrease from 0.48±0.39 logMAR before surgery to 0.93±0.41 logMAR after surgery ($p<0.001$).[4]

In a case series of 35 patients with congenital (n=10; 15 eyes) or traumatic (n=25; 25 eyes) aniridia who had a black diaphragm intraocular lens implanted, there was an overall mean improvement in best-corrected visual acuity of 0.56 logMAR units (using the best recorded visual acuity during follow up, mean 3.4 years). In the subanalysis according to indication, patients with traumatic aniridia had an improvement from 1.34±0.22 logMAR before surgery to 0.54±0.16 logMAR after surgery ($p<0.001$).[5]

In a case series of 31 patients with acquired iris defects who had a black diaphragm intraocular lens implanted the corrected distance visual acuity improved for 81% (25/31) of patients. The median corrected distance visual acuity improved from 20/125 before surgery to $20/30^{-1}$ at 1-year follow up ($p=0.001$). The median corrected distance visual acuity, measured with glare, improved from 20/400 before surgery to $20/50^{+1}$ at 1-year follow up ($p<0.0001$).[7]

In a non-randomised comparative study of 170 patients with traumatic aniridia, 82% (78/95) of eyes that had a black diaphragm intraocular lens implanted and 100% (75/75) of eyes that had a rigid gas permeable contact lens fitted had a best-corrected visual acuity of 20/200 or better.[6]

Photosensitivity

In the second case series of 34 patients, 75% (15/20) of patients reported reduced glare-related discomfort (4 patients did not have glare before or after the procedure).[2]

In a case series of 32 patients with congenital or acquired iris defects who had a flexible silicone artificial iris implanted, subjective impairment from glare (measured on a scale from 0 to 10) improved from 9.12 before surgery to 3.07 at the 3-month follow up ($p<0.001$).[3]

In the case series of 31 patients, the mean subjective daytime glare symptom score improved from 8.65 before surgery to 3.71 at 1-year follow up ($p<0.0001$). The mean subjective night-time glare symptom score improved from 7.00 before surgery to 3.37 at 1-year follow up ($p<0.0001$).[7]

In the non-randomised comparative study of 170 patients, the photophobia score improved from 4.27 before surgery to 0.97 after surgery for eyes that had a black diaphragm intraocular lens implanted ($p<0.0001$). There was no statistically significant difference for eyes that had a rigid gas permeable contact lens fitted (from 4.16 before to 3.96 after, $p=0.207$). The score for glare also statistically significantly improved for eyes that had a black diaphragm intraocular lens implanted (from 3.53 before surgery to 0.70 after, $p<0.0001$). There was no statistically significant difference for eyes that had a rigid gas permeable contact lens fitted (from 3.81 before to 3.59 after, $p=0.168$).[6]

Patient satisfaction

In the second case series of 34 patients, 80% (16/20) of patients reported satisfaction with the functional and cosmetic results.[2]

In the case series of 32 patients, subjective cosmetic dissatisfaction (measured on a scale from 0 to 10) reduced from 6.33 before surgery to 1.58 at 3-month follow up ($p<0.001$). Patient satisfaction with overall results (measured on a scale from 0 to 10) was 8.97 at 3-month follow up.[3]

In the case series of 31 patients, the mean cosmetic score improved from 3.61 before surgery to 5.84 at 1-year follow up ($p<0.0001$).[7]

In the non-randomised comparative study of 170 patients, the patient satisfaction score for cosmetic results was 4.38 for eyes that had a black diaphragm intraocular lens implanted and 2.93 for eyes that had a rigid gas permeable contact lens fitted ($p=0.007$).[6]

Congenital aniridia

Visual acuity

In the case series of 34 patients, including 7 patients with congenital aniridia or coloboma who had a flexible silicone artificial iris implanted, 47% (16/34) of patients gained 2 or more lines at final follow up (mean 50 months). Visual acuity was stable in 44% (15/34) of patients and 9% (3/34) of patients lost 2 or more lines.[1]

In the case series of 35 patients who had a black diaphragm intraocular lens implanted, the 10 patients (15 eyes) with congenital aniridia had a non-statistically significant improvement in mean best-corrected logMAR visual acuity from 1.17 before surgery to 1.01 after lens implantation ($p=0.20$).[5]

In a case series of 14 patients (19 eyes) with congenital aniridia who had a black diaphragm intraocular lens implanted, visual acuity improved in 74% (14/19) of eyes, it remained unchanged in 1 eye, and deteriorated slightly in 4 eyes.[10]

Photosensitivity

In the case series of 32 patients with congenital (n=3) or acquired iris defects who had a flexible silicone artificial iris implanted, subjective impairment from glare (measured on a scale from 0 to 10) improved from 9.12 before surgery to 3.07 at 3-month follow up ($p<0.001$).[3]

In the case series of 14 patients, reduced glare after the procedure was reported by 79% (11/14) of patients.[10]

Patient satisfaction

In the case series of 32 patients, subjective cosmetic dissatisfaction (measured on a scale from 0 to 10) reduced from 6.33 before surgery to 1.58 at 3-month follow up ($p<0.001$). Patient satisfaction with overall results (measured on a scale from 0 to 10) was 8.97 at 3-month follow up.[3]

Safety summary

Acquired aniridia

Glaucoma and ocular hypertension

Glaucoma was reported in 9% (3/34) of patients with congenital, traumatic or iatrogenic aniridia who had a flexible silicone artificial iris implanted in the case series of 34 patients; 1 patient needed surgery for progressive glaucoma.[1]

New onset of glaucoma that could be controlled by medication was reported in 6% (3/51) of patients in a case series of 51 patients with congenital or acquired iris defects who had a flexible silicone artificial iris implanted. Severe ocular hypertension that needed surgery was reported in 4% (2/51) of patients in the same study.[4]

Glaucoma that could be controlled by medication was reported in 32% (8/25) of eyes with traumatic aniridia after the procedure compared with 8% (2/25) of eyes before the procedure in the case series of 35 patients (40 eyes); in addition, 20% (5/25) of patients needed glaucoma surgery.[5]

Ocular hypertension was reported in 19% (6/31) of patients with acquired iris defects who had a black diaphragm intraocular lens implanted in a case series of 31 patients. In the same study, glaucoma was reported in 1 patient.[7]

Glaucoma therapy was needed by 38% (36/95) of patients who had a black diaphragm intraocular lens implanted in a non-randomised comparative study of 170 patients; 13% (12/95) of patients needed glaucoma surgery. Two patients ultimately lost their vision from glaucoma.[6]

Elevated intraocular pressure followed by complete apposition of the artificial iris and cornea was described in a case report. The artificial iris was immediately removed and a trabeculectomy was done 2 months later. Progressive endothelial dysfunction and therapy-resistant stromal and epithelial corneal oedema and opacity made a perforating corneal transplantation necessary 12 months after the artificial iris implantation.[9]

Retinal detachment

Retinal detachment was reported in 6% (2/34) of patients with congenital, traumatic or iatrogenic aniridia who had a flexible silicone artificial iris implanted in the case series of 34 patients; both patients had vitrectomies.[1]

Retinal detachment was reported in 1 patient in the case series of 51 patients; this was treated by vitrectomy with silicone oil tamponade.[4]

Retinal detachment was reported by 4% (4/95) of patients who had a black diaphragm intraocular lens implanted in the non-randomised comparative study of 170 patients.[6]

Intraocular inflammation

Postoperative intraocular inflammation was reported in 9% (3/34) of patients with traumatic aniridia who had a flexible silicone artificial iris implanted in a second case series of 34 patients.[2]

Inflammatory deposits on the intraocular lens were reported in 10% (3/31) of patients in the case series of 31 patients.[7]

Postoperative inflammatory reaction was reported in 24% (23/95) of eyes that had a black diaphragm intraocular lens inserted in the non-randomised comparative study of 170 patients; this resolved within 2 weeks after medical treatment.[6]

Macular oedema

Macular oedema was reported in 12% (4/34) of patients with traumatic aniridia who had a flexible silicone artificial iris implanted in the second case series of 34 patients; this resolved with local non-steroidal therapy or peribulbar injection of betamethasone in 3 of the 4 patients.[2]

Cystoid macular oedema was reported in 6% (3/51) of patients in the case series of 51 patients; this was treated with intravitreal steroids.[4]

Persistent cystoid macular oedema was reported in 5% (2/40) of eyes (both with traumatic aniridia) in the case series of 35 patients.[5]

Cystoid macular oedema was reported in 6% (2/31) of patients in the case series of 31 patients.[7]

Persistent cystoid macular oedema was reported in 3% (3/95) of patients who had a black diaphragm intraocular lens inserted in the non-randomised comparative study of 170 patients.[6]

Endophthalmitis

Suspected endophthalmitis (without microbiological proof) was reported in 6% (2/34) of patients with traumatic aniridia who had a flexible silicone artificial iris implanted in the second case series of 34 patients. Diagnostic vitrectomy yielded no micro-organisms and symptoms resolved after topical, intravitreal and systemic therapy with antibiotics and steroids.[2]

Endophthalmitis (not further defined) was reported in 2% (2/95) of patients who had a black diaphragm intraocular lens inserted in the non-randomised comparative study of 170 patients.[6]

Iritis

Iritis was reported in 6% (2/31) of patients in the case series of 31 patients.[7]

Corneal complications

Keratopathy was reported in 6% (2/34) of patients with congenital, traumatic or iatrogenic aniridia who had a flexible silicone artificial iris implanted in the first case series of 34 patients; 1 patient needed surgery for progressive keratopathy.[1]

Corneal transplantation was reported in 35% (12/34) of patients in the second case series of 34 patients; 6 were for corneal scarring after trauma and 6 were for corneal decompensation.[2]

Corneal decompensation was reported in 6% (3/51) of patients in the case series of 51 patients. Severe corneal complications were reported in 10% (5/51) of patients in the same study; 1 artificial iris had to be explanted after 1 year.[4]

Corneal decompensation necessitating a corneal graft was reported in 16% (4/25) of eyes with traumatic aniridia in the case series of 35 patients.[5]

Post-traumatic corneal graft dehiscence was reported in 6% (2/31) of patients in the case series of 31 patients. In the same study corneal oedema and ‘failed cornea’ were each reported in 1 patient.[7]

Corneal decompensation needing a graft was reported in 10% (9/95) of patients who had a black diaphragm intraocular lens inserted in the non-randomised comparative study of 170 patients.[6]

Endothelial cell loss

Mean endothelial cell density reduced from 2,306 cells/mm^2 before surgery to 1,920 cells/mm^2 after surgery (p=0.000) in patients who had a black diaphragm intraocular lens inserted in the non-randomised comparative study of 170 patients.[6]

Posterior capsule opacification

Posterior capsule opacification was reported in 4% (1/25) of eyes with traumatic aniridia in the case series of 35 patients.[5]

Posterior capsule opacification was reported in 13% (4/31) of patients in the case series of 31 patients.[7]

Visual axis opacity, including 1 case of posterior capsule opacification was reported in 6% (6/95) of patients who had a black diaphragm intraocular lens inserted in the non-randomised comparative study of 170 patients.[6]

Dislocation of artificial iris

Artificial iris suture loosening and dislocation was reported in 6% (3/51) of patients in the case series of 51 patients; this was treated by surgical revision.[4]

Dislocation of the lens was reported in 3% (3/95) of patients who had a black diaphragm intraocular lens inserted in the non-randomised comparative study of 170 patients. An eccentric lens was reported in 17% (16/95) of patients in the same study.[6]

Synechiae

Posterior synechiae needing synechiolysis was reported in 4% (2/51) of patients in the case series of 51 patients.[4]

Anterior synechiae was reported in 1 patient in the case series of 31 patients.[7]

Haemorrhage

Haemorrhage of the remnant iris was reported in 1 patient in the case series of 34 patients; this was treated by an anterior chamber lavage.[1]

Intraoperative retrobulbar haemorrhage caused by orbital injection of the anaesthetic agent was reported in 1 patient in the case series of 31 patients; this did not complicate the procedure.[7]

Silicone oil in the anterior chamber

Silicone oil in the anterior chamber was reported in 9% (3/34) of patients in the case series of 34 patients.[1]

Retraction syndrome of the residual iris

A retraction syndrome of the residual iris was reported in 17% (7/41) of eyes in a case series of 42 patients with iris defects who had a flexible silicone artificial iris implanted.[8]

Limbal stem cell failure

Limbal stem cell failure was reported in 13% (12/95) of eyes (all with traumatic aniridia) that had a black diaphragm intraocular lens implanted in the non-randomised comparative study of 170 patients.[6]

Other

Sutures cutting through the residual iris tissue was reported in 1 patient in the case series of 51 patients; no intervention was needed.[4]

Haptic breakage during surgery and intraocular lens optical part detachment were each reported in 1 patient who had a black diaphragm intraocular lens implanted in the non-randomised comparative study of 170 patients. Severe membrane proliferation in the anterior chamber was reported in 1 patient in the same study.[6]

Blepharoptosis and epiretinal membrane were each reported in 6% (2/31) of patients in the case series of 31 patients. In the same study, hyphema, convergence insufficiency, graft-host interface leak, transient hypotony and dry eye were each reported in 1 patient.[7]

Congenital aniridia

Glaucoma and ocular hypertension

Glaucoma that could be controlled by medication was reported in 53% (8/15) of eyes with congenital aniridia both before and after the procedure in the case series of 35 patients (40 eyes) with congenital or traumatic aniridia who had a black diaphragm intraocular lens implanted; in addition, 1 patient needed glaucoma surgery.[5]

Deterioration in glaucoma during follow up was reported in 4 of the 5 eyes with glaucoma before the procedure in a case series of 14 patients with congenital aniridia who had a black diaphragm intraocular lens implanted; it was controlled medically in 2 eyes and surgically in the other 2 eyes. In the same study, postoperative chronic glaucoma was reported in 29% (4/14) of eyes without a preoperative glaucoma history; this was controlled medically in 2 eyes and surgically in 2 eyes.[10]

Intraocular inflammation

Slight aqueous flare with a few cells in the anterior chamber was observed in all 19 eyes over the long term in the case series of 14 patients. It was recommended that 1 daily drop of prednisolone acetate should be continued long term.[10]

Macular oedema

Cystoid macular oedema was reported in 18% (2/11) of eyes examined using fluorescein angiography in the case series of 14 patients.[10]

Endophthalmitis

Endophthalmitis (not further defined) was reported in 1 patient with congenital aniridia who had a black diaphragm intraocular lens implanted in the case series of 35 patients.[5]

Corneal complications

Corneal decompensation necessitating a corneal graft was reported in 20% (3/15) of eyes with congenital aniridia in the case series of 35 patients.[5]

A postoperative deterioration in surface disorders was reported in 21% (4/19) of eyes in the case series of 14 patients; 2 with and 2 without pannus progression.[10]

Endothelial cell loss

Chronic endothelial cell loss was reported in 16% (3/19) of eyes in the case series of 14 patients.[10]

Posterior capsule opacification

Posterior capsule opacification was reported in 73% (11/15) of eyes with congenital aniridia in the case series of 35 patients.[5]

Posterior capsule opacification was reported in 84% (16/19) of eyes in the case series of 14 patients; 4 eyes were treated by surgical posterior capsulotomy with anterior vitrectomy and cataract surgery and 11 eyes were treated with a laser.[10]

Limbal stem cell failure

Limbal stem cell failure was reported in 27% (4/15) of eyes with congenital aniridia in the case series of 35 patients.[5]

Other

Posterior lens capsule rupture was reported in 1 patient in the case series of 14 patients.[10]

Anecdotal and theoretical adverse events

In addition to safety outcomes reported in the literature, professional experts are asked about anecdotal adverse events (events which they have heard about) and about theoretical adverse events (events which they think might possibly occur, even if they have never happened). For this procedure, professional experts described one anecdotal adverse event of dislocation of implant with capsular bag. They considered that the following were theoretical adverse events: patient not liking the colour and wanting the implant taken out, and tilted implant.

The evidence assessed

Rapid review of literature

The medical literature was searched to identify studies and reviews relevant to artificial iris implant insertion for aniridia. The following databases were searched, covering the period from their start to 18 November 2019: MEDLINE, PREMEDLINE, EMBASE, Cochrane Library and other databases. Trial registries and the Internet were also searched. No language restriction was applied to the searches (see the literature search strategy). Relevant published studies identified during consultation or resolution that are published after this date may also be considered for inclusion.

The following selection criteria (table 1) were applied to the abstracts identified by the literature search. Where selection criteria could not be determined from the abstracts the full paper was retrieved.

Table 1 Inclusion criteria for identification of relevant studies

Characteristic	Criteria
Publication type	Clinical studies were included. Emphasis was placed on identifying good quality studies. Abstracts were excluded where no clinical outcomes were reported, or where the paper was a review, editorial, or a laboratory or animal study. Conference abstracts were also excluded because of the difficulty of appraising study methodology, unless they reported specific adverse events that were not available in the published literature.
Patient	People with aniridia.
Intervention/test	Artificial iris implant insertion.
Outcome	Articles were retrieved if the abstract contained information relevant to the safety and/or efficacy.
Language	Non-English-language articles were excluded unless they were thought to add substantively to the English-language evidence base.

List of studies included in the IP overview

This IP overview is based on about 400 patients with acquired aniridia and 37 with congenital aniridia or coloboma (from 8 case series, 1 non-randomised comparative study and 1 case report).[1–10] Four studies included congenital or acquired aniridia,[1,3–5] 5 studies included acquired aniridia only[2,6,7–9] and 1 study included congenital aniridia only.[10]

Other studies that were considered to be relevant to the procedure but were not included in the main extraction table (table 2a and 2b) are listed in the appendix.

Table 2a Summary of key efficacy and safety findings on artificial iris implant insertion for acquired aniridia

Study 1 Rickmann A (2016)

Details

Study type	**Case series**
Country	Germany
Recruitment period	2004 to 2013
Study population and number	**n=34 patients (34 eyes); 7 patients had congenital aniridia or coloboma** Patients with congenital, traumatic or iatrogenic aniridia
Age and sex	Mean 49 years (range 28 to 85); 65% (22/34) male
Patient selection criteria	Consecutive patients who had an artificial iris with or without integrated fibre mesh. Only those eyes with a minimum follow up of 2 years were included. Indications were congenital, traumatic or iatrogenic aniridia (for example, after complicated phacoemulsification).
Technique	Device: flexible and foldable artificial iris (HumanOptics and Koch), custom-made to match the colour of the patient's natural iris. A full artificial iris prosthesis without mesh was used in 82% (28/34) of eyes and a partial prosthesis with mesh was used in the other 6 eyes. The mean size of the artificial iris was 11.2 mm (range 10 to 12). The mean size of the incision was 3.9 mm (range 3.5 to 6.5). The final transscleral fixation of the implant was done using a Z-suture technique in 26 eyes and with a scleral flap in 8 eyes. Some aphakic eyes needed permanent or long-standing silicone oil tamponade to maintain retina reattachment or to prevent phthisis. Vitrectomy was done in 8 eyes, cerclage in 1 eye and corneal graft in 4 eyes.
Follow-up	**Mean 50 months**
Conflict of interest/source of funding	None

Analysis

Follow-up issues: No losses to follow up were described.

Study design issues: Retrospective case series. All procedures were done by the same surgeon. The aim of the study was to evaluate the long term clinical outcome and complication spectrum after artificial iris implantation and the role of the implant embedded fibre mesh with regard to specific complications.

Study population issues: Reasons for artificial iris implant were congenital aniridia in 6 eyes (18%), congenital coloboma in 1 eye (3%), traumatic iris defect in 23 eyes (68%) and iatrogenic iris defect in 4 eyes (12%). Before the procedure, 14 eyes were pseudophakic (41%), 15 were aphakic (44%) and 5 were phakic (15%). The mean number of previous ocular interventions was 2 (range 0 to 6). At baseline, 5 eyes were hypotonic (15%), 10 eyes had glaucoma (29%), 6 eyes had pre-existing keratopathy (18%) and 4 eyes had silicone oil in the anterior chamber (12%). The iris defect was complete aniridia in 17 eyes (50%), partial aniridia in 8 eyes (24%), a circular remnant iris in 6 eyes (18%), a coloboma in 1 eye (3%), and a half-moon shaped defect in 2 eyes (6%). Mean visual acuity at baseline was 1.0 logMAR.

There is likely to be some patient overlap with Spitzer et al., 2016.

Key efficacy and safety findings

Efficacy	Safety
Number of patients analysed: **34** None of the implants needed to be repositioned. **Visual acuity at final follow-up** • Gain of 2 or more lines=47.1% (16/34) • Stable=44.1% (15/34) • Loss of 2 or more lines=8.8% (3/34) In the 6 eyes with pre-existing keratopathy, visual acuity increased from a mean baseline of 1.6 logMAR (±0.7) to a mean of 1.2 logMAR (±0.7), p=0.4. Of the 6 eyes, 2 gained 2 or more lines and 4 remained stable. In 7 patients with silicone oil tamponade, visual acuity was stable in 6 eyes and 1 eye lost 2 lines. **Mean intraocular pressure, mmHg** • Before procedure=14.6 (±5.6) • At final follow up=14.7 (±16.7), p=0.06 There was no statistically significant difference between the subgroups traumatic, congenital, and iatrogenic iris defects, neither at baseline, nor at the final follow-up (p=0.07). Hypotony was present in 5 eyes at baseline. In all 5 eyes, hypotony persisted at the final follow-up (3.2±2.2 mmHg). 30.4% (7/23) of eyes with traumatic aniridia needed permanent silicone oil tamponade. All eyes were aphakic at baseline. All eyes had a full prosthesis without mesh. Four of the 7 eyes had silicone oil in the anterior chamber before the procedure. In 3 eyes (all hypotonic), silicone oil returned into the anterior chamber after a mean 2.5 years.	There were no suture failures during follow up. **Complications** • Glaucoma=8.8% (3/34) • Keratopathy=5.9% (2/34) • Silicone oil in the anterior chamber=8.8% (3/34) • Haemorrhage of the remnant iris=2.9% (1/34) • Retinal detachment=5.9% (2/34) 5 eyes, all with traumatic aniridia, needed further surgery: 1 penetrating keratoplasty for progressive keratopathy, 1 Ahmed valve implant for progressive glaucoma, 2 vitrectomies for retinal detachment with proliferative vitreoretinopathy, and 1 anterior chamber lavage for recurrent haemorrhage of the remnant iris. Darkening of remaining iris tissue in eyes with traumatic aniridia=47.1% (8/17) (5 out of 6 eyes with an implant with mesh and 3 out of 28 eyes without mesh).

Study 2 Spitzer M (2016)

Details

Study type	**Case series**
Country	Germany
Recruitment period	2006 to 2014
Study population and number	**n=34 patients (34 eyes)** Patients with post-traumatic iris loss
Age and sex	Not reported
Patient selection criteria	Consecutive patients who had a customised silicone iris prosthesis after severe globe injury with total or subtotal iris loss.
Technique	Device: Artificial*Iris* (Humanoptics/Dr Schmidt, Germany) The implant was sutured into the sulcus using a Z-suture technique. In 13 patients, iris prosthesis insertion was combined with intraocular lens implantation. The lens was either attached to the artificial iris (n=7), fixated to the sclera (n=3), implanted into the sulcus (n=2) or into the capsular bag (n=1). In 5 patients, the procedure was combined with penetrating keratoplasty because of corneal scarring after trauma. Vitrectomy was done in 18 patients before the artificial iris insertion and a peripheral iridectomy was done in all eyes that had a complete artificial iris implanted to prevent pressure dysregulation.
Follow-up	**Median 24 months (interquartile range 12 to 49)**
Conflict of interest/source of funding	None

Analysis

Follow-up issues: Some results are presented for all patients at 12 month follow-up. Only 59% (20/34) of patients could be contacted for a follow up interview about subjective outcomes such as glare and cosmesis (the paper does not report when this was done).

Study design issues: Retrospective case series. The aim of the study was to analyse the functional and cosmetic outcomes and complications after the procedure.

Study population issues: The median period between trauma and artificial iris implantation was 15.5 months (range 9.8 to 45.5). A complete artificial iris was used in 91% (31/34) of patients and a partial artificial iris was used for the other 3 patients. At baseline, 6% (2/34) of patients had open-angle glaucoma, 9% (3/34) had secondary glaucoma after trauma and 24% (8/34) had hypotony (0 to 6 mmHg). The median visual acuity at baseline was 1.1 logMAR (range 0.3 to 2.6).

There is likely to be some patient overlap with Rickmann A et al., 2016.

Key efficacy and safety findings

Efficacy	Safety
Number of patients analysed: **34** **Visual acuity** Mean logMAR before procedure=1.1 (range 0.3 to 2.6) At 12-month follow up • Mean logMAR=1.4 (range 0.2 to 2.6) • Improvement of 0.2 or more logMAR=41.2% (14/34) • Change of less than 0.2 logMAR=32.4% (11/34) • Deterioration of 0.2 or more logMAR=26.5% (9/34) **Discomfort because of glare (n=20)** • Improvement=75% (15/20) • No change=5% (1/20) • No glare before or after procedure=20% (4/20) **Satisfaction with functional and cosmetic results=80% (16/20)** (3 patients were not satisfied because of persistent glaring or deteriorated vision and 1 patient complained that the colour of the iris was mismatched)	• Intraocular pressure changes ➢ Hypotony (0 to 9 mmHg)=29.4% (10/34) ▪ Pre-existing hypotony, n=7 ▪ New hypotony, n=3 ▪ Improvement of hypotony, n=1 ▪ Need for hyaluronic acid injection into anterior chamber, n=7 ▪ Enucleation done because of phthisis bulbi, n=2 ➢ Elevated intraocular pressure (>20 mmHg)=17.6% (6/34) ▪ Pre-existing glaucoma, n=3 ▪ New intraocular pressure elevation, n=3 ▪ Improvement of intraocular pressure elevation, n=2 ▪ Need for surgery, n=5 • Postoperative intraocular inflammation=8.8% (3/34) • Macular oedema=11.8% (4/34) ➢ Resolved with local non-steroidal therapy or peribulbar injection of betamethasone, n=3 ➢ Persisting, n=1 • Corneal transplantation=35.3% (12/34) ➢ For corneal scarring after trauma, n=6 ➢ For corneal decompensation, n=6 • Suspected endophthalmitis (without microbiological proof)=5.9% (2/34)

Study 3 Mayer C (2016)

Details

Study type	**Case series**
Country	Germany
Recruitment period	2011 to 2014
Study population and number	**n=32 patients (32 eyes); 3 patients had congenital coloboma** Patients with acquired or congenital iris defects
Age and sex	Mean 53 years; 69% (22/32) male
Patient selection criteria	Patients who had iris reconstruction for iris defects, with complete preoperative and postoperative examinations.
Technique	Device: Artificial*Iris* (HumanOptics, Germany) In all patients, the iris prosthesis was placed in the ciliary sulcus. Trephined concave iridectomies were done at the outer rim of the implant (each eye had 1 to 8 iridectomies, mean 2.78). The implant was rolled up and inserted through an incision (2.8 mm to 7.0 mm) by forceps or an injection system. The artificial iris was implanted directly into the ciliary sulcus without further suture fixation in 15 patients and 17 patients had a sclera-fixated artificial iris. In all phakic and aphakic eyes, an intraocular lens was implanted through the same tunnel before insertion of the iris prosthesis. Phakic patients had standard cataract surgery with intraocular lens implantation first, followed by artificial iris implantation in the ciliary sulcus in the same procedure. Aphakic patients had a secondary sclera-fixated or artificial iris-fixated intraocular lens.
Follow-up	**Mean 13.6 months (±10.9)**
Conflict of interest/source of funding	None

Analysis

Follow-up issues: An additional 5 patients were treated during the study period but were excluded because they did not attend follow up examinations at the clinic. Of these 5 patients, 3 were lost to follow-up and 2 were followed up in a clinic close to their home area.

Study design issues: Prospective, single centre case series. The aim of the study was to evaluate key structural and functional variables such as visual acuity, glare, contrast vision, pupil configuration, and aesthetic appearance.

Study population issues: Before the procedure, 13 patients were pseudophakic, 10 were phakic and 9 were aphakic. All patients had intense glare. The mean time between diagnosis and surgery was 12 years. The iris defect resulted from congenital coloboma in 3 patients (9%), from persistent mydriasis in 9 patients (28%) and from traumatic loss of iris tissue in 21 patients (66%).

There is likely to be some patient overlap with Mayer C et al., 2019 and Mayer C et al., 2018.

Key efficacy and safety findings

Efficacy

Number of patients analysed: **32**

Functional outcomes, mean ± standard deviation

Parameter	Before surgery	After surgery		p value
		1 month	3 months	
Best corrected visual acuity (logMAR)	0.77±0.62	0.68±0.64		0.792
Intraocular pressure (mmHg)	14.94±3.55	17.72±5.88		0.197
Pupillary aperture (mm^2)	42.1±20.1		8.7±0.3	<0.001
Contrast sensitivity (log; Pelli-Robson chart)	0.80±0.51		0.93±0.49	0.014
Endothelial cell density (cells/mm^2)*	1949±716		1841±689	0.003
Anterior chamber depth (mm)	4.03±1.06		4.29±0.70	0.186
Anterior chamber angle (degrees)	43.2±13.5		40.5±10.8	0.772
Subjective impairment through glare (1 to 10)	9.12±1.62		3.07±2.29	<0.001
Subjective cosmetic dissatisfaction (1 to 10)	6.33±3.21		1.58±0.86	<0.001
Patient satisfaction with overall results (1 to 10)	-		8.97±1.42	-

* only measured in 19 patients

Outcomes at 12 to 24 months after the procedure

- Best corrected visual acuity (logMAR)=0.51±0.58 (p=0.541)
- Mean intraocular pressure (mmHg)=14.84±4.42 (p=0.670)

Safety

Iris-related unexpected complications, n=4:

- 2 dislocation or subluxation of the implant disrupting the optical axis with a need for surgical correction
- 1 recurrent bleeding from ciliary body (resolved spontaneously)
- 1 artificial iris was explanted after corneal decompensation and chronic inflammation with macular oedema 1 year after the procedure.

1 patient had bulbar hypotony immediately after surgery that resolved within a few days.

7 patients had a temporary increase in intraocular pressure that was treated with topical and systemic antiglaucoma therapy; 4 of these 7 eyes had been diagnosed with glaucoma before surgery.

Study 4 Mayer C (2018)

Details

Study type	**Case series**
Country	Germany
Recruitment period	2011 to 2015
Study population and number	**n=51 patients (51 eyes); 3 patients had congenital coloboma** Patients with acquired or congenital iris defects
Age and sex	Mean 53 years; 67% (34/51) male
Patient selection criteria	Not reported
Technique	Device: Artificial*Iris* (HumanOptics, Germany) The type of implantation procedure depended on the pre-existing alterations in the affected eye. The custom-made implant was fixed in the ciliary sulcus without sutures in eyes with a pre-existing intracapsular intraocular lens, implanted in the capsular bag together with a new intraocular lens or sutured to the sclera with or without an attached intraocular lens. In 2 eyes, an artificial iris segment was sutured directly in the sectoral iris defect. At the end of surgery, all patients were pseudophakic.
Follow-up	**Mean 13.4 months (range 3 to 50)**
Conflict of interest/source of funding	None

Analysis

Study design issues: Retrospective, single centre case series. The main aim of the study was to describe the learning curve of the implantation surgery, limitations, pitfalls, and associated unexpected events.

Study population issues: The iris defect resulted from congenital coloboma in 3 patients (7%), from persistent mydriasis in 14 patients (27%), from traumatic loss of iris tissue in 31 patients (61%) and other causes (not described) in 3 patients (7%). Pre-existing glaucoma was present in 12% (6/51) of patients and pre-existing corneal impairment (scars or decompensation) in 10% (5/51) of patients.

There is likely to be some patient overlap with Mayer C et al., 2019 and Mayer C et al., 2016.

Key efficacy and safety findings

Efficacy	Safety
Number of patients analysed: 51 Best corrected visual acuity increased significantly (more than 2 lines of a Snellen projection chart) in 42.2% (19/45) of patients: • Before surgery=1.09±0.56 logMAR • After surgery=0.54±0.48 logMAR, p<0.001 In 13 eyes (28.9%) the best corrected visual acuity remained unchanged: • Before surgery=0.47±0.54 logMAR • After surgery=0.45±0.55 logMAR, p=0.502 In 13 eyes (28.9%) the best corrected visual acuity decreased significantly: • Before surgery=0.48±0.39 logMAR • After surgery=0.93±0.41 logMAR, p<0.001	**Overall complication rate=25.5% (13/51) of patients** Mild complications: • Recurrent bleeding in the anterior chamber and secondary rise in intraocular pressure=2.0% (1/51) (spontaneously resolved after 2 months) • Slight but stable artificial iris deviation=2.0% (1/51) • Capsular fibrosis=3.9% (2/51) (treated by laser-assisted capsulotomy) Moderate complications: • Sutures cutting through the residual iris tissue=2.0% (1/51) (no intervention needed) • Onset of glaucoma=5.9% (3/51) (controlled with medication) • Corneal decompensation=5.9% (3/51) Severe complications: • Artificial iris suture loosening and dislocation, needing surgical revision=5.9% (3/51) • Posterior synechiae needing synechiolysis=3.9% (2/51) • Severe ocular hypertension=3.9% (2/51) (1 had severe pigment dispersion syndrome and 1 patient needed shunt surgery with glaucoma valves) • Corneal complications=9.8% (5/51) (1 artificial iris had to be explanted after 1 year) • Cystoid macular oedema=5.9% (3/51) (treated with intravitreal steroids) • Retinal detachment=2.0% (1/51) (treated by vitrectomy with silicone oil filling) 46.2% of all complications happened within the first 3 postoperative months. **Complication rate by year of surgery:** • 2011=83.3% (5/6) • 2012=42.9% (3/7) • 2013=25.0% (3/12) • 2014=0% (0/2014) • 2015=13.3% (2/15)

Study 5 Aslam S (2008)

Details

Study type	**Case series**
Country	UK
Recruitment period	Not reported (patients were recruited over a 6-year period)
Study population and number	**n=35 patients (40 eyes); 10 patients (15 eyes) had congenital aniridia** Patients with aniridia (congenital or traumatic)
Age and sex	Congenital aniridia: mean age 40 years; 70% (7/10) male Traumatic aniridia: mean age 48 years; 56% (14/25) male
Patient selection criteria	Patients with traumatic or congenital aniridia who had had a black diaphragm intraocular lens inserted during the previous 6 years were included. Patients who had been implanted with capsular bag iris clip devices were not included. Three patients who had received a smaller 67G lens were also excluded from the study.
Technique	Device: black diaphragm intraocular lens Morcher 67F (Morcher GmBH, Germany) All implants were placed in the ciliary sulcus, either supported by an intact capsule or secured by transscleral sutures. A pre-existing standard intraocular lens was removed before insertion of the black diaphragm intraocular lens in 9 eyes.
Follow-up	**Mean 3.4 years (range 12 months to 6 years)**
Conflict of interest/source of funding	None

Analysis

Follow-up issues: Losses to follow-up are not described.

Study design issues: Retrospective single centre case series. The main outcome measures were biometry accuracy, visual outcome and the development of glaucoma and other complications.

Study population issues: Of the 35 patients, 10 had congenital aniridia and 25 had traumatic aniridia. Almost all patients with traumatic aniridia had previous intraocular surgery with a variety of procedures.

Key efficacy and safety findings

<table>
<tr><th>Efficacy</th><th>Safety</th></tr>
<tr><td>Number of patients analysed: 35 (40 eyes)

Best corrected visual acuity (logMAR) – all patients
• Before surgery=1.28±0.15
• After surgery=0.72±0.13 (at the best recorded visual acuity during the postoperative period)
• Overall mean improvement=0.56 logMAR units

Best corrected visual acuity (logMAR) – patients with traumatic aniridia (n=25 eyes)
• Before surgery=1.34±0.22
• After surgery=0.54±0.16, p<0.001</td><td>Intraoperative complications, n=1: zonular dehiscence and vitreous loss in an eye with congenital aniridia. After anterior vitrectomy, a 67F black diaphragm intraocular lens was supported successfully in the ciliary sulcus with no postoperative sequelae.

Ocular comorbidity before surgery<table><tr><th>Comorbidity</th><th>Congenital aniridia, n=15</th><th>Traumatic aniridia, n=25</th><th>Total n=40</th></tr><tr><td>Glaucoma therapy</td><td>8</td><td>2</td><td>10 (25%)</td></tr><tr><td>Retinal detachment</td><td>0</td><td>3</td><td>3 (7.5%)</td></tr><tr><td>Corneal scarring</td><td>6</td><td>2</td><td>8 (20%)</td></tr><tr><td>Phakic (cataract)</td><td>13</td><td>7</td><td>20 (50%)</td></tr><tr><td>Previous ocular surgery</td><td>3</td><td>24</td><td>27 (68%)</td></tr></table>Ocular comorbidity after surgery<table><tr><th>Comorbidity</th><th>Congenital aniridia, n=15</th><th>Traumatic aniridia, n=25</th><th>Total</th></tr><tr><td>Glaucoma therapy</td><td>8*</td><td>8*</td><td>16 (40%)</td></tr><tr><td>Trabeculectomy, tube, or cyclodiode laser</td><td>1</td><td>5</td><td>6 (15%)</td></tr><tr><td>Posterior capsule opacification</td><td>11</td><td>1</td><td>12 (30%)</td></tr><tr><td>Decompensated cornea needing graft</td><td>3</td><td>4</td><td>7 (18%)</td></tr><tr><td>Endophthalmitis</td><td>1</td><td>0</td><td>1 (3%)</td></tr><tr><td>Persistent cystoid macular oedema</td><td>0</td><td>2</td><td>2 (5%)</td></tr><tr><td>Limbal stem cell failure</td><td>4</td><td>0</td><td>4 (10%)</td></tr></table>*Includes patients with pre-existing glaucoma before surgery

The rise in intraocular pressure happened immediately after the procedure, suggesting a possible direct mechanical effect of the large black diaphragm intraocular lens.</td></tr>
</table>

Study 6 Qiu X (2015)

Details

Study type	**Non-randomised comparative study**
Country	China
Recruitment period	1999 to 2012
Study population and number	**n=170** (95 black diaphragm intraocular lens, 75 rigid gas permeable contact lenses) Patients with traumatic aniridia
Age and sex	• Black diaphragm lens: mean age 40 years; 66% (63/95) male • Contact lenses: mean age 27 years; 81% (61/75) male
Patient selection criteria	Inclusion criteria: extensively partial or complete aniridia, or a pupil diameter >8 mm because of an atonic iris; significant light sensitivity; significant cataracts or aphakic; endothelial cell density ≥1500 cells/mm^2; normal intraocular pressure (IOP) measurements (<21 mmHg), with no intervention or controlled IOP using topical anti-glaucoma medication; compliance with the follow-up requirements. Exclusion criteria: active ocular infection or inflammation, corneal decompensation, previous rigid gas permeable contact lens treatment, and active fundus pathology.
Technique	**Black diaphragm lens group** Device: black diaphragm poly(methyl methacrylate) (PMMA) intraocular lens (67G, Morcher, Germany). The specific procedure depended on the condition of the eye and whether simultaneous cataract extraction, primary or secondary intraocular lens implantation, or anterior vitrectomy was needed. Aniridectomy was done when non-functioning iris residue was found during the operation. The haptics of the lens in 61 eyes were fixed transsclerally. The capsule membranes of 34 eyes were present (7 eyes) or partly present (27 eyes) and the haptics were located in the capsule or at the sulcus. **Rigid gas permeable contact lens group** Device: Boston EO rigid gas permeable contact lens (oxygen permeability (DK)=60) made of fluorosilicone acrylate were fitted in all eyes.
Follow-up	**Mean 25 months**
Conflict of interest/source of funding	None

Analysis

Follow-up issues: Completeness of follow up was not discussed.

Study design issues: Non-randomised single centre comparative study. Patients who were unwilling to have surgery or who were allergic to the postoperative medications had rigid gas permeable contact lenses and the other patients had black diaphragm intraocular lens implantation. The main efficacy outcomes were best corrected visual acuity (BCVA), light sensitivity and patient satisfaction for cosmetic issues. Patients judged all symptom scores (range 0 to 5, strongly disagree to strongly agree) using a questionnaire.

Key efficacy and safety findings

Efficacy

Number of patients analysed: **170 (95 versus 75)**

Patient satisfaction with cosmetic results

- BDI lens=4.38±0.78
- RGP=2.93±0.29, p=0.007

82.1% (78/95) of eyes that had a BDI lens had a BCVA >20/200; all patients in the RGP group had a BCVA ≥20/200

Visual acuity in eyes implanted with a BDI lens (mean logMAR)

- Before surgery=1.842±0.05
- At last postoperative visit=0.625±0.06, p<0.0001

	BDI group		RGP group	
	Before	After	Before	After
Photophobia	4.27±0.68	0.97±0.59 p<0.0001	4.16±0.23	3.96±0.22 p=0.207
Glare	3.53±0.77	0.70±0.35 p<0.0001	3.81±0.32	3.59±0.27 p=0.168
Stereoscopic vision		45 (47.4%)		44 (58.7%)

Safety

	BDI group		RGP group	
	Before	After	Before	After
Endothelial cell density (mean)	2306±399	1920±501 p=0.000	2293±342	2406±358 p=0.223
IOP (mean)	14.21±4.03	18.69±3.74 p=0.000	14.14±3.78	13.56±3.56 p=0.974

Ocular comorbidities before surgery or RGP fitting

	BDI group	RGP group
Glaucoma therapy	14 (14.7%)	2 (2.7%)
Retinal detachment	6 (6.3%)	0 (0%)
Corneal scarring	58 (61.1%)	42 (56.0%)
Phakic (cataract)	5 (5.3%)	2 (2.7%)
Previous ocular surgery	95 (100%)	74 (98.7%)

Ocular comorbidities after surgery – BDI group

- Haptic broken during surgery=1.1% (1/95)
- Glaucoma therapy=37.9% (36/95)
- Trabeculectomy, tube, or cyclodiode laser=12.6% (12/95)
- Retinal detachment=4.2% (4/95)
- Decompensated cornea needing graft=9.5% (9/95)
- Endophthalmitis=2.1% (2/95)
- Persistent cystoid macular oedema=3.2% (3/95)
- Limbal stem cell failure=12.6% (12/95)
- Intraocular lens optical part detachment=1.1% (1/95)
- Eccentric BDI lens=16.8% (16/95)
- Dislocation of BDI lens=3.2% (3/95)
- Visual axis opacity (including 1 case of posterior capsule opacification)=6.3% (6/95)
- Severe membrane proliferation in anterior chamber=1.1% (1/95)

2 patients ultimately lost their vision from glaucoma.

RGP group

- Corneal infection=4.0% (3/75)
- Minimal corneal oedema=2.7% (2/75)
- Corneal neovascularisation=2.7% (2/75)

23 eyes in the BDI group had a postoperative inflammatory reaction, that resolved within 2 weeks after medical treatment; 8 eyes with hypopyon and anterior chamber fibrinous exudates also recovered after treatment.

Abbreviations used: BCVA, best corrected visual acuity; BDI, black diaphragm intraocular; IOP, intraocular pressure; RGP, rigid gas permeable

Study 7 Miller K (2018)

Details

Study type	**Case series**
Country	US
Recruitment period	2003 to 2013
Study population and number	**n=31 patients (31 eyes)** Patients with acquired iris defects
Age and sex	Mean 54 years; 74% (23/31) male
Patient selection criteria	Inclusion criteria included: age 18 years or older; a congenital or acquired iris defect causing significant light or glare sensitivity, contrast loss, blurred vision or multiplopia; the presence of a visually significant cataract, aphakia, or pseudophakia in the eye with the iris defect; willingness to comply with all study protocol requirements. Exclusion criteria included: asymptomatic individuals; those with clear crystalline lenses; iris defects small enough to be closed with sutures or addressed by Morcher 50D, 50F, 96S or 96F modified capsular tension rings; symptoms that could be treated adequately with tinted glasses or contact lenses; active ocular infection or inflammation; allergy or intolerance to postoperative medications; pregnant or lactating women.
Technique	Device: Black iris diaphragm intraocular lens Morcher 67B (Morcher GmBH, Germany) The device was never implanted as a standalone procedure – it was always combined with another medically necessary procedure. Operations included penetrating keratoplasty, cataract extraction, intraocular lens removal, and anterior vitrectomy. The black iris diaphragm intraocular lens was either passively fixated in the ciliary sulcus (23%) or sutured to the sclera (77%).
Follow-up	**1 year**
Conflict of interest/source of funding	None of the authors has a financial or proprietary interest in any material or method mentioned.

Analysis

Follow-up issues: Patients were followed up at 1 day, 2 weeks, 3 months, 6 months and 1 year after the procedure. All study visits were completed by 97% (30/31) of the patients.

Study design issues: Prospective single centre case series. Safety was ascertained by any decrease in Snellen corrected distance visual acuity (CDVA) and by surgical complications, adverse events or secondary surgical interventions. Efficacy was evaluated by measuring Snellen CDVA with glare and through subjective assessment of daytime and night-time glare symptoms. The CDVA with glare was measured in a phoropter or trial lens frame with a transilluminator light held 6 to 12 inches in front and slightly to the side of the study eye in 4 sequential quadrants, recording the lowest visual acuity thus obtained. Patients were instructed to rate their glare symptoms on a scale of 0 (very slight) to 10 (very significant) at baseline and 3 months after the procedure. Patients also provided a subjective assessment of the cosmetic appearance of the study eye on a scale from 0 (very unsatisfied) to 10 (very satisfied).

Study population issues: The aetiology of the iris defect was blunt trauma with rupture for 6 patients (19%), blunt trauma without rupture for 7 patients (23%), penetrating trauma for 8 patients (26%), surgical trauma for 9 patients (29%) and uveitis for 1 patient (3%). None of the iris defects were congenital. At baseline, 15 (48%) patients were aphakic, 5 (16%) had cataracts, 3 (10%) were pseudophakic with an anterior chamber intraocular lens and 8 (26%) were pseudophakic with a posterior chamber intraocular lens. Preoperative ocular hypertension or glaucoma was present in 52% (16/31) of eyes.

Key efficacy and safety findings

Efficacy	Safety
Number of patients analysed: **31** **Median corrected distance visual acuity (CDVA)** • Before surgery=20/125 (range light perception to $20/20^{+2}$) • 1 year after surgery=$20/30^{-1}$ (range counting fingers to 20/15), p=0.001 The CDVA improved for 25 patients (80.6%) and worsened for 6 patients (19.4%). For 2 patients, the loss was trivial and not considered to be a negative safety outcome. The other 4 patients are described in the safety column. **Median CDVA with glare** • Before surgery=20/400 (range light perception to 20/50) • 1 year after surgery=$20/50^{+1}$ (range hand motion to $20/20^{-2}$), p<0.0001 There was an improvement in all but 1 patient. The patient with no improvement had cystoid macular oedema, which was successfully treated after his exit from the study. **Mean subjective daytime glare symptom score** • Before surgery=8.65 • 1 year after surgery=3.71, p<0.0001 **Mean subjective night-time glare symptom score** • Before surgery=7.00 • 1 year after surgery=3.37, p<0.0001 **Mean cosmetic score** • Before surgery=3.61 • 1 year after surgery=5.84, p<0.0001 20 patients reported improved cosmesis and 11 patients reported no change.	**Intraoperative complications** • Retrobulbar haemorrhage, n=1 (caused by orbital injection of anaesthetic agent, it did not complicate the procedure) **Complications within 1 year of the procedure=71.0% (21/31) of patients (excluding preoperative comorbidities)** • Ocular hypertension, n=6 • Blepharoptosis, n=2 • Posterior capsule opacification, n=4 • Iritis, n=2 • Cystoid macular oedema=2 • Convergence insufficiency, n=1 • Hyphema, n=1 • Inflammatory deposits on the intraocular lens, n=3 • Post-traumatic corneal graft dehiscence, n=2 • Graft-host interface leak, n=1 • Glaucoma, n=1 • Epiretinal membrane, n=2 • Anterior synechiae, n=1 • Corneal oedema, n=1 • Transient hypotony, n=1 • Macular hole, n=1 (discovered after device implantation, likely to have been present before) • Dry eye, n=1 • Failed cornea, n=1 3 adverse events were reported to the institutional review board: cystoid macular oedema, corneal graft dehiscence and uveitis with ocular hypertension. 12 patients had secondary surgical interventions (the most common were corneal graft dehiscence repair, glaucoma tube shunt implantation, and strabismus surgery). 4 (12.9%) patients lost more than 1 line of Snellen CDVA by 1 year after the procedure.
Abbreviations used: CDVA, corrected distance visual acuity	

Study 8 Mayer CS (2019)

Details

Study type	**Case series**
Country	Germany
Recruitment period	2011 to 2016
Study population and number	**n=42 patients (42 eyes)** Patients with iris defects
Age and sex	Not reported
Patient selection criteria	Patients who had complete aniridia and those who had a sector-shaped implant were excluded because any change in the remaining iris tissue could not be observed.
Technique	Device: Artificial*Iris* (HumanOptics, Germany) The implant was fixed in the ciliary sulcus without sutures in pseudophakic eyes (n=20), implanted in the capsular bag with an intraocular lens (n=3) or sutured to the sclera with or without an attached intraocular lens (n=19). When sutures were used, an embedded fibre meshwork implant was used.
Follow-up	**24 months (±14)**
Conflict of interest/source of funding	None

Analysis

Follow-up issues: All patients had at least 1 year of follow up. The paper only describes results for the 7 patients who had a retraction syndrome of the residual iris after the procedure.

Study design issues: Prospective, single centre case series. The aim of the study was to evaluate the influence of the artificial iris prosthesis on the residual iris.

Study population issues: The main indication for surgery was intense sensitivity to glare.

There is likely to be some patient overlap with Mayer C et al., 2016 and Mayer C et al., 2018.

Key efficacy and safety findings

Safety
A retraction syndrome of the residual iris was identified in 16.7% (7/42) of eyes. All 7 patients had a continuous enlargement of the original pupillary aperture during follow up. None of them complained about disturbing symptoms, such as pain, cosmetic alterations or visual disturbances because of the dilated residual iris. 5 of the 7 implants were fibre mesh-free devices. 5 implants were positioned in the ciliary sulcus without suture fixation and 2 were sutured to the sclera in the ciliary sulcus. None of the 7 affected eyes had implantation in the capsular bag. Mean pupillary aperture before surgery=36.6±15.4 mm^2 Mean pupillary aperture of the residual iris at 6 months=51.2±16.6 mm^2 Mean pupillary aperture of the residual iris at 1 year=61.1±12.5 mm^2 Clinically, the residual iris 'disappeared' almost completely and could only be detected by gonioscopy or ultrasound biomicroscopy in the anterior chamber angle. 4 of the 7 patients with residual iris retraction had severe complications: 2 patients needed glaucoma shunt surgery because of pigment dispersion associated with glaucoma, 1 patient needed explantation of the implant because of chronic inflammation and elevated intraocular pressure and 1 patient had recurrent bleeding into the anterior chamber with temporarily raised intraocular pressure. Year of surgery • 2012=3 • 2013=2 • 2014=1 • 2015=1 • 2016=0 In all detected cases, neither the patient nor the treating ophthalmologist noticed the remnant iris retraction syndrome, but the alterations were clearly visible in photographic comparisons. There were no colour changes in the remnant iris. Anterior chamber depth and angle, endothelial cell count, and visual acuity were not affected.

Study 9 Gerding H (2013)

Details

Study type	**Case report**
Country	Switzerland
Recruitment period	Not reported
Study population and number	**n=1** Patient with traumatic aniridia
Age and sex	34 year old female
Patient selection criteria	Not applicable
Technique	Device: soft silicone artificial iris (Artificial*Iris*, Dr Schmidt, Germany) fibre free type combined with a posterior chamber intraocular lens. The artificial iris was inserted without sutures.
Follow-up	**12 months**
Conflict of interest/source of funding	None

Key efficacy and safety findings

Elevated intraocular pressure followed by complete apposition of the artificial iris and cornea

Before the procedure, intraocular pressure was within normal limits. The patient was referred 37 days after the artificial iris was implanted. Clinical findings were: visual acuity 0.1 (best corrected −2.0 sph. −1.5 cyl./88°), intraocular pressure 37 mmHg, conjunctival congestion, epithelial oedema, shallow anterior chamber with apposition of the artificial iris and the cornea temporally, and temporal angle closure between 1 and 6 o'clock. Local and systemic antiglaucoma therapy were unsuccessful so the anterior chamber was surgically reconstructed in combination with a partial pars plana vitrectomy and the prosthetic iris was repositioned in the ciliary sulcus.

Elevated intraocular pressure persisted and 6 days later a complete apposition of the artificial iris and cornea had developed. The artificial iris was immediately removed. Two months later a trabeculectomy was done. Progressive endothelial dysfunction and therapy resistant stromal and epithelial corneal oedema and opacity made a perforating corneal transplantation necessary 12 months after the artificial iris transplantation.

Table 2b Summary of key efficacy and safety findings on artificial iris implant insertion for congenital aniridia

Study 1 Rickmann A (2016)

Details

Study type	**Case series**
Country	Germany
Recruitment period	2004 to 2013
Study population and number	**n=34 patients (34 eyes); 7 patients had congenital aniridia or coloboma** Patients with congenital, traumatic or iatrogenic aniridia
Age and sex	Mean 49 years (range 28 to 85); 65% (22/34) male
Patient selection criteria	Consecutive patients who had an artificial iris with or without integrated fibre mesh. Only those eyes with a minimum follow up of 2 years were included. Indications were congenital, traumatic or iatrogenic aniridia (for example, after complicated phacoemulsification).
Technique	Device: flexible and foldable artificial iris (HumanOptics and Koch), custom-made to match the colour of the patient's natural iris. A full artificial iris prosthesis without mesh was used in 82% (28/34) of eyes and a partial prosthesis with mesh was used in the other 6 eyes. The mean size of the artificial iris was 11.2 mm (range 10 to 12). The mean size of the incision was 3.9 mm (range 3.5 to 6.5). The final transscleral fixation of the implant was done using a Z-suture technique in 26 eyes and with a scleral flap in 8 eyes. Some aphakic eyes needed permanent or long-standing silicone oil tamponade to maintain retina reattachment or to prevent phthisis. Vitrectomy was done in 8 eyes, cerclage in 1 eye and corneal graft in 4 eyes.
Follow-up	**Mean 50 months**
Conflict of interest/source of funding	None

Analysis

Follow-up issues: No losses to follow up were described.

Study design issues: Retrospective case series. All procedures were done by the same surgeon. The aim of the study was to evaluate the long term clinical outcome and complication spectrum after artificial iris implantation and the role of the implant embedded fibre mesh with regard to specific complications.

Study population issues: Reasons for artificial iris implant were congenital aniridia in 6 eyes (18%), congenital coloboma in 1 eye (3%), traumatic iris defect in 23 eyes (68%) and iatrogenic iris defect in 4 eyes (12%). Before the procedure, 14 eyes were pseudophakic (41%), 15 were aphakic (44%) and 5 were phakic (15%). The mean number of previous ocular interventions was 2 (range 0 to 6). At baseline, 5 eyes were hypotonic (15%), 10 eyes had glaucoma (29%), 6 eyes had pre-existing keratopathy (18%) and 4 eyes had silicone oil in the anterior chamber (12%). The iris defect was complete aniridia in 17 eyes (50%), partial aniridia in 8 eyes (24%), a circular remnant iris in 6 eyes (18%), a coloboma in 1 eye (3%), and a half-moon shaped defect in 2 eyes (6%). Mean visual acuity at baseline was 1.0 logMAR.

There is likely to be some patient overlap with Spitzer et al., 2016.

Key efficacy and safety findings

Efficacy	Safety
Number of patients analysed: **34** None of the implants needed to be repositioned. **Visual acuity at final follow-up** • Gain of 2 or more lines=47.1% (16/34) • Stable=44.1% (15/34) • Loss of 2 or more lines=8.8% (3/34) In the 6 eyes with pre-existing keratopathy, visual acuity increased from a mean baseline of 1.6 logMAR (±0.7) to a mean of 1.2 logMAR (±0.7), p=0.4. Of the 6 eyes, 2 gained 2 or more lines and 4 remained stable. In 7 patients with silicone oil tamponade, visual acuity was stable in 6 eyes and 1 eye lost 2 lines. **Mean intraocular pressure, mmHg** • Before procedure=14.6 (±5.6) • At final follow up=14.7 (±16.7), p=0.06 There was no statistically significant difference between the subgroups traumatic, congenital, and iatrogenic iris defects, neither at baseline, nor at the final follow-up (p =0.07). Hypotony was present in 5 eyes at baseline. In all 5 eyes, hypotony persisted at the final follow-up (3.2±2.2 mmHg).	There were no suture failures during follow up. **Complications** • Glaucoma=8.8% (3/34) • Keratopathy=5.9% (2/34) • Silicone oil in the anterior chamber=8.8% (3/34) • Haemorrhage of the remnant iris=2.9% (1/34) • Retinal detachment=2.9% (2/34)

Study 3 Mayer C (2016)

Details

Study type	**Case series**
Country	Germany
Recruitment period	2011 to 2014
Study population and number	**n=32 patients (32 eyes); 3 patients had congenital coloboma** Patients with iris defects
Age and sex	Mean 53 years; 69% (22/32) male
Patient selection criteria	Patients who had iris reconstruction for iris defects, with complete preoperative and postoperative examinations.
Technique	Device: Artificial*Iris* (HumanOptics, Germany) In all patients, the iris prosthesis was placed in the ciliary sulcus. Trephined concave iridectomies were done at the outer rim of the implant (each eye had 1 to 8 iridectomies, mean 2.78). The implant was rolled up and inserted through an incision (2.8 mm to 7.0 mm) by forceps or an injection system. The artificial iris was implanted directly into the ciliary sulcus without further suture fixation in 15 patients and 17 patients had a sclera-fixated artificial iris. In all phakic and aphakic eyes, an intraocular lens was implanted through the same tunnel before insertion of the iris prosthesis. Phakic patients had standard cataract surgery with intraocular lens implantation first, followed by artificial iris implantation in the ciliary sulcus in the same procedure. Aphakic patients had a secondary sclera-fixated or artificial iris-fixated intraocular lens.
Follow-up	**Mean 13.6 months (±10.9)**
Conflict of interest/source of funding	None

Analysis

Follow-up issues: An additional 5 patients were treated during the study period but were excluded because they did not attend follow up examinations at the clinic. Of these 5 patients, 3 were lost to follow-up and 2 were followed up in a clinic close to their home area.

Study design issues: Prospective, single centre case series. The aim of the study was to evaluate key structural and functional variables such as visual acuity, glare, contrast vision, pupil configuration, and aesthetic appearance.

Study population issues: Before the procedure, 13 patients were pseudophakic, 10 were phakic and 9 were aphakic. All patients had intense glare. The mean time between diagnosis and surgery was 12 years. The iris defect resulted from congenital coloboma in 3 patients (9%), from persistent mydriasis in 9 patients (28%) and from traumatic loss of iris tissue in 21 patients (66%).

There is likely to be some patient overlap with Mayer C et al., 2019 and Mayer C et al., 2018.

Key efficacy and safety findings

Efficacy

Number of patients analysed: **32**

Functional outcomes, mean ± standard deviation

Parameter	Before surgery	After surgery		p value
		1 month	3 months	
Best corrected visual acuity (logMAR)	0.77±0.62	0.68±0.64		0.792
Intraocular pressure (mmHg)	14.94±3.55	17.72±5.88		0.197
Pupillary aperture (mm^2)	42.1±20.1		8.7±0.3	<0.001
Contrast sensitivity (log; Pelli-Robson chart)	0.80±0.51		0.93±0.49	0.014
Endothelial cell density (cells/mm^2)*	1949±716		1841±689	0.003
Anterior chamber depth (mm)	4.03±1.06		4.29±0.70	0.186
Anterior chamber angle (degrees)	43.2±13.5		40.5±10.8	0.772
Subjective impairment through glare (1 to 10)	9.12±1.62		3.07±2.29	<0.001
Subjective cosmetic dissatisfaction (1 to 10)	6.33±3.21		1.58±0.86	<0.001
Patient satisfaction with overall results (1 to 10)	-		8.97±1.42	-

* only measured in 19 patients

Outcomes at 12 to 24 months after the procedure

- Best corrected visual acuity (logMAR)=0.51±0.58 (p=0.541)
- Mean intraocular pressure (mmHg)=14.84±4.42 (p=0.670)

Safety

Iris-related unexpected complications, n=4:

- 2 dislocation or subluxation of the implant disrupting the optical axis with a need for surgical correction
- 1 recurrent bleeding from ciliary body (resolved spontaneously)
- 1 artificial iris was explanted after corneal decompensation and chronic inflammation with macular oedema 1 year after the procedure.

1 patient had bulbar hypotony immediately after surgery that resolved within a few days.

7 patients had a temporary increase in intraocular pressure that was treated with topical and systemic antiglaucoma therapy; 4 of these 7 eyes had been diagnosed with glaucoma before surgery.

Study 4 Mayer C (2018)

Details

Study type	**Case series**
Country	Germany
Recruitment period	2011 to 2015
Study population and number	**n=51 patients (51 eyes); 3 patients had congenital coloboma** Patients with acquired or congenital iris defects
Age and sex	Mean 53 years; 67% (34/51) male
Patient selection criteria	Not reported
Technique	Device: Artificial*Iris* (HumanOptics, Germany) The type of implantation procedure depended on the pre-existing alterations in the affected eye. The custom-made implant was fixed in the ciliary sulcus without sutures in eyes with a pre-existing intracapsular intraocular lens, implanted in the capsular bag together with a new intraocular lens or sutured to the sclera with or without an attached intraocular lens. In 2 eyes, an artificial iris segment was sutured directly in the sectoral iris defect. At the end of surgery, all patients were pseudophakic.
Follow-up	**Mean 13.4 months (range 3 to 50)**
Conflict of interest/source of funding	None

Analysis

Study design issues: Retrospective, single centre case series. The main aim of the study was to describe the learning curve of the implantation surgery, limitations, pitfalls, and associated unexpected events.

Study population issues: The iris defect resulted from congenital coloboma in 3 patients (7%), from persistent mydriasis in 14 patients (27%), from traumatic loss of iris tissue in 31 patients (61%) and other causes (not described) in 3 patients (7%). Pre-existing glaucoma was present in 12% (6/51) of patients and pre-existing corneal impairment (scars or decompensation) in 10% (5/51) of patients.

There is likely to be some patient overlap with Mayer C et al., 2019 and Mayer C et al., 2016.

Key efficacy and safety findings

Efficacy	Safety
Number of patients analysed: 51 Best corrected visual acuity increased significantly (more than 2 lines of a Snellen projection chart) in 42.2% (19/45) of patients: • Before surgery=1.09±0.56 logMAR • After surgery=0.54±0.48 logMAR, p<0.001 In 13 eyes (28.9%) the best corrected visual acuity remained unchanged: • Before surgery=0.47±0.54 logMAR • After surgery=0.45±0.55 logMAR, p=0.502 In 13 eyes (28.9%) the best corrected visual acuity decreased significantly: • Before surgery=0.48±0.39 logMAR • After surgery=0.93±0.41 logMAR, p<0.001	**Overall complication rate=25.5% (13/51) of patients** Mild complications: • Recurrent bleeding in the anterior chamber and secondary rise in intraocular pressure=2.0% (1/51) (spontaneously resolved after 2 months) • Slight but stable artificial iris deviation=2.0% (1/51) • Capsular fibrosis=3.9% (2/51) (treated by laser-assisted capsulotomy) Moderate complications: • Sutures cutting through the residual iris tissue=2.0% (1/51) (no intervention needed) • Onset of glaucoma=5.9% (3/51) (controlled with medication) • Corneal decompensation=5.9% (3/51) Severe complications: • Artificial iris suture loosening and dislocation, needing surgical revision=5.9% (3/51) • Posterior synechiae needing synechiolysis=3.9% (2/51) • Severe ocular hypertension=3.9% (2/51) (1 had severe pigment dispersion syndrome and 1 patient needed shunt surgery with glaucoma valves) • Corneal complications=9.8% (5/51) (1 artificial iris had to be explanted after 1 year) • Cystoid macular oedema=5.9% (3/51) (treated with intravitreal steroids) • Retinal detachment=2.0% (1/51) (treated by vitrectomy with silicone oil filling) 46.2% of all complications happened within the first 3 postoperative months. **Complication rate by year of surgery:** • 2011=83.3% (5/6) • 2012=42.9% (3/7) • 2013=25.0% (3/12) • 2014=0% (0/2014) • 2015=13.3% (2/15)

Study 5 Aslam S (2008)

Details

Study type	**Case series**
Country	UK
Recruitment period	Not reported (patients were recruited over a 6-year period)
Study population and number	**n=35 patients (40 eyes); 10 patients (15 eyes) had congenital aniridia** Patients with aniridia (congenital or traumatic)
Age and sex	Congenital aniridia: mean age 40 years; 70% (7/10) male Traumatic aniridia: mean age 48 years; 56% (14/25) male
Patient selection criteria	Patients with traumatic or congenital aniridia who had had a black diaphragm intraocular lens inserted during the previous 6 years were included. Patients who had been implanted with capsular bag iris clip devices were not included. Three patients who had received a smaller 67G lens were also excluded from the study.
Technique	Device: black diaphragm intraocular lens Morcher 67F (Morcher GmBH, Germany) All implants were placed in the ciliary sulcus, either supported by an intact capsule or secured by transscleral sutures. A pre-existing standard intraocular lens was removed before insertion of the black diaphragm intraocular lens in 9 eyes.
Follow-up	**Mean 3.4 years (range 12 months to 6 years)**
Conflict of interest/source of funding	None

Analysis

Follow-up issues: Losses to follow-up are not described.

Study design issues: Retrospective single centre case series. The main outcome measures were biometry accuracy, visual outcome and the development of glaucoma and other complications.

Study population issues: Of the 35 patients, 10 had congenital aniridia and 25 had traumatic aniridia. Almost all patients with traumatic aniridia had previous intraocular surgery with a variety of procedures.

Key efficacy and safety findings

<table>
<tr><th>Efficacy</th><th>Safety</th></tr>
<tr><td>
Number of patients analysed: 35 (40 eyes)

Best corrected visual acuity (logMAR) – all patients
• Before surgery=1.28±0.15
• After surgery=0.72±0.13 (at the best recorded visual acuity during the postoperative period)
• Overall mean improvement=0.56 logMAR units

Best corrected visual acuity (logMAR) – patients with congenital aniridia (n=15 eyes)
• Before surgery=1.17±0.14
• After surgery=1.01±0.21, p=0.20
In a subgroup analysis of the 9 patients with congenital aniridia and no other comorbidity, there was no improvement in best corrected visual acuity after the procedure and the trend was towards a worse outcome (−0.22±0.23, p=0.24).
</td><td>
Intraoperative complications, n=1: zonular dehiscence and vitreous loss in an eye with congenital aniridia. After anterior vitrectomy, a 67F black diaphragm intraocular lens was supported successfully in the ciliary sulcus with no postoperative sequelae.

Ocular comorbidity before surgery
<table>
<tr><th>Comorbidity</th><th>Congenital aniridia, n=15</th><th>Traumatic aniridia, n=25</th><th>Total n=40</th></tr>
<tr><td>Glaucoma therapy</td><td>8</td><td>2</td><td>10 (25%)</td></tr>
<tr><td>Retinal detachment</td><td>0</td><td>3</td><td>3 (7.5%)</td></tr>
<tr><td>Corneal scarring</td><td>6</td><td>2</td><td>8 (20%)</td></tr>
<tr><td>Phakic (cataract)</td><td>13</td><td>7</td><td>20 (50%)</td></tr>
<tr><td>Previous ocular surgery</td><td>3</td><td>24</td><td>27 (68%)</td></tr>
</table>
Ocular comorbidity after surgery
<table>
<tr><th>Comorbidity</th><th>Congenital aniridia, n=15</th><th>Traumatic aniridia, n=25</th><th>Total</th></tr>
<tr><td>Glaucoma therapy</td><td>8*</td><td>8*</td><td>16 (40%)</td></tr>
<tr><td>Trabeculectomy, tube, or cyclodiode laser</td><td>1</td><td>5</td><td>6 (15%)</td></tr>
<tr><td>Posterior capsule opacification</td><td>11</td><td>1</td><td>12 (30%)</td></tr>
<tr><td>Decompensated cornea needing graft</td><td>3</td><td>4</td><td>7 (18%)</td></tr>
<tr><td>Endophthalmitis</td><td>1</td><td>0</td><td>1 (3%)</td></tr>
<tr><td>Persistent cystoid macular oedema</td><td>0</td><td>2</td><td>2 (5%)</td></tr>
<tr><td>Limbal stem cell failure</td><td>4</td><td>0</td><td>4 (10%)</td></tr>
</table>
*Includes patients with pre-existing glaucoma before surgery

The rise in intraocular pressure happened immediately after the procedure, suggesting a possible direct mechanical effect of the large black diaphragm intraocular lens.
</td></tr>
</table>

Study 10 Reinhard T (2000)

Details

Study type	**Case series**
Country	Germany
Recruitment period	1991 to 1998
Study population and number	**n=14 (19 eyes)** Patients with congenital aniridia
Age and sex	Mean 30 years (range 10 to 59); 21% (4/19) male
Patient selection criteria	Patients with a black diaphragm aniridia intraocular lens implanted for congenital aniridia. Four eyes with trans-scleral suturing of the intraocular lens were excluded as well as 3 eyes with combined penetrating keratoplasty. A 'homogenous' group of 19 eyes was included from a consecutive series of 26 eyes treated during the study period.
Technique	Device: black diaphragm aniridia intraocular lens (types 67, 67B, 67C, 67D and 67G) Several modifications of the device were necessary because of initial difficulties in implanting the first large intraocular lens types. In 10 adult eyes, surgery was done using retrobulbar anaesthesia. For all other patients, general anaesthesia was used. Extracapsular cataract extraction was done in 10 eyes and phacoemulsification in 9 eyes. The device was implanted in front of the capsular bag using 170-degree corneal incisions. If bilateral surgery was necessary, the second eye was not treated before an uneventful course of at least 6 months was observed in the first eye.
Follow-up	**Mean 46 months (range 12 to 84)**
Conflict of interest/source of funding	Not reported

Analysis

Follow-up issues: Patients were followed up at 1 and 3 months and once a year thereafter.

Study design issues: Single centre case series. The main aim of the study was to present long-term results of the procedure.

Study population issues: All eyes had advanced cataracts, 10 eyes had mature cataract or very brown nuclei. Corneal epithelial disorders, corneal pannus, hypoplasia of the macula or optic nerve, and nystagmus were also present in all 19 eyes. Clinically detectable glaucoma was present in 5 eyes. The procedure was only done if intraocular pressure was well controlled medically or surgically beforehand.

Key efficacy and safety findings

Efficacy	Safety
Number of patients analysed: **14 (19 eyes)** **Visual acuity and glare** Visual acuity improved in 73.7% (14/19) of eyes. It remained unchanged in 1 eye and deteriorated slightly in 4 eyes. Reduced glare=78.6% (11/14) of patients	**Intraocular inflammation** Slight aqueous flare with a few cells in the anterior chamber was observed in all 19 eyes over the long term. It was recommended that 1 daily drop of prednisolone acetate should be continued long term. **Glaucoma** Deterioration in glaucoma during follow up was reported in 4 of the 5 eyes with glaucoma before the procedure. It was controlled medically in 2 eyes and surgically (trabeculectomy, cyclodestruction) in the other 2 eyes. Postoperative chronic glaucoma was reported in 28.6% (4/14) of eyes without a preoperative glaucoma history. This was controlled medically in 2 eyes and surgically (trabeculectomy, cyclodestruction, intraocular lens explantation) in 2 eyes. 6 of 9 contralateral eyes that did not have surgery had a history of glaucoma at the first preoperative visit. Of these, 2 had a deterioration during follow up that was controlled medically. **Cystoid macular oedema** Of the 11 eyes that could be examined using fluorescein angiography, 2 had cystoid macular oedema. Fundoscopy alone did not reveal cystoid macular oedema in any eye. **Endothelial cell loss** In the 11 eyes examined, there was a less than 15% drop in endothelial cell density in 8 eyes and chronic endothelial cell loss in 3 eyes. **Surface disorders** A postoperative deterioration was reported in 21.1% (4/19) of eyes; 2 with and 2 without pannus progression. **Posterior lens capsule** Posterior lens capsule rupture was reported in 1 patient. 4 eyes (21.1%) were treated by surgical posterior capsulotomy with anterior vitrectomy and cataract surgery for fibrous posterior capsule opacification. Of the remaining 14 eyes, 12 developed posterior capsule opacification, which was treated in 11 eyes with a laser.

Validity and generalisability of the studies

- No randomised controlled trials were identified.
- There are data from Europe, US and Asia. One study included patients from the UK.
- Patient populations are heterogenous and the number of patients with congenital aniridia is low.
- There are several publications from the same centres and there is likely to be some patient overlap between them.
- There are different devices used in the studies. Some patients had an artificial iris combined with an intraocular lens implanted. Some studies report outcomes from earlier versions of a device that were subsequently modified.
- Techniques for implantation vary between the studies.
- Some of the events described in the safety section may be related to the underlying condition rather than the intervention.
- There are some long-term data.

Existing assessments of this procedure

There were no published assessments from other organisations identified at the time of the literature search.

Related NICE guidance

There is currently no NICE guidance related to this procedure.

Additional information considered by IPAC

Professional experts' opinions

Expert advice was sought from consultants who have been nominated or ratified by their Specialist Society or Royal College. The advice received is their individual opinion and is not intended to represent the view of the society. The advice provided by specialist advisers, in the form of the completed questionnaires, is normally published in full on the NICE website during public

consultation, except in circumstances but not limited to, where comments are considered voluminous, or publication would be unlawful or inappropriate. Three Professional Expert Questionnaires for artificial iris implant insertion for aniridia were submitted and can be found on the NICE website.

Patient commentators' opinions

NICE's Public Involvement Programme was unable to gather patient commentary for this procedure.

NICE received 1 submission from a patient organisation.

Company engagement

A structured information request was sent to 3 companies who manufacture a potentially relevant device for use in this procedure. NICE received 1 completed submission.

Issues for consideration by IPAC

- Ongoing trials:
  - Safety and Effectiveness of the CustomFlex Artificial Iris Prosthesis for the Treatment of Iris Defects; NCT01860612; non-randomised; n=580; estimated completion date June 2019
  - Clinical Evaluation of Morcher Artificial Iris Diaphragms; NCT00812708; single group assignment; n=72; estimated completion date December 2020
- This overview does not include iris implants that have been used for cosmetic reasons only, to change the iris colour in normal eyes.

References

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9. Gerding H, Hailemariam S, Timmermann M (2013) Complications after prosthetic iris implantation in a case of traumatic aniridia. Klinische Monatsblatter fur Augenheilkunde 230: 323–25
10. Reinhard T, Engelhardt S, Sundmacher R (2000) Black diaphragm aniridia intraocular lens for congenital aniridia: long-term follow-up. Journal of Cataract & Refractive Surgery 26: 375–81

Literature search strategy

Databases	Date searched	Version/files
Cochrane Database of Systematic Reviews – CDSR (Cochrane Library)	18/11/19	Issue 11 of 12, November 2019
Cochrane Central Database of Controlled Trials – CENTRAL (Cochrane Library)	18/11/19	Issue 11 of 12, November 2019
HTA database (CRD website)	18/11/19	-
MEDLINE (Ovid)	18/11/19	1946 to November 15, 2019
MEDLINE In-Process (Ovid) & Medline ePub ahead (Ovid)	13/11/19	1946 to November 12, 2019
EMBASE (Ovid)	13/11/19	1974 to 2019 November 12

The following search strategy was used to identify papers in MEDLINE. A similar strategy was used to identify papers in other databases.

1	Aniridia/ (692)
2	aniridia*.tw. (1276)
3	iriderem*.tw. (5)
4	Iris Diseases/ (2376)
5	(iris adj4 (diseas* or defect* or deform* or defic* or fault*)).tw. (406)
6	((absen* or missing* or lost* or incomplet* or fragment* or insuffic* or inadequat* or underdevelop* or damag* or abnormal*) adj4 iris).tw. (502)
7	or/1-6 (4375)
8	"Prostheses and Implants"/ (44492)
9	Prosthesis Implantation/ (12968)
10	(iris* adj4 (implant* or prosthe* or artificial* or reconstruct*)).tw. (608)
11	Morcher.tw. (61)
12	or/8-11 (54715)
13	7 and 12 (211)
14	CustomFlex.tw. (2)
15	"ArtificialIris".tw. (5)
16	BrightOcular.tw. (3)
17	or/13-16 (213)
18	animals/ not humans/ (4546399)

19	17 not 18 (210)
20	limit 19 to english language (172)

Appendix

The following table outlines the studies that are considered potentially relevant to the IP overview but were not included in the main data extraction table (table 2). It is by no means an exhaustive list of potentially relevant studies.

Case reports have been excluded unless they report an adverse event.

Article	Number of patients/ follow-up	Direction of conclusions	Reasons for non-inclusion in table 2
Al-Rashidi SH (2019) Black diaphragm intraocular lens implantation in patients with aniridia. Journal of Ophthalmic & Vision Research 14: 27-31	Case series n=14 FU=median 30 months	All patients reported a significant decrease in photophobia and glare. Postoperatively, 11 eyes (78%) gained 2 or more lines of UCVA. At the last follow-up, BCVA increased by 2 or more lines in all cases. Early postoperative complications included main wound leakage (1 eye) and anterior chamber hyphema (1 eye). Late complications included corneal decompensation (1 eye), failed penetrating keratoplasty graft (2 eyes), and subluxation of a scleral fixated black diaphragm intraocular lens (1 eye). Surgical interventions included penetrating keratoplasty in 2 eyes with corneal decompensation and failed graft (1 each), and re-suturing of a subluxated intraocular lens (1 eye).	Studies with more patients or longer follow-up are included.
Ayliffe W, Groth SL, Sponsel WE (2012) Small-incision insertion of artificial iris prostheses. Journal of Cataract & Refractive Surgery 38: 362-7	Case series n=4	All 4 patients experienced a positive outcome that was visually beneficial.	Studies with more patients or longer follow-up are included.
Beltrame G, Salvetat ML, Chizzolini M et al. (2003) Implantation of a black diaphragm intraocular lens in ten cases of post-traumatic aniridia. European Journal of Ophthalmology 13: 62-8	Case series n=10 FU=mean 33 months	Best-corrected visual acuity (BCVA) improved in 8 eyes and remained unchanged in 2. Glare and photophobia decreased in all patients. Intraoperatively, ciliary sulcus bleeding occurred in 2 eyes and haptic rupture during lens insertion in 1. Postoperatively, persistent intraocular inflammation was seen in 4 eyes, secondary glaucoma in 4 eyes, transient hyphema and/or haemovitreous in 4, IOL decentration in 2, and post-traumatic haptic detachment in 1 eye.	Studies with more patients or longer follow-up are included.

Brown MJ, Hardten DR, Knish K (2005) Use of the artificial iris implant in patients with aniridia. Optometry 76: 157-64	Case series n=6 FU=1 year	All patients experienced decrease in glare and light sensitivity following artificial iris implant surgery. Two experienced improved best-corrected vision. All 6 patients felt the cosmetic appearance of their affected eye improved.	Studies with more patients or longer follow-up are included.
Burk SE, Da Mata A, Snyder ME et al. (2001) Prosthetic iris implantation for congenital, traumatic, or functional iris deficiencies. Journal of Cataract and Refractive Surgery 27: 1732–40	Case series n=25 FU=mean 10 months	The procedure reduced glare and, in selected patients, corrected aphakia. Visual acuity improved in 79% (22/28) of eyes. Intraoperative complications included 3 fractured implants and incomplete or torn capsulorhexis in 3 eyes. Postoperative complications included transient hypotony in 2 eyes, mild persistent inflammation in 1 eye and macular oedema followed by a retinal detachment in 1 eye with recent severe trauma.	Studies with more patients or longer follow-up are included.
Date RC, Olson MD, Shah M et al. (2015) Outcomes of a modified capsular tension ring with a single black occluder paddle for eyes with congenital and acquired iris defects: Report 2. Journal of Cataract & Refractive Surgery 41: 1934-44	Case series n=16 FU=1 year	There was a statistically significant improvement in the median CDVA of 2.5 Snellen lines ($p<0.01$), with 4 patients having minor decreases in CDVA for reasons unrelated to the device. There were no intraoperative complications. Three adverse events were reported: 1 ocular hypertension, 1 postoperative retinal detachment, and 1 25-degree rotation of the CTR. There were 4 secondary surgical interventions. There was a statistically significant improvement in the median CDVA with glare of 8 Snellen lines ($p<0.01$), but 2 patients had a decrease in CDVA with glare for reasons unrelated to the device. There were statistically significant improvements in the median daytime and night-time glare symptom scores of 5 points and 4 points, respectively (both $p<0.01$). There was no change in cosmesis for most patients.	Studies with more patients or longer follow-up are included.
Dong X, Xiu H, Yu B et al. (2009) Long-term outcome of black diaphragm intraocular lens implantation in traumatic aniridia. Br J Ophthalmology 94: 456-459	Case series n=18 FU=41 months	BDI lens implantation is safe and effective in most traumatic eyes. Glaucoma and corneal decompensation appear to be the major long-term complications. The position of BDI lens is crucial for the long-term outcome.	Studies with more patients or longer follow-up are included.
Durukan, H.; Kerimoglu, H.; Hurmeric, V.; et al. (2010) Retinal detachment after implantation of iris-prosthetic IOL in a case with traumatic	Case report n=1	**Retinal detachment** Three months after the procedure, the patient presented with decreased visual acuity due to retinal detachment. This was	Case report of adverse event that is already described in table 2.

aniridia. Retina-Vitreus 18: 240-242		repaired with a high buckle. The visual acuity was 0.6 without any sign of inflammation or raised intraocular pressure at the end of 6 month follow-up.	
Farahi A, Hashemi H, Mehravaran S (2015) Combined cataract surgery and aniridia ring implantation in oculocutaneous albinism. Journal of Cataract & Refractive Surgery 41: 2438-43	Case series n=6 (12 eyes) FU=6 months	None of the patients had any intraoperative or postoperative complications. In addition to improved uncorrected and corrected distance visual acuity and significant reduction of refractive error, all patients had a marked reduction of glare and photophobia after surgery.	Studies with more patients or longer follow-up are included.
Firl KC, Montezuma SR (2016) Chronic post-operative iris prosthesis endophthalmitis in a patient with traumatic aniridia: a case report. Ophthalmology 16: 197	Case report n=1	**Iris prosthesis endophthalmitis** Patient with traumatic aniridia who experienced chronic, recurrent low-grade intraocular inflammation and irritation for months after implantation of the Ophtec 311 prosthetic iris. Symptoms and signs of inflammation improved temporarily with sub-Tenon's capsule triamcinolone injections. Ultimately after more than 2 post-operative years, the iris prosthesis was explanted, and intravitreal cultures showed Propionibacterium acnes growth after 5 days. Intravitreal antibiotics treated the infection successfully.	Case report of adverse event that is already described in table 2.
Forlini C, Forlini M, Rejdak R et al. (2013) Simultaneous correction of post-traumatic aphakia and aniridia with the use of artificial iris and IOL implantation. Graefe's Archive for Clinical and Experimental Ophthalmology 251: 667-675	Case series n=4 FU=6 months	Management of post-traumatic aniridia combined with aphakia by haptic fixation of a foldable acrylic IOL on a foldable iris prosthesis appears to be a promising approach which gives the surgeon the possibility to correct a complex lesion with one procedure, which is less traumatic and faster. Existence of foldable materials, both iris and IOL, permits relatively small corneal incisions (4.0 to 5.0 mm). Moreover, the custom-tailored iris prosthesis gives a perfect aesthetic result.	Studies with more patients or longer follow-up are included.
Hermann MM, Muether PS, Kuhn L et al. (2012) Clinical outcome of the artificial iris diaphragm in silicone oil surgery. British Journal of Ophthalmology 96: 1008-11	Case series n=94 FU=mean 586 days	No silicone oil in the anterior chamber at the last follow-up visit was found in 58 patients (62%). The Kaplan-Meier survival analysis returned a mean survival time for a functional diaphragm of 1227 days. Keratopathy improved in 55% at least temporarily, and vision improved or remained stable in 38% until last follow-up. The diaphragm was more successful when the underlying disease was trauma or congenital malformation.	Study focuses on the use of an artificial iris diaphragm to prevent silicone oil from entering the anterior chamber.

Karatza EC, Burk SE, Snyder ME et al. (2007) Outcomes of prosthetic iris implantation in patients with albinism. Journal of Cataract & Refractive Surgery 33: 1763-9	Case series n=8 (13 eyes)	All eyes achieved the desired anatomic result. The best corrected visual acuity improved in 8 of 13 eyes, remained stable in 3 eyes, and decreased in 2 eyes. Glare and photophobia improved subjectively in 6 of 8 patients, remained unchanged in 1 patient, and increased in 1 patient after implantation of an artificial iris diaphragm. There were no intraoperative or postoperative complications.	Studies with more patients or longer follow-up are included.
Koch KR, Heindl LM, Cursiefen C et al. (2014) Artificial iris devices: benefits, limitations, and management of complications. Journal of Cataract & Refractive Surgery 40: 376-82	Case series n=2 (3 eyes) FU=6 months	In patients with major iris defects ineligible for pupilloplasties, the artificial iris allows functionally and aesthetically satisfactory anterior segment reconstruction. To prevent secondary complications, the artificial iris should only be implanted in aphakic or pseudophakic eyes and placed in the posterior chamber.	Studies with more patients or longer follow-up are included.
Li J, Dong X-G (2013) Black diaphragm intraocular lens implantation and penetrating keratoplasty in aphakic eyes with traumatic aniridia. Int J Ophthalmol 6: 183-186	Case series n=6 FU=mean 24 months	The best corrected visual acuity improved in 5 patients (0.1-1.0) and decreased in 1 patient from 0.4 to 0.2. Three patients had normal intraocular pressure (IOP) after implantation. Two patients needed antiglaucoma medications to control IOP within the normal range and 1 patient implanted Ahmed glaucoma valve to control IOP.	Studies with more patients or longer follow-up are included.
Lin SR, Miller KM (2017) Lessons learned from implantation of Morcher 50D and 96S artificial iris diaphragms. Case Rep Ophthalmol 8: 527-534	Case series n=5	Complications included postoperative rotation, device mis-sizing, difficult intraoperative rotation, zonular dehiscence, and intraoperative haemorrhage. Artificial iris implantation has a steep learning curve.	Studies with more patients or longer follow-up are included.
Mashor RS, Bahar I, Kaiserman I et al. (2011) Combined penetrating keratoplasty and implantation of iris prosthesis intraocular lenses after ocular trauma. Journal of Cataract and Refractive Surgery 37: 582–87	Case series n=11 FU=1 year	Implantation of iris prosthetic intraocular lenses combined with corneal transplantation in traumatic aniridia improved visual acuity in most patients and reduced photophobia and glare symptoms. Potential complications include graft rejection, glaucoma and inflammation.	Studies with more patients or longer follow-up are included.
Mavrikakis I, Mavrikakis E, Syam PP et al. (2005) Surgical management of iris defects with prosthetic iris devices. Eye 19: 205-9	Case series n=9 (10 eyes) FU=mean 18 months	Best-corrected visual acuity improved in 90% (9/10) of eyes and remained unchanged in 1 eye. Glare subjectively improved in 4 of 5 eyes (80%) of patients complaining of glare preoperatively. Intraoperative complications included 1 anterior capsular tear.	Studies with more patients or longer follow-up are included.

		Postoperative complications included a short period of mild postoperative anterior uveitis in 4 eyes.	
Mayer C, Tandogan T, Hoffmann AE et al. (2017) Artificial iris implantation in various iris defects and lens conditions. Journal of Cataract and Refractive Surgery 43: 724–31	Case series n=51	There were 4 intraoperative complications. Postoperative complications included decentration or subluxation of iris prosthesis, transient increase in intraocular pressure, recurrent bleeding. Later complications included long-term elevated intraocular pressure (n=3), corneal decompensation (n=1) and macular oedema (n=1).	Study focuses on 6 different techniques for inserting the artificial iris. No efficacy outcomes are reported.
Menezo JL, Martinez-Costa R, Cisneros A et al. (2005) Implantation of iris devices in congenital and traumatic aniridias: surgery solutions and complications. European Journal of Ophthalmology 15: 451-7	Case series n=8 (9 eyes) FU=mean 22.5 months	Several kinds of artificial iris implants are available. In all 8 patients with aniridia, iris artificial prostheses improved visual acuity and diminished visual discomfort. Glaucoma is the most important complication after artificial iris implant. It is possible to implant the iris prosthesis in the capsular bag, but this requires a large capsulorrhexis and presents a surgical challenge.	Studies with more patients or longer follow-up are included.
Miller KM, Nicoli CM, Olson MD et al. (2016) Outcomes of implantation of modified capsule tension rings with multiple black occluder paddles for eyes with congenital and acquired iris defects: Report 3. Journal of Cataract & Refractive Surgery 42: 870-8	Case series n=12 FU=1 year	There were no lost lines of CDVA and no intraoperative complications. The most common postoperative complication was posterior capsule opacification. Four patients had secondary surgical interventions, the most common of which was laser capsulotomy. The median CDVA with glare improved from less than 20/400 before surgery to 20/50 after surgery. One patient worsened. The median subjective daytime glare symptom score improved from 9 to 3 on a 10-point scale (p=0.001). The median night-time subjective glare symptom score improved from 8 to 2 (p=0.001). The subjective cosmetic appearance of the eye stayed the same or improved for all patients (p=0.031).	Studies with more patients or longer follow-up are included.
Miller AR, Olson MD, Miller KM (2007) Functional and cosmetic outcomes of combined penetrating keratoplasty and iris reconstruction lens implantation in eyes with a history of trauma. Journal of Cataract & Refractive Surgery 33: 808-14	Case series n=9 eyes	Ophtec iris reconstruction lens implantation and simultaneous penetrating keratoplasty reduced visual disturbances and improved the aesthetic appearance of the eyes. The long-term safety of the procedure, judged by BCVA and postoperative complications, was mixed, with both good and bad outcomes.	Studies with more patients or longer follow-up are included.

Mostafa YS, Osman AA, Hassanein DH et al. (2018) Iris reconstruction using artificial iris prosthesis for management of aniridia. European Journal of Ophthalmology 28: 103-107	Case series n=4 (5 eyes) FU=2 years	All patients had improved uncorrected distance visual acuity and best-corrected distance visual acuity. All patients had a transient corneal oedema that resolved within the first postoperative week. Only the patient with congenital aniridia had a permanent increase in intraocular pressure and developed a band keratopathy throughout a 2-year follow-up period. The prosthesis was well-centred in all eyes except for 1 that needed scleral suture fixation after 3 months. All patients had a satisfactory cosmetic appearance.	Studies with more patients or longer follow-up are included.
Nessmann A, Wagner J, Yoeruek E et al. (2015) Customized Iris Prosthesis in eyes with post-traumatic aniridia. Investigative Ophthalmology and Visual Science 56: 6060	Case series n=36 FU=median 17.5 months	The customised silicone iris prosthesis is an individualised treatment approach, which can be tailored to distinct eye properties. It is a favourable cosmetic solution for the reconstruction of the iris in post-traumatic eyes. However, in some patients the implantation of this device may cause an increase of IOP, corneal endothelial decompensation or persisting inflammation. Thus, the risks of benefits of implantation must be weighed carefully in patients with high or low IOP as well as pre-existing corneal endothelial damage.	Studies with more patients or longer follow-up are included.
Olson MD, Masket S, Miller KM (2008) Interim results of a compassionate-use clinical trial of Morcher iris diaphragm implantation: report 1. Journal of Cataract & Refractive Surgery 34: 1674-80	Case series n=13 FU=1 year	There was a statistically significant improvement in median BCVA of 2 Snellen lines (p=0.002). One patient lost 2 letters of BCVA on the 20/20 line. There were 2 adverse events. One was minor bleeding during a posterior synechialysis that resolved without intervention. The second was piggyback intraocular lens decentration from worsening zonular dialysis in an eye with a trauma history. One postoperative intervention was the repositioning of a 50D ring. There was a statistically significant median improvement in best corrected glare acuity of 10 Snellen lines (p≤0.001). Subjective daytime glare improved 5 questionnaire scale points (p=0.004), and night-time glare sensitivity improved 3 scale points (p=0.001).	Studies with more patients or longer follow-up are included.
Osher RH, Burk SE (1999) Cataract surgery combined with implantation of an	Case series n=6 (7 eyes)	In 5 eyes, a prosthetic iris was successfully implanted in combination with small incision	Studies with more patients or longer

artificial iris. Journal of Cataract & Refractive Surgery 25: 1540-7		cataract surgery. In 2 eyes, a single-piece iris diaphragm and optical lens was implanted. Artificial irides offer a safe alternative for patients who previously had no viable options for iris reconstruction.	follow-up are included.
Ozturk F, Osher RH, Osher JM (2006) Secondary prosthetic iris implantation following traumatic total aniridia and pseudophakia. Journal of Cataract & Refractive Surgery 32: 1968-70	Case series n=2	Two pseudophakic patients had traumatic episodes that resulted in total expulsion of the iris without disturbing the intraocular lens (IOL). Because of intolerable glare, each patient was managed by reopening the fibrosed capsular bag and implanting 2 multi-finned prosthetic iris devices through a small incision, leaving the IOL in place. Following surgery, glare was no longer present and excellent visual acuity was maintained.	Studies with more patients or longer follow-up are included.
Petousis V, Krause L, Willerding G et al. (2011) Results and complications after implantation of a black iris-lens diaphragm in patients with traumatically induced aphakia and aniridia. European Journal of Ophthalmology 21: 754–59	Case series n=16 FU=median 1.5 years	11 patients were satisfied with the cosmetic result and 5 were neutral. 82% of patients had stable or improved visual acuity after the procedure. The severity of the primary injury had an impact on the postoperative result. One patient had an enucleation because of painful phthisis. Other complications included silicone oil prolapse in the anterior chamber (n=3), secondary glaucoma (n=2), haemorrhage in the anterior chamber (n=1) and implant subluxation (n=1).	Studies with more patients or longer follow-up are included.
Pozdeyeva NA, Pashtayev NP, Lukin VP et al. (2005) Artificial iris-lens diaphragm in reconstructive surgery for aniridia and aphakia. Journal of Cataract & Refractive Surgery 31: 1750-9	Case series n=19 (20 eyes)	Fifteen eyes (75%) experienced improvement in corrected visual acuities. The best spectacle-corrected visual acuity (BSCVA) in 2 eyes did not change, while the uncorrected visual acuity (UCVA) in these eyes increased. There were 3 eyes in which BSCVA deteriorated with no change or even slight improvement in UCVA. All patients were satisfied with the cosmetic results of the surgery and reported a decrease in glare and photophobia. There was 1 intraoperative complication of vitreous haemorrhage. Postoperatively, 2 cases of hyphaema, 1 case of ciliochoroidal detachment, 4 eyes with exaggerated immediate postoperative reaction, and 1 eye with persistent low-grade cyclitis were observed. In 1 eye, there was persistent intraocular pressure rise.	Studies with more patients or longer follow-up are included.

		One eye showed signs of cystoid macular oedema.	
Price MO, Price FW Jr, Chang DF et al. (2004) Ophtec iris reconstruction lens United States clinical trial phase I. Ophthalmology 111: 1847-52	Case series n=10 FU=12 months	Uncorrected VA improved in all eyes after implantation of the iris reconstruction lens. Best-corrected VA did not change significantly (p=0.24). Postoperative photophobia was reduced in all 9 eyes that experienced moderate to severe preoperative photophobia. Likewise, postoperative glare was reduced in all 6 eyes with moderate to severe preoperative glare. There were no surgical complications. Adverse events included 2 cases of iritis and 1 case of macular oedema.	Studies with more patients or longer follow-up are included.
Qiu X, Ji Y, Zheng T et al. (2016) The efficacy and complications of black diaphragm intra-ocular lens implantation in patients with congenital aniridia. Acta Ophthalmology 94: e340-e344	Case series n=15 FU=mean 26 months	Black diaphragm intra-ocular lens implantation can effectively improve visual acuity, decrease photophobia and resolve cosmetic issues in most congenital aniridia eyes. Glaucoma, corneal decompensation and visual axis opacity were the major long-term complications of BDI lens implantation in patients with congenital aniridia. All patients should be managed attentively because of high risk of complications and followed long term to achieve favourable outcomes.	Studies with more patients or longer follow-up are included.
Rossi T, Boccassini B, Iossa M et al. (2009) Combined pars plana vitrectomy and artificial iris diaphragm implant after globe rupture. Graefes Archive for Clinical & Experimental Ophthalmology 247: 439-43	Case series n=12 FU=mean 19 months	At the end of follow-up, 7 patients gained more than 2 lines (58%), 2 lost vision (17%) and 3 were unchanged (25%). Seven patients (58%) had a VA better than 20/400 and 1 (8%) 20/40 vision. Eight patients (67%) retained a clear cornea, 2 (17%) had minimal corneal oedema and 2 (17%) corneal decompensation. Implanted prosthesis included two silicone diaphragms, four PMMA diaphragms and six aniridic IOLs. After an average 1.6 operations, the retina was completely attached in 6 patients (50%), partially attached in 4 (33) and detached in 2 (17%).	Studies with more patients or longer follow-up are included.
Sminia ML, Odenthal MT, Gortzak-Moorstein N et al. (2008) Implantation of the Artisan iris reconstruction intraocular lens in 5 children with aphakia and partial aniridia caused by perforating ocular trauma.	Case series n=5 children FU=mean 9 years	Visual acuity improved in 2 of 5 eyes, remained stable in 2 of 5 eyes, and decreased in 1 of 5 eyes. Complaints of photophobia were reduced, and a satisfactory cosmetic outcome was achieved in 3 of 5 patients. The mean spherical equivalent refraction error at last follow-up was -4.0 D. Mean	Studies with more patients or longer follow-up are included.

Journal of AAPOS: American Association for Pediatric Ophthalmology & Strabismus 12: 268-72		endothelial cell loss when compared with the healthy fellow eye was 42%. Two cases were complicated by partial luxation of the IOL, one case by persistent anterior uveitis and secondary glaucoma. One eye developed a retinal detachment.	
Snyder ME, Osher RH, Wladecki TM et al. (2017) Results in combined cataract surgery with prosthetic iris implantation in patients with previous iridocyclectomy for iris melanoma. American Journal of Ophthalmology 175: 45-51	Case series n=16 FU=median 29.5 months	Best-corrected visual acuity was improved in 13 eyes (81%), remained stable in 2 eyes (12%), and decreased in 1 eye (6%). Photophobia and glare improved in every case except for 1 (94%). After surgery 12 patients (75%) reported no photophobia and 10 patients (63%) reported no glare. All iris devices were in the correct position, and all eyes achieved the desired anatomic result.	Studies with more patients or longer follow-up are included.
Spitzer MS, Yoeruek E, Leitritz MA et al. (2012) A new technique for treating posttraumatic aniridia with aphakia: first results of haptic fixation of a foldable intraocular lens on a foldable and custom-tailored iris prosthesis. Archives of Ophthalmology 130: 771-5	Case series	The combined implant was inserted through a 5-mm incision and fixated with a transscleral suture in the ciliary sulcus using a knotless technique (Z suture). In all patients, the combined implant stayed firmly fixed within the sulcus and showed a stable and centred position without any tilt or torque during follow-up. Thus, managing posttraumatic aniridia with aphakia by means of haptic fixation of a foldable intraocular lens on a custom-tailored iris prosthesis is a promising approach for visual rehabilitation and cosmetic improvement.	Small case series.
Srinivasan S, Ting DSJ, Snyder ME et al. (2014) Prosthetic iris devices. Canadian Journal of Ophthalmology 49: 6–17	Review 24 studies	Prosthetic iris devices are an effective and safe treatment modality in managing iris defects of different underlying pathologies. The quality of the evidence is not robust because most studies were retrospective case series with no controls. Further studies with longer term follow up are needed.	Review with no meta-analysis.
Srinivasan S, Yuen C, Watts M et al. (2007) Endocapsular iris reconstruction implants for acquired iris defects: a clinical study. Eye 21: 1109-13	Case series n=4 (5 eyes) FU=mean 29 months	There were no intraoperative or postoperative complications. Mean BCVA, subjective glare, and photophobia improved in all 5 eyes. Desired anatomic results were achieved in all of them.	Studies with more patients or longer follow-up are included.
Sundmacher R, Reinhard T, Althaus C (1994) Black-diaphragm intraocular lens for correction of aniridia. Ophthalmic Surgery 25: 180-5	Case series n=13 eyes FU=up to 15 months	Slight persistent intraocular inflammation was observed in all of the eyes, more obviously in the traumatic cases. Cystoid macular oedema was observed in 1 eye, but probably pre-existed in this eye,	Studies with more patients or longer follow-up are included.

		following several earlier surgical procedures. Glaucoma was observed preoperatively in 5 eyes; postoperatively, in 6. After surgery, it was controlled medically in 4 eyes, surgically in 1, and remained uncontrolled in 1.	
Taneri S, Gerding H (2003) Retinal detachment and phthisis bulbi after implantation of an iris prosthetic system. Journal of Cataract and Refractive Surgery 29: 1034–38	Case reports n=2	**Persistent inflammation, hypotony and total retinal detachment** Implantation of an iris prosthetic system combined with cataract surgery can trigger decompensation of post-traumatic eyes that have been stable over a long period.	Two case reports of safety events that are already described in table 2.
Tang S, Qiu G, Wang P et al. (2001) Management of post-traumatic aniridia with retinal detachment. Yen Ko Hsueh Pao [Eye Science] 17: 35-8	Case series n=4 FU=5 to 22 months	All 4 patients reported successful anatomic and functional reconstruction after surgery. All retinas remained attached during follow up. The final visual acuity increased from finger counting to 0.1 to 0.3.	Studies with more patients or longer follow-up are included.
Thompson CG, Fawzy K, Bryce IG et al. (1999) Implantation of a black diaphragm intraocular lens for traumatic aniridia. Journal of Cataract & Refractive Surgery 25: 808-13	Case series n=7 FU=mean 19 months	Best corrected visual acuity improved in 5 eyes and was unchanged in 1. The lens was well centred in 5 eyes. Two eyes developed secondary glaucoma, 1 requiring trabeculectomy. One eye developed infective endophthalmitis but had a visual acuity of 6/18 at last follow-up, and 1 had a vitreous and anterior chamber haemorrhage, which resolved.	Studies with more patients or longer follow-up are included.
Thumann G, Kirchhof B, Bartz-Schmidt KU et al. (1997) The artificial iris diaphragm for vitreoretinal silicone oil surgery. Retina 17: 330-7	Case series n=44 FU=409 days	Silicone oil was retained behind the open diaphragm throughout the observation period in 40% of the eyes. Major long-term complications were hypotony and fibrous overgrowth. Silicone was retained behind the closed diaphragm in 50% of the eyes.	Study focuses on the use of an artificial iris diaphragm to prevent silicone oil from entering the anterior chamber.
Toygar O, Snyder ME, Riemann CD (2016) Pars plana vitrectomy through a custom flexible iris prosthesis. Retina 36:1474-9	Case series n=20 FU=mean 16 months	Postoperative best-corrected visual acuity improved in 11 eyes (55%), remained unchanged in 5 eyes (25%), and declined in 4 eyes (20%). No intraoperative complications were noted. Short-term anatomical success was 100%. Postoperative complications occurred in 5 eyes (recurrent retinal detachment in 3 eyes, recurrent epiretinal membrane in 1 eye, and custom flexible iris prosthesis and intraocular lens subluxation in 1 eye).	Studies with more patients or longer follow-up are included.

Weissbart SB, Ayres BD (2016) Management of aniridia and iris defects: an update on iris prosthesis options. Current Opinion in Ophthalmology 27: 244-9	Review	Prosthetic iris devices can often simultaneously treat aphakia or cataract as well as aniridia, and various models are currently available around the world from Morcher GMBH (Germany), Ophtec USA Inc. (USA) and HumanOptics (Germany). Surgical planning and technique are important in optimising the safety of these devices.	Review with no meta-analysis.
Yoeruek E, Bartz-Schmidt K (2019) A new knotless technique for combined transscleral fixation of artificial iris, posterior chamber intraocular lens, and penetrating keratoplasty. Eye 33: 358-362	Case series n=5 FU=mean 24.6 months	Management of post-traumatic aniridia combined with aphakia and corneal scars or graft failure by haptic fixation of a foldable IOL on an artificial iris combined with a simultaneous keratoplasty appears to be a promising approach, which allows to correct a complex lesion with a less traumatic and faster procedure.	Studies with more patients or longer follow-up are included.