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Effect of active evaluation on the detection of negative dysphotopsia after sequential cataract surgery: discrepancy between incidences of unsolicited and solicited complaints

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ABSTRACT.

Purpose: **To evaluate the incidence of negative dysphotopsia after sequential cataract surgery.**

Methods: **Retrospective cohort study. The incidence of negative dysphotopsia was assessed by retrospective reviewing of medical records and interviews with patients between 2 and 4 months after sequential cataract surgery. Inclusion criteria were uncomplicated surgery, postoperative corrected distance visual acuity (CDVA) ≥20/25 Snellen and the absence of ocular comorbidity. The majority of intra-ocular lens (IOL) implants were one-piece AcrySof SN60WF (161 eyes). Other IOLs (29 eyes) were toric (SN6AT3-6), spherical (SN60AT), three-piece (MN60MA) and multifocal (ReSTOR SN6AD1, PanOptix TFNT00 and Finevision Micro F trifocal).**

Results: **The study population was comprised of 95 patients with a mean age of 72 ± 10 years. Unsolicited complaints of negative dysphotopsia were reported by eight patients (8%), and two of them had a resolution of symptoms within 1 month of follow-up. Eighteen patients (19%) reported negative dysphotopsia at the time of the interview. Two patients reported bothersome negative dysphotopsia, and one of them was successfully treated with implantation of a supplementary IOL in the ciliary sulcus. Patients with negative dysphotopsia were younger than patients without dysphotopsia ($p = 0.045$) and had shorter axial eye length ($p = 0.04$), a tendency for higher IOL power ($p = 0.09$) and a higher CDVA ($p = 0.001$).**

Conclusion: **The incidence of unsolicited negative dysphotopsia after sequential cataract surgery appears to be a substantial underestimation of complaints identified in active interviewing. Although symptoms are not bothersome in the majority of cases, some patients with undiagnosed severe negative dysphotopsia may benefit from reassurance or secondary treatment.**

Key words: cataract surgery – incidence – negative dysphotopsia – unwanted optical phenomena

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Introduction

Current cataract surgery is a safe procedure with a highly predictable outcome. However, despite excellent surgical results (e.g. good visual acuity) from the perspective of the ophthalmologist, some patients may be dissatisfied with the quality of vision after surgery. Kinard et al. (2013) recently analysed the factors, which might contribute to satisfaction after cataract surgery in a cohort of healthy patients with excellent visual acuity (VA) and the absence of complaints during follow-up consultations. They concluded that unwanted optical phenomena, such as positive and negative dysphotopsia, were the major causes of dissatisfaction (Kinard et al. 2013).

Negative dysphotopsia is a well-known complication of cataract surgery, which is characterized by the presence of a dark shadow obscuring the temporal field of vision. A review by Henderson & Geneva (2015) summarized factors that may contribute to the development of negative dysphotopsia as proposed by former research: edge design, in particular, thickness and smoothness (Davison 2000, 2002; Narvaez et al. 2005; Osher 2008; Holladay et al. 2012; Holladay & Simpson 2017), refraction index of the IOL (Davison 2000, 2002; Narvaez et al. 2005; Trattler et al. 2005; Radford et al. 2007; Holladay et al. 2012), shape of the IOL (Holladay & Simpson

2017), pupil size (Trattler et al. 2005; Masket & Fram 2011; Holladay et al. 2012; Holladay & Simpson 2017), extension of functional nasal retina (Holladay et al. 2012), incision oedema (Osher 2008), iris–IOL distance (Osher 2008; Vamosi et al. 2010; Holladay & Simpson 2017), cornea shape (Davison 2000), prominent globe and shallow orbit (Osher 2008), larger positive angle κ (Holladay & Simpson 2017) and interaction between the IOL and the anterior capsulorhexis (Hong et al. 2011; Masket & Fram 2011; Cooke et al. 2013; Folden 2013; Masket & Fram 2013; Holladay et al. 2012 Holladay & Simpson 2017). The incidence of negative dysphotopsia varied highly dependent on the duration of follow-up and the method used to categorize the symptoms (Table 1). Although it is widely assumed that in most cases negative dysphotopsia is transient and resolves spontaneously within 6 months (Davison 2000, 2002; Osher 2008), published incidence rates do not completely agree with this assumption. Three longitudinal studies with questionnaires showed a decrease in the incidence of negative dysphotopsia from 8% to 25% of operated eyes in the first postoperative week to 0–3.2% 6 months postoperatively (Bournas et al. 2007; Radford et al. 2007; Osher 2008; Henderson et al. 2016). Incidences reported in cross-sectional studies using self-reported questionnaires varied from 4.3% to 20% of patients 6 months after surgery (Aslam et al. 2007; Jin et al. 2009; Kinard et al. 2013). Remarkably, up to 20% of patients who never reported dysphotopsia to their eye doctor reported to experience it 1 year after surgery and 6% of patients reported severe negative dysphotopsia when actively questioned (Kinard et al. 2013). Finally, although the incidence of negative dysphotopsia in patients who were not directly asked about the symptoms is low in most cases (below 2.7%) (Davison 2000, 2002; Vamosi et al. 2010; Kim 2014; Wenzel et al. 2015), two studies showed that 6.7% of patients with monofocal IOLs (Narvaez et al. 2005) and 25.9% with multifocal IOLs (Agulair 2014) reported negative dysphotopsia to their doctor.

The goal of this study was to evaluate and compare the incidence of unsolicited and solicited complaints of negative dysphotopsia in a population of pseudophakic patients.

Patients and Methods

The study population consisted of patients who underwent sequential cataract surgery in the University Eye Clinic Maastricht and had a 1-month follow-up visit between 15 July 2015 and 17 September 2015. Three hundred and thirty-one medical files were screened, and 226 patients were excluded from the study (Figure 1). The exclusion criteria were the presence of ocular comorbidity, which may reduce the detection of negative dysphotopsia, such as advanced Fuchs' endothelial dystrophy, glaucoma, advanced age-related macular degeneration, central visual loss, history of intra-ocular surgery other than cataract surgery, postoperative CDVA <20/25 Snellen, Nd:YAG posterior capsulotomy or physical or mental impairment that might hinder participation in the study. The high exclusion rate in this study was related to a high prevalence of the above-listed ocular comorbidity among patients with cataract in our referral University Eye Clinic. Five excluded patients had a history of negative dysphotopsia.

The patients were implanted with single-piece AcrySof IQ (Alcon Laboratories, Inc., Fort Worth, TX, USA), 161 eyes; toric AcrySof IQ SN6AT3-6, 12 eyes; spherical SN60AT, 1 eye; 3-piece spherical AcrySof MN60MA, 2 eyes; bifocal AcrySof ReSTOR SN6AD1, 2 eyes; trifocal AcrySof IQ PanOptix IQ TFNT00, 2 eyes; and Finevision Micro F trifocal (PhysIOL, Liège, Belgium), 10 eyes, IOLs. Preoperative examination included CDVA, manifest refraction, slit-lamp examination, biometry (IOL Master; Carl Zeiss Meditec, Jena, Germany) and Scheimpflug photography (Pentacam; Oculus Optikgeräte GmbH, Wetzlar, Germany). Anterior chamber depth, total corneal refractive power, total corneal spherical aberration within 6-mm zone around the corneal apex, photopic pupil diameter and axial eye length were measured. Postoperative examination took place at 1-week and 1-month follow-up and included CDVA, manifest refraction and slit-lamp examination. Unsolicited complaints of negative dysphotopsia were recorded at all follow-up visits.

Hundred and five patients met the inclusion criteria and were invited for a telephone interview. Ten patients were not available for the interview or declined to participate without specification of a reason. The other 95 patients were successfully interviewed by the first author (resident in ophthalmology) between two and 4 months after surgery. A structured interview scheme was used to standardize the conversation. The patients were asked whether they noticed any changes in the temporal peripheral visual field after cataract surgery. The following question was used: 'Some patients are able to notice changes on the outside of the visual field, in other words on the outside of the area that you can see looking in front of you. What about you? Do you notice any changes?' Negative dysphotopsia was defined as a presence of a dark or blurred area in the temporal field of view, which developed immediately after cataract surgery and became worse under photopic conditions. The positive response to the former question was regarded as solicited negative dysphotopsia. Those patients that responded negatively to the question were specifically asked about the presence of a shadow of a blurred area in the temporal visual field. This did not yield any additional negative dysphotopsia cases. The patients with complaints of negative dysphotopsia were reassured by the interviewer, and an examination was scheduled if patients asked for an additional ophthalmological evaluation.

The local ethical committee concluded that the Medical Research Involving Human Subjects Act (WMO) did not apply to the above-mentioned study, and therefore, an official approval of this study by the ethical committee was not required. The study adhered to the principles of the Declaration of Helsinki, and all patients provided verbal informed consent.

Snellen visual acuities were converted into LogMAR values for statistical analysis. Mean and standard deviation were calculated for continuous variables. Statistical difference between the means of preoperative parameters of patients with and without negative dysphotopsia was assessed with independent samples *t*-test. p-values of ≤ 0.05 were considered

Table 1. Overview of reported incidences of negative dysphotopsia.

First author (year)	Design	Evaluation of the incidence	Inclusion criteria	IOLs	*N**	Incidence after surgery (%)		
						≤1 week	1-2 months	≥6 months
Osher (2008)	Prospective	Interview	Uncomplicated surgery	SN60WF and SN60AT	250 eyes	15.2	4.4	3.2
Henderson (2016)	Prospective randomized	Interview	Uncomplicated cataract surgery	SN60WF, optic–haptic junction vertical	114 eyes	14	0.9	
				SN60WF, optic–haptic junction inferior-temporal	205 eyes	5.4	1.5	
				LI61AO, optic–haptic junction vertical	60 eyes	0	0	–
				LI61AO, optic–haptic junction inferior-temporal	39 eyes	0	0	–
Bournas (2007)	Prospective randomized	Questionnaire and interview	Uncomplicated surgery, no comorbidity	HP60M	150 eyes	8	7.3	0
				MA60BM	150 eyes	8.7	8	0.7
				MA30BA	150 eyes	9.3	8.7	1.3
				Clariflex	150 eyes	4.7	2.7	0
Radford (2007)	Prospective randomized	Questionnaire	Uncomplicated surgery, no comorbidity, VA ≥20/40	Akreous AO	29 eyes	0	0	–
				SN60AT	32 eyes	25	9.4	–
Aslam (2007)	Retrospective	Photographic questionnaire	Uncomplicated surgery, no comorbidity	Clariflex, AR40e, MA30BM	55 patients	–	–	7
Kinard (2013)	Prospective	Questionnaire	Uncomplicated surgery, no comorbidity, VA ≥20/20, no reported ND, inclusion of a better seeing of dominant eye	AcrySof 1-piece	70 eyes	–	–	20
Jin (2009)	Retrospective	Questionnaire	VA ≥20/25 after surgery, first operated eye was included	AR40e	47 eyes	–	–	4.3
				SA60AT	52 eyes	–	–	13.5
Agulair (2014)	Retrospective	Unsolicited complaints	Uncomplicated surgery, no comorbidity, VA ≥20/30	ReSTOR	347 patients	25.9†		
Kim (2014)	Retrospective	Unsolicited complaints	No comorbidity	SN60WF	146 eyes	2.7†		
				Akreous AO	656 eyes	1.2†		
Wenzel (2015)	Prospective	Unsolicited complaints	Uncomplicated surgery	SN60WF or SN60AT	800 eyes	1†		
Vamosi (2010)	Retrospective	Unsolicited complaints	No comorbidity	610 HPS, MA60AC, Akreous Adapt, AR40e, SN60WF	3806 eyes	0.13†		
Narvaez (2005)	Case series	Unsolicited complaints	Patients implanted with a Z900 IOL	Z9000	30 eyes	6.7†		
Davison (2000)	Prospective	Unsolicited severe complaints	Not specified, only severe cases were catalogued	MA60BA, MA30BA, SI40NB, SA30AL	6668 eyes	0.1†		
Davison (2002)	Prospective	Unsolicited severe complaints	Only severe cases were catalogued	SA30AL, SA60AT	2630 eyes	0.5†		

* The data are reported either as a percentage of eyes or patients, and in some studies, one eye was included per patient.
† Follow-up was not specified.

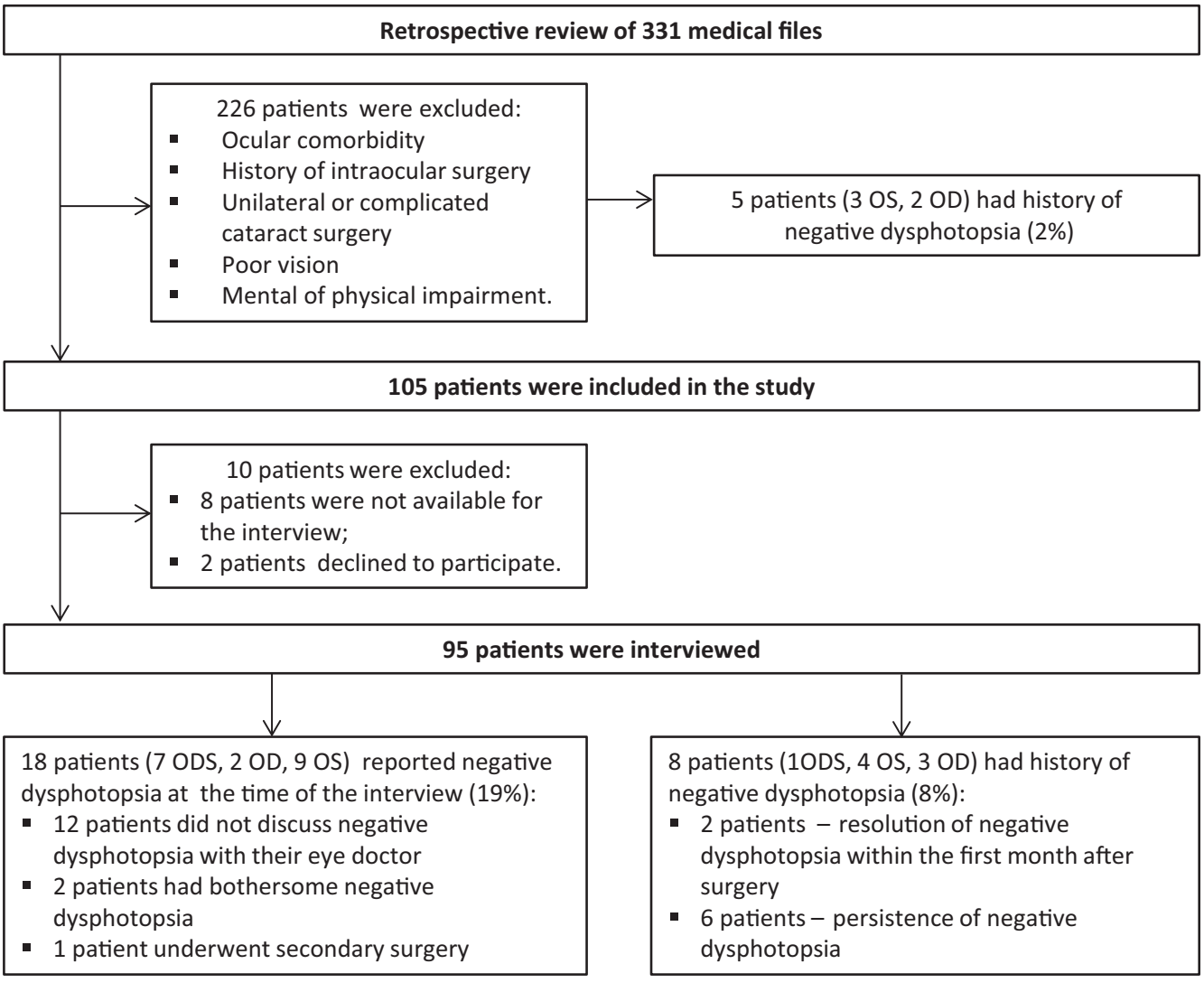

Fig. 1. Schematic overview of the inclusion and exclusion of patients and incidences of unsolicited and solicited negative dysphotopsia complaints.

significant. One eye was chosen randomly for statistical analysis in the asymptomatic group and in cases of bilateral negative dysphotopsia. In case of unilateral dysphotopsia, the eye affected by negative dysphotopsia was analysed. Measures were taken to avoid or critically consider the potential sources of bias in this observational study. Selection bias was checked with a paired samples *t*-test, and no statistically significant differences were found between the included and excluded eyes with respect to preoperative CDVA, anterior chamber, IOL power, axial eye length or pupil diameter. Interviewer bias was prevented by a standardized telephone interview protocol. Furthermore, the rate of nonparticipants was indicated and reasons for refusing to participate were registered.

Results

The study population was comprised of 95 patients (50 men and 45 women) with a mean age of 72 ± 10 years.

Incidences of unsolicited and solicited complaints of negative dysphotopsia are shown in Figure 1. Eight patients (8%) reported negative dysphotopsia to their eye doctor, and in two of them, the symptoms were resolved within 1 month of follow-up.

At the time of the interview, 18 patients (19%) reported negative dysphotopsia (Figure 1 and Table 2). Two-thirds of these patients ($n = 12$) did not discuss the symptoms with their eye doctor. However, two of them (11%) did consult an ophthalmologist after the interview. One patient was successfully reassured by the examiner, and in another patient, the symptoms were so bothersome that secondary surgery was required. A Rayner Sulcoflex Aspheric 653L IOL (Rayner Intraocular Lenses Ltd) was implanted in the ciliary sulcus anterior to the primary IOL–capsular bag complex, thereafter, negative dysphotopsia was completely resolved.

Patients who experienced negative dysphotopsia after cataract surgery were compared with asymptomatic patients (Table 3). Patients with negative dysphotopsia were significantly younger ($p = 0.045$) and had shorter axial eye length ($p < 0.04$), better postoperative CDVA ($p = 0.001$) and a tendency for clinically relevant higher IOL power (>2 D difference, $p = 0.09$). No significant or clinically relevant difference was found regarding preoperative CDVA, anterior chamber depth, total corneal refractive power,

Table 2. Incidence of ND at 2- to 4-month follow-up in patients implanted with different IOLs.

	Patients		Eyes	
IOL type	Total, *N*	Negative dysphotopsia, *N* (%)	Total, *N*	Negative dysphotopsia, *N* (%)
Multifocal 1-piece	7	2 (29)	14	3 (21)
Monofocal 1-piece	86	16 (19)	171*	22 (14)
Other†	2	0 (0)	3	0 (0)

IOL = intra-ocular lens; *N* = number.
* In one patient, SN60WF IOL was used in one eye and SN60AT IOL in another eye, he did not have negative dysphotopsia.
† Spherical SN60AT IOL, 3-piece MN60MA

Table 3. Differences between patients with and without negative dysphotopsia.

Mean ± SD	Patients without negative dysphotopsia (*N* = 75)	Patient with negative dysphotopsia (*N* = 20)	p-value	95% CI
Age, years	73 ± 9	68 ± 10	0.045	0.11; 9.51
IOL, D	20 ± 4	22 ± 3	0.09	−3.83; 0.30
ACD (pre), mm	2.6 ± 0.4	2.5 ± 0.5	0.17	−0.07; 0.38
Km, D	43.1 ± 1.6	43.2 ± 1.6	0.78	−0.92; 0.69
Spherical aberration	0.33 ± 0.11	0.33 ± 0.16	0.38	−0.09; 0.03
Photopic pupil diameter, mm	2.8 ± 0.5	2.8 ± 0.5	0.98	−0.25; 0.26
Axial length, mm	24.1 ± 1.7	23.5 ± 0.9	0.04	0.02; 1.2
Pre CDVA, LogMAR	0.21 ± 0.16	0.16 ± 0.18	0.20	−0.03; 0.14
Post CDVA, LogMAR	−0.01 ± 0.05	−0.05 ± 0.05	0.001	0.02; 0.07

ACD = anterior chamber depth, CI = confidence interval, CDVA = corrected distance visual acuity, IOL = intra-ocular lens, Km = mean total corneal refractive power, pre = preoperative, post = postoperative.

total corneal spherical aberration or pupil diameter.

Discussion

At the 15th Annual AAO Cataract Spotlight Symposium 'My Top 5 Pearls' (Chicago 2016), 75.8% of attendees responded that <2% of their patients experience long-term negative dysphotopsia and only 1.7% of the attendees rated the percentage of negative dysphotopsia patients as more than 10% (S. Masket, B. A. Henderson, D. F. Chang, personal communications).

In the present study, 19% of patients (13% of eyes), who underwent sequential cataract surgery, reported negative dysphotopsia symptoms between 2 and 4 months after surgery. This percentage exceeds previously reported incidences in patients interviewed 1–2 months after surgery (Table 1) (Bournas et al. 2007; Radford et al. 2007; Osher 2008; Henderson et al. 2016). In general, there is a great discrepancy in the reported incidences of negative dysphotopsia between studies (Table 1). This may be related to cultural differences in symptom perception, influenced by expectations, norms, education, pre- and postoperative counselling, definition of the negative dysphotopsia used to categorize symptoms, inclusion criteria and the absence of a widely acknowledged validated questionnaire. Although some studies reported variation in negative dysphotopsia incidence with different IOL types and designs (Bournas et al. 2007; Radford et al. 2007; Henderson et al. 2016), larger randomized studies are required to investigate the possible relationships.

Despite the current opinion that the majority of negative dysphotopsia symptoms will spontaneously resolve within 6 months after surgery, only 10% (2/20) of our patients reported resolution of symptoms within the first month and none had resolution after 1 month. The symptoms were mild in most of the cases, and most patients were able to cope with negative dysphotopsia. Bothersome negative dysphotopsia complaints were reported by two patients, and one of them was successfully treated with implantation of a supplementary IOL in the ciliary sulcus. Remarkably, at first this patient did not report negative dysphotopsia after surgery but did consult an ophthalmologist shortly after the interview.

Because adaptation to negative dysphotopsia will likely occur in the first 6 months, early reassurance after cataract surgery may help patients to cope with symptoms and prevent additional surgery. Consequently, the low percentage of negative dysphotopsia resolution during the first month of follow-up in this study might be related to the high number of patients who did not discuss the symptoms with their ophthalmologist and could not be adequately informed about the natural course of this phenomenon.

In our study, only 6.8% of patients (six of 88) implanted with monofocal IOLs reported symptoms to their ophthalmologist. In the literature, the incidence of unsolicited complaints of negative dysphotopsia varied between 0.1% and 6.7% of eyes implanted with different monofocal IOLs (Davison 2000, 2002; Narvaez et al. 2005; Vamosi et al. 2010; Agulair 2014; Kim 2014 and Wenzel et al. 2015) and severe unsolicited complaints were found in 0.1–0.5% of eyes. The highest incidence of unsolicited negative dysphotopsia complaints was found previously in patients implanted with multifocal IOL's (Agulair 2014). Agulair (2014) reported that 25.9% of patients with AcrySof IQ ReSTOR IOLs reported negative dysphotopsia. Patients with multifocal IOLs usually have more healthy eyes, higher expectations (Nijkamp et al. 2004) and therefore pay more attention to the quality of their vision than patients implanted with monofocal IOLs. In our study, all patients who had negative dysphotopsia in the multifocal IOL group (two of seven patients) had reported the symptoms to the ophthalmologist.

From the data reported in this study, it can be concluded that younger age, shorter axial eye length and a higher CDVA are risk factors for self-reported negative dysphotopsia. Because of its cross-sectional design, no causal relationships could

be tested. Younger patients are generally more critical about their vision and therefore may express one's perception of negative dysphotopsia more frequently compared with older cataract patients. In contrast, Aslam et al. (2007) did not find a correlation between patient's age and long-term dysphotopsia. However, only four of 55 patients reported seeing 'arcs' at the periphery of the visual field in their study (Aslam et al. 2007), and therefore, the numbers might be too small for a reliable correlation analysis.

While patients with negative dysphotopsia had also significantly better postoperative CDVA compared with asymptomatic patients, the difference between groups was not clinically relevant. It is important to note that only patients with a CDVA of ≥20/25 were included in this study, and consequently, the difference may possibly be larger in a population with more variation in VA. A higher CDVA may possibly lead to more bother from a disturbing shadow. On the other side, severe negative dysphotopsia was also reported in patients with poor VA due to amblyopia and advanced age-related macular degeneration (Makhotkina et al. 2015, 2016).

Patients with negative dysphotopsia had a significantly shorter eye length and a tendency for higher IOL power than patients without dysphotopsia. This supports our previous results (Makhotkina et al. 2016) as well as the supposition of Davison (2000, 2002) that negative dysphotopsia is more likely to occur in patients implanted with IOLs with moderate-to-high dioptric powers. Although the inclusion of patients with several types of IOLs (monofocal, toric and multifocal) in this study might lead to inconsistency in the incidence ciphers, we believe that this did not affect the results as all but one patients were implanted with single-piece acrylic IOLs with squared edges, which have been associated with the development of negative dysphotopsia (Narvaez et al. 2005; Osher 2008 and Holladay et al. 2012). Incisions were constructed in superior location and covered by the upper eyelid in all cases. Therefore, corneal oedema at the place of the exposed temporal excision (Osher 2008) could not be a cause of negative dysphotopsia in our patients. Because of the retrospective nature of the study, we did not analyse other potential contributing factors, such as iris – IOL distance (Osher 2008; Vamosi et al. 2010) or opacification of the lens capsule peripheral and anterior to the IOL edge (Masket & Fram 2011, 2013; Holladay et al. 2012; Cooke et al. 2013; Folden 2013; Holladay 2013).

This observational study tried to clarify the incidence of negative dysphotopsia by comparing solicited and unsolicited perceptions/complaints of negative dysphotopsia after sequential cataract surgery. The higher reported incidence of negative dysphotopsia in this study could be biased by the participants' reactivity to the study: being asked about their quality of vision may have increased the reported negative dysphotopsia (also referred to as the Hawthorne effect/the observer effect) (McCambridge et al. 2014).

Including negative dysphotopsia complaints in patients reported outcome measures (PROMS) after cataract surgery, e.g. Catquest-9SF (Visser et al. 2017), as well as the construction of a specific negative dysphotopsia questionnaire will be essential steps for establishing the true incidence of negative dysphotopsia after cataract surgery. Such a specific negative dysphotopsia questionnaire should not only ask about the perceived effects on the temporal field of vision (presence of a dark shadow) but also about the effects on physical and emotional functioning.

In conclusion, this study showed a high incidence of undiagnosed negative dysphotopsia after sequential cataract surgery as more than half of the patients did not report negative dysphotopsia to the ophthalmologist. Alertness during preoperative counselling and active investigation of negative dysphotopsia postoperatively might be useful for a timely reassurance and prevention of long-term complaints. Young emmetropic and hypermetropic patients with good VA might have a higher probability of reporting negative dysphotopsia after cataract surgery.

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