

# Complications Caused by Contact Lens Wearing

Jasna Beljan<sup>1</sup>, Kristina Beljan<sup>1</sup> and Zdravko Beljan<sup>1,2</sup>

<sup>1</sup> Optika »Vitrum«, Zagreb, Croatia

<sup>2</sup> University of Applied Sciences Velika Gorica, Vellika Gorica, Croatia

## ABSTRACT

*Complications in wearing contact lenses are very rare and caused by poor maintenance, over-extended wear and wearing of contact lenses in a polluted environment. Regular control by a professional person can efficiently reduce the number of complications. This paper describes the most common risks factors for complications, and complications of wearing contact lenses with the classification according to the anatomic parts of the eye: eyelids, tear film, limbus, corneal epithelium, corneal stroma and corneal endothelium. Every complication has been described by the characteristic signs and symptoms, etiology and pathology, as well as therapy and prognosis. The paper describes how to select adequate customers as contact lens users, with proper education in order to ensure minimal incidence of complications due to contact lens wear, thus attracting a lot of satisfied and healthy customers.*

**Key words:** complications, contact lenses, eyelids, tear film, limbus, cornea

## Introduction

Contact lenses cause a wide range of changes in the eye. The complications related to contact lens wear include inflammatory, mechanical, or metabolic changes that are related to contact lens wear.

In Croatia, contact lenses are Class I medical product, and the care solutions for contact lenses are Class IIa medical product, regulated by the Act on Medical Products (NN 67/08), and therefore have to be safe and efficient. They are one of the safest medical products but complications still do occur<sup>1</sup>. About 6% of all contact lens wearers have experienced some type of problem related to contact lens wearing every year<sup>2</sup>.

In spite of the low rate of complications, the medical literature is full of case studies in which failures regarding hygiene and handling of contact lenses were the main reason for complications. The majority of problems are insignificant and without consequences for the user; however, sometimes serious and vision-dangerous complications may occur.

The selection of a client is the first important task in contact lens fitting. The optometrists should recommend lenses that satisfy the needs of their customers that have no significant risk of complications. Therefore, extended lens wear (24 hours) is considered risky since this method of wearing is related to significant increase in the

risk of complications. Advanced achievements in contact lens materials have reduced some of the risks related to extended wear but many, including bacterial keratitis still exist today.

To stimulate the customers to apply better habits, they should be informed about the fact of how much the misuse of contact lenses can have serious effect on the vision. Education and constant reminding of the customers about the importance of adequate hygiene of contact lenses and the means for cleaning and handling, as well as the recommended replacement of contact lenses will significantly reduce the frequency of complications.

## Contact Lenses and Corneal Physiology

Contact lenses are made of synthetic polymers and they are worn on the surface of the cornea. Contact lens wear reduces the oxygen transmissibility and therefore affects the cornea changing the physiological and metabolic cell activity.

If the lids are closed for longer than five minutes the oxygen pressure falls from 155 mmHg to 50 mmHg<sup>3</sup>.

The volume of CO<sub>2</sub> grows due to the retention of the glucose metabolism that increases the production of CO<sub>2</sub>, causing a shift into acid pH in corneal stroma. The

stromal oedema results from the production and accumulation of lactate. The corneal swelling is reflected in the response to the reduced oxygen pressure, approximately by 3% during the night in the eyes without contact lenses and approximately 10–15% in conventional hydrogel lenses with low oxygen transmissibility (Dk)<sup>4</sup>.

Also a slight increase in temperature is noticed on the eye surface.

The users of such lenses have reduced corneal sensitivity that is partly adaptable. The change is more expressed in the RGP lens wearers than in soft contact lens users.

Contact lens wear causes also changes in the tear film. The tear film changes consist in the reduction of the tear film volume which is partly due to increased evaporation, which leads to increased osmolarity of the tear film. Also, the amount of proteins in the tears increases.

The final effect of these changes is the condition of sub-clinical infections that partly contribute to the problems related to contact lens wear. The optometrist's task is to distinguish the mechanical and physiological changes in the eye that are more acceptable than anomalies and pathologic conditions<sup>5</sup>.

## **Risk Factors for Complications Related to Contact Lens Wear**

### *Contact lens material*

It has been noticed that the frequency of complications is greater in case of soft contact lens wearers as compared to the RGP contact lens users<sup>6</sup>. Regardless of the safety of RGP lenses, they are losing their popularity on the world markets. They account for 3% of newly fitted contact lenses. Most often the hydrogel and silicone hydrogel lenses are used, which change from daily ones to three months. The popularity of silicone hydrogel contact lenses with high oxygen transmissibility is growing. The silicone lenses have also caused fewer complications than other types of soft lenses, but they are not often used due to the discomfort of wearing. It has been found that silicone lenses carry lower risk of limbal injections and corneal neovascularisation. The health of epithelium is not compromised and the functions are retained. The findings that cause fitters enthusiasm are based on the studies that have shown that the bacterial invasiveness on the corneal epithelium is inversely proportional to oxygen transmissibility through the contact lens material.

### *Deposits and contamination of contact lenses*

In the tear film there are about 400 types of proteins that may get deposited on the contact lenses. It should be considered that proteins deposit less on the silicone hydrogel materials than on the older materials<sup>7</sup>. The deposits appear already in the first minutes after inserting the contact lenses and increase with the time of wear. The most of deposits found on the contact lens surfaces are proteins and lipids from the tear film. Proteins are

seen as a thin foggy coat on the lens surface. The most frequent protein is a denaturised lysozyme, but there are also albumin and gamma globulin. The lipid deposits are mainly from the Meibomian glands and render a fatty or oily appearance to the lens surface. The calcium deposits are also found and these point deposits have a transparent or whitish appearance. The lipids and mucins can form massive deposits called jelly bumps. These deposits are a factor which causes some complications in contact lens wearing. They can cause immunological and mechanical stimulations of conjunctiva.

The water content in the hydrogel lens materials as well as chemical and ionic characteristics of material affect the quantity of deposits that are formed on the contact lens surface in everyday wear. In general, the lenses with higher water content accumulate greater quantities of deposits in comparison to the lenses with lower water content. The ionic lenses accumulate more protein deposits compared to non-ionic lenses that attract more lipids<sup>8</sup>. Various contaminations in the environment can also form lens deposits which include oils, dirt, lotions, make-up, powders and hair sprays, perfumes, and other substances that can be applied by hands. Hair spray is often seen and looks as a protein layer. Dust, smoke and other aerosols can also participate in lens contamination. The bacteria, such as *Pseudomonas aeruginosa* and *Staphylococcus epidermidis* as well as fungi and protozoa, can also be found on the lens surface. The bacteria can form a bio film on the lens surface and on the surface of the lens case, and the deposits with fungi content are thread-like in appearance, and they can penetrate into the lens structure, especially into the lens material with higher percentage of water. The capability of micro-organisms to penetrate into the lens surface and the increase in the quantity of bacteria on the epithelium in combination with the fact that contact lens wearers often have compromised epithelium, increase, multiply the natural risk factors for the development of the bacterial keratitis, one of the most serious complications for wearers. The studies show that the usage of contact lenses with faster change program show lower risk of deposit formation and complications that they develop than from the usage of conventional contact lenses<sup>9</sup>.

### *Contact lens deformation and damage*

Deformation is the change in relation to original parameters. It can be confirmed at a laboratory using a spherometer. The customers can notice reduced vision with contact lenses, and more often they will notice foggy vision when the lenses are replaced by eyeglasses. The changes can be the result of too high pressure or temperature through the cleaning and maintenance process in especially hot environment. The lens deformation is indicated by bad fit with increased or reduced movement of the lens on the cornea. This can cause trauma on the epithelium increasing the possibility of other complications related to the contact lens wear. The lens deformation can be suspected if the customer's visus changes, and it is confirmed in the changes of the fluorescein picture or

changes on the corneal topography where irregular and unusual forms can be seen.

### *Contact lens cleaning and care solutions*

Proper cleaning of contact lenses is especially important. The trend in contact lens handling is the use of multi-purpose solutions. The multi-purpose solutions should contain cleaning detergents, disinfection means, preservatives and polymers or softeners which make contact lenses more comfortable to wear.

The popularity of the frequently exchanged lenses contributes to this trend as well as the wish of the producer to provide comfort for the contact lens wearers.

Today, there are more and more persons sensitive to preservatives, and these contact lens users should use peroxide substances in combination with abrasive means (for RGP lens users). Many practitioners believe that rubbing of the lens between finger and palm is necessary for complete cleaning.

Customer: The customer has the maximum control over the handling of their contact lenses, wearing and exchanging them within the deadlines.

### **Existing Customer's Conditions – Risk Factors**

Many existing conditions may lead to eye surface irritation or infection and may be the limiting factor for the customer's possibilities in wearing contact lenses. These conditions include allergic eye diseases, as well as seasonal and constant allergic conjunctivitis, vernal conjunctivitis, and atypical keratoconjunctivitis. Another frequent case of eye surface irritation is the dry eye syndrome or keratoconjunctivitis sicca; many systematic diseases as auto-immune diseases and thyroid diseases may be related to dry eyes. Some dermatological conditions may be related to the Meibomian glands dysfunction and this can affect the quality of the tear film. Often the lenses can be successfully fitted in case of customers suffering from these conditions but attention should be paid to the quality and quantity of the tear film in order to minimize the complications. The use of punctal occlusion and the means for tear film improvement can help customers with dry eyes to successfully wear contact lenses. The means for tear film improvement are recommended but the preservatives can be absorbed in the hydrogel lens matrix and can sometimes cause eye irritation. There are also the means for improving the tear film free of preservatives packaged in very small sterile doses for single-time use. The use of contact lenses with high percentage of water should be avoided in customers with dry eye since the lens gets thinner due to dehydration and results in the tight lens syndrome.

### *Incomplete blinking*

Abnormal blinking causes problems on the eye surface, and it can be often seen in all types of contact lens wearers. Insufficiently frequent blinking or incomplete

blinking can cause contact lens drying and formation of deposits. The reduced tear exchange between the contact lens and the cornea leads to retinal hypoxia and retention of dendrites below the lens. Blinking exercises should be recommended in order to achieve full blinking.

### *Use of drugs*

Use of many usual drugs such as diuretics, antihistamines, anticholinergics, and psychotropic drugs can cause reduced production of tears, increasing the dryness of the eye surface. Another area of interest is the use of steroids and other immunological drugs that may change the body's natural defense system, increasing the risk of infection in contact lens wearers.

### *Smoking*

The difference in the stability of tear film and statistically significant reduction of conjunctiva and corneal sensitivity in smokers confirms the theory that due to smoking the lipid layer of precorneal tear film deteriorates<sup>10</sup>. Smoking is a risk factor for the development of the problems related to contact lens wear.

### *Time schedule of contact lens wear*

Some physiological changes that are reflected in contact lens wear increase with extended or continuous wear. The changes on the epithelium also occur, which includes thinning of the epithelium and slowing down of the epithelium cell exchange. Additionally, there is increase in the upper epithelium cells. Although these changes can be observed also by extended wear of silicone lens with high oxygen transmissibility, it is obvious that the changes are much smaller in cases of lenses with high oxygen transmissibility. It is well known that wearing lenses during night is a risk factor for various problems related to contact lens wear. It is possible that silicone hydrogel lens with proven increased oxygen transmissibility will permit night wear with fewer complications, but the frequency of infiltrative ulcerations has remained at a similar number as in case of lenses with lower oxygen transmissibility.

Orthokeratology allows corrected vision and it is an alternative to conventional lens wear or refractive surgery. This approach has been known for years but the interest for it has increased in the recent years with the development of technology and availability of materials with high oxygen transmissibility. However, due to compromised corneal epithelium serious complications are possible. The professionals sometimes recommend orthokeratology for children who are too young for refractive surgery; but one should be warned about the possible consequences<sup>11</sup>.

### *Plan of contact lens change*

It is known that polymers age and over time gather more and more deposits, being removed only partially by regular cleaning and disinfection. Since our understanding of the problems related to deposits on the contact

lens is improving, and with the aging of polymers of which the contact lens is made, we are increasingly prone to the trend of replacing the lens as often as possible. Disposable or “daily” contact lenses are the highest standard of this concept. In practice higher safety of contact lens wear with shorter change intervals has been proven.

#### *Wear of contact lenses without professional control*

Especially frequent are the irregularities in handling contact lenses in case of wearers who buy their lenses over the Internet. Lack of compliance with the producer’s instructions is responsible for a large number of complications related to contact lens wear. According to a study of contact lens user profile the major non-compliance aspects show that 50% wearers do not remember how often they were advised to return for an aftercare. Lens wearers who purchased contact lenses from the Internet were 3.8 times more likely to forget their aftercare schedule than those who purchased contact lenses from the optometrists<sup>12</sup>. Similar studies have shown that the producers find simpler ways of using and handling contact lenses in the belief that the simpler systems for contact lens care will increase the safety of contact lens wear. Uncontrolled wear occurs when a person without experience of wearing contact lenses purchases the lenses from a dealer without a licence and without a prescription for contact lenses.

#### *Hygiene*

Keeping proper hygiene of contact lenses, cases, and cleaning solution bottles is important to avoid the sources of contamination. Appropriate hygiene allows health and comfort of contact lens wear. A recent study has shown that in Australia the trend of not washing hands was present in 11% of examinees. The same study in Hong Kong counted 34% cases, 9% lenses and 11% solutions that were contaminated<sup>13</sup>. Occasional contact lens wearers have worse hygiene of the contact lens cases.

The optometrists play an important role in the education and stimulation of better hygienic habits in contact lens wearers.

#### *Contraindication of contact lens wear*

There are very few diseases and conditions which are contraindications for contact lens fitting or causing drop-outs. The contraindications may be of visual, professional, medical, and psychological nature, and related to the environment.

The visual reasons for not fitting the lenses are low refractive values, from  $-0.75$  dptr to  $+1.00$  dptr, correction only in the near, when visual acuity is lower than with eyeglasses, and when horizontal or vertical prisms greater than 3 cm/m are necessary.

Professional reasons are e.g. fire brigade activities, piloting, etc.

Cosmetic reasons are when the eyeglasses hide a facial deformation.

Psychological reasons understand customer’s rejection of the foreign body in the eye, when they cannot tolerate their level of discomfort, and in total perfectionists.

The reasons related to the environment are: dust, smoke, dry air (central heating, air-conditioning), higher above-sea-level altitude.

Medical reasons are: active infection, return of corneal erosion, allergies, herpes simplex, diabetes (due to sensitive corneal epithelium), anatomic reasons (irregular shape of eyelids), smoking and dry eye syndrome.

Dry eye is the most frequent contraindication to contact lenses.

Beside all the difficulties caused by the dry eye often the contact lenses, especially the RGP ones, can be well tolerated, so that the dry eye is not an absolute contraindication for contact lens wear.

### **Diseases and Complications Related to Contact Lens Wear – Analysis**

Complications can be analyzed through the ethyology – infection, inflammation, toxic reaction or allergy. Analysis can also be done according to the structure that is included. I have decided to make the analysis according to the affected structures: eyelids, tear film, conjunctiva, limbus, corneal epithelium, corneal stroma, corneal endothelium.

#### **Eyelids**

##### *Abnormal blinking*

The symptoms and signs of blinking abnormality can include incomplete blink, insufficient number of blinks, forced blink, and dry eye. The consequences are: eye drying, deposits, tear stagnation behind the lens, hypoxia, hypercapnia, erosions at 3 and 9 o’clock, reduced TBUT. The blinking training will improve only blinking and reduce the signs.

##### *Ptosis*

It is the reduction of the palpebral slit which can be observed in RGP lens wearers. It is the result of an oedema during the trauma while inserting and taking out the lenses, forced pressing of the eyelids, lateral eyelid extension, blepharospasms and papillary conjunctivitis (GPC).

The lenses should be removed for one to three months, GPC should be treated, soft contact lenses fitted, and in more severe cases eyelid surgery is also performed.

##### *Meibomian glands dysfunction*

It occurs as the result of the blockage of the Meibomian glands ducts. A yellowish creamy secret can be seen. The contact lens lubrication deteriorates, the lens is fatty, there is dry eye and intolerance to the lens.

It is recommended to apply warm compresses on the lids, use artificial tears, improve the eyelid hygiene –

which yields good results in removing this complication. If this does not help, the ophthalmologist can prescribe antibiotics and eyelid scrubbing as therapy.

### *External hordeolum*

It results from the eyelash root tissue inflammation. Sometimes it is related with the inflammation of the Zeis or Moll's gland. It is a typical acute staphylococcal infection, frequent in persons with staphylococcal external blepharitis. There is obvious infectious swelling of the external lid edge, and it looks like a lot of small abscesses. There is slight discomfort and sensitivity to touch.

The eyelash needs to be removed from the follicle, hot compresses should be applied and after that it can be drained spontaneously to the outside, and the lens should not be worn during the acute phase which is over in about seven days.

### *Internal hordeolum*

This is acute inflammation of the Meibomian gland. This is a typical acute staphylococcal infection, frequent in persons with staphylococcal external blepharitis. There is obvious increased swelling deep on the tarsal plate, lid swelling and lid edge inversion. The patient feels discomfort and intolerance to lenses.

A visit to the ophthalmologist is recommended. The ophthalmologist will make an incision, apply hot compresses and antibiotics after surgery. It is also recommended not to wear lenses during the acute phase. The healing takes about seven days.

### *Staphylococcal external blepharitis*

It is caused by staphylococcal endotoxin which causes complications as weak conjunctivitis, toxic punctal epitheliopathy and staphylococcal infection of the eyelash follicles. One can see redness, sticking eyelashes, scales at eyelash roots. One feels warmth, itching, slight photophobia. One has a foreign body feeling. Dry eye is more felt in the morning. There is intolerance to lenses.

The customer should see an ophthalmologist who will prescribe a therapy (antibiotics, corticosteroids), artificial tears, increased hygiene of the lids. Lenses should not be worn during the acute phase.

The forecast is variable, there may be periods of remission and recurrence of the disease.

## **Complications Related to Tear Film**

### *Dry eye*

It is caused by the lack of lipids and watery part of the tear film. The contact lens wearers have compromised tear film due to the very geometry of the contact lens which is ten times thicker than the tear film which covers the cornea which causes poor mobility of lipid deposits on the surface of the contact lens and reduces their exchange, making them therefore more exposed to the influence of light and oxygen which speeds up their disintegration, and reduces the lens lubrication leading in turn to discomfort and intolerance<sup>14</sup>.

One can see abnormalities in interference colours, quantity of tears, structure, tear film stability, micro-erosions on the epithelium. There is photophobia, foreign body feeling, stinging, itching, redness, increased tearing and stringy discharge. The lens thickness, material, and design should be changed, and the care solution of contact lenses should be changed as well. One should use artificial tears, control the tear evaporation, reduce tear drainage and reduce the time of lens wear.

The forecast is good if the problem is related to the lens wear or to the care solution, and bad if it is caused by pathology.

### *Mucins*

These are balls of mucins that may compromise the corneal natural defence against microbes. Many small grey points are visible in the direct slitlamp illumination, and they are found in silicone hydrogel lenses.

Visual acuity can be slightly compromised in extreme cases. A flatter lens should be fitted. More frequent exchange of contact lenses is recommended with change in the lens material. Artificial tears should be added. The improvement occurs soon after the lens is taken out.

## **Conjunctiva**

### *Conjunctival redness*

Vasodilatation due to relaxation of smooth muscles, hypoxia, and hypercapnia, mechanical irritation, immunologic reaction.

The cause can be the contact lens, toxicity of the solutions, pH change. There may be infections and inflammations. The visible various levels of redness are usually without symptoms, sometimes itching with the feeling of hot or cold. There is also slight irritation.

In case of stronger redness the lenses should be removed. It takes from several hours to two days to heal.

### *Papillary conjunctivitis*

Conjunctiva is thicker, there are deposits on the lens. There is hypoxia below the lid, with immunological reaction. There are papillae on the tarsal conjunctiva and conjunctiva oedema. There is a slight feeling of itching which is intensified by the mechanical irritation. The vision is a bit blurred. In advanced disease the lens becomes uncomfortable.

The lens should be removed until the inflammation is over, reduce the time of lens wear, change the material of the lens, reduce the time of lens change, change the care solution, improve the eye hygiene. The papillae can remain for weeks, months, even years. The lenses can be worn with the control of a specialist.

## **Limbus**

### *Limbal redness*

It may be partial or complete. There is vasodilatation, hypoxia and hypercapnia, mechanical irritation, immu-

nological reaction, infection, inflammation (acute red eye), care solution toxicity.

The cause needs to be removed, a silicone hydrogel lens fitted. It is over in a few hours to two days.

#### *Vascularized limbal keratitis*

It is found in rigid contact lenses. Vascularized tissue appears on the limbus with an oedema on the conjunctiva and limbus. There are corneal infiltrates near the limbus, fluorescein staining around the limbus. This is accompanied by discomfort and photophobia.

The time of contact lens wear needs to be shortened, the design of the lens bevel improved, the lenses should be removed for five days, and soft lenses should be fitted. The patient should be sent to the ophthalmologist (antibiotics and corticosteroids).

The forecast is good, and the condition can be healed in several days or weeks.

#### *Upper limbic keratoconjunctivitis*

There is redness on the superior limbus with infiltrates, micro-panus, micro-erosions of the cornea and conjunctiva. Foggy epithelium and corneal deformation are found, the contact lenses cause discomfort and itching. There is photophobia and a moderate fall of visus in case of stronger panus.

The lenses should be removed until the inflammation is over, the time of lens wear should be reduced, the solution changes, and artificial tears should be added with more frequent change of the lenses.

The patient should be sent to an ophthalmologist who will prescribe non-steroid anti-inflammation drugs or surgery. The forecast: the redness disappears soon, the epithelium heals slowly, the treatment can take from 3 weeks to nine months.

### **Complications on Corneal Epithelium**

The contact lens wear may result in the erosion of epithelium, appearance of epithelial microcysts and epithelial oedema.

The epithelial erosions are the most frequent undesired phenomenon in contact lens wearers. The epithelial erosions are a surface defect of the epithelium which may be observed in the fluorescein test as stains to a smaller or greater extent of different shapes and the affected area of the cornea. The stains appear when the fluorescein fills the inter-cellular space at places where the epithelium tissue has been compromised. Healthy epithelium cannot be dyed by fluorescein. Smaller dotted stains can be seen in 60% of contact lens wearers and do not represent any problem. The problem occurs when these stains affect a larger area and deeper epithelium layers. The customer has a foreign body feeling, sometimes also photophobia and more severe pain.

Erosions at three and nine o'clock are typical phenomena in RGP contact lens wearers. They occur laterally and inferior in the area of contact between the upper

and lower lids while blinking. The customer claims to feel slight discomfort and feeling of eye dryness. The tissue compromise occurs due to the drying out in case of incomplete or insufficiently frequent blinking or due to the elevation of the lids as result of the thicker contact lens edge. The contact lens diameter should be reduced and/or the contact lens thickness should be reduced. If the reason lies in insufficient blinking the customer should be instructed to blink properly. The stains disappear within 24 hours after having removed the contact lens or after 4–5 days with wearing the contact lenses.

Superior epithelial arcuate lesion (SEAL) is the erosion superior parallel with limbus, frequent in silicone hydrogel lenses. The customer does not complain about difficulties. The entire epithelial thickness is affected due to mechanical friction of the epithelium due to the pressure of the upper lid on the contact lens of improper design and elasticity. A contact lens made of less elastic material should be selected or a hard RGP lens. Three days after removing the lens the stains will not be noticed any more.

Inferior epithelial arcuate lesion (smile stain) where punctal erosions form the shape of an arc parallel with the inferior limbus, it occurs in soft lenses. The customer complains about slight discomfort. There is metabolic defect due to the sticking lens, inadequate tear film under the lens and due to lens drying out. A thicker contact lens with better movability on the cornea should be selected, the material of the soft contact lens changed or one should opt for hard RGP lenses. The stains disappear within 24 hours after contact lens removal or after 4–5 days if contact lenses remain in the eyes.

Central erosion of corneal epithelium is a large area of epithelium lack, usually circular in shape, which is filled with fluorescein. The loss of visual acuity, if central, may be asymptomatic or painful. The epithelium is completely removed along with removal of the lens which was sticking to it; the epithelial function is compromised due to chronic hypoxia. A typical condition due to extended hydrogel lens wear. The lens should be removed from the eye until full recovery of the epithelium. The contact lenses with high oxygen transmissibility should be fitted. The recovery of the epithelium can take up to a week.

Foreign body can easily damage the epithelium surface when it comes below the hard contact lens. The stain is in the form of irregular lines that are a trace of the foreign body on the epithelium. The condition is not dangerous. After the lens is rinsed it can be immediately re-inserted. The stain will vanish already after several hours.

Microcysts are tiny scattered points of circular or oval shape, 15 to 50  $\mu\text{m}$  in diameter, can cause slight discomfort and slightly reduced visual acuity. They appear in the epithelium and can be observed in the regredient illumination using a slitlamp with a shade in the direction from which the light is coming, they represent a disorganized growth of epithelial cells, the plugs of dead cells travel slowly towards the surface due to extended hypoxia, mechanical irritation, reduced mitosis. They are typ-

ical for extended hydrogel contact lens wear. A minor number of microcysts is tolerated whereas in case of mass phenomenon silicone hydrogels or hard RGP contact lenses are fitted<sup>15</sup>.

After having removed the lens from the eye the number of microcysts grows in the first seven days, and then starts to fall to complete disappearance after two months.

Epithelial oedema is observed as slight haze in the epithelium viewed in the optical trans-section. It may appear during the adaptation to hard contact lenses. There are no symptoms, and halo effects are possible. There is disturbance in the epithelial cells due to hypertonic stress, water enters the epithelium and stays between the basal epithelial cells. The adaptation regime of changing to hard lenses needs to be modified. Fast recovery after removing the hypotonic stress.

Vacuoles are tiny scattered points of circular shape, 5 to 30  $\mu\text{m}$  in diameter filled with fluid. They differ from microcysts in that their shadow is laid opposing to the direction of light. Vacuoles occur in the hypoxia conditions. They are not considered to be dangerous, they are asymptomatic and do not affect the visual acuity but they indicate careful control of other indicators of hypoxia in contact lens wearers. Vacuoles are not treated but rather only recorded in the customer's file-card. They disappear fast after having stopped wearing contact lenses.

### Complications in Corneal Stroma

Corneal stroma is not especially sensitive to mechanical influences but this corneal layer shows significant change in the thickness when exposed to hypoxia and can lose transparency as a result of various infective processes.

Stromal oedema is an increase in the share of water in the tissue reflected in increased thickness of the cornea. The cause of oedema is hypoxia due to which the stroma breathes anaerobically producing lactates that cause tissue swelling. Clear signs of stromal oedema can be observed in optical trans-section of the cornea using a slitlamp. The size of the oedema is expressed in percentage increase of the corneal thickness. The increase in the thickness of the cornea of up to 2% is regarded as not dangerous and no actions are undertaken. In case of the increase of up to 5% of the corneal thickness vertical striae in stroma can be observed, which are the result of disturbed relation between collagen fibres within the stroma. This condition requires caution. In case the cornea thickens by 8%, striae can be observed in the posterior stroma and the condition becomes serious and the contact lenses should be replaced by those made of materials of higher oxygen transmissibility. It is also useful to choose lenses of thinner design and with better movability on the cornea. In this way chronic oedema is avoided, which eventually makes the cornea thinner. The oedema prognosis, after having removed the contact lens from the eye is disappearance of symptoms in two hours up to 7 days if chronic oedema has occurred. In oedema in which the corneal thickness has increased by 15%, when

folds in the stroma can be observed, caused by the separation of individual collagen lamellas, there comes to the loss of transparency which is a pathological state. Apart from hypoxia the corneal oedema can occur also due to the hypotonic characteristic of the tears, hypercapnia, low temperatures and due to mechanical impacts.

Stromal thinning is detected by pachimetry after the oedema has disappeared. The stroma becomes thinner by approximately 2.1 mm annually, if contact lenses of low oxygen transmissibility are worn extensively, there are no symptoms, the vision can be reduced if corneal deformation is present. It is the result of the reduction of stromal mass due to chronic stromal oedema. One should act on the cause of the problem, the stromal oedema. The loss of tissue is irreparable, and the achieved corneal thickness remains permanently and cannot be recovered to the state before the onset of oedema.

Surface corneal neovascularisation grows in from the limbus into the surface layer of the stroma immediately behind the Bowman's membrane. The neovascularisation is the response of the tissue to hypoxia, lack of oxygen due to the blockage of the normal inflow of oxygen from the atmosphere due to contact lens wear, damage of the epithelium, toxic character of the lens care means and due to infections. The ingrowing of 0.2 mm is physiological and it is tolerated up to 2 mm. In extreme cases it can affect the central cornea and cause loss of vision. The customers do not report any disturbances. In extreme cases the wear of contact lenses is abandoned permanently. In moderate ingrowth the contact lens care system should be improved, lens with higher oxygen transmissibility fitted, the daily schedule of lens wear reduced and the condition carefully controlled. After having stopped to wear contact lenses the vessels are quickly emptied but years are necessary for them to disintegrate.

Deep stromal neovascularisation develops insidiously without any acute symptoms in the deeper layers of the stroma. It develops quickly into a fine widely spread network similar to buds with many anastomosing thinner thin-wall vessels surrounded by inflammatory cells. It happens often after the transplantation of the corneal tissue, due to keratoconus, aphakia, stroma softening due to oedema caused by hypoxia. It gets activated after the damaging of the epithelium, due to toxic reaction to the contact lens care substances, and due to infection. If the neovascularisation is serious, apart from treating the cause, it is necessary to completely abandon contact lens wearing. In milder cases the method of handling lenses should be improved, oxygen transmissibility increased, the schedule of daily lens wear reduced and carefully monitored. After having stopped to wear contact lenses the vessels are quickly emptied but years are necessary for them to disintegrate.

Corneal vascular panus is the ingrowing of fibrovascular limbal tissue on the surface of the cornea with neovascularisation. The edge of the panus is flat, and may be dyed by Rose bengal contrast agent. There are two types of panuses: active panus caused by the inflammation, and fibrovascular, which is of degenerative na-

ture. The panus does not cause subjective difficulties but if it is extreme it can reduce the visual acuity. It occurs after stroma softening due to oedema caused by hypoxia. It is activated after the damaging of the epithelium, due to toxic reaction to the contact lens care solutions and due to infection. In case of serious panus contact lens wear is permanently abandoned and it is treated surgically. In milder cases the manner of lens handling should be improved, the oxygen transmissibility increased, the schedule of daily lens wear reduced and carefully monitored. After having stopped wearing the lenses the vessels are quickly emptied but years are necessary for them to disintegrate. After starting to wear contact lenses again, the vessels are filled quickly again.

Peripheral ulcer (CLPU – Contact lens peripheral ulcer) is a small circular ulcer of 0.5 to 1.00 mm in diameter at the corneal periphery. Around it light infiltration of leucocytes is visible. The necrosis of the front stroma, Bowman's membrane is untouched. It is dyed by fluorescein. It is accompanied by limbal and bulbar redness. It is frequent in case of extended contact lens wear. The symptoms include eye redness, moderate to strong pain, foreign body feeling. Sometimes there may be no symptoms. The cause of ulceration are toxins from the gram-positive bacteria on hypoxic cornea. The lens should be removed, the customer sent to the ophthalmologist for treatment by antibiotics, cold compresses, analgesics and steroids.

Red eye induced by contact lens (CLARE – Contact lens induced acute red eye) is acute inflammatory reaction of the cornea and conjunctiva characterized by strong hyperaemia on the conjunctiva and on the corneal periphery. Punctal and diffuse infiltrates are present on the corneal periphery. It usually occurs after a period of closed eye (typically after sleeping) in extended contact lens wear. Due to sudden onset of the symptoms accompanied by severe pain after waking, profuse tearing, extreme photophobia and strong injection, the customers are usually quite panicky and come with sunglasses and hands full of handkerchiefs. Inflammatory reaction is caused by endotoxins from Gram-negative bacteria which have colonised the contact lens or the care solution. The customers with red eyes should be first instructed to stop wearing contact lenses and then sent to the ophthalmologist for antibiotic treatment. The prognosis is good since red eye is successfully treated and the redness disappears after three days, the infiltrates are resorbed in seven to fourteen days, and all signs of inflammation disappear in two to six weeks. After the incident with the red eye, contact lenses with high Dk/t can be fitted and the customer will wear them on a daily basis.

Infiltrative keratitis (IK) is a unilateral inflammatory reaction in which numerous small infiltrates in the front stroma at the corneal periphery of irregular shape are seen, along with bulbar redness in daily and extended contact lens wearers. Using fluorescein one can see a little point staining. It is caused by the action of toxin from bacteria. The symptoms include bulbar redness, increased tear discharge, to strong eye irritation, there may be

purulent discharge, and it may occur at any time during the day. The procedure is the same as in the red eye but the prognosis is better and all the signs of complications disappear in maximally fourteen days.

Infectious keratitis is a condition after microbial (most often pseudomonas) invasion into the corneal epithelium and stroma. It is accompanied by tissue necrosis combined with inflammation. Corneal ulceration, loss of epithelium with stromal infiltrates represent a typical picture of this complication. There is often inflammation of the anterior chamber. Permanent loss of vision is possible due to disfigured or/and perforated cornea which makes this condition one of the most dangerous complications in contact lens wear. The symptoms develop within several hours from mild irritation to the feeling of a foreign body to severe pains, photophobia, profuse tear secretion with purulent discharge. The eye is intensely red and the surrounding tissue is inflamed and swollen. The pain is sufficiently severe to make the patient promptly request professional help. The incidence is relatively small, about 20 out of 10,000 extended hydrogel lens wearers experience this complication unlike RGP lens wearers on a daily basis where the incidence of microbial keratitis is 1 out of 10,000. Apart from extended lens wear the risk factors include non-compliance with the contact lens wear and care instructions, poor hygiene, hypoxia, swimming with lenses, mechanical trauma, dry eye, smoking, diabetes, warm climate, etc. The optometrist's procedure in such cases is to send the customer urgently to the ophthalmologist who will apply proper treatment by antibiotics and other drugs. The prognosis is good in 90% of cases that will end without reduction of visual acuity whereas in 10% of cases there will be various damages to the vision. The speed of reaction and the beginning of the treatment have significant influence on the results of the treatment.

Acanthamoeba keratitis is parasite keratitis caused by invasion of protozoa acanthamoeba in the corneal stroma. The acanthamoeba can be found in the environment in waters, on domestic animals, and even in the mouth cavity where they form part of normal fauna. Although contact with acanthamoeba is very frequent, the infections are rare and persons affected are those with bad immunologic response. Most often the sources of infection are rivers, lakes, pools, contact lens cases, non-compliance with contact lens wear and care instructions, poor hygiene, hypoxia, swimming with lenses, mechanical trauma, dry eye, smoking, diabetes, warm climate, etc. The signs are typically uni-ocular conjunctival redness, lids swelling, stronger tear secretion, photophobia, loss of visual acuity, deep ulceration, hypopion, etc. The symptoms include foreign body feeling, pain and eye redness. The demanding treatment is carried out by the ophthalmologist. The prognosis is long treatment using aggressive means with frequent recurrence of the disease with uncertain outcome. After successful treatment the RGP lenses with high Dk/t can be fitted, with strict compliance with the instructions regarding the wearing and handling of contact lenses.

## Complications on the Corneal Endothelium

Endothelial bubbles (blebs) are black non-reflecting places on the endothelium visibly restricted to the cell form. They do not reflect because the cells are oedemas and thus of spherical surface so that the light gets dispersed and the cell becomes dark. The cause is hypoxia. The complication is reversible, and the oedema disappears already after two minutes following removal of contact lens. The condition needs no treatment but rather serves as information about the response of the eye to hypoxia. When the number of blebs is large a contact lens with higher Dk/t should be fitted.

Endothelial polymegathism is the occurrence of endothelial cells of various sizes. This condition is the result of many years of wearing contact lenses made of material with poor oxygen transmissibility. Chronic hypoxia and hypercapnia result in the weakening of the connections between the endothelial cells which due to abatement change their original cellular shape so that the layer of cells seen by the slitlamp looks changed as if the cells were of different forms and sizes. The symptoms are intolerance to contact lenses, reduced time of lens wear during the day and discomfort. With such a condition lenses made of high oxygen transmissibility should be fitted, and the daily lens wear should be reduced. The prog-

nosis is possible return of cells to the original condition after several years.

## Conclusion

Contact lens wearing can cause various changes on the eye that can be found during slitlamp examination. They are most often caused by careless handling and too long wear and wear in prohibited environment. The changes are usually the result of hypoxia, hypercapnia, acid tears, injuries, oversensitivity to some ingredients in the care solutions or by contamination of contact lenses, solutions or hands. The optometrist has to carefully and systematically control and record every change on the eye tissues in order to preserve the health of the customer's eye. Important is also the selection of customers suitable for contact lens wear. The education of customers about the handling of contact lenses is of extreme importance, as well as how to recognise the risky/emergency situations related to contact lens wear. Early identification of the mentioned conditions in the eye and application of adequate measures makes it possible to reduce the complications in the eye caused by contact lenses.

Reducing the complication incidence to a minimum renders contact lenses a safe medical aid.

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J. Beljan

Optika »Vitrum«, Masarykova 12, 10000 Zagreb, Croatia  
e-mail: vitrum@vitrum.hr

## KOMPLIKACIJE UZROKOVANE NOŠENJEM KONTAKTNIH LEĆA

### SAŽETAK

Komplikacije kod nošenja kontaktnih leća su jako rijetke i uzrokovane su lošim održavanjem, predugim nošenjem i nošenjem kontaktnih leća u zagađenom okolišu. Redoviti nadzor profesionalne osobe može učinkovito smanjiti broj komplikacija. U ovom radu su opisane najčešće komplikacije nošenja kontaktnih leća s podjelom prema anatomskim dijelovima oka: vjeda, suzni film, limbus, epitel rožnice, stroma rožnice i rožnični endotel. Svaka komplikacija je opisana sa karakterističnim znakovima i simptomima, etiologijom i patologijom te terapijom i prognozom. Opisano je kako odabrati pogodne klijente za nošenje kontaktnih leća a uz to i pravilnu edukaciju kako bi se osigurala minimalna učestalost komplikacija zbog nošenja kontaktnih leća, te na taj način steklo puno zadovoljnih i zdravih klijenata.