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Review

A review of contact lens discomfort: from the clinic to the laboratory

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ABSTRACT

The exact mechanisms underlying contact lens discomfort (CLD) remain unknown. CLD results from reduced compatibility between the lens and the ocular environment, and multiple factors can trigger discomfort when wearing the lens. Consequently, this narrative review aims to elucidate the symptoms, clinical signs (singly and in combination) and ocular surface inflammatory mediators associated with CLD. This information could be useful for improving CLD management strategies in the future. A literature search of the PubMed database revealed widespread use of dry eye questionnaires in contact lens (CL) wearers, however, the emerging use of specific questionnaires for CLD is considered more appropriate. Besides, several inflammatory mediators might play a role in the development of CLD. Therefore, further studies are needed to investigate the role of ocular surface inflammatory mediators involved in CLD to better understand this condition.

Introduction

The last definition of contact lens discomfort (CLD) states that "is a condition characterized by episodic or persistent adverse ocular sensations related to lens wear, either with or without visual disturbance, resulting from reduced compatibility between the contact lens (CL) and the ocular environment, which can lead to decreased wearing time and discontinuation of CL wear".[1] Despite improvements in CL designs, materials, and wearing schedules over the past few years, CLD continues to be a pivotal point of study. Its prevalence is around 35 % among CL wearers,[2] and is the main reason for CL abandonment.[3]

Numerous studies have addressed this condition. It must be taken into account that the condition is episodic, variable in degree, and resolves after CL removal.[4] Moreover, there is a diversity of clinical presentations reported by CL wearers suffering from discomfort.[5] Clinicians should bear this variability in mind when dealing with CLD, thus the use of questionnaires specifically designed to evaluate CLD is highly recommended.[6]

The exact mechanisms underlying CLD remain unknown. The ocular surface represents a dynamic environment where numerous inflammatory mediators orchestrate complex physiological responses.[7–9] The mechanical irritation produced during CL wear can trigger a cascade of inflammatory events that could be potentially related to CLD.[10] Understanding the involvement of inflammatory mediators in the tear film and ocular surface cells is paramount for elucidating the underlying mechanisms of CLD.

There is a significant variability in the criteria used in scientific studies to classify CL wearers as asymptomatic or symptomatic.[11–13] This lack of consistency makes it difficult to draw robust conclusions about the various aspects of CLD that have been evaluated. Moreover, symptomatology can vary depending on the CL wearing time,[14,15] the environment to which the individual is exposed,[16] and personal factors,[17,18] further complicating the reliability of symptom-based assessments.[4] As CLD might be associated with clinical alterations of the ocular surface, previous authors have also provided data regarding the status of the ocular surface in those patients suffering from CLD.[19–22] Besides, several authors have also used a combination of clinical parameters to describe the possible signs associated to CLD,[23,24,25] which can help to understand the cause of CLD and designing a treatment plan.

Therefore, the purpose of this review was to identify and synthesize the parameters reported in the scientific literature that may contribute to CLD, including diagnostic questionnaires, associated clinical signs, and inflammatory biomarkers. By integrating these diverse elements, the review seeks to provide a comprehensive understanding of the mechanisms and predictors involved in CLD development. Furthermore, it incorporates recent evidence to inform future diagnostic and management strategies, ultimately improving detection and evaluation in both clinical and research settings.

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Methods

A review identifying peer-reviewed articles from Medline (PubMed-NCBI, http://ncbi.nlm.nih.gov/) published on or before May 10, 2024, was conducted. The search strategy combined the following keywords: "contact lens discomfort" or "contact lens-related dry eye", and "questionnaire" or "symptom" or "clinical sign" or "tear film" or "eyelid" or "lid margin" or "corneal sub-basal nerve plexus" or "*in-vivo* corneal confocal microscopy" or "clinical score" or "formula" or "inflammatory mediator" or "interleukin" or "cytokine" or "neuropeptide" or "artificial tear" or "rewetting drop" or "refit" or "management" or "eyelid hygiene". Additional peer-reviewed papers were also obtained from the references of the retrieved papers. All publications in English were consulted in their entire length. The English abstracts available for those publications in other languages were also consulted. The level of evidence for each study included in this review, which addresses parameters for detecting and measuring CLD, has been classified in Table S1 of Supporting Information, following the Scottish Intercollegiate Guidelines Network (SIGN).[26]

To enhance the comprehension of the literature review, the present article has been organized into four main sections, which may intersect: symptom questionnaires used in the scientific literature for the assessment of CLD, clinical signs (singly and in combination) found to be associated with CLD, ocular surface inflammatory mediators related to CLD, and strategies for the management of CLD.

Literature review

The search generated covered 13 symptom questionnaires, including their abbreviated forms, but not language variations (Table S1 of Supporting Information). With respect to the sections on clinical signs, inflammatory mediators, and strategies for the management of CLD, the extensive volume of generated results led the authors to concentrate solely on recent (2000−2024) articles necessary to provide a comprehensive overview of the state of the art (Table S1 of Supporting Information).

Discussion

Symptom questionnaires

Since dryness has been reported as the main symptom experienced by CL wearers,[27] many dry eye disease questionnaires, such as the Ocular Surface Disease Index (OSDI),[28] the Ocular Comfort Index (OCI),[29] the Dry Eye Questionnaire (DEQ)-5,[30] or the McMonnies questionnaire,[31] have been used to assess dryness symptoms associated to CL wear.[32–34] However, the use of these questionnaires developed for the diagnosis of dry eye has not been validated in CL wearers.

Some questionnaires initially designed to detect dry eye have been adapted for use in CL wearers. A modified McMonnies questionnaire was developed to specifically address the symptoms and satisfaction levels experienced during CL use.[35] In addition, a cut-off value was proposed to classify CL wearers as asymptomatic or symptomatic.[36] An adapted version of the Subjective Evaluation of Symptom of Dryness (SESOD) questionnaire[37] was also used,[38] but neither the SESOD nor the McMonnies questionnaires have been validated for CL wearers.

The ability of the Standard Patient Evaluation of Eye Dryness (SPEED) questionnaire[39] to detect dry eye symptoms in CL wearers has been studied.[40] It was observed that the SPEED questionnaire was not able to predict dry eye in CL wearers. The items of the questionnaire with poor fit statistics were removed. This refinement resulted in an 8-item questionnaire, named the SPEED-8 questionnaire, which was proposed as a reasonable instrument to measure dry eye symptoms when directly comparing both CL and non-CL wearers.

The Contact Lens User Experience (CLUE) questionnaire was specifically designed for CL wearers and comprises four domains: quality of vision, comfort, lens handling, and packaging.[41] However, the questionnaire has not been widely used in scientific literature.

The Contact Lens Dry Eye Questionnaire (CLDEQ) evaluates the frequency and intensity of many different ocular symptoms and their effect on daily living activities.[42] Two abbreviated questionnaires were also proposed to promptly identify symptomatic CL wearers. The CLDEQ-short form only asks about the frequency and intensity of dryness and light sensitivity during the last week of CL use,[43] while the CLDEQ-8 evaluates the frequency and intensity of a selected range of symptoms experienced in the last 2 weeks.[44] Its score ranges from 1 to 37 and it allows the classification of CL wearers as asymptomatic or symptomatic through the cut-off value of 12.[45]

The CLDEQ and its short form address CLD in the medium term (in the last 1 or 2 weeks). For short-term CLD quantification (e.g. the assessment of symptoms at different time points during the same day), interval scales or visual analogue scales (VAS)[46] have been widely used in the literature,[47,48] but they have been poorly validated for use in CLD assessments.[4] The global rate of change scale (GRCS) is a simple way to compare the improvement or deterioration of a condition over time.[49] Its usefulness for evaluating CLD has been recently assessed,[50] concluding that the GRCS was more sensitive in detecting small changes in comfort throughout the day compared to the VAS. Therefore, the GRCS can also be considered a valid instrument to evaluate short-term CLD changes.

Since CLD is a condition specific to CL wear, and has different patterns compared to dry eye disease,[51] a questionnaire specifically designed for the diagnosis of CLD according to its last definition[1] has been recently developed: The Contact Lens Discomfort Index (CLDI).[52] The score of this questionnaire ranges from 0 to 18, and the cut-off value to consider CL wearers as symptomatic is >8.

Among the available questionnaires, the CLDEQ has been validated for use in CL wearers.[44,45] The GRCS is an effective tool for short-term assessment of CLD,[50] while the CLDI is the only questionnaire specifically designed for a comprehensive assessment of CLD according to Rasch modeling.[52,53]

Clinical signs associated with CLD

Some research studies have found differences in specific clinical signs among asymptomatic and symptomatic CL wearers. Regarding tear film-related parameters, one of the most commonly observed signs in subjects of the CL-associated dryness group, as classified through a modified CLDEQ questionnaire, was a reduced tear film stability value.[5] Reduced tear volume has also been found in intolerant wearers defined as the ability to wear CLs for 9 h or longer.[11] Higher tear evaporation rates and lower tear meniscus height, tear film stability, and tear film volume values have been found in symptomatic CL wearers classified through the CLDEQ-8 compared to the asymptomatic wearers.[12]

It has been suggested that the dynamic interaction of the CLs with the eyelids with each blink could be involved in CLD.[54,55] The high prevalence of lid wiper epitheliopathy observed in CL wearers has been attributed to an insufficient ocular lubrication and increased friction leading to damage to the stratified squamous epithelial cells in the lid wiper region.[56] The development of lid wiper epitheliopathy could be influenced by CL-related characteristics such as the high coefficient of friction in silicone hydrogel materials, edge design, lens thickness, surface properties, and issues with improper fit or positioning.[57,58] Additionally, several studies have found associations between lid wiper epitheliopathy and CLD symptoms assessed with the SPEED and CLDEQ-8 questionnaires.[20,23] Higher lid-parallel conjunctival fold scores have also been found in symptomatic CL wearers classified using the CLDEQ,[20,238] while eyelid roughness has also been associated with dryness symptoms in soft CL wearers.[59]

Regarding eyelid parameters, higher pouting, capping, and Meibomian gland secretion quality and expressibility have been found in symptomatic CL wearers classified through the CLDEQ-8.[12] On the other hand, CL wearers with displacement of the mucocutaneous junction

showed better comfort scores than those without mucocutaneous junction displacement, with the symptomatology evaluated through the CLUE questionnaire.[13]

A reduction in goblet cell density was observed in the bulbar conjunctival region covered by the CLs compared to the region not covered by the CLs.[60] The reduction, as observed through laser scanning confocal microscopy and conjunctival impression cytology, was reported to be higher in symptomatic CL wearers, as classified through the CLDEQ-8, after 6 months of CL wear.[61] However, no differences in bulbar and limbal redness, or in conjunctival staining, were observed between asymptomatic and symptomatic CL wearers classified through the CLDEQ-8 and the ability to wear CLs for 6 h.[12,62,63]

Despite some studies having found associations between specific clinical signs and CLD symptoms, other studies have not found them. One study did not find any correlations between the clinical signs evaluated (bulbar, limbal, and tarsal redness; lid roughness, tear break-up time, corneal and conjunctival staining, and Schirmer test) and the CLDEQ-8 symptom scores.[64] This fact could be attributed to the quick recovery of the possible ocular surface alterations produced by CL wear, because measurements were performed at least 24 h after removing the CLs. However, another study[5] evaluated the participants while wearing the CLs (after at least 5 h of CL wear) and did not find altered clinical signs in all the subjects reporting discomfort symptoms using a modified CLDEQ questionnaire. In fact, they observed a diversity of clinical presentations in the symptomatic CL wearers. Finally, another study did not find differences in clinical signs and CL questionnaires among CL wearers reporting CLD when grouped following the 5-step CLD progression scale proposed by the Tear Film and Ocular Surface Society (TFOS): (0) no CLD, (1) physical awareness of the CL and visual disturbance, (2) reduced comfortable CL wearing time, (3) reduced total CL wearing time, (4) temporary discontinuation of CL wear and (5) permanent discontinuation of CL wear or CL dropout.[22] Similarly, no differences were detected in clinical signs when using the 2-step classification proposed by the authors[22]: (1) reduced comfortable CL wearing time, and (2) reduced total CL wearing time; in contrast to the significant differences found between groups in CL questionnaires.

Regarding confocal microscopy findings, CLD appears not to be associated with alterations in the corneal sub-basal nerve plexus. No differences in corneal nerve density, nerve tortuosity, and dendritic cell density were found between asymptomatic and symptomatic CL wearers according to the CLDEQ-short form and CLDEQ-8.[65,66] One clinical trial[67] discovered a higher corneal dendritic cell density among symptomatic CL wearers compared to asymptomatic wearers (as assessed with a CLDEQ-8 score $\geq$12 or $\leq$7, and a difference between the average and comfortable CL wearing time $\geq$3 h or $\leq$1 hour), but solely following the use of a particular CL (nelfilcon A, Alcon, Geneva, Switzerland). No distinctions in cell density were observed between symptomatic and asymptomatic wearers following the use of the other CLs evaluated in the study (etafilcon A, Johnson & Johnson Vision, Jacksonville, FL). Nevertheless, the sample size was rather small, ranging from 2 to 5 subjects per group. The discrepancies found among studies reflect the common lack of relationship reported between clinical signs and CLD symptoms.[5,22,68] Therefore, emphasis should be placed on the assessment of symptoms when dealing with CLD, as they can provide a better insight into the condition.

Besides, it has been suggested that the combination of different parameters in clinical scores is more strongly associated with the presence of CLD than the use of the parameters alone. These combinations could be helpful for understanding the origin of CLD and also designing a treatment plan. A multivariate logistic regression analysis has been performed in a group of CL wearers with and without CLD using the CLDEQ.[69] The combination of female gender, the use of CLs with higher water content, rapid pre-lens tear film thinning time, frequent use of over-the-counter pain medication, limbal redness, and increased tear film osmolality were found to be associated with CL-related dry eye symptoms. Likewise, a cross-sectional study reported that the combination of an altered tear evaporation rate without CLs, in addition to the presence of lid-parallel conjunctival folds and altered eye lid parameters (i.e. Meibomian gland secretion and morphology) could be highly associated with the appearance of symptoms of discomfort during CL wear.[24] Finally, a different study[70] assessed several factors associated with CL discontinuation, and they observed that Meibomian gland plugging and tortuosity, and meibum quality increased the subject's odds of dropping out of CLs.

Inflammatory mediators

CLD is not associated with the classic signs of inflammation (swelling, heat, and redness), but some alterations in ocular surface immune regulation have been observed.[62] Therefore, it is thought that low-grade inflammation (parainflammation) occurs during uncomfortable CL wear, though its role in the etiology of CLD remains controversial.[71,72]

An increased vascular endothelial growth factor (VEGF) concentration in the tears of CL wearers who experienced a large decrease in ocular comfort during the day (evaluated though a comfort VAS) was observed.[73] VEGF can promote the growth of vascular endothelial cells and induce vascular leakage and vasodilation.[74] The lack of correlation between VEGF and slight decreases in comfort suggests that VEGF changes in tears are secondary to ocular comfort changes and not a causative effect, as a gradual increase in VEGF with an increased level of discomfort was not found.[73]

Higher tear concentrations of the neuropeptide substance P were observed in symptomatic CL wearers compared to asymptomatic wearers (classified using the CLDEQ-short form).[75] Substance P is involved in the transmission of pain and appears to be directly related to the sensory function of the ocular surface.[76] Therefore, it was proposed that the higher levels of substance P found in the tears of symptomatic CL wearers may facilitate nociceptive sensitization of the ocular surface, enhancing the development of CLD symptoms.

The concentration of nerve growth factor (NGF) and transforming growth factor (TGF)-β1 was found to be higher in the CL-related dry eye group compared to CL wearers without dry eye (being CL-related dry eye defined as an OSDI >20 and a Schirmer test without anesthesia <10 mm in 5 min).[77] Both NGF and TGF-β1 have already been related to chronic inflammatory conditions.[78,79] Therefore, their elevated concentrations in CL-related dry eye wearers were attributed to the chronic inflammation characteristic of the dry eye condition.[80]

A positive association between higher symptoms and ratios of proinflammatory to anti-inflammatory cytokines, interleukin (IL)-1β to IL-10 (assessed with the CLDEQ-8 and OCI questionnaires) and IL-12 (p70) to IL-10 (only with the OCI), has been found.[60] Therefore, the balance between cytokines appears to be critical in maintaining the homeostasis of the ocular surface, and hence, comfort during CL wear.

IL-17A has been found to be higher in symptomatic CL wearers compared to asymptomatic wearers (classified through the CLDEQ-8).[62] IL-17A can promote epithelial cell damage by stimulating the production of other pro-inflammatory cytokines, such as IL-1, IL-6, and IL-8, and enzymes such as MMP-9, from ocular surface immune cells.[81,82] Thus, it was proposed that the activation of the immune system is an adaptive mechanism intended to maintain ocular surface homeostasis, possibly through the induction of discomfort as a signal to remove the CL as an offending stimulus.

In CL-related dry eye subjects (classified according to the CLDEQ, a difference between total and comfortable daily lens wear $\geq$2 h, and a tear break up time <7 s), higher concentrations of other tear inflammatory mediators have been observed compared to normal subjects.[83] These mediators included IL-1 receptor antagonist (Ra), IL-2, IL-7, IL-8, IL-11, IL-12 (p70), IL-13, IL-15, epidermal growth factor (EGF) receptor, granulocyte colony-stimulating factor (G-CSF), macrophage colony-stimulating factor, growth-related oncogene-α, and eotaxin. These results disagree with other studies where no associations were found between CLD symptoms and many tear inflammatory molecules, including IL-1A,

IL-1β, IL-1 Ra, IL-2, IL-4, IL-5, IL-6, IL-7, IL-8, IL-9, IL-10, IL-12 (p70), IL-13, IL-15, IL-17A, granulocyte-monocyte colony-stimulating factor (GM-CSF), G-CSF, platelet-derived growth factor (PDGF)-BB, basic fibroblast growth factor (FGF)-b, EGF, monocyte chemotactic protein (MCP)-1, macrophage inflammatory protein (MIP)-1α, MIP-1β, eotaxin, fractalkine, interferon-induced protein (IP)-10, regulated upon activation normal T-cell expressed and secreted (RANTES), interferon (IFN)-γ, matrix metalloproteinase (MMP)-9, and tumor necrosis factor (TNF)-α.[60,62,73,75,84] The discrepancies between studies have been attributed to the mild symptoms reported by the participants.[60]

A recent study[85] found statistically higher tear concentrations of IL-2, IL-6, IL-10, NGF, TNF-α, fractalkine, MCP-3, MIP-1β, and RANTES in CL wearers who remained symptomatic after daily disposable CL refitting compared to those who became asymptomatic according to the CLDEQ-8. In addition, the authors performed simple logistic regression models to predict the success of CLD management by daily disposable CL refitting. In these models, significant results were found for all of these inflammatory molecules except for NGF, MCP-3, and MIP-1β. These results could suggest that monitoring the tear concentrations of IL-2, IL-6, IL-10, TNF-α, fractalkine, and RANTES might be useful in predicting the success of CLD management by refitting a daily disposable CL.

No differences have been found between asymptomatic and symptomatic CL wearers in the levels of the following tear mediators: secretory immunoglobulin A (sIgA), lysozyme, lactoferrin, lipocalin 1, proline-rich 4, prolactin-induced protein, prostaglandins, and cysteinyl leukotrienes.[63,86] Furthermore, no associations between comfort (evaluated with a VAS), sIgA, and complement components C_3 and C_{3a} have been observed.[87] However, the level of leukotriene B4 (LTB4) has been found to be higher in the evening in symptomatic CL wearers (defined as a comfort VAS score $\leq$70).[86] Intolerant CL wearers (defined as experiencing dryness symptoms in the first 6 h of CL wear) had more lipid-related protein secretory phospholipase A2 (sPLA2) in their tears compared with tolerant subjects and showed more enzyme activity.[88] The increased levels of both LTB4 and sPLA2 may be indicative of the localized inflammatory processes existing in CL wearers experiencing discomfort.[89,90]

Finally, the differentially expressed genes found in the bulbar conjunctival epithelial cells of asymptomatic and symptomatic CL wearers (classified using the CLDEQ-short form) have been analysed.[91] This study showed promising results but were limited by the small sample size; therefore, an expanded study was performed. In the later study, the expression of genes involved in synaptic transmission (GRIN1, GRM1, HTR1A, and CACNA1B), pain conduction (ADORA1 and P2RX3), and pain response modulation (PTGS1, BDKRB1, TNF, DBH, and PDYN) was downregulated in symptomatic CL wearers compared to the asymptomatic CL wearers.[92] CL wear in the symptomatic group appeared to inhibit the gene expression of molecules associated with analgesia and stimulate the gene expression of molecules associated with inflammation and pain.[91,92] These results lead to the proposal that asymptomatic CL wearers might be protected by adaptive mechanical mechanisms on the ocular surface, which might alleviate symptom severity. However, these adaptive mechanisms might fail in symptomatic CL wearers, leading to the development of discomfort symptoms.

The involvement of ocular surface inflammatory mediators during CL wear shows potential as a source of information on the biochemical mechanisms responsible for the appearance of CLD. Consequently, they could play an important role in aiding the development of future CLD management techniques.

Management of CLD

To effectively manage CLD, it is very important to first identify risk factors such as coexisting allergies, diseases, or specific environmental conditions that may further induce or exacerbate the symptoms of CLD.[93,94] Additionally, it is recommended to observe the status of the CL and its interactions with the ocular surface.[95]

The most common problem associated with CL wear is dry eye, a multifactorial ocular surface disease characterized by tear film instability, ocular symptoms, and inflammation.[96–98] When a CL is placed on the ocular surface, the tear film is divided into pre-lens and post-lens layers, and the aqueous volume in the pre-lens tear film is reduced. The CL surface lacks a hydrophilic mucin layer, resulting in decreased wettability and instability of the pre-lens tear film, leading to breakup shortly after blinking.[99] This instability, combined with insufficient tear volume or a thinning post-lens tear film, causes friction between the eyelid and the CL, often resulting in discomfort or dryness symptoms.[99] CL wearers are 2.38 times more likely to develop dry eye and are 3.61 times more likely to experience severe dry eye symptoms compared to non-wearers.[100]

CL wearers have also been found to have an increased incidence of Meibomian gland dropout.[101] Possible explanations include a decrease in the aqueous volume of the pre-lens tear film or the direct mechanical stimulation of the Meibomian glands by the CL.[97] Improvements in lid margin status and symptoms of discomfort have been observed in CL wearers following the implementation of lid hygiene practices.[25,102] Although traditional warm compresses are effective in restoring Meibomian gland function,[103] patient compliance can be a challenge. To improve treatment efficacy, new options such as electronic eyelid-heating devices,[104] thermal pulsation systems,[105] and intense pulsed light (IPL) therapy[106] have been developed, all of which have shown improvements in symptoms of CL wearers.[107,108]

Once all the risk factors have been identified and the modifiable ones have been addressed, the next recommended step in managing CLD would be to change the CL type or wear schedule, if clinically indicated.[95,109] Few CL wearers fully adhere to cleaning and disinfection protocols, making simplified care routines essential to improve hygiene.[110] CL storage cases are a major source of microbial contamination, and reuse of disinfectant solutions can increase the risk of infection.[111,112] Additionally, avoiding disinfectant chemicals prevents adverse effects like solution-induced corneal staining.[113] Several authors have successfully demonstrated that switching from frequent replacement CLs to daily disposables can alleviate symptoms of discomfort.[114,115] The use of different CL materials when refitting daily disposable CLs in CLD have been proven to be useful.[116–119] Therefore, since comfort and vision rates appear to be similar across different daily disposable materials,[120,121] the choice of CL material could be based on patient and practitioner preference, provided that ocular health considerations are always taken into account. Moreover, contemporary daily disposable CL materials have evolved so much that it has been demonstrated that these CLs can provide similar levels of comfort and vision to those experienced by emmetropes who do not wear CLs.[122]

Artificial tears and rewetting drops are commonly used to provide supplemental agents that stabilize and add bulk to the tear film, reduce ocular friction, and provide a protective ocular surface barrier.[123,124] Improvement in symptoms of discomfort and dryness symptoms has been observed after the use of artificial tears or rewetting drops in CL wearers.[125–128] However, studies are inconsistent as to whether the use of rewetting drops improves clinical signs.[125–128] The application of rewetting drops to the CL prior to its insertion into the eye also resulted in a significant improvement in symptoms of discomfort and dryness, as well as in clinical signs.[129] In addition to the fact that preserved eye drops may negatively affect ocular health, CL wearers prefer non-preserved drops to reduce their symptoms.[130] Furthermore, CLs can absorb preservatives, which is of particular concern with reusable CLs, as this may prolong preservative exposure to the eye.[131] Another important consideration is that high-viscosity eye drops can cause transient blurred vision; to avoid it, the use of low-viscosity versions is recommended.[131]

The effectiveness of various strategies for managing CLD has been well documented in scientific literature. These include changing the CL material or replacement schedule,[116–119] using artificial tears,[125–128] and adhering to lid hygiene practices.[25,102,107,108] Building upon this, a recent study evaluated the efficacy of a stepwise management approach

for CLD by assessing a sequential protocol involving lid hygiene, switching to daily disposable CLs, and adding lubricating drops (2 % povidone) in symptomatic CL wearers.[25] The findings indicated that implementing lid hygiene measures and transitioning to daily disposable CLs significantly reduced discomfort symptoms, as measured by CLDEQ-8 scores, whereas adding lubricating drops did not provide a significant additional benefit. These results suggest that prioritizing lid hygiene and changing to daily disposable CLs should be considered first-line interventions before prescribing lubricants in the management of CLD.

Conclusions and future directions

CLD has commonly been evaluated subjectively using questionnaires originally designed for the diagnosis of dry eye.[32–34,77] However, additional diagnostic value can be gained by asking not only about the frequency and intensity of dryness symptoms, but also about other symptoms associated with the CLD condition.[27] Therefore, the use of questionnaires specifically designed to evaluate CLD, such as the CLDEQ-8 or the CLDI,[44,45,52] is highly recommended.

There are many discrepancies between studies in determining which clinical signs are most associated with CLD. However, not all studies selected the same criteria to classify CL wearers as symptomatic or asymptomatic.[5,11,13] A consistent criterion for classifying CL wearers as asymptomatic or symptomatic in research studies, through the use of the aforementioned questionnaires CLDEQ-8 or CLDI,[44,45,52] can help determine which clinical signs (singly and in combination) are most associated with CLD. Studies evaluating combinations of parameters, rather than individual measures alone, have identified non-invasive tear break-up time, limbal redness, lid-parallel conjunctival folds, and Meibomian gland secretion quality and morphology as some of the most predictive clinical signs associated with CLD.[24,69,70]

Many studies have already shown the important role that the inflammatory mediators might play in the ocular surface during uncomfortable CL wear. The cytokine balance, as well as the levels of several inflammatory mediators, including IL-17A, substance P, LTB4, sPLA2, and pain-related genes, seem to be related to the development of discomfort symptoms during CL wear.[60,62,75,83,86,88,89,92] A comprehensive understanding of the behavior of these inflammatory mediators in the context of CLD, properly defined by using validated questionnaires, is imperative to advance the clinical management of this prevalent condition. Additionally, it could pave the way for the development of targeted therapeutic strategies aimed at reducing discomfort and improving the overall wearing experience for CL wearers.

Several strategies have been proposed for the management of CLD, intended to be implemented in a sequential manner. First, it is advisable to identify any confounding factors that might trigger the condition, such as allergies, underlying diseases, or environmental factors.[93,94,96,97,101] If Meibomian gland dysfunction is present, it should be appropriately treated to address its contribution to CLD.[25,102] Second, a change in CL type or the replacement schedule is recommended to effectively alleviate symptoms.[25,95,116–119] In particular, switching from frequent replacement CLs to daily disposables has been shown to successfully alleviate discomfort symptoms.[114,115] Third, the use of non-preserved artificial tears or rewetting drops has been described as a safe and effective option for improving CLD symptoms.[125–128] However, the efficacy of eye drops in improving clinical signs remains unclear.[125–128] Differences between studies are likely due to variations in drop formulations and in participant recruitment criteria. Further comprehensive and controlled research is needed to draw reliable conclusions about the efficacy of different formulations.

Disclosure

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Supplementary materials

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