Contact Lens and Anterior Eye 42 (2019) 123–126

Contents lists available at ScienceDirect

Contact Lens and Anterior Eye

journal homepage: www.elsevier.com/locate/clae

The treatment of ocular hypotony after trabeculectomy with a scleral lens: A case series☆

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ARTICLE INFO

Keywords:
Hypotony
Tamponade
Bandage lens
Scleral lenses
Extended wear
Infection risk

ABSTRACT

Purpose: Ocular hypotony after trabeculectomy may be treated medically, surgically and with a tamponade. Three cases are reported in which a scleral lens was applied to treat ocular hypotony after mitomycin C (MMC) augmented trabeculectomy.

Methods: In this retrospective case series the records of three eyes of three patients who developed ocular hypotony after they had undergone trabeculectomy augmented with MMC were evaluated. The patients were between 11 and 69 years of age and the intraocular pressure (IOP) after surgery ranged between 3 and 6 mmHg. All three patients showed a negative Seidel test; one had suspected hypotonic maculopathy and one had a collapsed anterior chamber. After unsuccessful treatment with large bandage lenses all three patients were subsequently fitted with a scleral lens. The scleral lens was fitted to fully cover and compress the bleb. Scleral lenses were worn continuously with a check-up after one night of wear and subsequent check-ups when needed. One patient continued to wear the scleral lens for a further 6.5 months on a daily wear basis.

Results: In all three eyes the IOP was higher after wearing the scleral lens. Two patients stopped wearing the scleral lens after the IOP was stable. One patient developed a cataract; the cataract surgery was combined with a bleb revision and scleral lens wear was therefore discontinued.

Discussion: The scleral lens might be a useful tool in the treatment of ocular hypotony after trabeculectomy augmented MMC surgery. The effect of the scleral lens on the ocular pressure is unpredictable. Caution is advised in vulnerable corneas due to risk factors such as hypoxia and infection. Further research is warranted to establish the safety of the procedure, the patient selection and the overall success in a larger patient group.

1. Introduction

The term glaucoma describes a group of ocular disorders with multifactorial aetiology however with intraocular pressure-associated optic neuropathy as a united clinical characteristic [1]. The treatment of glaucoma is generally aimed at lowering the IOP either by decreasing the formation of aqueous fluid or increasing the outflow of fluid. Trabeculectomy is a surgical procedure to reduce IOP by increasing the outflow of aqueous fluid [2]. To allow aqueous fluid to flow out of the eye an opening is created beneath a partial thickness scleral flap into the anterior chamber [3]. A bulging (filtering bleb) arises due to the aqueous outflow into the subconjunctival space.

Antimetabolites (also described as anti-fibrotic agents), such as mitomycin C (MMC), are used as part of the treatment to prevent bleb failure due to scarring [4]. A complication of trabeculectomy is ocular hypotony, often combined with a shallow or flat anterior chamber and/or posterior pole abnormalities. An IOP of less than 6.5 mmHg, three standard deviations below the mean, is described as ocular hypotony [5]. Ocular hypotony occurs at a rate of 1.3–30% and the use of MMC is a risk factor [6].

Several methods of management of post-operative hypotony have been developed [5,7,8]. Treatment algorithms for ocular hypotony are proposed by Tunç et al and Hyung et al [7,8]. However, treatment is dependent on correctly identifying the cause of the hypotony [5].

☆ This research did not receive any specific grant from funding agencies in the public, commercial or not-for-profit sectors

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https://doi.org/10.1016/j.clae.2018.10.018
Received 30 June 2018; Received in revised form 7 October 2018; Accepted 23 October 2018

Conservative treatment of filter bleb leaks can be medical with aqueous suppressants; decreased production of aqueous fluid may decrease flow though the bleb and thus promote healing [5,9]. More invasive treatment is surgical with a non-resorbable suture over the bleb [5,10] or via bleb revision [5]. However, in selected cases various kinds of tamponade may be adequate. Examples of tamponades applied are a pressure patch, a (large) soft bandage lens, a symblepharon ring or a Simmons shell [3,5,7,8,11–16].

In this case series the effectiveness of a rigid gas permeable, non-fenestrated scleral lens, as a tamponade, in the management of ocular hypotony after MMC augmented trabeculectomy and unsuccessful treatment with a large diameter bandage contact lens is evaluated.

2. Methods

The records of three patients with ocular hypotony after they had undergone trabeculectomy augmented with MMC were evaluated. This study was conducted according to the principles of the declaration of Helsinki (version 64, October 2013) and in accordance to Good Clinical Practice and other guidelines, regulations and Acts.

Three eyes of three patients were fitted with a scleral lens after MMC augmented trabeculectomy. The patients' ages were between 11 to 69 years and the IOP ranged between 3 mmHg and 6 mmHg. All three eyes showed a negative Seidel, one eye had suspected hypotonic maculopathy and one had a collapsed anterior chamber. After unsuccessful treatment with a large bandage lens of 20 to 20.5 mm all three eyes were subsequently fitted with a scleral lens. The scleral lens designs used were large-scleral lenses, according to the Scleral Lens Education Society nomenclature [17]. The scleral landing zone design was either curved or tangential in shape. Scleral lenses were fitted diagnostically from an extensive collection of practice-owned commercial trial lenses. The choice of lens was based on an on-eye estimation of the shape of the cornea and sclera. The fitting of the scleral landing zone, corneal and limbal clearance and lens diameter were assessed after 15 to 30 min of wear and, if necessary, a different lens was placed and reassessed. The scleral landing zone was fitted to align and equally distribute the pressure on the sclera except on the bleb which was compressed. The scleral lens clearance was fitted as minimally as possible with the available scleral lens set. In Table 1 the fitted scleral lens design and parameters are displayed. The fitting was graded according to the Visser Contact Lens Practice method, see Table 2 [18].

3. Results

Scleral lenses were worn on an extended wear (EW) basis and the patients were prescribed antibiotics to use during scleral lens wear. The scleral lenses were checked after one night of wear and then subsequently checked within one week. At the same time the eyes were also checked by an ophthalmologist. At the consultations the fit was evaluated together with the cornea and the anterior chamber depth. Special attention was paid to signs of hypoxia and inflammation. At the follow-up consultations if the scleral lens was removed, the IOP was monitored as well as the lens being cleaned and re-inserted, if needed.

Table 1
Scleral lens selection and parameters.

Case	Design	Dk	Sagitta (mm)	BCR (mm)	Scleral landing zone (mm/°)	Diameter (mm)
1	Curved	85	3.87	8.1	12/11.85 mm	20
2	Curved	85	4.27	8.1	12.25/11.80mm	20
3	Tangential	100	4.2	8.2	46/48°	20

(Dk = oxygen permeability, mm = millimetre, ° = degrees).

3.1. Cases

3.1.1. Case 1

An 11-year-old Caucasian male had an MMC assisted trabeculectomy. One day post-operatively he had a flat anterior chamber. A 20 mm and 20.5 mm diameter hydrogel bandage lens, which both fully covered the bleb, was fitted. After 6 days of extended wear the treatment appeared unsuccessful as the anterior chamber was flat and the IOP 2 mmHg. The bandage lens wear was discontinued, and a scleral lens was fitted. The first trial lens fitted well and was left on the eye. At the follow-up after one day and night of wear the clearance and landing zone fitted optimal with minimal debris in the clearance. The anterior chamber had re-formed, the cornea showed no oedema and the conjunctival hyperaemia was grade 1. The scleral lens was left in the eye. The anterior chamber remained re-formed on day 3 of extended wear and the IOP measured 8 mmHg. Scleral lens wear was ceased, and the anterior chamber remained re-formed. The bleb function remained stable and IOP between 10–18 mmHg at the regular follow-ups over a 7-year period until the last check in June 2018.

3.1.2. Case 2

A 15-year-old Caucasian female developed macular hypotony after MMC assisted trabeculectomy, with an IOP of 6 mmHg. A bandage lens was worn unsuccessfully for 34 days with the IOP remaining at 6 mmHg and no change in the hypotony maculopathy. Therefore, a scleral lens was fitted, see Fig. 1. Based on the initial trial lens, a second lens was fitted to increase the sagittal height and flatten the landing zone to achieve an optimal fitting. At follow-ups after 1 night and 7 nights of wear the lens was removed and the IOP measured each time, respectively 8 mmHg and 9 mmHg.

After 15 days of EW of the scleral lens the IOP was 14 mmHg and the hypotony maculopathy showed improvement on the OCT. However, occasionally the eye appeared red and active neovascularisation was seen during slit lamp investigation. She was advised to remove the scleral lens every day for 2 h. The redness resolved. After 7 days scleral lens wear was ceased at night but continued during the day as the macular hypotony was stable with the scleral lens in situ and the vision improved when wearing the scleral lens. The patient was monitored at regular intervals with the IOP measuring between 5–10 mmHg shortly after lens removal, reducing to 2 mmHg if the lens was left out for a longer period of time. However, after 6.5 months she developed a cataract and the bleb was surgically restored during the cataract extraction and IOL placement. Scleral lens wear was ceased thereafter.

3.1.3. Case 3

A 69-year-old Caucasian male was treated for ocular hypotony with an IOP of 2 mmHg and folds in Descemet's membrane, 3 days after MMC assisted trabeculectomy. A large bandage lens was fitted to fully cover the filter bleb and worn for 4 days. The treatment was unsuccessful with the IOP measuring 3 mmHg and unchanged appearance of the folds in Descemet's membrane. The decision was made to cease bandage lens wear and fit a scleral lens. Two trial lenses were inserted, and in both the scleral landing zone fitted too flat, a third trial lens fitted well and was left on the eye. A follow up was planned after 1 day of wear, 3 days of wear and on the sixth day of wear. On the first and third day of wear the fitting was optimal and the Descemet folds improved. After 6 days of extended scleral lens wear the IOP was 39 mmHg. The bleb was massaged to reduce the pressure to 16 mmHg. The scleral lens wear was ceased and a 250 mg daily dosage of acetazolamide prescribed for 3 days. The optic nerve appeared unchanged to previous assessment. The IOP was monitored after one day (20 mmHg) and two days (10 mmHg). The IOP and bleb were monitored at regular intervals for one-year post trabeculectomy and measured between 11–13 mmHg with a well-functioning bleb. There were no further follow-ups due to a transfer to another hospital ophthalmology department.

Table 2
Scleral lens wear and fitting characteristics, * except pressure on bleb.

Case	Fitting of the scleral landing zone	Scleral lens clearance (μm)	Extended scleral lens wearing time (days)	Prescribed antibiotics
1	No blanching*	300	3	Chloramphenicol
2	No blanching*	300	22	Chloramphenicol
3	No blanching*	450	6	Ofloxacin

(μm = micrometre).

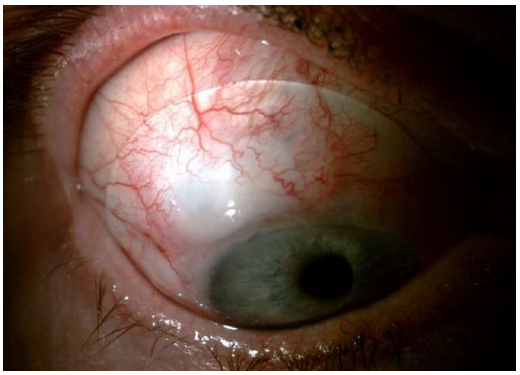

Fig. 1. Scleral lens in situ covering the filter bleb.

4. Discussion

In this case series, three cases of ocular hypotony were treated with a scleral lens as a tamponade after unsuccessful treatment with a large bandage lens. However, this case series is limited due to the sample size of only three cases with ocular hypotony.

Several types of tamponading have been used in hypotony; however, not many studies have been conducted to assess the success of each treatment. Table 3 shows an overview of the current literature on the use of a tamponade as treatment of ocular hypotony.

A large bandage lens has been used successfully as a tamponade in treatment for ocular hypotony in 64–100% of the cases described in the literature [7,11,12,19–21]. A scleral lens might be an extra tool to exert more pressure on the bleb compared to a bandage lens, as all cases were first unsuccessfully treated with a bandage lens. However, in case three the IOP increased to 39 mmHg demonstrating that the effect of the scleral lens on the ocular pressure is unpredictable. The risk of prolonged raised intra-ocular pressure (and subsequent damage to the optic nerve and bleb failure) needs to be considered if a scleral lens is applied. To minimize this risk daily lens removal, eye assessment and IOP measurement should be incorporated in the care regime, except for patients with a flat anterior chamber when the scleral lens should be left in the eye.

In both contact lens modalities infection risk needs to be considered. Extended wear has been associated with a 10– to 15– fold increase in infection risk [22]. In a review of bandage lens wearers for ocular surface disease, 2% developed infectious corneal infiltrates [23]. However, the infection risk in this indication might be closer to the infection risk of extended wear of soft lenses, which is 19.5–24.5 per 10,000 [24]. Neither the risk of microbial keratitis in scleral lens wear nor the risk factors have been defined [25,26], since most of the patients in studies and case reports have severe ocular surface disease, which makes it difficult to determine whether the infection is due to the ocular surface disease or the scleral lens wear [25]. Based on studies of small groups of patients with ocular surface disease risks of 0.5% [27] and 1.6% [28] have been reported [25]. In the SCOPE study a rough estimation is made of 70 cases of microbial keratitis from 84,375 patients (0.1%) [29].

Ciralsky et al have described a scleral lens care regime for extended wear in compromised corneas; daily removal, cleaning and reinsertion with replacement of the reservoir fluid with an antibiotic drop [30]. In this case series the scleral lenses are worn on eyes without severe ocular surface disease and none developed infectious keratitis. Nonetheless, as part of the proposed daily eye assessment and IOP measurement future advice would be to incorporate daily lens cleaning and reinsertion as a preventative measure.

Hill et al reported six out of seven cases were successfully treated with a symblepharon ring used as a tamponade. With the seventh case failing due to inability to achieve appropriate fitting of the ring. Also, a fenestrated, 22 mm, non-oxygen permeable scleral lens (Simmons shell) has been used [16]. The Simmons scleral shell was reported successful in 3 out of 10 cases but had complications such as corneal abrasions and 1 corneal ulcer [14]. Modern scleral lenses (oxygen permeable, non-fenestrated) are widely used in medical contact lens practice and trial sets in varying scleral landing zone designs have been developed [18]. Therefore, the chance of achieving an appropriate fit is greater than with the Simmons shell or a scleral ring.

Extended wear of scleral lenses has been reported to cause hypoxia-induced corneal changes [31–34]. Corneal tissue depends on oxygen flux of approximately 100 mmHG for healthy metabolism [31].

Table 3
Overview on use of tamponade in ocular hypotony after trabeculectomy.

Reference	Year	Article type	Type of tamponade	N (eyes)	N (eyes) successfully treated with tamponade
Smith et al [11]	1996	Retrospective case record study	Bandage lens (17mm)	10	9 (90%)
Blok et al [12]	1990	Prospective longitudinal study	Bandage lens (20.5mm)	15	13 (87%)
Shoham et al [19]	2000	Prospective longitudinal study	Bandage lens (17.5mm)	24	22 (92%)
Tunç et al [7]	2015	Retrospective study	Bandage lens (14mm)	50	32 (64%)
Wu et al [20]	2015	Prospective longitudinal study	Bandage lens (14mm)	11	11 (100%)
Gollakota et al [21]	2017	Retrospective study	Bandage lens (> = 15 mm)	19	17 (89%)
Hill et al [13]	1990	Case series	Symblepharon ring	7	6 (86%)
Rajeev et al [14]	1991	Case series	Simmons shell	10	3 (30%)

(mm= millimetre).

Calculations to predict oxygen transmissibility of scleral lens systems have shown that wearing scleral lenses is likely to lead to some level of hypoxia-induced corneal swelling [31,32]. Several case reports and studies have shown hypoxia-induced corneal changes related to low oxygen permeable scleral lens materials and clearance thickness [33–35]. Recommendations are to use contact lens material with a Dk > 150, a maximal central scleral lens thickness of 250 µm and a clearance that does not exceed 200 µm [31,32]. Thus, when fitting a scleral lens in ocular hypotony the lowest possible clearance needs to be achieved together with the use of high oxygen permeable materials. In these cases, a scleral lens needed to be fitted and dispensed as soon as possible and therefore a scleral lens was chosen from a collection of trial lenses as there was not enough time to manufacture a bespoke lens. The clearance was fitted as minimally as possible but didn't follow these recommendations due to the limitations of the trial set.

In this case series the scleral lenses were worn between 3 and 22 days EW. No complications were seen in case 1 and 3 but in case 2 the EW of the scleral lens was ceased after 22 days of wear due to signs of hypoxia. The DW could be continued for a further 6.5 months without further complications.

5. Conclusion

Scleral lenses might be a useful tool in the treatment of ocular hypotony after trabeculectomy surgery when a large soft bandage lens fails. However great care should be taken as the effect of the scleral lenses on the ocular pressure is unpredictable. A care regime to remove, clean the scleral lens and measure the IOP on a daily basis is suggested to minimize the risk of bleb failure, infection and damage to the optic nerve by prolonged raised IOP. Special attention should be given to vulnerable corneas due to risk factors of hypoxia and infection. Further research is warranted to establish the safety of the procedure, the patient selection and the overall success in a larger patient group.

Declarations of interest

None.

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