

CATARACT SURGERY AND DRY EYE DISEASE : A SYSTEMATIC REVIEW

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ABSTRACT

Background: Dry eye disease (DED) after cataract surgery is associated with various risk factors, while causing a wide range of heterogeneous symptoms including decreased quality of vision.

Methods: By comparing itself to the standards set by the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) 2020, this study was able to show that it met all of the requirements. So, the experts were able to make sure that the study was as up-to-date as it was possible to be. For this search approach, publications that came out between 2013 and 2023 were taken into account. Several different online reference sources, like Pubmed and SagePub, were used to do this. It was decided not to take into account review pieces, works that had already been published, or works that were only half done.

Result: In the PubMed database, the results of our search brought up 385 articles, whereas the results of our search on SagePub brought up 56 articles. The results of the search conducted for the last year of 2013 yielded a total 27 articles for PubMed and 21 articles for SagePub. In the end, we compiled a total of 5 papers, 4 of which came from PubMed and 1 of which came from SagePub. We included five research that met the criteria.

Conclusion: This study comprehensively analyzed DED prevalence and characteristics after cataract surgery. It presents a concise and up-to-date description of the risk factors, prevention, and treatments. Our findings contribute to generating increased awareness among physicians, researchers, and the general population regarding DED after cataract surgery and encourage the development of effective preventative and treatment strategies.

Keyword: Cataract Surgery, Dry Eye Disease

INTRODUCTION

Cataracts are the world's leading cause of remediable blindness. While some cataracts, may be congenital, secondary to trauma, or drug-induced, most cataracts are age-related. Age-related cataracts are due to the opacification of the lens. The crystalline lens is a biconvex structure that focuses light on the retina. It is transparent with a diameter of 10 mm and an axial length of around 4 mm. The lens consists of fibers that are derived from lens epithelium, a thin surrounding capsule, and zonular fibers that allow for accommodation in conjunction with the ciliary body. With age, the lens stiffens, leading to farsightedness known as presbyopia. While one of the main functions of the lens is to focus light, it is not a passive optical element. In order to maintain transparency, the lens has a microcirculation pathway driven by sodium channels that deliver nutrients to deeper fibers through extracellular inward flow. Intracellular outward flow is maintained through gap junctions and is used to remove waste. The lens also serves as a UV filter that protects the retina. Finally, the lens acts as an oxygen sink with some of the highest concentrations of the antioxidant glutathione (GSH) in the body. Glutathione scavenges reactive oxygen species, is a co-factor for repair enzymes, and is thought to be released into the aqueous humor to be used by the avascular tissues such as the cornea and trabecular network. With age, oxidative damage can accumulate, causing an opacification of the lens.^{1,2}

Regardless of the etiology, the treatment is cataract surgery when the visual function is affected. Cataract has secondary complications such as glaucoma and uveitis when it is allowed to progress on its natural course. With newer and well-developed techniques, cataract surgery is one of the most successful clinical managements in medicine with direct improvements in visual acuity as well as large improvements in activities of daily living and decreased mortality. While as many as 95% of patients will have improved visual acuity, cataract surgery does have complications. The most common include posterior capsule opacification and cystoid macular edema. Rare but serious complications include endophthalmitis and retinal detachment.³

Cataracts are one of the most common ophthalmic pathologies characterized by the opacification of the lens. In 2013, the United States had more than 22 million people who had cataracts. In 2020, that number is expected to reach 30.1 million. Incidence increases with age; 43-year-old to 54-year-old patients have an incidence of 8.3%, while patients over 75 have an incidence as high as 70.5%. Women are slightly more affected, with an average incidence of 26% and men 22.6%. In 2015, 3.7 million cataract surgeries were performed in the United States with data suggesting that the incidence of cataract surgery will continue to increase.^{4,5}

The development of visually symptomatic cataract is common. Cataract surgery is one of the most frequent and successful interventions currently undertaken in medicine with approximately 434,000 cataract operations performed annually in England and Wales. Modern small-incision cataract surgery offers excellent clinical outcomes coupled with rapid post-operative recovery and low risk of complications. As such, it is accompanied by ever-increasing surgeon and patient expectations. Although the technological breakthroughs in cataract surgery over the past half century have had a positive impact on the quality of life (QOL) of millions of individuals around the world, there are potential complications, which in cataract surgery may be both sight and non-sight threatening.^{6,7}

While research, clinical and technological developments tend to be focused on the prevention of sight-threatening complications, it is important that they do not neglect the avoidance and minimization of non-sight-threatening adverse events, as these can significantly impact on patient QOL. Such an example is dry eye disease (DED), such that the detrimental effects of cataract surgery on the ocular surface can both directly cause and exacerbate pre-existing DED. This is important not only with reference to symptomatology and complications of DED itself, such as increased risk of infections, but also with regards to the accuracy of pre-operative assessments. Precise topography, tonometry and biometric measurements are prerequisites for surgical planning and eventual post-operative visual performance. They require, as the first refractive component of the eye, an intact, healthy pre-corneal tear film.^{7,8}

The aim of this systematic review is to summarize the current evidence to identify the prevalence, characteristics, perioperative risk factors, treatment and preventative measures for dry eye disease after cataract surgery.

METHODS

Protocol

By following the rules provided by Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) 2020, the author of this study made certain that it was up to par with the requirements. This is done to ensure that the conclusions drawn from the inquiry are accurate.

Criteria for Eligibility

For the purpose of this literature review, we review published literature concerning cataract surgery and dry eye disease. This is done to provide an explanation and improve the handling of treatment at the patient. As the main purpose of this paper, to show the relevance of the difficulties that have been identified as a whole.

In order for researchers to take part in the study, it was necessary for them to fulfil the following requirements: 1) The paper needs to be written in English. In order for the manuscript to be considered for publication, it needs to meet both of these requirements. 2) The studied papers include several that were published after 2013, but before the time period that this systematic review deems to be relevant. Examples of studies that are not permitted include editorials, submissions that do not have a DOI, review articles that have already been published, and entries that are essentially identical to journal papers that have already been published.

Search Strategy

We used "cataract surgery" and "dry eye disease" as keywords. The search for studies to be included in the systematic review was carried out using the PubMed and SagePub databases by inputting the words: *((("cataract extraction"[MeSH Terms] OR ("cataract"[All Fields] AND "extraction"[All Fields]) OR "cataract extraction"[All Fields] OR ("cataract"[All Fields] AND "surgery"[All Fields]) OR "cataract surgery"[All Fields]) AND ("dry eye syndromes"[MeSH Terms] OR ("dry"[All Fields] AND "eye"[All Fields] AND "syndromes"[All Fields]) OR "dry eye syndromes"[All Fields] OR ("dry"[All Fields] AND "eye"[All Fields] AND "disease"[All Fields]) OR "dry eye disease"[All Fields])) AND ((clinicaltrial[Filter]) AND (2018:2023[pdat]))* used in searching the literature.

Data retrieval

After reading the abstract and the title of each study, the writers performed an examination to determine whether or not the study satisfied the inclusion criteria. The writers then decided which previous research they wanted to utilise as sources for their article and selected those studies. After looking at a number of different research, which all seemed to point to the same trend, this conclusion was drawn. All submissions need to be written in English and can't have been seen anywhere else.

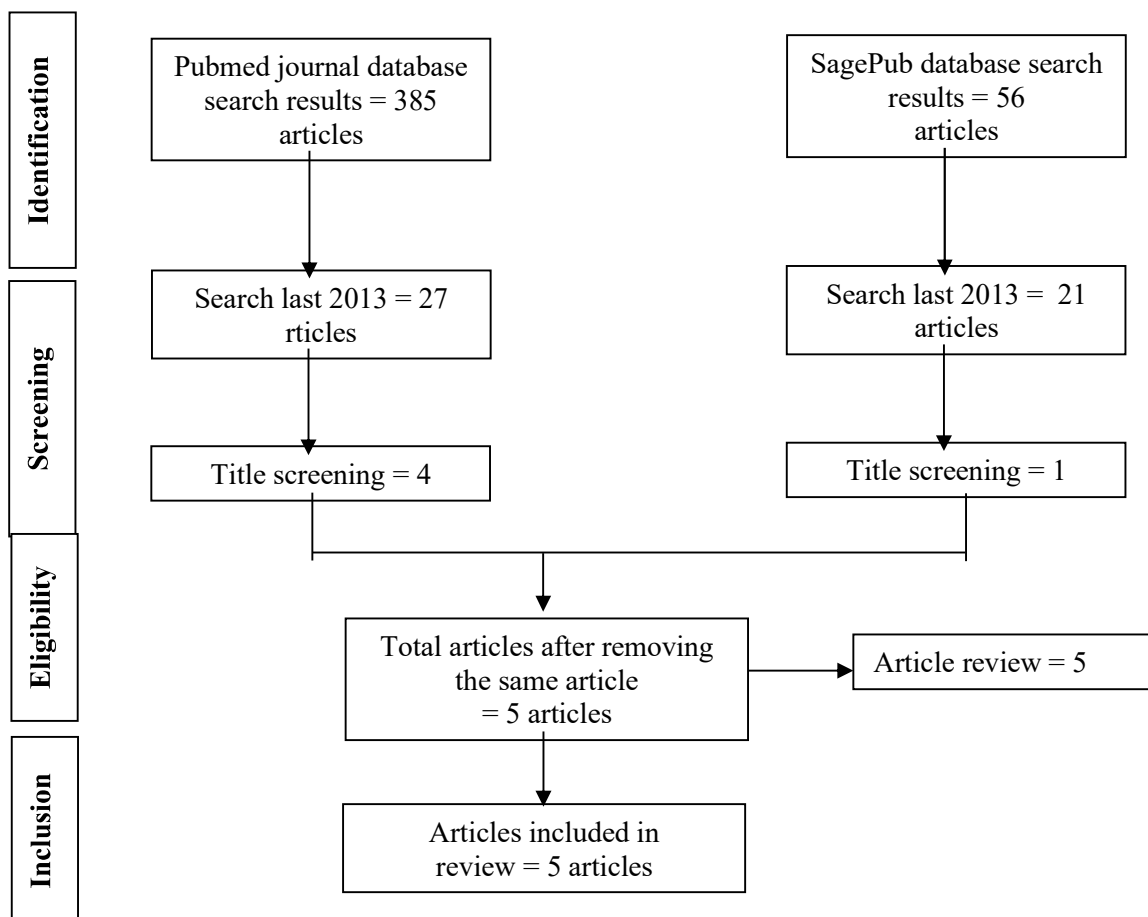


Figure 1. Article search flowchart

Only those papers that were able to satisfy all of the inclusion criteria were taken into consideration for the systematic review. This reduces the number of results to only those that are pertinent to the search. We do not take into consideration the conclusions of any study that does not satisfy our requirements. After this, the findings of the research will be analysed in great detail. The following pieces of information were uncovered as a result of the inquiry that was carried out for the purpose of this study: names, authors, publication dates, location, study activities, and parameters.

Quality Assessment and Data Synthesis

Each author did their own study on the research that was included in the publication's title and abstract before making a decision about which publications to explore further. The next step will be to evaluate all of the articles that are suitable for inclusion in the review because they match the criteria set forth for that purpose in the review. After that, we'll determine which articles to include in the review depending on the findings that we've uncovered. This criteria is utilised in the process of selecting papers for further assessment. In order to simplify the process as much as feasible when selecting papers to evaluate. Which earlier investigations were carried out, and what elements of those studies made it appropriate to include them in the review, are being discussed here.

RESULT

In the PubMed database, the results of our search brought up 385 articles, whereas the results of our search on SagePub brought up 56 articles. The results of the search conducted for the last year of 2013 yielded a total 27 articles for PubMed and 21 articles for SagePub. In the end, we compiled a total of 5 papers, 4 of which came from PubMed and 1 of which came from SagePub. We included five research that met the criteria.

Sahu, et al⁹ (2015) showed that phacoemulsification surgery is capable of inducing dry eye, and patients should be informed accordingly prior to surgery. The clinician should also be cognizant that increased CDE can induce dry eyes even in eyes that were healthy preoperatively. In addition, intraoperative exposure to the microscopic light should be minimized.

He, et al¹⁰ (2017) showed that intraoperative use of HPMC 2% on the cornea surface could improve clinical outcomes of tear film and ocular surface health to some degree, especially in the patients diagnosed with dry eye before the surgery, male patients, and patients whose surgical time was relatively longer.

Ntonti, et al¹¹ (2019) showed that the increased 0.2% sodium hyaluronate concentration in the artificial tears provided in the COMOD® device seems to address dry-eye-disease symptoms better in patients who underwent phacoemulsification surgery than the 0.1% concentration.

Table 1. The litelature include in this study

Author	Origin	Method	Sample	Result
Sahu et al, 2015 ⁹	India	Prospective, observational study	100 patients	There was a significant deterioration of all dry eye test values following phacoemulsification surgery along with an increase in subjective symptoms. These values started improving after 1-month postoperatively, but preoperative levels were not achieved till 2 months after surgery. Correlations of dry eye test values were noted with the operating microscope light exposure time and CDE, but they were not significant.
He et al, 2017 ¹⁰	China	Prospective, parallel-desing, continuous, randomized, controlled study	149 patients	The Schirmer test value of male patients in the study group at 1 week postoperation was higher than that of male patients in the control group (P=.019). For patients diagnosed with dry eye before the surgery, Schirmer test value in the male patients in the study group at 1 month after surgery was higher than that in the male patients in the control group (P=.037). Furthermore, for the cluster of preoperative dry eye patients whose surgical time was longer than median, corneal fluorescein staining of

				the patients in the study group was superior to that of the patients in the control group ($P=.032$).
Ntonti et al, 2019¹¹	Greece	Prospective, multicenter, randomized trial	180 patients	Both groups showed reduced CCS values at all postoperative examination points; however, SG participants had significantly better CCS (all $p < 0.05$). SG had better TBUT than CG at the 3rd ($p = 0.03$) and 6th examination points ($p = 0.04$). Moreover, SG had better SDI scores at the 3rd ($SDI = 9.26 \pm 0.55$) and 6th weeks ($SDI = 9.47 \pm 0.48$) vs. CG participants ($p = 0.03$ and $p < 0.01$, respectively).
Song et al, 2020¹²	China	Prospective, randomized, clinical trial	106 patients	Ocular surface disorders and MGD showed aggravated status at 1 month postoperatively in Cohort I and Cohort III, and the aggravated MGD resolved by 3 months postoperatively. At 1 month postoperatively, Cohort II and Cohort III presented high NIKBUT and low OSS, lid margin, and meibum quality and expressibility (Cohort II vs Cohort I: all $P < 0.001$, respectively; Cohort III vs Cohort I: $P = 0.011$, $P = 0.024$, $P = 0.046$, $P = 0.045$, and $P = 0.012$, respectively). Additionally, Cohort II had better outcomes of lid margin and meibum quality and expressibility than Cohort III at 1 month postoperatively ($P = 0.031$, $P = 0.026$, and $P < 0.001$, respectively). At 3 months postoperatively, Cohort II presented a significantly higher NIKBUT than Cohort I and Cohort III ($P < 0.001$ and $P = 0.001$, respectively).
Jun et al, 2019¹³	Korea	Prospective, randomized, controlled, clinical trial	117 patients	We divided subjects who were diagnosed with DED and scheduled to undergo cataract surgery, into 3 groups (preservative-free diquafosol, group 1; preservative-containing diquafosol, group 2; preservative-free hyaluronate, group 3), and each eye drops was administered 6 times daily after surgery. Tear break up time (TBUT), Ocular Surface Disease Index (OSDI), corneal

				<p>staining score, lid margin abnormality, and meibum quality improved over time in group 1. Groups 1 and 2 had significantly superior TBUT, meibomian gland dysfunction grade, and meibomian gland expressibility throughout the study period than group 3. Meibum quality of group 1 was significantly better than group 2 at 1 and 3 months after surgery.</p>
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Song, et al¹² (2019) showed that preoperative management of MGD is effective and optimal in alleviating obstructive-MGD and dry eye induced by cataract surgery.

Jun, et al¹³ (2019) showed that preservative-free diquafosol showed better efficacy in treating DED after cataract surgery than preservative-containing diquafosol or preservative-free hyaluronate. Preservative-free diquafosol may serve as a reliable option for the management of patients with pre-existing DED after phacoemulsification.

DISCUSSION

Dry eye disease (DED) is defined as “a disorder of the tear film due to reduced tear production or excessive tear evaporation, which causes damage to the inter-palpebral ocular surface and is associated with symptoms of ocular discomfort and/or visual symptoms”. A more descriptive definition given by the dry eye workshop defines it as “a multifactorial disease of the tear film and ocular surface that results in symptoms of discomfort, visual disturbance, and tear film instability with potential damage to the ocular surface. It is accompanied by increased osmolality of the tear film and inflammation of the ocular surface”.¹⁴

The etiology of dry eye syndrome has been attributed to a number of causes and factors that include old age, gender, disorders affecting the connective tissue, metabolic disorders like diabetes and hypertension, contact lens usage, drugs like antihistamines, anticholinergics, antidepressants, oral contraceptives and topical eye drops containing preservatives, and ocular diseases like blepharitis, chronic conjunctivitis, meibomitis, and pterygium.¹⁴

Apart from the conventional risk factors of dry eye syndrome, it has been seen that some surgical procedures related to the anterior segment like photorefractive keratectomy, laser-assisted in situ keratomileusis, and cataract surgery are also responsible for causing dry eye syndrome or aggravating existing symptoms of dry eye.¹⁵ Surgical procedures like cataract surgery cause denervation of the cornea, which results in impaired epithelial wound healing, increased epithelial permeability, decreased epithelial metabolic activity, and loss of cytoskeletal structures associated with cellular adhesion. The incidence of dry eye syndrome among patients undergoing cataract surgery has been shown to be dependent on a host of factors including type of procedure, type of ophthalmic solution being used, intraoperative medication, coexistent systemic disorders,¹⁰ operating microscope light exposure and cumulative dissipated energy (CDE) used during the procedure,¹⁶ and time since surgery.⁹

The prevalence of DED after cataract surgery is unclear. Ishrat et al.¹⁷ reported clinical signs of DED in 9% of patients 4 weeks after surgery, while Miyake and Yokoi¹⁵ documented such problems in 31% at the same time period. In a prospective study of 100 patients, Dasgupta and Gupta¹⁸ found that at 12 weeks post-surgery, 100% of patients showed abnormalities in tear break up time (TBUT), Schirmer I tests and DED symptomatology, while a prospective study by Choi et al.¹⁹ indicated that at 3 months 27% of patients experienced persistent DED symptoms based on the Ocular Surface Disease Index (OSDI) questionnaire (Allergan plc, Irvine, CA), and this was associated with reduced TBUT, increased corneal fluorescein staining and meibomian gland drop out.

With regards to duration of DED events after cataract surgery, in a prospective study of 86 patients Iglesias et al.²⁰ reported that 32% experienced symptoms of DED up to 6 months post-surgery. However, in a prospective study of 50 patients by Kohli et al.²¹ and a retrospective study of 96 patients by Cetinkaya et al.²², the signs and symptoms of DED appeared to return to pre-operative levels at 3 months.

The situation is further complicated as pre-existing DED in patients with cataracts is frequent, with one study in a prospective series of 120 patients presenting with cataracts, reporting that 80% had at least 1 abnormal test indicative of ocular surface disease (OSD) prior to surgery. These findings are in keeping with those of a multi-centre prospective study of 136 patients which revealed that 77% had positive corneal staining and 63% TBUTs of less than 5 seconds prior to cataract surgery.²³

DED is a complex disease process and this is highlighted by the lack of a globally agreed definition, which may perhaps explain the variation in data relating to DED in the existing literature.¹⁷

The definition by Asia Dry Eye Society²⁴ states that 'dry eye is a multifactorial disease characterized by unstable tear film causing a variety of symptoms and/or visual impairment, potentially accompanied by ocular surface damage', while the Korean Corneal Disease Study Group defines DED as a disease of the ocular surface that is associated with tear film abnormalities, where patients have at least one clinical sign and symptom for diagnosis. Although the overlap between the various definitions can be appreciated, this lack of consensus demonstrates the complex nature of DED.²⁵

There are two main sub-categories of DED: evaporative dry eye (EDE) and aqueous deficient dry eye (ADDE), with a degree of overlap between the two. In EDE there is a rapid rate of tear film evaporation from the ocular surface, whereas in ADDE there is a reduced secretion of tears from the lacrimal gland. In both situations there is a net increase in tear film hyperosmolarity, resulting in a series of pro-inflammatory signalling processes which contribute to the disease process. Patients with DED can suffer from an array of symptoms including grittiness, foreign body sensation, photosensitivity, epiphora and visual disturbances which can have a significant impact on QOL. A utility assessment study to quantify the impact of DED on QOL showed utility scores in DED to be comparable to patients with angina or who undergo regular dialysis. DED can also have a negative impact on mental well-being, with a systematic review and meta-analysis by Wan et al. showing that patients with DED have higher rates of anxiety and depression compared to controls.²⁶

Incision sizes in modern PCS cataract surgery are typically less than 3.00 mm, but micro-incisional techniques (under 2.00 mm) may cause less disruption in their neurotrophic and DED potentiating effects and requires further investigation. Astigmatic keratotomy incisions, both penetrating and partial thickness, require careful surgical planning both with respect to refractive outcome and to pre-existing DED problems. In cases with severe DED, surgeon's use of the larger incision astigmatic keratomies/LRIs should be carefully considered in order to limit additional corneal nerve trauma, and alternatives such as toric intraocular lenses should be considered. The use of a dispersive OVD such as HMPC 2% on the ocular surface during cataract surgery may have protective effects, with prospective randomized and non-randomized studies showing benefits in reduced symptoms and signs of DED post-operatively and it is the authors' choice to coat the ocular surface with an OVD in eyes with pre-existing DED during cataract surgery. Finally, to limit post-operative DED it is sensible that the use of any peri-operative topical medications needs to be both appropriate and not excessive, direct ocular surface trauma is kept to a minimum with careful tissue handling, operative light exposure is appropriate for surgical visualization and not excessive, and operative/ocular exposure times are minimized by careful surgical planning. The latter is important in the selection of cases for teaching purposes where operative times are often extended.^{10,27}

CONCLUSION

This study comprehensively analyzed DED prevalence and characteristics after cataract surgery. It presents a concise and up-to-date description of the risk factors, prevention, and treatments. Our findings contribute to generating increased awareness among physicians, researchers, and the general population regarding DED after cataract surgery and encourage the development of effective preventative and treatment strategies.

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