Contact Lens Induced Dry Eye

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One of the major causes of discontinuation of contact lens wear is discomfort. The first comprehensive study investigating contact lens dropout conducted almost 20 years ago (Weed et al, 1993) indicated that end-of-day dryness and discomfort was the most common reason for ceasing contact lens wear. Approximately 50 percent of wearers cited this as their primary complaint with lenses.

Despite the advances in contact lens materials since that time, patients are still "dropping out" of contact lens wear as a result of discomfort (Pritchard et al, 1999; Young et al, 2002; Richdale et al, 2007; Chalmers et al, 2009). Studies suggest that 22 percent to 24 percent of patients permanently discontinue contact lens wear. It is surprising to note that comfortable wearing time, even with the most modern soft lens materials, is only about 10 hours per day for many patients, which does not meet the lifestyle requirements of most patients. Contact lens induced dry eye (CLIDE) is arguably one of the biggest challenges facing the contact lens practitioner and the industry.

With the number of contact lens wearers continuing to grow, it is likely that the prevalence of CLIDE will increase and therefore the physicians should develop the skills to more effectively manage the condition and retain contact lens wearers. This article aims to review the causes, symptoms, diagnosis and management of this end-of-day dryness and discomfort.

Clinical Presentation

When a contact lens is placed in the eye several changes occur to the pre-corneal tear film (PCTF) and adnexa such as thinning of the PCTF, lipid layer disruption, increase in mucous secretions, changes in the blink characteristic and rate, and changes in lid conformity (Snyder C, 2000).

An adequate and stable PCTF is necessary to sustain contact lens (CL) wear. Sometimes corneal dessication. results due to the increase in tear evaporation, increase in tear osmolarity, decrease in tear break up time and increase in lysozyme and lactoferrin. These changes are affected by the inherent properties of the CL material or due to the status of the PCTF prior to lens wear. Dry eye symptoms experienced by patients as a result of these changes is referred to as CL-associated or CL-related or Contact Lens Induced Dry Eye (CLIDE) (Tomlinson A, 1992).

Symptoms of CL-induced dry eye include foreign body sensation, tearing or burning, ocular discomfort, red irritated eyes, difficulty associated with visual acuity and a sensation of ocular surface dryness. Most characteristically these symptoms often worsen with the progression of the day. (Bron A J, 2001)

It is important to differentiate the true dry eye patient from the CLIDE. Contact lens patient neither complains of ocular dryness nor exhibit Clinical signs of dry eye when not wearing the lenses. The symptoms of dryness limit their ability to comfortably wear lenses. They also complain of dryness followed by blurry and changeable vision. Corneal staining is seen and are in a younger demographic group. On the contrary the complaints of a true dry patient are most frequently dryness and soreness, symptoms are present both day and night with rapid tear break up time and conjunctival staining. They have an older demographic (above 40). (William Townsend)

The ocular sign most commonly associated with CL-induced dry eye is corneal staining. With rigid gas permeable (RGP) lenses, the corneal staining is most often found at 3 and 9 o'clock, close to the limbus. With soft hydrogel lenses, the staining is most commonly found on the lower third of the corneal surface. Other common signs are lens surface dehydration, surface deposits, bulbar hyperaemia and an increased conjunctival papillary response. Non- specific signs of corneal distress such as corneal infiltrates may sometimes be seen.

More recently Lid Wiper Epitheliopathy (LWE) and Lid Parallel Conjunctival Fold (LIPCOF) have been

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used as significant discriminators of CLIDE.

Incidence

The first study in the 1990's (Weed et al, 1993) reported nearly 50% percent of CL wearers with end-of-the-day dryness. Since then various studies have given figures from 25% to nearly four out of five with symptoms of dryness. It has been noted the symptoms are more prevalent in females. Nichols et al (2005) have reported that contact lens wearers are 12 times more likely than emmetropes and five times more likely than spectacle wearers to report dry eye symptoms.

Recent studies conducted at the Centre for Contact Lens Research to assess compliance with replacement frequency of daily disposable and silicone hydrogel lenses (Dumbleton et al, 2009; Richter et al, 2010) indicate that 47 percent of patients in the United States and 55 percent of patients in Canada reported that their lenses became less comfortable later in the daynumbers that are depressingly close to those published in the 1990s!

What is significant is that majority of the contact lens wearing population are young healthy individuals having adequate tear production. In this population, true aqueous deficiency or keratoconjunctivis sicca (KCS) is extremely rare. Not only that, in spite of newer contact lens materials and frequent replacement of CLs the incidence of CLIDE has not reduced. Therefore it is interesting to understand the etiology, diagnose and manage this condition.

Etiology

CLIDE is a multi-factorial condition that can arise due to any of the following reasons; alteration in the PCTF or the Contact lens itself (material, water content, thickness, fit, design) or contact lens care products (solution, etc) or a combination of these.

Though traditionally dehydration has been attributed as the cause for CLIDE, other possible causes such as hypoxia, tear evaporation, solution sensitivity and psychological component of comfort needs consideration.

PCTF : When contact lenses are put on the ocular surface, they disrupt the tear film. The tear film can be divided into a pre-lental film, retro-lental film, circum- lental meniscus and intra- lental tears. The pre-lental film is very thin as there is lack of glycocalix. The break-up time is very low. Thinning of the pre-lens tear film (PLTF) depends on the quality and thickness of the lipid tear film layer (Cedarstaff and Tomlinson, 1983), which is disrupted by a contact lens (Sindt and Longmuir, 2007). During PLTF rupture, an evaporative-dehydration process starts that draws water through the lens and out of the post-lens tear film, leading to corneal staining (Fonn, 2007). Even though the PLTF thickness with Silicon Hydrogel (SiHy) contact lenses is similar to that with hydrogel contact lenses, the pre-lens break-up time is shorter for SiHy lenses (Nichols et al, 2005).

The retro-lental film has no lipids but there is an accumulation of cellular debris and other active substances, which may change normal epithelial physiology.

The length of the circum-lental tear meniscus depends on the lens diameter. If the diameter is 7 mm, the circumference will be 25 mm and if the diameter is 13 mm, the meniscus will be 41 mm. It takes a large amount of the aqueous component of the tears. Further the volume of the meniscus also depends on the peripheral thickness, thicker it is, higher the quantity of tears needed.

A normal tear-secreting eye will recover after the contact lens is put in the eye, however it will need a higher quantity of tears. Total tear volume increases 2-3 fold whilst wearing contact lenses. A marginally dry eye will not recover and attract tears from other areas to replenish the volume. As the tear film is unstable at the meniscus, evaporation will take place, which in turn changes the quality of the tear film. (Duran de la Colina)

Effects of Tear Evaporation - Evaporation increases the osmolarity, which attracts tears from other parts such as the surface of the lens and epithelium. Dehydration of the epithelium causes epithelial damage and visual fluctuations will be observed due to irregularity of the lens surface (Pritchard and Fonn, 1995). This can also increase the lens surface deposits.

Blinking and CLIDE Discomfort while blinking, due to dry lens surface, makes blinking abnormal. Blinking is essential to renew retro-lental tear film. Hypoxia causes neural damage there by reducing

reflex secretion, hypoesthesia and reduced blink stimulation. There will also be a decrease in thermal stabilisation and increase in the temperature of the ocular surface due to altered blinking. (Duran de la Colina)

CL dehydration and Induced Dryness Contact lenses loses water while wearing, this decreases the oxygen transmissibility there by increasing the hypoxic stress on the cornea. Hypoxia reduces the corneal sensitivity and reflex tearing causing dry eye. Hypoxia is also aggravated by increased wearing time. Another hypothesis suggests increased osmolarity can also cause dehydration of the lens and dry eye. Still little is known about the effect of lens dehydration and its relationship to the symptom of dryness. Conflicting results also exist, where a relationship was found by Efron and Brennan (1987) and no relationship was found with studies by Pritchard and Fonn (1995) and Fonn, Situ and Simpson. (1999)

Increase in temperature of the ocular surface, reduced blink rate, evaporation combined with inflammatory stimuli contributes to drying of the anterior surface of the lens. Thus in accordance with the DEWS definition Contact Lenses act at the beginning of dry eye symptoms both for evaporation and for deficiency.

Corneal epithelial damage occurs due to either hypoxia, toxicity, osmotic changes, metabolic changes or mechanical damage and is related to the permeability of the lens and wearing time. Cellular mitotic rate is decreased; cell size is enlarged and there is thinning of the epithelium causing fragility of cell unions.

Inflammation and Dry Eye Whatever the cause of dry eye -- tear deficiency, evaporation, allergy or reaction to toxins - the result is an inflammatory reaction. The contact lens wearer with symptoms of dryness is no exception. The patient shows elevated levels of conjunctival antigens and reduced density of goblet cells - a pattern typical of chronic allergic conjunctivitis. Just as chronic allergy leads to elevation of local immune response and affects the ocular surface, so does contact lens wear in many instances. (Jennifer Smythe et al)

It can be considered clinically, the immense relief that both allergy and dry eye patients obtain with topical corticosteroids as circumstantial evidence that local immune processes are at work when symptoms occur. Clearly, the use of corticosteroids for treatment of contact lens symptomatic dryness, although potentially effective, is contraindicated in any but the most extreme circumstances. Efforts should be concentrated on eliminating the stimulus to inflammation, rather than blocking the inflammatory process.

Contact Lens Material, Water Content and Thickness Lens comfort depends on parameters such as water content, wettability, adsorption of proteins, modulus, and oxygen permeability (Sindt and Longmuir, 2007). Dehydration changes the flexibility of the contact lens as well as its oxygen transmission and lens fit, which can affect lens comfort, visual quality, and the ocular surface (Dillehay, 2007). Because the bulk water content of contact lenses changes significantly only within the first 5 to 10 minutes on the eye (Brennan et al, 1987; Efron et al, 1987), lens surface dehydration is more important (Sindt and Longmuir, 2007).

One of the factors often stated as being important in contact lens-induced dry eye is bulk material dehydration, as dryness symptoms appear to occur more frequently in soft lens wearers whose lenses undergo greater dehydration (Efron and Young, 1988). Potential factors that may explain dehydration-induced discomfort include increased lid-lens interaction through alterations in material front-surface. Many studies have shown that dehydration is influenced by a number of factors, including the surrounding environment (Brennan et al, 1988), water content (with higher-water-content materials dehydrating to a greater extent) (McConville and Pope, 2001; Jones et al, 2002; Gonzalez-Meijome et al, 2007), water binding properties (Larsen et al, 1990), and thickness (with thin lenses dehydrating more compared to thick lenses) (Helton and Watson, 1991). Most studies indicate that traditional polyHEMA-based hydrogel materials dehydrate to a greater extent and at a faster rate compared to silicone hydrogel lens materials (Jones et al, 2002; Gonzalez-Meijome, et al, 2007) or materials containing permanently embedded high-molecular-weight wetting agent, polyvinyl pyrrolidone (PVP), and higher-water-content

materials are more likely to be associated with dry eye symptoms (Nichols and Sinnott, 2006; Ramamoorthy et al, 2008; Ramamoorthy et al, 2010). In addition, several studies now indicate that silicone hydrogel materials, which are all relatively low in water content, may prove beneficial in managing patients who have symptoms of ocular dryness (Chalmers et al, 2008; Riley et al, 2006;and others).

Summarizing all of these data, it would seem compelling to believe that bulk dehydration is directly linked to comfort and that developing materials with low dehydration rates would result in enhanced lens comfort. However, several studies show a poor direct relationship between bulk dehydration and wearing comfort (Pritchard and Fonn, 1995; Nichols and Sinnott, 2006), and it may well transpire that higher-water-content lenses induce lower comfort scores not as a result of bulk water loss/dehydration but rather due to alterations in surface wetting, surface dehydration, or surface deposition (Nichols and Sinnott, 2006). Much work remains to unravel why lower-water-content materials tend to result in enhanced comfort scores. RGP lenses contain mixtures of Silicone and Fluorine and attract deposits (protein and lipid respectively). This influences the dryness of the surface rather than the material itself, which has no water to lose. (Etty Bitton, Luigina Sorbara, 2011).

Contact Lens Care Regime It may be unrealistic to think that a solution containing chemicals such as a surfactant (soap for cleaning), a preservative for disinfection and an ingredient to solubilize protein, could be continually used without compromising the delicate balance between the ocular surface and the tear film. Solutions should be considered as the causative factor until proven otherwise, because they can cause symptoms of dryness and may sometimes reveal themselves by causing a punctate keratitis, dry spots on the cornea or tarsal plate changes. (Jennifer Smythe et al)

The need to balance microbial efficacy with patient convenience is a challenge for the makers of modern lens care products. While the exact ingredient(s) in preserved contact lens disinfection systems that is culprit hasn't been clearly identified, specific preservatives have been shown to cause epithelial sloughing and loss of microvilli on the surface of the cornea. For example, lens care regimens with polyaminopropyl biguanide (PHMB) have been indentified as a culprit in causing corneal staining or what could be considered "solution-related keratitis" when used with a variety of lens materials, including HEMA-based hydrogels, silicone hydrogels and GP polymers.

Soft lens patients may display diffuse corneal staining that typically begins in the inferior region of the cornea, then works its way around the periphery, with the central cornea typically being the last region affected. In GP solution sensitivity reactions, the corneal staining is often confined to the area underneath the lens, especially if the lens is fitted with apical clearance. Yet absence of significant staining doesn't rule out solution sensitivity. Researchers have documented increasing tarsal plate hyperemia with the use of certain multi-purpose disinfection systems. Hyperemia is often the first sign of inflammation resulting from increased vascular permeability.

Another element of multipurpose solutions to consider suspect in tear film disruption is the surfactant. Patients are soaking these porous, sponge-like lens materials not only in preservatives on a routine basis, but also in soap. Surfactants, which dissolve lipids and mucins, could cause tear evaporation, disrupt cell membranes and allow preservatives to further react with the surface cells.

A combination of excessive tear evaporation and loss of surface microvilli can lead the observation of dry spots on the cornea or areas of non-wetting. Thus, fluoroscein staining and simple lid eversion in contact lens follow-up exams to ascertain the ocular response to both contact lens wear and lens care solutions should be practiced.

Even in the absence of corneal staining or palpebral hyperemia, one can suspect multipurpose solutions when patients complain of chronic dryness while wearing contact lenses. Thus many patients find relief when change or eliminate lens care products is recommended. Use of wrong contact lens care product for the specific lens is observed in many cases.

Diagnosis

As dry eye symptoms are more distinct compared to its ocular signs, a good history is crucial in the

diagnosis of CLIDE. Many questionnaires are available, such as the Contact Lens Dry Eye Questionnaire (CLDEQ) (Nichols et al, 2002), the Dry Eye Questionnaire (DEQ) (Begley et al, 2001), the CLDEQ-8 (Chalmers et al, 2010), the Impact of Dry Eye on Everyday Life questionnaire (IDEEL) (Rajagopalan et al, 2005), McMonnies Dry Eye Index (McMonnies and Ho, 1987b,a and others), and the Ocular Surface Disease Index (OSDI) (Nichols and Smith, 2002; Vitale et al, 2004).

The McMonnies Dry Eye Index is probably the most noted questionnaire and is more useful for dry eye diagnosis than as a measurement of dry eye symptoms (Gothwal et al, 2010). It considers epidemiological risk factors, the frequency of symptoms of ocular irritation, and sensitivity to environmental triggers. Even though developed for non-lens wearers , it was suggested to be useful in contact lens wearers also. (Michel et al, 2009); others reported reduced predictive abilities (sensitivity = 34 percent and specificity = 86 percent) (Nichols et al, 2002).

Even though the OSDI was developed more recently to grade the severity of dry eye as well as for diagnosis in non-contact lens wearers, it was also successfully used in contact lens studies (sensitivity = 76.9 percent and specificity = 90.0 percent [naïve lens wearers (Pult et al, 2009)]). It is notable among other ocular surface disease questionnaires for having undergone psychometric testing and having been accepted by the U.S. Food and Drug Administration (FDA) as an outcome measure for use in dry eye trials (Schiffman et al, 2000).

A Comprehensive anterior segment evaluation, with particular attention to the lid margins and PCTF, can often unmask numerous problems when dry eye is suspected. An evaluation of the PCTF production, distribution, outflow, stability and ocular surface integrity should be meticulously performed.

Tear production can be assessed by Schirmer test, Phenol Red Cotton thread test and tear meniscus height. Digital expression of the meibomian gland providing a clear sebaceous fluid-like secretion is indicative of healthy lipid layer. Intact lid margin, completeness of blink and good lid globe apposition ensures proper distribution of the tears. Untreated blepharitis and environmental debris, will contribute to a reduced flow and distribution. Jones test will reveal the presence of a good outflow.

In order to determine the stability of the tear film tests such as the tear break up time (TBUT), Dry Eye Test (DET) with narrower fluorescein strip with lesser amount of fluorescein, non-invasive break up time (NIBUT) and Tear Thinning time (TTT) can be used.

Even though a battery of tests can be applied in naïve contact lens wearers (before fitting lenses), non-invasive break-up time (NIBUT) (sensitivity = 61.5 percent and specificity = 10.0 percent) and **lid parallel conjunctival fold (LIPCOF)** sum (sensitivity = 69.2 percent and specificity = 90.0 percent) were reported to be the only significant discriminators of later CLIDE in naïve lens wearers (Pult et al, 2009).

However, the investigation into more or less uncommon tests such as **lid wiper epitheliopathy (LWE)** (Korb et al, 2002), LIPCOFs (Höh et al, 1995; Pult et al, 2009; Pult et al, 2008) and tear osmolarity (Benelli et al, 2010; and others) as well as test combinations demonstrated promising results.

LWE is a clinically observable alteration in the epithelium of the advancing lid margin, called the lid wiper. In patients who have dry eye, the tear film is insufficient to separate the ocular surface and lid wiper (Korb et al, 2005); hence the lid wiper is subjected to trauma during the entire lid movement (Korb et al, 2002; Korb et al, 2005). LWE is a significant discriminator of CLIDE (sensitivity = 87.0

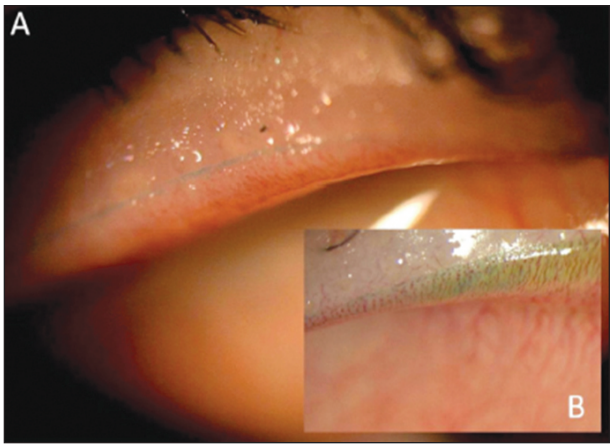


Fig. 1 : Line of Marx (A) versus lid wiper epitheliopathy (B) (Source: Heiko Pult Dry Eye in soft contact lens wearers, Jul 2011, CLS)

percent, specificity = 42.1 percent) (Pult et al, 2008).

LWE (Fig. 1) is visible using a combination of instilled 1% lissamine green (or rose bengal) and 2% fluorescein, and is evaluated for the upper lid. A second instillation of both dyes should be carried out after 5 minutes (Korb et al, 2006). LWE is classified by width and length (Table 1) (Korb et al, 2002). Care

Table 1 : Grading of Lid Wiper Epitheliopathy

	Grade 0	Grade 1	Grade 2	Grade 3
Horizontal Length of staining	< 2 mm	2 mm to 4 mm	5 mm to 9 mm	> 9 mm
Average sagittal width of staining	< 25%	25% to %50%	50% to 75%	> 75%

should be taken to differentiate between staining associated with Marx's line and that from the staining of the lid wiper.

The individual grades of each of the two characteristics are averaged for a final grade for staining.

LIPCOFs are sub-clinical folds in the lateral, lower quadrant of the bulbar conjunctiva that are parallel to

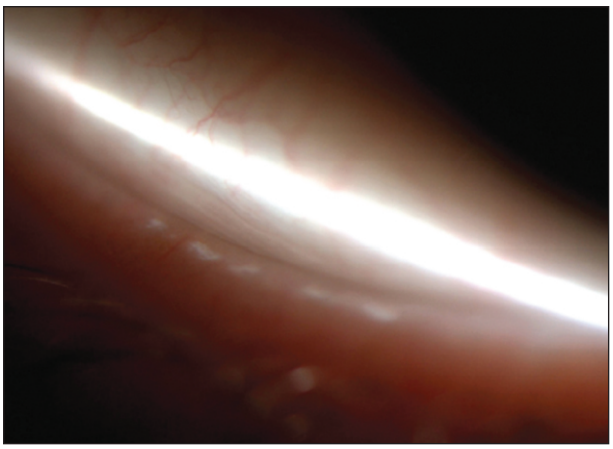


Fig. 2 : Grade 2 temporal LIPCOF (Source: Heiko Pult Dry Eye in soft contact lens wearers, Jul 2011 CLS)

the lower lid margin (Höh et al, 1995; Sickenberger et al, 2000; Pult et al, 2008) and are easily observable by slit lamp (Fig. 2).

LIPCOFs are evaluated in the area perpendicular to the temporal and nasal limbus on the bulbar conjunctiva above the lower lid with a slit lamp microscope using 16x to 25x magnification as necessary, and are classified by number of folds (Table 2) (Pult et al, 2009; Pult et al, 2008). The sum of temporal and nasal LIPCOFs has a higher predictive value compared to regional LIPCOF scores (sensitivity = 82.6 percent, specificity = 84.1 percent) (Pult et al, 2008). The combined LIPCOF score (LIPCOF Sum) is calculated by adding together the temporal and the nasal LIPCOF grade (Pult et al, 2008). Care should be taken to differentiate between parallel, permanent conjunctival folds (LIPCOFs)

Table 2 : Grading scale of LIPCOF

	LIPC of Grade
No conjunctival folds	0
One permanent and clear parallel fold	1
Two permanent and clear parallel folds (normally lower than 0.2mm)	2
More than two permanent and clear parallel folds (normally higher than 0.2mm)	3

and disrupted micro-folds and to use the correct technique (no fluorescein, no contact lens, primary gaze) and area of observation (Pult et al, 2009).

LIPCOFs are assumed to result from mechanical forces in blinks in dry eye patients, since LWE and LIPCOF are significantly correlated and LWE and LIPCOF are also related to mucin quantity (Berry et al, 2008). Both tests can be performed immediately after lens removal (Pult et al, 2008; Korb et al, 2002).

Other laboratory tests such as osmolarity, lactoferrin levels and impression cytology of the conjunctival epithelium need special instrumentation and technical knowledge and are not conducive in clinical setting.

The International Dry Eye Workshop (DEWS) (2007) recognized the role of tear hyperosmolarity in dry eye. Tomlinson et al (2006) concluded that tear hyperosmolarity, defined by a referent of 316 mOsmol/L, is superior in overall accuracy to any other single test for dry eye diagnosis. Khanal et al (2008) concluded that the measurement of the tear osmolarity is the best single test for the diagnosis of dry eye (sensitivity = 78 percent and specificity = 78 percent [non-lens wearers]).

The TearLab Osmolarity Test (TearLab Corp.) has now enabled a possibility of measuring tear film osmolarity in clinical practice. Many studies have discussed its value in dry eye diagnosis (Versura et al,

2010b; Tomlinson et al, 2010; and others). The "TearLab Research Guide" recommends measuring osmolarity 10 to 15 minutes before application or after removal of contact lenses and to measure the effect of lens wear with the lens on the eye. The usefulness of evaluating tear osmolarity in contact lens wearers is obvious, but still not fully investigated (Landers et al, 2011).

Combining different tests can increase predictive ability of dry eye (Sullivan et al, 2010; Begley et al, 2000a; Glasson et al, 2003). The Contact Lens Dry Eye Index (CLIDE-Index), a combination of temporal and nasal LIPCOF with patient symptoms (CLDEQ questions 2 through 5 [dryness minus grittiness) was reported to screen and measure the dry eye state of experienced contact lens wearers (sensitivity = 87 percent and specificity = 87 percent) (Pult et al, 2010b). Glasson et al (2003) suggested a combination of the McMonnies dry eye questionnaire with tear film stability and tear film volume to detect symptomatic experienced lens wearers (sensitivity = 87 percent and specificity = 50 percent). The combination of the OSDI with temporal and nasal LIP-COF and NIBUT (named the Contact-Lens-Predicting-Test [P-Test]) showed good predictive ability (sensitivity = 92 percent and specificity = 90 percent) (Pult et al, 2009) of later CLIDE symptoms in naïve contact lens wearers.

Standardised documentation is essential for comparison, and to track progression or regression of the disease.

Evaluation Flow Chart of contact lens-related symptoms.

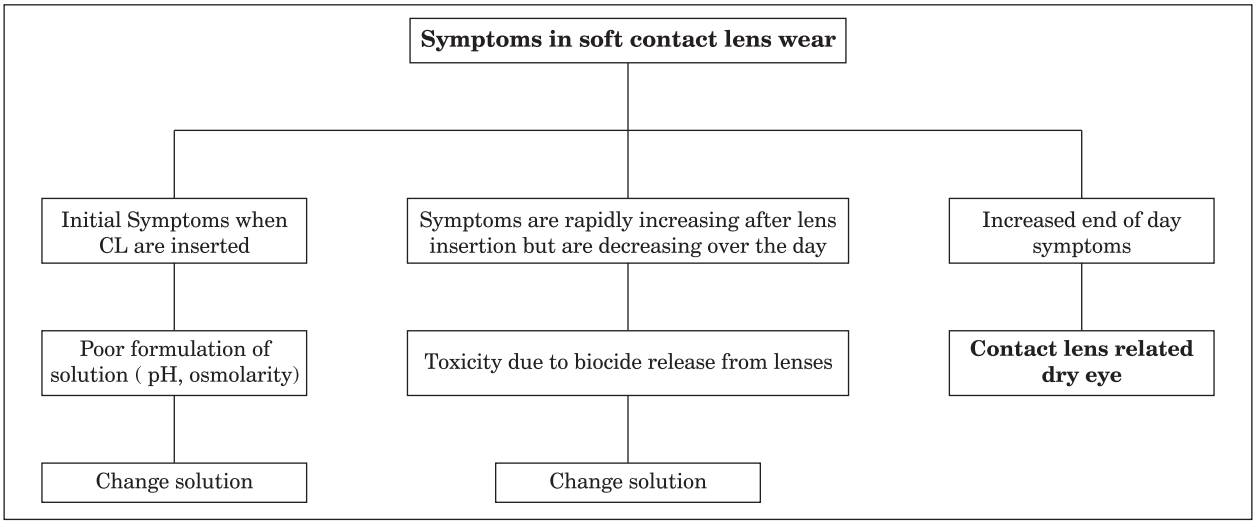
Management of Clide

Managing patients with CLIDE needs a holistic approach. Many symptomatic lens wearers demonstrate pre-existing dry eye (Pult et al, 2009). Therefore, a good history and proper evaluation of the tear film and the ocular surface are essential. An understanding of the work environment needs is essential to identify the need for a more ergonomic approach. Finally the management will depend on the problem identified.

Contact Lens Options Extensive search for enhanced comfort has resulted in a number of manufacturers attempting to use sophisticated chemistry to try to produce lenses that reduce the incidence of CLIDE.

One current area of great interest is biomimesis or bioinspiration (involves examining nature's systems and processes and then exploiting these to solve human problems). The first soft lens material to use such a process is the non-silicone hydrogel material omafilcon A used in the Proclear series of lenses (CooperVision). The material combines polyHEMA and synthetically produced molecules of phosphorylcholine (PC) - found on the outer surface of various cell membranes. Studies have shown that it exhibits low levels of **bulk dehydration** and tear film deposition (Young et al, 1997; Hall et al, 1999; Lemp et al, 1999).

In order to improve the **surface material properties** a variety of approaches, broadly divided



into three concepts viz., Surface Treatments, Internal Wetting Agents and Migratory Polymers have been made. (Lyndon Jones, 2011)

Surface treatments convert the lens materials into wettable, clinically viable lenses (Jones et al, 2006). One example is PureVision (balafilcon A, Bausch + Lomb) lenses surface treated in a reactive gas plasma chamber transforms the silicone components on the surface of the lenses into hydrophilic silicate compounds (Tighe, 2004). Other lenses such Air Optix Aqua (lotrafilcon B, Ciba Vision) use a 25nm thick hydrophilic plasma coating for the same purpose.

Internal Wetting Agents- Lenses such as Acuvue Advance (galyfilcon A) and Acuvue Oasys (senofilcon A) feature technology that renders the lens wettable without the need for modification. The materials contain a permanently embedded high-molecular-weight wetting agent, polyvinyl pyrrolidone (PVP), that helps to achieve a highly wettable, smooth lens (Sheardown and Liu, 2009).

Migratory Polymers The Ciba Vision Dailies series of lenses is manufactured in nelfilcon A, which is based on polyvinyl alcohol (PVA). PVA is commonly found in artificial tear formulations such as Hypotears (Novartis). In the original formulation, the PVA was polymerized into the lens material to N-formylmethyl acrylamide and was termed as being “functionalized.” The newest formulation has functionalized PVA in the lens matrix as well as excess non-functionalized PVA that float free in the lens matrix. This non-functionalized PVA migrates to the lens surface and is slowly released from the lens over the course of the day (Morris, 2008). As a result, the lens surface maintains its wettability and releases a moisturizing agent into the tears over the course of the day.

Changing to contact lens with the above mentioned newer materials will relieve the patients of their end-of-the-day dry eye symptoms. Using thicker lenses without compromising oxygen transmissibility with non-ionic, low water content materials have also shown to help. Even though not all characteristics of SiHy contact lenses are superior to those of traditional hydrogel contact lenses, refitting symptomatic hydrogel lens wearers into SiHy lenses is worth a try because they usually improve CLIDE symptoms (Chalmers et al, 2008). Also, fitting criteria and different lens designs have to be addressed (Dumbleton et al, 2002). A reduced wearing schedule, daily replacement of lenses or even switching to RGP lenses can also be considered.

Lubrication Therapy On-eye wetting agents: Simple use of lens rewetting drops, at regular intervals, at the onset of symptoms is effective but disappointingly short-lived solution to the problem. This regimen is expensive, particularly when the most appropriate formulations (preservative free) are used. (Jennifer Smythe et al, 2003)

Five o'clock, five-minute soak: All soft lens materials dehydrate in vivo, most likely through evaporation. Unfortunately, rewetting agents only minimally relieve symptoms. It's much more effective to remove the lens for brief immersion in saline or multi-purpose solution, allowing the lens to fully rehydrate. For many, this provides noticeably longer relief of symptoms than rewetting drops. The "five o'clock, five minute soak" is a simple and effective strategy for the patient who has a long evening ahead. Hypo-Osmotic eye drops (Stahl et al, 2010) or Liposomal eye sprays (Craig et al, 2010) can help improve symptoms, ocular signs, and tear film.

Contact Lens care products When simple rehydration with drops or soaking doesn't work, lens care solutions should be suspected. The simplest solution to these solution-related dryness problems is to eliminate the solutions! Ideally, a trial with single-use lenses is indicated. For those patients for whom this isn't an option, changing the care regimen to a preservative-free disinfection system such as peroxide or UV-C is the best alternative. It may take up to two weeks to purge the residual effects from previous tens care products; often the patient won't notice any immediate relief but will be gradual. Dispensing a new pair of lenses with a preservative-free disinfection system whenever possible will speed recovery.

Packaging agents: Removing lenses from the packaging and soaking them in certain types of contact lens solution may further increase the initial lens wettability (Sindt and Longmuir, 2007). For example, the latest generation of daily disposable lenses exhibit significantly different wettabilities, some of which are directly due to the components of

the packaging solutions (Menzies et al, 2010). Another area that has attracted much attention over the past two to three years relates to the impact of adding various lubricating agents (such as HPMC) or surface active agents (such as poloxamine) to the blister pack solution (BPS) in which the lenses are stored in an attempt to enhance lens surface wettability following lens application. This is obviously of greatest impact for daily disposable lenses, although the concept of using the BPS to positively impact lens comfort has also been adopted by manufacturers of reusable silicone hydrogel materials, particularly in the Air Optix Aqua and Air Optix Night & Day Aqua lenses from Ciba.

PCTF For production problems such as aqueous deficiency, tear substitutes (preferably non-preserved) inserts or punctal plugs can offer relief. (For mucin deficiency, mast cell stabiliser can aid in the treatment of the tarsal plate as well as vitamin A drops and hypotonic solutions.) For severe cases, acetylcystine can be used for mucous strands. For lipid deficiency, hot compresses, lid scrubs, topical antibiotics can be useful to stimulate the sebaceous glands. Systemic tetracycline may also be useful in severe cases.

For distribution problems such as incomplete blinks, the patient may be made aware of the problem and that in itself may induce more frequent blinking. For outflow problems, dilation and irrigation procedures should eliminate any obstruction. Pre-existing stability problems, caused by blepharitis, Meibomian gland Dysfunction or excessive make-up debris should be treated with proper lid hygiene (daily lid scrubs, warm compresses) to improve the quality and hence the stability of the PCTF. (Foulks G. N. et al, 2003)

After tears- a new option for CLIDE patients is topical Cyclosporin ophthalmic emulsion 0.05%(Restasis), which treats inflammation that has been found to be the underlying cause of dry eye disease. These drops are not to be used while wearing the lenses. (Sall et al, 2000)

Adjuvants Nutritional supplement like omega 3 fatty acids from fish oil or flaxseed oil may help alleviate symptoms. Healthy practices such as avoiding the following: smoky poorly ventilated rooms, low humidity environments, drinking alcohol and drugs that can cause dryness, like oral antihistamnics and antidepressants, can minimise dry eye. (Joseph) 2010 Annual report on Dry Eyes, presented by Jason J. Nichols, has shown the top three preferred ways to treat CLIDE as Lubricating/wetting drops (23%), Refit with different contact lens material (22%) and change of care solution (21%). Nearly 46% of the re-fits were done using Si-Hy lenses.

Conclusion

Dry eye symptoms in contact lens wearers are multi-factorial. Contact lenses can produce or aggravate dryness (Increased tear film evaporation, Decreased corneal sensation leads to lower tear production, increased osmolarity irritates the eye). Pre-existing dry eye states should be addressed in managing CLIDE. New objective tests such as LWE and LIPCOF might be useful in clinical practice because they can be performed easily, without additional equipment, and immediately after lens removal. The best option to evaluate the dry eye status of naïve and experienced contact lens wearers is with a combination of objective tests and questionnaires. Refitting symptomatic hydrogel contact lens wearers with newer SiHy lenses can help reduce dry eye symptoms in most patients. The additional avoidance of preservatives and use of wetting agents and continuous lubrication of the ocular surface is promising.

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