

# Negative dysphotopsia

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## Impact paragraph

### **Relevance and purpose of this research**

The rates of cataract surgery have increased in the last decennia from 61 096 in 1995 to 180 000 in 2013.<sup>1,2</sup> This increase will continue due to the ageing of the population combined with the trend to perform the surgery at a younger age for refractive error correction even in absence of a significant cataract.<sup>3-5</sup> It leads to a huge increase in the prevalence of patients having an artificial intraocular lens in one or both eyes (pseudophakic state), with different optical properties compared to their natural lens.<sup>3-5</sup> This may lead to unwanted optical side effects, named pseudophakic dysphotopsias, in up to 49% of patients even after uncomplicated surgery.<sup>6</sup> Pseudophakic dysphotopsias are divided in two groups, positive and negative dysphotopsias. Positive dysphotopsia is characterized by seeing halo's, streaks of light, flashes or glare, while negative dysphotopsia (ND) is defined by seeing of a dark crescent, shadow or vertical line partly obscuring the temporal visual field. At the moment of the research presented in this thesis, ND was an enigmatic phenomenon, without a consensus about its mechanisms and treatment.<sup>7,8</sup> In this thesis we reported new insights in its prevalence, , diagnostic strategies and treatment.

Considering the average annual volume of 360 cataract surgeries per respondent surgeon of the ESCRS Clinical Trends Survey (2021), up to 68 of these patients may suffer from ND and in up to 7 cases the complaints may be bothersome according to this thesis.<sup>9,10</sup> However, the current cataract guideline of Dutch Ophthalmology Society, does not include any information about the risk of ND and there are no recommendations about preoperative patients' education about this complication.<sup>11</sup> At the University Eye Clinic Maastricht, a referral centrum for ND patients, we noticed that this group of patients require numerous consultations after surgery because of dissatisfaction, anxiety and fear about the problems with their intraocular lens. It leads to a referral for a second opinion, even multiple, before the problem is acknowledged, and can result in a secondary surgery, which is not always successful.<sup>12,13</sup> This thesis suggests that the impact of bothersome ND leading to a secondary surgery with corresponding additional risks and costs may be even larger, if we consider that these patients are younger and have a higher best corrected visual acuity than the asymptomatic pseudophakic group.<sup>10</sup>

The absence of an objective test makes it difficult for an ophthalmologist to confirm the diagnosis of ND and to assess its severity. In this thesis, we developed tools that can aid to its clinical evaluation,<sup>14,15</sup> namely a validated extension of the Quality of Vision Questionnaire, presented in Chapter 3. It is able to quantify

quality of vision including ND<sup>15</sup> and is the first questionnaire on ND aiming to provide a linear measurement that is validated with a Rasch analysis, a method being acknowledged to be a gold standard for evaluation of the performance of questionnaires.<sup>16</sup> The included photographic images of ND can help patients and physicals to recognize and describe the symptoms and to assess their severity.<sup>15</sup>

In Chapter 4, we reported that Goldman kinetic perimetry can be successfully used for registration of ND.<sup>14</sup> Combining psychometric data with visual field data helps to assess ND severity and may guide the decision about indication of a secondary treatment. The choice of treatment strategy is usually based on preferences and experience of the surgeon and characteristics of the eye, as no randomized trials are published to compare different treatment modalities. This thesis shows that supplementary implantation of a sulcus-fixated intraocular lens is an effective and safe treatment strategy for bothersome ND.<sup>12</sup> In Chapter 6, we presented, for a first time, optical models of eyes with ND based on patient-specific data in correlation with clinical course after treatment with supplementary implantation of a sulcus-fixated intraocular lens.<sup>13</sup> The studies with a patient-specific data were followed up in the scientific community and are emerging in the last years.<sup>17,18</sup>

### **Target groups**

The results of this thesis are relevant for a general ophthalmologist and a cataract surgeon. Awareness of the high prevalence of ND may help to adequately inform patients before surgery.<sup>10</sup> Suggested diagnostic and treatment modalities may guide the management in bothersome cases as discussed above.<sup>12-15</sup>

Researchers in the field of cataract surgery may benefit from the use of extended version of Quality of Vision questionnaire presented in this thesis.<sup>15</sup> This questionnaire can be used in future studies studying performances of intraocular lenses or clinical research in patients with ND. Inclusion of Goldman visual fields data in research in ND patients may help to increase our understanding in mechanisms of this phenomenon as well as mechanism of success or failure of different treatment modalities.<sup>10</sup> Recent studies from another institution have already reported perimetric measurements based on our study protocol in context of research on possible neuroadaptation mechanisms to ND.<sup>19,20</sup>

Results of our optical modeling of ND may be of interest for industry. In Chapter 6, we reported the optical simulation of ND before and after treatment, which was a part of a collaborative research with Rayner British medical device company.

<sup>13</sup> Application of the real clinical data in laboratory optical research of effect of different IOLs can potentially lead to further development and implementation of IOLs with a minimal risk of ND and development of new effective treatment modalities for existing cases.

### **Activities and future implementations**

Results of this thesis were submitted to and published in peer-review journals to reach the target group of practicing ophthalmologists, researchers in the field of cataract surgery and the intraocular lens industry. They were reported at several meetings of the European Society of Cataract and Refractive Surgeon (ESCRS) and the Dutch Ophthalmological Society (NOG). Further, we recommend to include information about ND, gathered in this thesis, in patient education during preoperative counselling. Finally, we hope that this thesis will increase the industry awareness of the high prevalence of ND after cataract surgery and lead to changes in the IOL design, e.g. (1) larger IOL-optic size, which may require a development of new materials allowing the insertion of the lens through a small incision; (2) a broader optic-haptic junction; (3) further development and sophistication of capsulorhexis-fixated IOLs or IOL's specially designed for reverse optic-capture.

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