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Concurrent Plano Supplementary Sulcus Intraocular Lens Implantation During Endothelial Keratoplasty in Pseudophakic Eyes: Surgical Technique and Early Outcomes in Six Eyes

Sameer Mohammad Khan
Goulburn Valley Health
Kunind Oberoi
kunindoberoi12@gmail.com

Goulburn Valley Health
John J Males
University of Sydney

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Abstract

Purpose

Air or SF_6 tamponade during endothelial keratoplasty (EK) can calcify the primary intraocular lens (IOL) in pseudophakic eyes, and exchange from the capsular bag is hazardous. We describe concurrent implantation of a plano supplementary sulcus lens, intended as an exchangeable barrier between tamponade and primary IOL, and report its early tolerability.

Methods

Retrospective single-surgeon series at a tertiary centre in Sydney, Australia. Pseudophakic eyes receiving a plano 1stQ AddOn concurrently with EK were included. Lens-related adverse events, primary IOL clarity, intraocular pressure (IOP) and visual acuity are reported descriptively.

Results

Six eyes of six patients (mean age 73.0 years; four DMEK, two DSAEK; five repeat grafts) were included, of which five were followed beyond the first postoperative day (median 19 months, range 4 to 44). No lens-related adverse event occurred (0 of 5 evaluable eyes; 95% CI 0 to 52.2%), and no primary IOL calcification was recorded. One AddOn was retained through repeat DMEK at 44 months. Pressure-lowering treatment was started in two eyes and escalated in two; postoperative IOP exceeded 21 mmHg in two (maximum 44 mmHg), and none required glaucoma surgery. Median uncorrected acuity improved from 1.31 to 0.41 logMAR in four paired eyes, reflecting graft clearance. Given the published incidence of calcification, the probability of observing none in these eyes without any protection was about 92%.

Conclusions

Concurrent plano supplementary lens implantation during EK was feasible without lens-related complications in this small series, but postoperative IOP rise was common. The series cannot show whether the lens protects the primary IOL.

1. Introduction

Endothelial keratoplasty (EK) procedures such as Descemet membrane endothelial keratoplasty (DMEK) and Descemet stripping automated endothelial keratoplasty (DSAEK) have become the preferred surgical treatments for corneal endothelial failure.[1] Both procedures require either intracameral air or sulfur hexafluoride (SF_6) tamponade to support graft attachment. However, calcification and opacification of the primary intraocular lens (IOL) in pseudophakic patients have been reported following intracameral air and SF_6 tamponade, potentially resulting in visual impairment and need for IOL exchange.[2–4]

Exchange of an opacified primary IOL from the capsular bag can be technically challenging and can carry additional intraocular risk such as posterior capsule rupture, zonular dehiscence, vitreous loss, cystoid macular oedema, corneal decompensation, and retinal detachment.[5,6] Implantation of a supplementary plano IOL in the ciliary sulcus at the time of EK may provide an alternative strategy. The supplementary lens can act as a physical barrier between the tamponade bubble and primary IOL while avoiding additional spherical refractive correction. Furthermore, should the supplementary lens itself opacify, it can be removed from the sulcus without opening the capsular bag, which is the lens designed to be exchanged.

Concurrent DMEK with a powered hydrophobic sulcus lens has been reported for refractive correction in a single eye.[7] To our knowledge, implantation of a plano supplementary lens to shield the primary IOL from tamponade has not been described. We therefore report a case series describing the technique and its early tolerability.

2. Materials and methods

2.1 Patients

This retrospective single-surgeon case series was reported in accordance with the STROBE statement[8] and the Declaration of Helsinki, and was approved by the St Vincent's Hospital Human Research Ethics Committee, Sydney, under the low and negligible risk pathway (2026/ETH02149), with a waiver of individual consent. Patients were identified from billing records for 1stQ/Medicontur intraocular lens implantation by one surgeon (J.J.M.) between April 2021 and April 2026 (16 patients, 17 eyes; Fig. 1). One patient who had received a Medicontur lens at primary cataract surgery, without a supplementary lens, was excluded. Eligible eyes were pseudophakic eyes in which a plano AddOn was implanted

concurrently with EK. Use of a concurrent supplementary lens was at the surgeon's discretion; selection criteria were not recorded, and the number of pseudophakic EK procedures performed without a supplementary lens during the period was not available. Data were extracted retrospectively from electronic medical records.

2.2 Intraocular lens and surgical technique

The 1stQ AddOn (1stQ GmbH, Mannheim, Germany) is a single-piece hydrophilic acrylic supplementary IOL designed for ciliary sulcus fixation, with a 6.0 mm convex-concave optic, four closed-loop haptics and a 13.0 mm overall diameter. The plano model (A4SW00) has no spherical or cylindrical power, so no lens-power calculation was required. Surgery was performed under general anaesthesia. At the time of EK, the folded AddOn was implanted through a corneal incision into the ciliary sulcus anterior to the capsular-bag IOL, so that the supplementary optic lay between the tamponade bubble and the primary optic. The tamponade agent was documented in two eyes (20% SF_6 in one, air in one) and was not recorded in four. Adjunctive procedures were exchange of a pre-existing sulcus IOL with placement of four 10 − 0 nylon sutures in one eye, excision of prolapsed anterior vitreous with peripheral iridectomy in one, and anterior vitrectomy in one. Postoperative topical corticosteroids are listed per eye in Table 1.

Table 1
Per-eye clinical summary

Eye	Age / Sex / side	Concurrent graft	Previous graft(s)	Intraoperative event(s)	Longest follow-up	Preop UDVA logMAR	MRFU UDVA logMAR*	Peak IOP (mmHg)	IOP medication (anytime)	Topical corticosteroid
PT_1	60 M, OS	DMEK	None	None	29 mo	2.28	0.16	21	Timolol	Prednisolone acetate
PT_2	85 M, OD	DMEK†	DSAEK x2	AVP	4 mo	0.64	0.64	18	Simbrinza	Prednisolone acetate
PT_3	81 F, OS	DSAEK	DSAEK x1	None	16 mo	1.98	0.50	44	Combigan, Azopt, Diamox	Fluorometholone
PT_4	79 F, OS	DMEK‡	DSEK x1, DSAEK x2	None	1 day	—	—	6	None	—
PT_5	60 M, OD	DMEK	PK x1, DMEK x1	None	19 mo	0.58	0.32	28	Combigan, Simbrinza, Xalacom	Dexamethasone
PT_6	73 M, OS	DSAEK§	DSEK x1	None	44 mo	—	—	18	Azopt, Simbrinza[a]	—

M, male; F, female; OS, oculus sinister; OD, oculus dexter; DMEK, Descemet membrane endothelial keratoplasty; DSAEK, Descemet stripping automated endothelial keratoplasty; PK, penetrating keratoplasty; AVP, anterior vitreous prolapse; IOP, intraocular pressure; UDVA, uncorrected distance visual acuity; —, not recorded; MRFU, most recent follow-up. *MRFU defined as longest follow-up within 4 weeks and 10 mo.

Adjunct procedures: †Peripheral iridectomy, ‡Explantation of pre-existing sulcus IOL, §Anterior vitrectomy.

[a]Maintained on pre-op glaucoma medication post-DSAEK

2.3 Outcomes

The primary outcome was any lens-related adverse event: interlenticular opacification, pupillary optic capture, iris chafing or pigment dispersion, decentration or dislocation, and lens-related repositioning, explantation or reoperation. The co-primary outcome was calcification or opacification of the primary IOL and any resulting exchange. Both were taken from slit-lamp findings documented in routine clinical notes; no standardised retroillumination or lens-imaging protocol was used. Secondary outcomes were IOP as recorded in the clinical notes, uncorrected distance visual acuity (UDVA), corrected distance visual acuity (CDVA; best spectacle-corrected or pinhole), and graft events (rebubbling, graft failure and regrafting). Acuity was measured on a Snellen chart and converted to logMAR, with counting fingers and hand movements assigned 1.98 and 2.28 logMAR respectively.[9] Acuity was not tested inferentially, as improvement after EK reflects graft clearance rather than the plano lens. Postoperative endothelial cell density was not measured; donor density is reported where recorded.

2.4 Analysis

No hypothesis testing was performed. Results are reported per eye and as medians with ranges at approximate visits (day 1, week 1, and 2, 6 and 10 months), each eye contributing the documented visit nearest each nominal time point. Adverse events are reported as proportions with exact Clopper–Pearson 95% confidence intervals for all six eyes and for the five followed beyond the first postoperative day. For paired acuity and IOP, baseline was compared with the most recent follow-up between 4 weeks and 10 months, a window defined during data extraction to capture post-graft stabilisation while preceding late graft events. To estimate the information content of the series, the 60-month cumulative incidence of calcification reported by Memmi et al. (4.5%)[2] was applied linearly to each eye's follow-up to give the expected number of events in the absence of any protective effect. Analyses were performed in R (version 4.5.3; R Foundation for Statistical Computing, Vienna, Austria).

3. Results

3.1 Patients

Six eyes of six patients received a plano AddOn concurrently with EK between May 2022 and March 2025 (Fig. 1). Four patients were male and two female, with a mean age of 73.0 ± 10.8 years (range 60 to 85). Four eyes underwent DMEK and two DSAEK, and five were repeat grafts (median 1.0 prior EK procedure, range 0 to 3). Median follow-up was 17.5 months (range 1 day to 44 months).

The primary lens was recorded as monofocal in all six eyes, with exact model and material not documented in any. The indication was Fuchs dystrophy with pseudophakic bullous keratopathy for primary DMEK in one eye and graft failure in five (underlying Fuchs dystrophy in four, keratoconus after penetrating keratoplasty in one). Excluding the eye followed for one day, median follow-up was 19 months (range 4 to 44). Per-eye detail is presented in Table 1.

3.2 Supplementary lens and primary intraocular lens

No lens-related adverse event was recorded (0 of 6; 0 of 5 eyes followed beyond day 1, 95% CI 0 to 52.2; Table 2). No calcification or opacification of the primary IOL was recorded, and no IOL was exchanged for opacification. No rebubbling was recorded.

Table 2
Adverse events and reoperations

Event	n/N	% (exact 95% CI)
Plano supplementary lens		
Interlenticular opacification	0 / 6	0.0 (0.0 to 45.9)
Pupillary optic capture	0 / 6	0.0 (0.0 to 45.9)
Iris chafing or pigment dispersion	0 / 6	0.0 (0.0 to 45.9)
Decentration or dislocation	0 / 6	0.0 (0.0 to 45.9)
Repositioning	0 / 6	0.0 (0.0 to 45.9)
Explantation	0 / 6	0.0 (0.0 to 45.9)
Lens-related reoperation	0 / 6	0.0 (0.0 to 45.9)
Primary intraocular lens		
Calcification or opacification	0 / 6	0.0 (0.0 to 45.9)
Exchange for opacification	0 / 6	0.0 (0.0 to 45.9)
Intraocular pressure		
Peak IOP > 21 mmHg	2 / 6	33.3 (4.3 to 77.7)
Peak IOP ≥ 25 mmHg	2 / 6	33.3 (4.3 to 77.7)
Pressure-lowering medication initiated de-novo	4 / 6	66.7 (22.3 to 95.7)
Glaucoma surgery	0 / 6	0.0 (0.0 to 45.9)
Other		
Cystoid macular oedema	1 / 6	16.7 (0.4 to 64.1)
Graft re-failure	1 / 6	16.7 (0.4 to 64.1)
Subconjunctival haemorrhage	1 / 6	16.7 (0.4 to 64.1)
Transient visual disturbance	1 / 6	16.7 (0.4 to 64.1)
Epiphora with ocular surface disease	1 / 6	16.7 (0.4 to 64.1)

IOP, intraocular pressure; CI, confidence interval

PT_6's graft re-failed and was replaced by DMEK at 44 months with the AddOn left in situ; on the first day after regrafting, acuity was 3/60 and IOP 17 mmHg.

One intraoperative complication was recorded (1 of 6; 16.7%, 95% CI 0.4 to 64.1): prolapse of anterior vitreous, which was excised before lens implantation. Three further postoperative events were not attributed to either lens: cystoid macular oedema in PT_5, subconjunctival haemorrhage with a transient visual disturbance in PT_1, and epiphora with ocular surface disease in PT_6.

3.3 Intraocular pressure

Median IOP was 17.0 mmHg preoperatively (range 6 to 26), 8.0 mmHg at one week, 19.5 mmHg at two months and 12.0 mmHg (range 10 to 26) at most recent follow-up within the window (Fig. 4). Postoperative IOP exceeded 21 mmHg in two eyes (33.3%, 95% CI 4.3 to 77.7). PT_3 recorded 33 mmHg at about 5.5 weeks and 44 mmHg at seven months during non-adherence to topical therapy, the latter resolving after a single dose of oral acetazolamide; PT_5 peaked at 28 mmHg at about 15 months, having measured 26 mmHg before surgery. Pressure-lowering treatment was started in two eyes and added to existing brimonidine/timolol in two (4 of 6; 66.7%, 95% CI 22.3 to 95.7); a fifth eye continued pre-existing glaucoma therapy unchanged. No eye required glaucoma surgery.

3.4 Visual acuity

Preoperative UDVA was a median 1.31 logMAR (range 0.58 to 2.28) in the four eyes with a baseline measurement. Acuity fell transiently on the first postoperative day with the anterior chamber air- or SF_6-filled, before recovering to a median 0.49 logMAR at one week and 0.32 at both six

and ten months (Fig. 2). Among the four eyes with both a baseline and a follow-up measurement within the analysis window, acuity improved from a median 1.31 to 0.41 logMAR, with three of four eyes improving and one unchanged.

CDVA was recorded too inconsistently for comparison, with only two eyes having paired values; both improved, from 1.98 and 0.52 to 0.18 logMAR each at 10 months (Fig. 3).

Two eyes fell outside the analysis window. One was followed only to the first postoperative day, at hand movements. The other had no acuity recorded between day 1 and 40 months. Vision was 1.40 logMAR at 40 months and 0.60 logMAR at 44 months, immediately before regrafting for graft re-failure.

4. Discussion

In six eyes, a plano supplementary sulcus lens was implanted at the time of EK without recorded lens-related complications over a median 17.5 months, with no interlenticular opacification, optic capture, iris chafing or malposition, no lens explantation, and no opacification or exchange of the primary IOL. One lens was retained through a further DMEK at 44 months.

The problem a plano supplementary lens addresses is uncommon but consequential. In a large retrospective series the cumulative incidence of IOL calcification after EK in pseudophakic patients was 4.5% ± 1.3% at 60 months, independently associated with hydrophilic acrylic IOL material ($P < 0.001$) and use of SF_6 for anterior chamber tamponade ($P = 0.001$).[2] This is particularly relevant in an era where SF_6 has become increasingly routine particularly during DMEK, providing a longer-lasting tamponade than air and reducing rebubbling by 58% with no significant difference in endothelial cell loss.[10] However, the risk is not confined to SF_6. Similar cases of primary IOL opacification have been described after air tamponade, which may be preferred for DSAEK.[3,4]

Contrary to Memmi et al.'s large series,[2] the risk may not be confined to hydrophilic lenses. In a Cologne cohort the distribution of hydrophilic and hydrophobic material was comparable between affected and unaffected eyes ($P = 0.677$), leading those authors to conclude that hydrophilic lenses per se carry no higher risk and three affected eyes had a hydrophobic or hydrophobic-surfaced optic.[3] The AddOn is itself hydrophilic acrylic, the material independently associated with calcification after EK,[2] and supplementary lenses are not immune. Among seven polypseudophakic eyes with explanted calcified lenses, all with hydrophilic Sulcoflex supplementary lenses, the only eye that underwent DSAEK developed calcification of both lenses, densest in the supplementary lens.[11] Hydrophilic material is nonetheless favoured for sulcus fixation for its uveal biocompatibility,[11] and experimental work localises calcification to the meniscus where bubble, aqueous and optic meet.[12] The rationale here is therefore not that the AddOn resists calcification, but that it occupies that interface and, if it opacifies, can be removed from the sulcus without opening the capsular bag. A hydrophobic sulcus lens has been combined with DMEK in a single eye;[7] whether it would provide the same barrier at lower risk is untested.

Nevertheless, neither risk factor is reliably modifiable at the time of grafting. Tamponade can be chosen, but air is itself implicated; material is chosen at cataract surgery, often years earlier and elsewhere. In the Cologne cohort the IOL type was unrecoverable in 296 of 550 unaffected eyes (54%) because cataract surgery had been performed externally,[3] and the primary IOL model was not recorded in any eye here. A supplementary lens interposed between bubble and primary optic is agnostic to both, addressing the contact rather than the agent or the substrate. Critically, this is achieved without disturbing the capsular bag, avoiding the posterior capsule rupture, zonular dehiscence and vitreous loss that attend lens exchange in an eye already committed to a corneal transplant.[5,6]

No lens-related complication was recorded in this series, consistent with the lens design. The AddOn's convex-concave optic vaults anteriorly away from the primary lens. Its rounded, posteriorly angulated haptics are intended to maintain clearance from the iris, which are features developed specifically to avoid the interlenticular opacification, pigment dispersion and optic capture that complicated earlier renditions of 'piggyback' implantations.[13,14] Our findings are consistent with a series where nine eyes were implanted for negative dysphotopsia, which described no adverse events or opacification.[15] Our eyes differ substantially, being repeatedly grafted, inflamed and gas-filled.

This study has several limitations. Six eyes from a single surgeon, analysed retrospectively without a comparator, cannot establish whether the technique confers benefit; zero events carry an upper 95% confidence bound of 45.9%, and no attributable risk can be estimated for any outcome. The series also cannot detect the outcome the technique is intended to prevent. Applying the 60-month cumulative incidence of 4.5%[2] linearly to each eye's follow-up, the expected number of calcifications without any protection is 0.08, and the probability of observing none is 92% (76% even had every eye completed five years); about 35 unprotected eyes followed for five years would be needed to expect at least one event with 80% probability. Ascertainment was limited by the retrospective design. Eyes were selected at the surgeon's discretion without recorded criteria, the number of eyes grafted without a supplementary lens is unknown, the tamponade agent was recorded in only two eyes, and the primary lens model and material were unrecorded in every eye. Lens findings came from routine slit-lamp notes without a standardised retroillumination or imaging protocol, so the absence of recorded calcification may not exclude early or subtle deposits. In that

same cohort calcification was first recognised at a mean 53.4 ± 43.5 weeks (range 6 to 144); four of our five evaluable eyes were followed beyond that mean, but only one beyond 144 weeks.[3] Endothelial cell density was not measured, and one eye contributed a single postoperative day. The absence of a comparator likewise prevents attribution of the pressure findings, since corticosteroid response, tamponade and angle crowding by a sulcus implant are indistinguishable in the four of six eyes requiring treatment.

In conclusion, concurrent implantation of a plano supplementary sulcus IOL during EK was technically feasible in six eyes, with no recorded lens-related adverse events over a median 17.5 months and no recorded opacification or exchange of the primary IOL, although postoperative IOP rise was common. In one eye the supplementary lens was retained through a subsequent DMEK, suggesting the construct does not preclude regrafting. The rationale for the technique is that it addresses the contact between tamponade and optic rather than the agent or the lens material, neither of which is reliably modifiable once an eye presents for grafting. Whether it confers protection cannot be determined from six uncontrolled eyes in which the primary lens material was unknown, and these data establish tolerability rather than efficacy or safety. Prospective evaluation recording lens material at entry, imaging both optics at fixed intervals, and comparing against eyes grafted without a supplementary lens would be required to answer the question this series can only raise.

Declarations

Conflicts of interest:

The authors declare no relationship with 1stQ GmbH (Mannheim, Germany) and no other competing interests.

Ethics approval:

This study was approved by the St Vincent's Hospital Human Research Ethics Committee, Sydney, under the low and negligible risk pathway of the National Statement on Ethical Conduct in Human Research (2025) (2026/ETH02149; approved 1 October 2026), and was conducted in accordance with the Declaration of Helsinki.

Informed consent:

The requirement for individual consent was waived for this retrospective analysis of de-identified data for this low and negligible risk project.

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The authors declare that no funding was received for this work.

Author Contribution

S.M.K.: methodology, visualisation, writing (original draft). K.O.: methodology, visualisation, writing (original draft). J.J.M.: data curation, formal analysis, conceptualisation, investigation, resources, supervision, writing (review and editing). All authors approved the final manuscript.

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Data Availability

The de-identified eye-level and longitudinal datasets supporting this study are available from the corresponding author on reasonable request.

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Figures

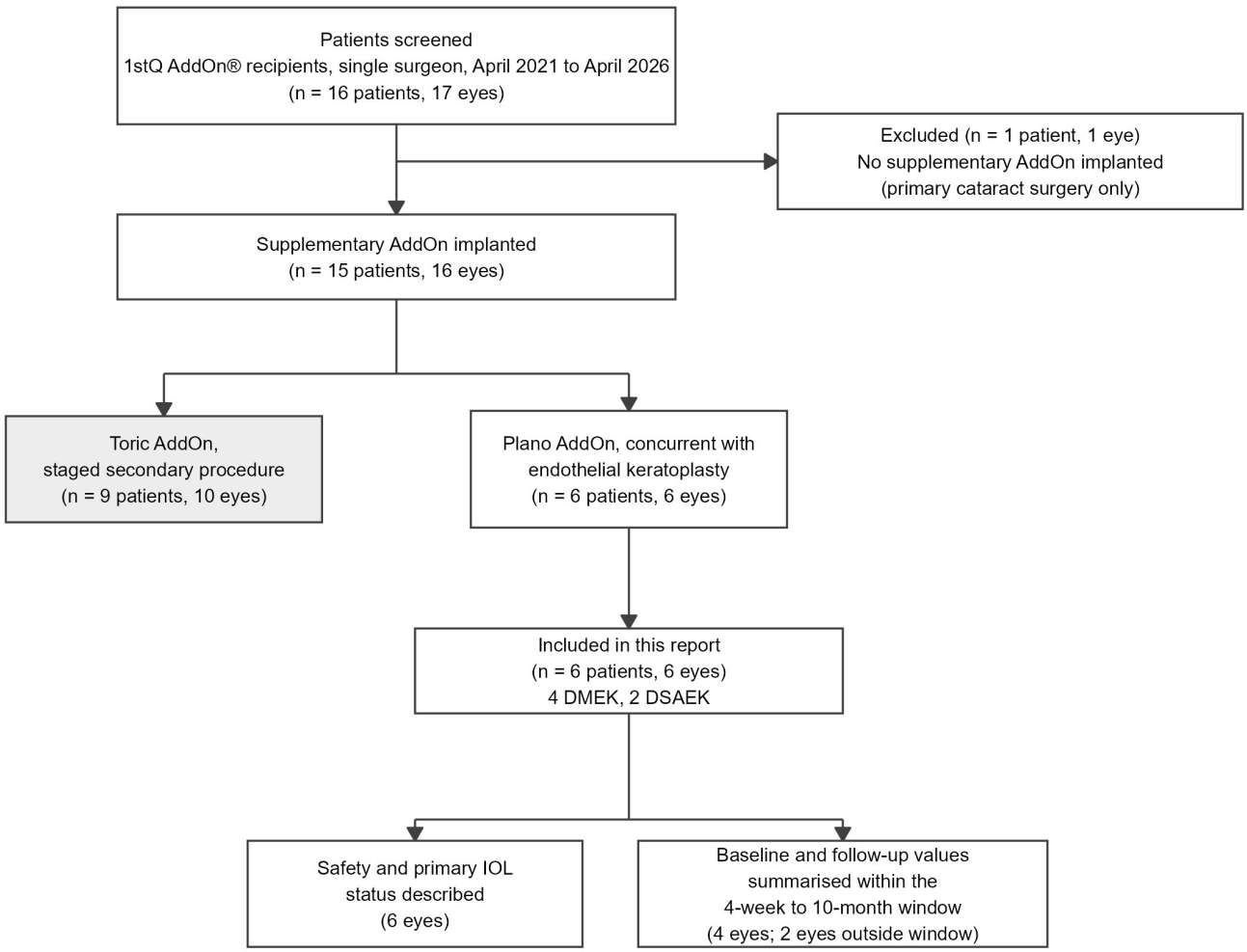


Figure 1

STROBE participant flow diagram

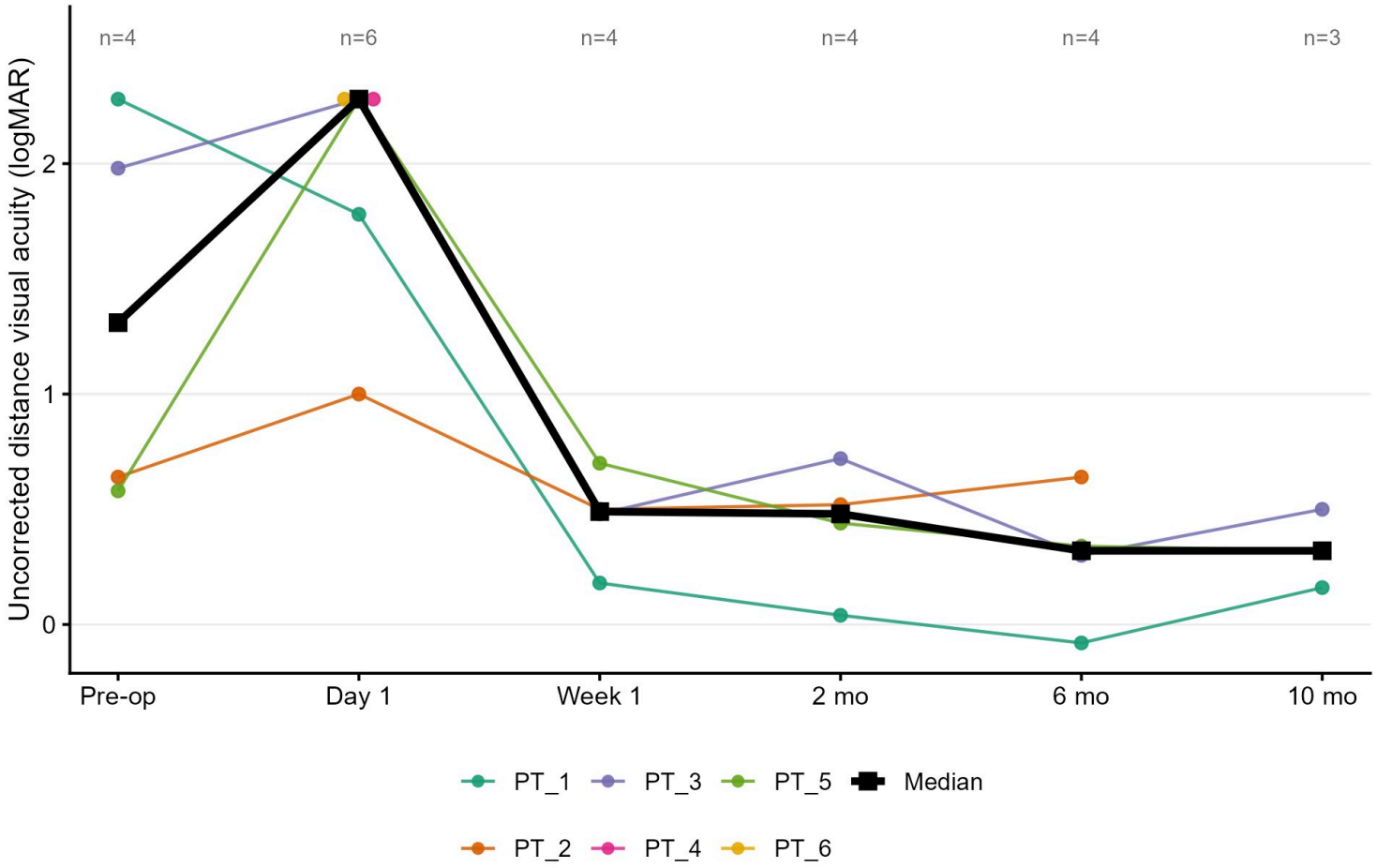


Figure 2

Uncorrected distance visual acuity from baseline to 10 months

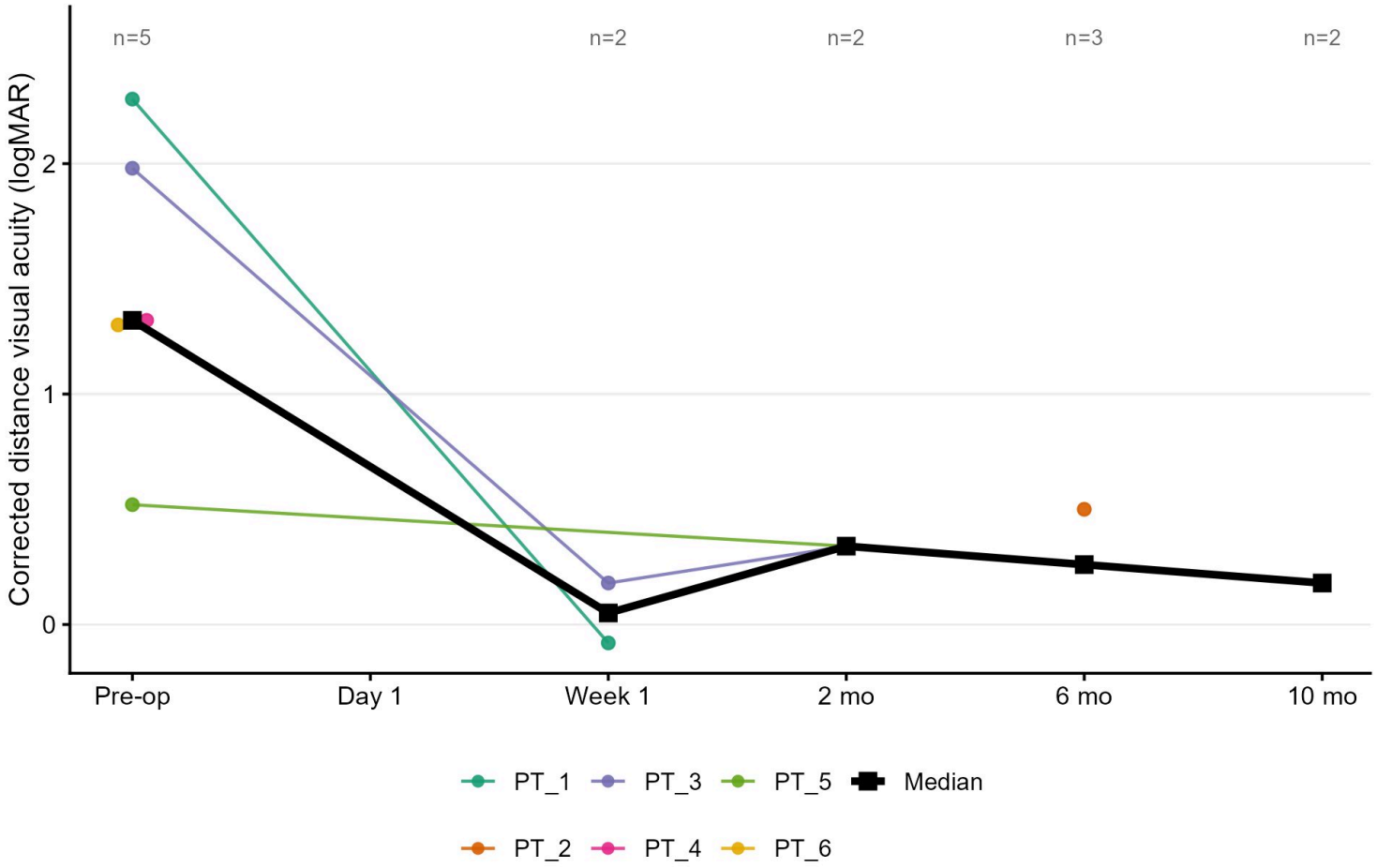


Figure 3

Corrected distance visual acuity from baseline to 10 months

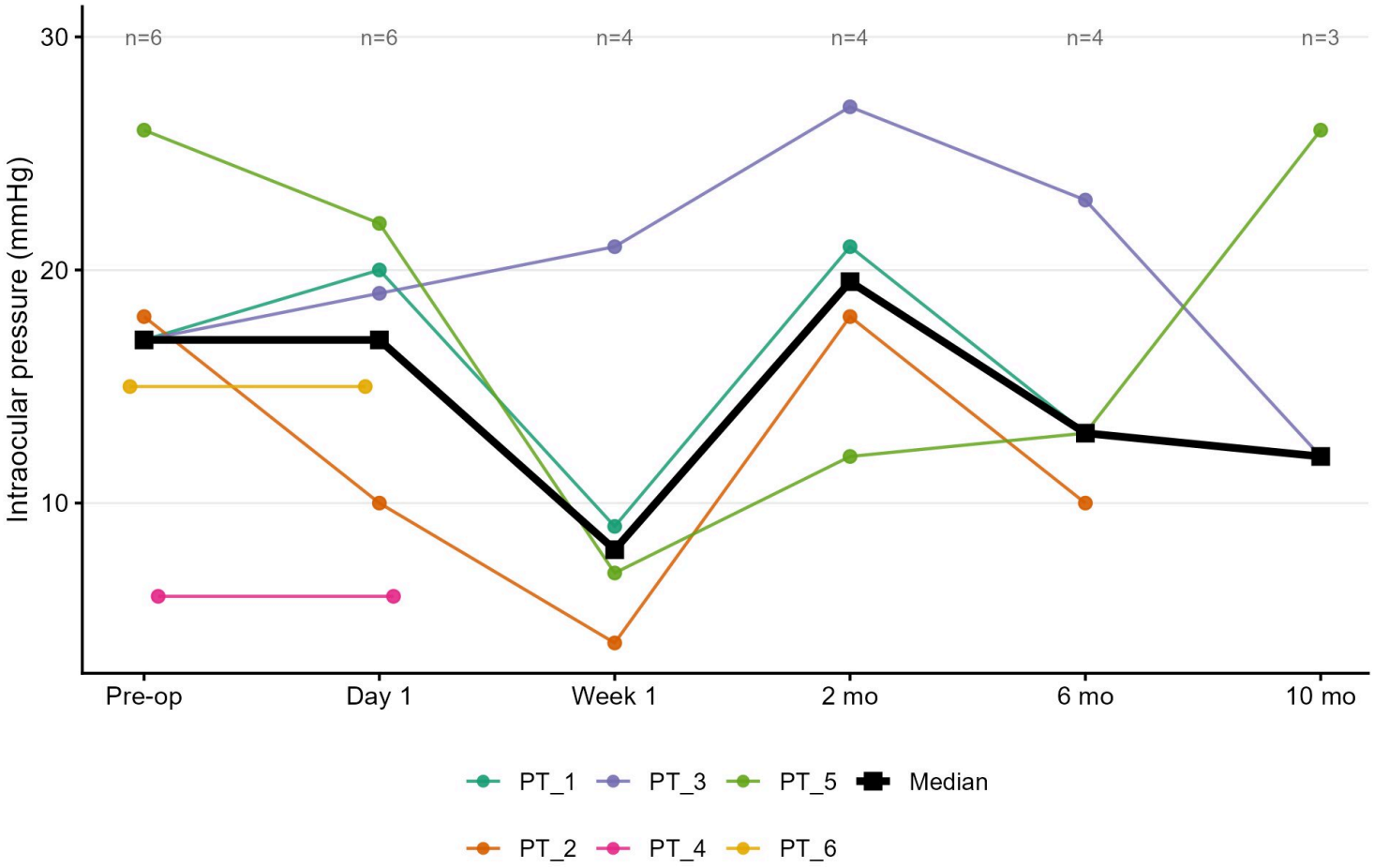


Figure 4

Intraocular pressure from baseline to 10 months