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Case Report

Supplementary Implantation of 1stQ AddOn® Sulcus-Fixated Intraocular Lens to Treat Negative Dysphotopsia: A Retrospective Case Series

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Keywords
Dysphotopsia · Sulcus-fixated intraocular lenses · Intraocular lenses · Surgery

Abstract
Negative dysphotopsia (ND) refers to the subjective perception of an arc-shaped darkness or shadow in the temporal field of vision. This condition occurs after uneventful cataract surgery with an in-the-bag intraocular lens (IOL). To address this issue, supplementary implantation of conventional three-piece IOLs in the sulcus or dedicated supplementary Rayner Sulcoflex® IOL have been used successfully. The aim of this retrospective case series was to assess the effectiveness of resolving ND using a supplementary 1stQ AddOn® (Medicontur) IOL. The 1stQ AddOn® has a different design and optic size compared to the Rayner Sulcoflex®. Patients experiencing severe and persistent ND underwent supplementary implantation of the 1stQ AddOn® IOL. The primary outcome measure was the resolution of dysphotopsia. Nine eyes received the 1stQ AddOn® IOL, with complete symptom resolution observed in 6 eyes, partial improvement in 1 eye, and no change in 2 eyes. This indicates that supplementary implantation of the 1stQ AddOn® IOL can effectively and safely treat ND, performing equally well as the Rayner Sulcoflex®. The positive impact of sulcus-fixated supplementary IOLs seems to be related to the interaction between the central optic and the pupil margin.

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Introduction

Positive dysphotopsia and negative dysphotopsia (ND) represent undesirable subjective optical phenomena that occur after uneventful cataract surgery. They are among the leading causes of patient dissatisfaction after cataract surgery [1]. Where positive dysphotopsia is directly related to intraocular lens (IOL) material and design, ND seems to be multifactorial in its origin [2]. The term ND was first introduced by Davison in 2000 as a subjective darkness or a shadow, which can be arc-shaped, usually in the temporal field of vision emerging after uneventful cataract surgery with an in-the-bag IOL [3]. Currently, there are no specific objective tests available to diagnose ND, although it is accompanied by demonstrable far peripheral visual field changes on Goldmann kinetic testing [4]. The prevailing understanding suggests that ND arises from a complicated interaction between IOL optics and the anatomical predisposition of the eye [5]. Notable primary risk factors for developing ND include smaller photopic pupils, larger positive angle κ, nasal anterior capsule overlying the in-the-bag IOL, and higher dioptric IOL power [5]. In recent years, supplementary IOL implantation in the sulcus has become more popular to treat ND. Historically, an additional 3-piece IOL with 6 mm optic was used. However, more recently, supplementary one-piece IOLs, specifically designed for sulcus placement, are being used. To our knowledge, this is only described in the literature with the Sulcoflex® supplementary IOL (Rayner Intraocular Lenses, Ltd, Worthing, United Kingdom). This IOL is made of a large 6.5-mm central optic with a posterior concave surface and two large undulating haptics [6–11]. We describe our clinical experience in treating ND with the 1stQ AddOn® (Medicontur International SA, Geneva, Switzerland), a supplementary IOL with a different design. The IOL is composed of a hydrophobic and hydrophilic copolymer and features a smaller 6-mm central optic with a posterior concave surface and four special rectangular closed loops with 0° angulation (see Fig. 1, 2).

Materials and Methods

All patients who underwent implantation of a 1stQ AddOn® IOL between January 2015 and January 2023 were retrospectively reviewed. Patients who were treated for ND were further analyzed. The CARE Checklist has been completed by the authors for this case series, attached as online supplementary material (for all online suppl. material, see https://doi.org/10.1159/000533686). Only patients with severe persistent ND, existing more than 3 months, were eligible for sulcus-fixated implantation. Primary IOL implantation in the capsular bag and anterior chamber depth more than 3 mm are the only preliminary conditions for safe implantation of the 1stQ AddOn® and were fulfilled in all participants. The surgeries were performed by two experienced surgeons at Ghent University Hospital and Ooginstituut Aalst in Belgium. Selected demographic and clinical data were gathered. In most cases, topographic data to measure angle κ were unavailable. Instead, Chang-Waring chord length values, which serve as a functional equivalent, were obtained from the optical biometers. An angle κ value higher than 3.26 degrees was considered abnormally high [12]. A standard approximation conversion of 7.5 degrees to 1 mm was used; converting a Chang-Waring chord length value above 0.44 mm as abnormally high [5].

Results

Between 2017 and 2022, a total of nine eyes underwent 1stQ AddOn® implantation to address persistent ND complaints. For a detailed description of the participants' characteristics, see Table 1. All 9 patients with ND had previously undergone uneventful

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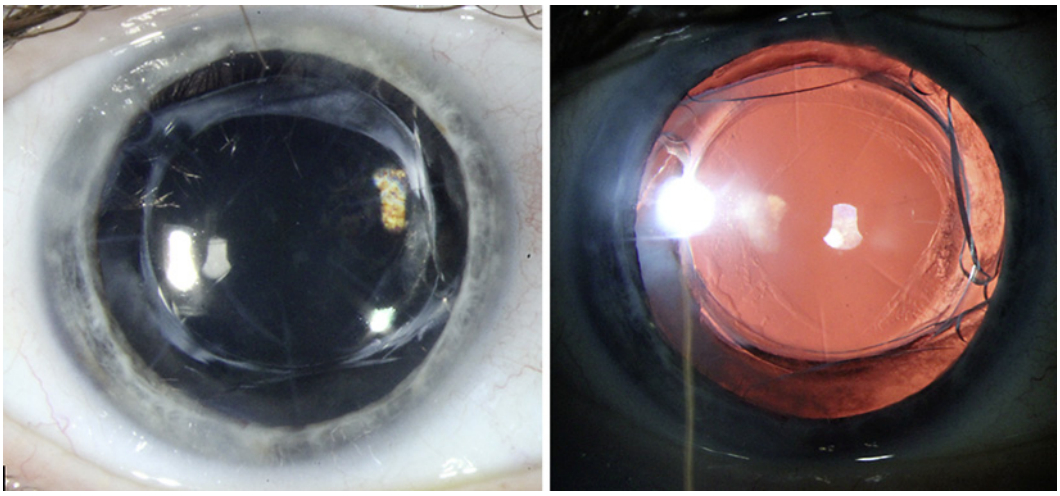

Fig. 1. Slit lamp image without and with retro-illumination of the 1stQ AddOn® IOL.

phacoemulsification with IOL implantation in the capsular bag. None of them had bilateral complaints of ND. The mean duration of complaints before 1stQ AddOn® implantation was 11.4 months, ranging from 6 to 25 months. All supplementary implantations were free from any pre- and post-operative adverse events, like capsular tear, anterior chamber hemorrhage, iris chafing, inflammation, or post-operative IOP elevation. No long-term complications, including interlenticular opacification, pupillary optic capture, pigment dispersion syndrome, or secondary pigmentary glaucoma were observed during the follow-up period. The patients' mean age was 66 years ± 7.4 years. Among the 9 patients, 6 were female and 3 male. All, except two, had the 1stQ AddOn® implanted in their right eyes. The primary IOLs were all composed of acrylic material and had a biconvex shape, with their power ranging between 19 and 29.5 diopters. The power of the 1stQ AddOn® lenses ranged between −0.25 and +0.25. Regarding the measurement of Chang-Waring chord length, it was elevated in three of the nine eyes, surpassing the value of 0.44 mm. One month after the 1stQ AddOn® implantation, the ND complaints completely resolved in 6 eyes (66.7%), improved in one eye (11.1%), and remained unchanged (22.2%) in two eyes.

Discussion

ND can be highly distressing for patients after cataract surgery, with reported incidences as high as 15–20% [1, 7]. However, accurately predicting which eyes will develop ND remains challenging. While angle κ is recognized as a known risk factor, it was found to be elevated in only 33% of the subjects in our study. Similarly, there was no notable association with high-power primary IOLs, another established risk factor [8]. Additionally, we observed no preponderance of ND in left eyes or women in our confined series, in contrast to findings made by Osher and Masket [1]. These findings underscore the multifactorial origin of ND and the difficulty in foreseeing which patients will be affected. Fortunately, due to neuro-adaptation and the opacification of the peripheral lens capsule, the incidence of ND typically reduces to approximately 3% 1 year after surgery [1]. Consequently, the primary treatment approach involves a combination of counseling and reassurance, which proves effective in most cases. However, 3% incidence remains a considerable burden. As a result, various treatment strategies have been attempted to alleviate this burden.

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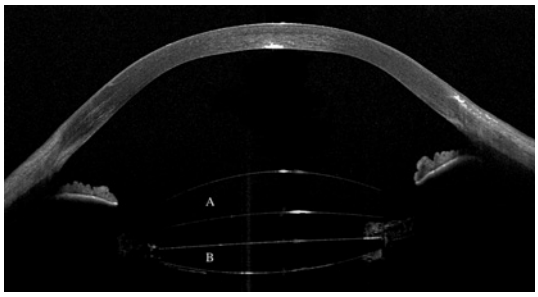

Fig. 2. Anterior segment optical coherence tomography image. A: 1stQ AddOn® IOL. B: Primary IOL.

Table 1. Participants' demographic and ocular data

Case	Characteristics			Primary cataract surgery				ND post-op	CW chord
	age, Years	eye	duration ND, months	IOL type	IOL material	IOL geography	IOL power, D		
1	57	R	8	Alcon SN60WF	Hydrophobic acrylic	Biconvex	19	Gone	0.4
2	58	R	10	Zeiss CT Lucia 611	Hydrophobic acrylic	Biconvex	20.5	Improvement	0.5
3	72	R	11	Zeiss CT Lucia 611	Hydrophobic acrylic	Biconvex	18	No effect	0.1
4	76	R	25	Kowa Avansee Clear	Hydrophobic acrylic	Biconvex	25.5	Gone	0.4
5	77	R	6	Zeiss CT Lucia 621	Hydrophobic acrylic	Biconvex	23	Gone	0.4
6	65	R	6	Physiol FineVision Micro F	Hydrophilic acrylic	Biconvex	22	No effect	0.5
7	70	L	8	Hoya Vivinex XY1	Hydrophobic acrylic	Biconvex	20	Gone	/
8	58	R	16	Physiol FineVision Micro F	Hydrophilic acrylic	Biconvex	23.5	Gone	/
9	63	L	13	Alcon PanOptix	Hydrophobic acrylic	Biconvex	29.5	Gone	0.7

Y, years; ND, negative dysphotopsia; IOL, intraocular lens; D, diopter; CW, Chang-Waring chord length; R, right; L, left.

Ray-tracing investigation conducted by Hong et al. [13] proposed that the interaction between the anterior capsulorhexis and the IOL was the root cause of ND [6]. More recently, Holladay et al. [5] revealed that a peripheral retinal image is formed from two optical paths: rays refracted by the IOL and rays that bypass the IOL. They suggested that if there exists a gap between these two retinal images, ND may occur. Building upon these findings, Nd:YAG laser anterior capsulectomy of the nasal quadrant overlying the IOL has been reported to

successfully treat ND [14]. Additionally, surgical strategies like reverse optic capture, IOL exchange for a 3-piece IOL in the sulcus or an in-the-bag IOL with rhexis capture in a dedicated groove in the optic (Masket ND lens, bag-in-the-lens IOL) are based on the same principle [2, 8]. Due to the complexities involved in some of the surgical procedures, supplementary IOL implantation has become a more popular treatment. This approach is based on the observation made by Holladay et al. [5] that the definite treatment of ND involves either eliminating the gap between the maximum refracted ray and the minimum ray that misses the IOL optic or moving the gap anteriorly beyond the functional retina. It is suggested that the placement of a supplementary IOL can shift the rays refracted by the primary IOL, moving the resulting shadow toward a more peripheral part of the visual field [5]. Ray-tracing analysis demonstrated that the introduction of plano surfaces of a sulcus-fixated IOL in the optical system, combined with a larger optic diameter (6.5 mm), may lead to an increase of light irradiance and decrease in ND [15]. Another hypothesis is that the addition of a supplementary IOL to the optical system increases multiple reflections and ghost images, which could bridge the gaps between the multiple reflections formed by the in-bag IOL, thereby reducing the visibility of these gap structures [13]. IOL exchange for a 3-piece IOL in the sulcus, and secondary implantation of a dedicated supplementary IOL positions the IOL complex closer to the posterior iris, altering the angles of the minimum missing rays and maximum refracted rays by the IOL. This will move the shadow further peripherally but not necessarily beyond the functional retina [5]. Supplementary implantation of the Rayner Sulcoflex® IOL to treat ND has been reported with success in multiple instances, resulting in improvement or resolution of ND in up to 78% of treated eyes [6–11]. The confined case series described in this study also demonstrated a similar result in 77.8% of treated eyes. Since the two IOLs have distinct designs and optic diameters, we believe that the observed effect might be connected to how the central optic of the supplementary IOL interacts with the pupil margin. To better understand and validate this hypothesis, additional research using ray-tracing analysis would be beneficial. Conducting such analyses could provide more insight into the interaction between the two different IOL designs, shedding light on the exact factors influencing ND.

Although successful elimination of ND has been achieved by nasal anterior Nd:YAG capsulectomy, supplementary IOL implantation is now the first-line treatment in our practices. There have been cases where the free-floating capsular crescent migrated into the anterior chamber, necessitating surgical removal. Moreover, if supplementary IOL implantation is still required after unsuccessful Nd:YAG capsulectomy, the many irregular microtears in the capsule may prone to extending if inadvertently captured by the unfolding haptics, compromising the stability of the capsular bag and/or IOL. Our research is the first to demonstrate the impact of using the supplementary implantation of the 1stQ AddOn® IOL in treating ND. The 1stQ AddOn® IOL has a distinct design and a smaller optic diameter compared to the Rayner Sulcoflex®. Despite these differences, it seems to be equally effective. The beneficial outcome associated with supplementary IOLs might therefore be attributed to the central optic's interaction with the pupil margin. However, to validate this assumption, further ray-tracing analyses are required.

Statement of Ethics

Ethical approval was not required for this study in accordance with local guidelines. Written informed consent was obtained from participants to participate in the study.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Funding Sources

Authors have no funding to declare.

Author Contributions

Dr. Maxim Van Slycken reviewed the medical records, wrote the original draft of the case series, and revised the intellectual content. Dr. Guy Sallet and Dr. Thierry Derveaux critically revised the manuscript and intellectual content.

Data Availability Statement

All data generated or analyzed during this study are included in this published article and its online supplementary material. Further inquiries can be directed to the corresponding author.

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