OPTOELECTRONICS AND ADVANCED MATERIALS – RAPID COMMUNICATIONS Vol. 4, No. 7, July 2010, p. 1052 - 1059

# The effects of some liquids of general use upon the shape and structure of the monthly worn contact lenses used for visual comfort

C. OPRAN*, M. BARITZ[a] , D. COTOROS[a]
*University POLITEHNICA Bucuresti, Romania*
[a]*University TRANSILVANIA from Brasov, Romania*

In this paper are presented the effect of some liquids of general use upon the shape and structure of the monthly worn contact lenses used for visual comfort. A split lamp was used to observe the position and adjustment on the subject corneal surface of the contact lenses for visual comfort and physiological acceptance.

(Received February 2, 2010; accepted July 14, 2010)

*Keywords*: Contact lens, Visual comfort, Digital microscope

## 1. Introduction

Contact lenses are presently an effective and flexible alternative to the refraction faults correction equipments of the visual system. Also the contact lenses present an extremely fast evolution of the materials construction and structure mostly due to their manufacturing technologies. In the process of using contact lenses, an extremely important aspect is represented by the carrying out in good conditions of the corneal metabolism, without affecting the corneal structure or inducing new pathologies at corneal level. The corneal metabolism is particularly slow and takes place at the level of the three layers: epithelial, stromal and endothelial, while its *source is assured by the limbus capillaries*, which provide big molecules, then by the *aqueous humor* representing the main source of glucose, water and other metabolic substances and not last by the *lachrymal film*, which takes over the oxygen from the atmosphere, dissolves it into tears and offers it to the corneal epithelium. So the corneal metabolism is ensured by the oxygen and glucose share, which allows a correct cell function and this is why the use of the contact lens should not alter in any way this metabolism, it should even become a part of the fluids circuit or of the substances exchanged during the metabolic process. The multitude of existing contact lenses at the present moment rise some complex issues.

Contact lenses can be classified by the nature of the material of which they are made, by their wearing schedule, by their purpose, or by their design. Nature of the contact lenses material is: hard, rigid gas permeable, hydro gel and hybrid. Other classification criteria of the contact lenses are: according to their function they might be optical esthetical, therapeutic, tectonic (kerato-cone) and adjuvant (optical-muscular-nistagmus); according to their position on the anterior pole, there are corneal, hard, permeable or not for oxygen, with smaller diameter than the cornea (8,2-10,7 mm), then corneal-scleral lenses with a diameter between 12,5-13,5 mm, that are supported by the limbus, and may be hard or soft and not last scleral lenses with a diameter between 14-25 mm, which cover the cornea entirely and are supported by the sclera. Other classification criteria are those connected to the material and manufacturing process, the lenses range containing contact lenses produced by "spin-casting" process or by "lathe-cutting" and respectively "cast-molding". From the hardness point of view we may use hard (rigid) lenses, gas permeable or not, obtained of polymethilacrylate (PMMA) or soft lenses made of hydrofoil polymers called hydro gel or of hydro gel silicon.

## 2. Contact lens adjustment

The main issue in all cases of any type contact lenses adjusting connected to their maintenance and handling is related to how necessary and important is this maintenance and cleansing of the lens surfaces along the whole prescribed use duration.

In order to ensure a suitable comfort to the lens user, it is necessary to: check if the cornea is oxygenated enough and the lachrymal film is sufficient and allows the direct contact between the oxygen and cornea; and in case of pressure due to the contact lens own weight, must be checked the possibility of offering a bigger cornea surface and finally the perfect focusing of the lens must be ensured by the suitable choice of the radius of curvature and lens diameter.

For the correct wear of the contact lenses we need to consider also the adjusting type to be chosen in order to avoid other manifestations at corneal level and to offer a simple and effective solution to the human subject.

The adjustments of the contact lenses consist in:

- Plane adjustment: it is considered when the lens is relatively uniformly distributed as posterior surface with respect to the corneal anterior surface with a more obvious clearance towards the lens edge.

- Parallel adjustment: the lens is uniformly distributed on both corneal surfaces. The corneal radius is smaller than the posterior surface of the contact lens. The contact is produced in the central area.
- Tight adjustment: the position is characterized by a considerable closeness to the lens edge. It is characterized by a relation between the posterior radius of the lens and the corneal radius. The lens is very stable to blinking.
- Parallel adjustment is the correct one: there is an equality relation between the two central radii, there is no support and between the lens and the cornea there is an uniform lachrymal film.

According to the choice of the contact lens adjustment type we must establish the choice criteria for diagnosis and correction lenses, so that they be easily accepted during long periods of time (a day, a week, a month).

The choice of the diagnosis lens must correspond to the diopter correction required for a comfortable visual sensation that allows in the same time the correction adjustment. By the same selection procedure of the lens, the exercising of handling and estimating the visual quality in the usual environment of the user must be allowed and the assessment of the subjective adjustment should be accomplished by the optometrist at the bio-microscope.

The assessment of the perfectly adjusted contact lens is made by the analysis of the lens focusing, meaning the covering of the cornea along all the visual directions, with a 0.2-0.4 mm mobility with the so-called push-up test.

Following these adjustment analyses we may find if the lens is loose, resulting in low visual comfort, instability during blinking, ample movements or the lens slides inside the conjunctiva. If the lens is tight, then it seems comfortable in the beginning but later there occurs a burning sensation, blurred vision, the position after blinking is better but the motion is insufficient and a print appears immediately after removing, sometimes it is even difficult to remove it from the corneal surface.

During the use of contact lenses (CL) in an inappropriate way, deposits may appear on its surface, that may lead to the occurrence of vision problems, altering of the visual comfort, initiates new pathologies, etc. These deposits mainly consist of lipids and proteins and depend on the individual factors and on the material and replacement frequency.

There are three types of deposits form on contact lenses: organic, inorganic, and environmental.

Being a"strange body" on the eye surface (cornea), contact lens alters, sometimes, the natural defense mechanisms of the eye. As deposits form on the contact lens, an inflammatory reaction and/or infection may develop on the contact lenses surfaces and the use of the contact lens alters the ocular defense mechanism by different factors like: limiting tear exchange, interrupting the tear film, reducing the efficiency of debris removal from the ocular surface, interfering with the normal protective function of a mucin layer, inducing micro-trauma due to both metabolic and mechanical effects, augmenting retention of microorganisms on the ocular surface and functioning as a vector, facilitating infection.

The deposits on the CL may determine the strong mitigation of the visual comfort and acuity affecting even the surface hydration, determining dryness and interruption of the lachrymal film.

Also the deposits determine inflammatory complications such as:

- conjunctivita giganto;
- papillary (signs of congestion, prominent papilla, excessive mucus, with the following symptoms: burning, mucous filaments, lens dislocations, lens intolerance)
- dry eye syndrome having as favorable factors the dry climate, wind, dust, use of air conditioning, prolonged activity at the computer, prolonged use of CL, age, smoking;
- palpebral diseases (incomplete occlusion, blepharitis)
- general diseases (Lupus, Sjogren, hormonal dysfunctions)
- drugs like antihistamines, birth control pills (dry eye) – aspirin – ocular irritations, blepharo-conjunctivitis, affection of the corneal epithelium, anticholinergic – reduce the tear secretion, anxiolytics – rare blinking, dry eye, beta-adrenergic – dry eye, low lysozyme, diuretics – low tear secretion, low lysozyme, allergies, photophobia, etc.

## 3. Contact lenses. Materials and parameters

Polymethylmethacrylate (PMMA) is the material from which rigid corneal contact lenses were made in the early time of modern contact lens practice. It is a relatively stable polymer that is easily molded and machined. The contact lens made by PMMA material generally had excellent optics features, are durable, easy to maintain and relatively inexpensive, but its primary disadvantage was a lack of gas permeability. Modern rigid lenses are made of gas permeable polymers. Their permeability to gases is primarily a function of the quantity of silicone and fluorine contained in the molecules. Gas permeability (P) is a property of certain polymers expressed as the product of the coefficient of diffusion (D) and the coefficient of solubility (k) meaning: $P = Dk$

Oxygen transmissibility *(t)* is the quantity of oxygen that passes across a specific contact lens and depends on the Dk value of the polymer and is inversely proportional to the thickness (L) of the lens: $t = Dk/L$.

The majority of hydrophilic soft contact lenses (or hydrogel lenses) are made of hydroxyethyl methacrylate (HEMA) and maintain a water content that is more or less constant when they are immersed in saline solution or tears. The water content of hydrogel lenses ranges from approximately 38%to approximately 76%. For this reason, they should not be stored dry.

By introducing silicone hydro gel lenses we obtained a hybrid that combines the oxygen permeability of silicone with the hydrophilic HEMA of traditional soft lenses. The water content of silicone hydro gel lenses is relatively low

(20% to 40%), depending on the brand of the lenses. The oxygen transmissibility-gas permeability (P=Dk/t) of silicone lenses is much higher than traditional hydro gel soft lenses, making them the best choice for patients who prefer extended wearing schedules.

Parameters of contact lenses are:

- Diameter (D) The first parameter that needs to be determined is the diameter of the contact lens. Selection of the diameter of the contact lens is based on the diameters of the visible iris and the pupil as well as the corneal curvature. The choice of the diameter should be made after measurement of the horizontal visible iris diameter (HVID),which can be classified as small, medium, or large. As a general rule, lens diameter is chosen to be approximately 2.5 mm smaller than HVID. Generally, rigid gas permeable contact lenses are fitted with diameters between 8.8 and 9.8 mm with an optical zone of 7.4 to 8.4 mm. Larger diameters may be chosen to provide a larger optical zone for large pupil diameter. The optical zone is typically 1.0 to 1.4 mm smaller than the overall diameter.
- Base curve (BC) The base curve is the radius of curvature of the central area of the posterior surface of the contact lens. The first trial lens's base curve is generally on K or slightly steeper than K, depending on the degree of astigmatism present and the diameter of the lens. Some professionals prefer to choose a base curve for the first trial lens, using the average K; that is half the difference between the measurements of the two principal meridians of the cornea added to the flat K. (A nomogram for choosing base curve using diameter and astigmatism as variables follows; see question 10.) A criterion commonly used in the course of trial fitting contact lenses is evaluation of the contact lens movement on the cornea. At the slit lamp, one should examine the position of the contact lens on the cornea as well as its movement. The evaluation criteria depend on one's experience with fitting and observation of the lenses. A contact lens of appropriate diameter should not cross the limbus, nor should it reach the inferior pupillary margin with blinking.
- Power The dioptric power of the primary trial contact lens is ideally close to the spherical component of the minus cylinder form of the manifest refraction.

## 4. Analysis method of the contact lenses behavior immersed in different solutions

The system of contact lenses maintenance contains conventional rules and concepts concerning the use of specific products for each stage of contact lenses maintenance but alos the safe, compensating methods of the cleansing, disinfecting, hydration systems (physiological serum and saline solutions).

*The cleansing systems* have the role of removing organic components accumulated during the wear of the lenses (mucus, proteins, lipids), inorganic salts, exogenous deposits (such as nicotine, cosmetics, atmospheric pollutants), by cleansing we understand prophylactic action.

In case of daily cleansing we aim at eliminating certain organic deposits that diminish the antimicrobial action of the disinfecting products and also the reducing of the microorganisms on the lens surface.

In case of periodical cleansing we aim at the elimination of the specific organic contamination and the principal proteins.

Out of the daily cleansing systems we consider the cleansing solutions containing surfactants, conservative agents, buffer solution, purified water and sodium chloride, rubbing agent.

The surfactants achieve the solubility of deposits and the lipid emulsifying.

*The principle of action* is the diminishing of the contact surface between two molecules. Thus, the hydrophobic cells become attached to the lipids and the hydrophillic ones become attached to the watery cells.

The disinfectant is used to prevent the solution contamination after opening the bottle, and it is usually benzalkonium chloride 0.004 ~ 0.002% for the gas permeable lenses.

The buffer solution and the soluble part has the aim to maintain the pH value near $\cong 7.4$ and also the inorganic soluble part which influences the calcium and magnesium.

The rubbing agent includes polymeric micro-spheres which remove by mechanical action the microorganisms, the key factor being the digital mechanical friction very effective together with the physiological serum.

The periodical cleansing systems – enzymatic systems – deal with the particular cases of proteins when the cleansing solutions are ineffective in removing proteins, especially the ones in the lachrymal film (albumin, lactoferrin, globulin, lysozyme) by adsorption of the chemical attachment influenced by the protein types, material and proteins denaturalization.

*The way of action* is by enzymes, which represent the biochemical catalyst.

*Clinical use* is critical for the spherical contact lenses, useful for the gas permeable, performing the elimination of the enzymatic systems for frequent replacement lenses and the replacement of the lenses before the bio-film corruption.

Professional cleansing systems – aim at the elimination of important deposits, representing a chemical alternative of the material, with clinical use and lenses replacement.

The disinfection (decontamination) systems are used for five main groups of microorganisms (bacteria, fungi, viruses etc) being physical and chemical systems that need to respect the present European regulations concerning disinfection.

Physical disinfection systems are represented by the thermal disinfection ($80^0$ C for 10 minutes in wet environment, effective for Acanthamoeba, sterilized at $121^0$ C for 15 minutes under controlled atmospheric pressure and non compatible to the ionic spherical lenses), ultraviolet disinfection, microwaves radiation (very little used), ultrasounds.

Chemical disinfection systems have anti-microbial activity by using preservatives, toxicity prevention by eliminating the active elements before the degradation and neutralization of the lens, being effective and toxic due to the active elements formula and concentration. They contain preservatives, microbial agents, tampon solution, purified water, mineral salts, sodium chloride and sometimes potassium chloride.

Systems with no preservatives are oxidant systems having the benefit of eliminating the toxic and hypersensitivity effects associated to the intrusion of residual preservatives in the eye tissues.

Hydration systems are facilitated by introducing lubricants, which contain surfactants, viscous components (like methyl cellulose) preservative, tampon solution, purified water and sodium chloride.

Saline solutions are used for thermal disinfection, enzymatic treatments, neutralizing some peroxide systems, rinsing lenses, being available with or without preservative.

Multifunctional solutions for spherical contact lenses have a multiple task: hydration, disinfection, moistening, consisting of two main preservation molecules from the same group (like polyxamines).

Gas permeable lenses specific solutions introduce new preservatives and agents, allowing the interaction of the benzalkonium chloride and chlorhexine with the carboxylic groups.

If these solutions are not suitable used or are expired, or if the lenses are immersed in inadequate solutions some alterations of their shape and structure may occur, making them incompatible to further use. These studies have been accomplished based on a unified methodology based on analyses of the surface structure at microscopic level. By help of these analyses we could emphasize and measure the deformations, structure and material alterations of the same lens type, immersed in various solutions during an identical time period, in a temperature controlled environment ($18^0$C), normal relative humidity and natural light.

The chosen type of contact lens was Ciba Vision brand and the used substances were: expired solutions from Ciba Vision, brand "AoSept" and Bausch&Lomb brand "Renu MultiPlus", drinkable water, medicinal mineral water, sugary water, saline solution, cold soluble coffee, Coke, dish washer, oxidant, iodine, milk, cooking oil, after shave, medicinal alcohol and ethylic alcohol. These substances were chosen because they are among the daily used substances and for the wide public some of these substances represent an alternative from the optometrist advice, where they bought the lenses.

Solution Ciba Vision, brand "AoSept" represents an easy to use maintenance system for all types of contact lenses, including those of silicon hydro gel. Peroxide hydrogen and poloxamer as surface active agent allows disinfection and cleanses the lenses. AODISC decomposes hydro gel peroxide in water and oxygen producing a saline solution. After finishing the neutralization process, the contact lenses may be applied directly upon the eye.

This solution consists of: hydrogen peroxide 3%, phosphonic acid (stabilizer), sodium chloride, and other substances like buffer system and surfactant.

Solution Bausch&Lomb, brand "Renu Multiplus" is the solution that cleanses, rinses, disinfects, preserves the contact lenses and removes the protein deposits in case of daily use. It is the only solution with multiple effects containing HYDRANATE®, a special ingredient that removes the protein deposits. Caring for the lenses is easier because HYDRANATE is effectively used for removing damaged proteins, POLOXAMINE for effective removal of lipids, impurities and maintaining humidity, DYMED used for disinfection. This brand contains: an isotonic sterile solution with boric acid, sodium borat and sodium chloride, DYMED 0.0001%, HYDRANATE 0.03%, POLOXAMINĂ 1%.

The solutions used for the experiment have the following characteristics:

Drinkable water: colorless, tasteless and odorless liquid, hydrogenated compound of oxygen, tap water unfiltered may contain traces of mineral salts. The primary conditions of drinkability are connected to the organoleptic characteristics – taste, color, smell – easy to detect by our senses. Later we introduce chemical conditions concerning the mineralization degree and then the content of chemical index substances for pollution. The relation of water with the infectious diseases lead to the elaboration of some bacteriological conditions for the drinkable water. The drinkability rules are not fixed, they may change according to the evolution of the technological procedures and the possibilities of determining some compounds of the water.

Medicinal mineral water drinkable mineral bottled water containing: mineral natural sparkling water with Ca, Mg, Na, standard chemical composition.

Sugary water: water with dissolved sugar. It contains tap water and cubic sugar, concentration 20%.

Saline solution: water with dissolved salt. It contains: tap water and granulated salt without iodine, concentration 20% salt.

Cold soluble coffee: it is a sort of coffee much more acid and concentrated, being in a soluble form with micro granules. It contains: 100% soluble natural coffee at the environmental temperature.

"Coke": refreshment drink prepared with caramel sugar, seeds and cola leaves. It contains: water, sugar, carbon dioxide, colorants, caffeine, acidifier, phosphoric acid.

Dish washer: chemical product with the property of cleaning objects by disinfection and degreasing. It contains: 5–15% anionic surfactants, <5% amphoteric surfactants, perfume.

Oxidant: chemical or natural substance with the property of producing oxidation in yarious concentrations. It contains: oxygenated water 12%, oxidant concentration 12%.

Iodine: solid chemical element of the halogen group, black-purple, with an aspect of lamellar crystals black-grey, metal shine and strong smell, very volatile, easily soluble in alcohol, used in medicine as antiseptic and external disinfectant, extracted from sea water. It contains: pure substance.

Rivanol: pharmaceutical product used in medicine, being a yellow solution used as an antiseptic. Content: medical substance with a strong yellow color.

Milk: white-yellowish liquid sweet and nourishing. Content: 3,5% fat, wholly standardized from the cow.

Cooking oil: fat liquid of vegetal, animal, mineral or synthetic type, not soluble in water and lighter than water. It contains: sun flower extract, coldly presses from seeds.

After shave: slightly alcoholized, perfumed, to be applied on the face. It contains: provitamin B5, alcohol, glycerin, PEG–40 Hydrogenated castor oil, perfume etc.

Medicinal alcohol: ethylic alcohol used in medicine as disinfectant, especially external. It contains: refined ethylic alcohol, softened water, ethyl salicylate, methylene blue 70 % .

Ethylic alcohol: derivative obtained by replacing a hydrogen atom in a hydrocarbon molecule with an oxydril or colorless liquid, volatile, easy-flammable, with specific taste and smell, concentration 85% alcohol.

The analyses of the structure and shape changes are made with a Keyence microscope variable zoom between 500 × and 5000 ×, with the possibility of storing the images in computer and performing measurements using a dedicated software.

During the preparation stage we prepared samples of solutions in sterile recipients, with clear tags, where the contact lenses of the same type were entirely immersed, freshly unpacked out of blisters, having good quality and maintained for seven days in the same environmental conditions. We used lenses out of a freshly opened blister, which were analyzed in the microscope the shape of the edges, inscriptions, surface, quality and dimensions.

## 4. Results of the study

Here are presented the results of the study, the images from digital microscope of the same contact lens brand immersed and kept in normal environmental condition in different liquid substances.

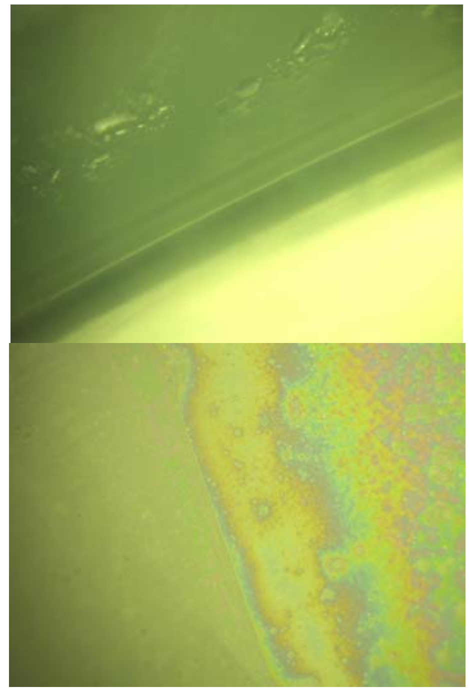

*Fig. 1. (a) Contact lens in AoSept expired solution (b)Contact lens in Renu expired solution.*

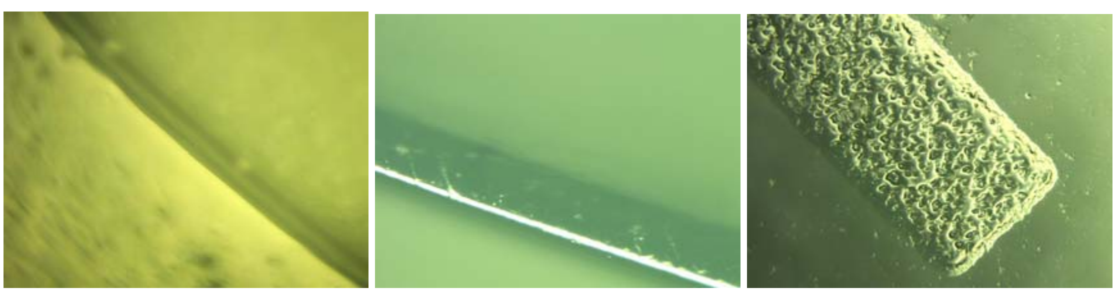

*Fig. 2. One use lens at the edge, concave position, 500x magnifying, lens marking SofLense 66 Toric.*

In the case of a contact lens immersed in expired AoSept solution, it has apparently normal aspect, shape and edges, with visible deposits at the microscope, 500x magnification but without color changes. The lens preserves its initial shape after extraction out of the solution for a longer time (15 minutes interval), the malleability is lower than initially, fact that makes the handling more difficult. Transparency is good.

The contact lens immersed in RENU expired solution has apparently normal shape and edges, with more consistent deposits, visible by microscope with 500x magnifying and without color changes. It keeps its initial shape less time after removing it from the solution (10 minutes interval), malleability is lower making handling more difficult by the examiner. Adherence in the presence of solution is higher on the working table than on the examiner’s fingers and transparency is good. The micrograph of one use lens at the edge concave position is shown in Fig. 2.

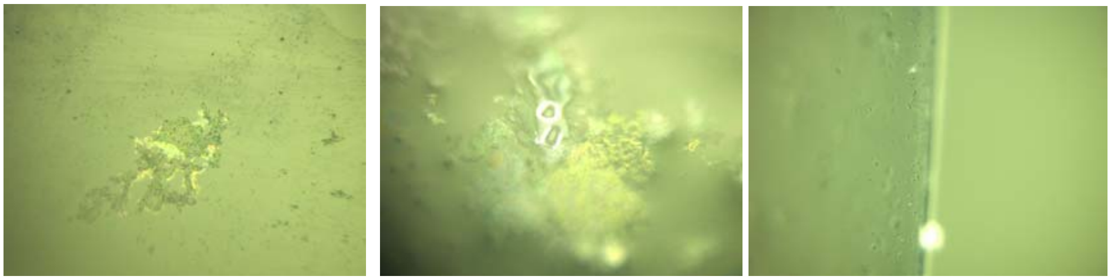

*Fig. 3. Contact lens immersed in medicinal mineral water (surface and edges).*

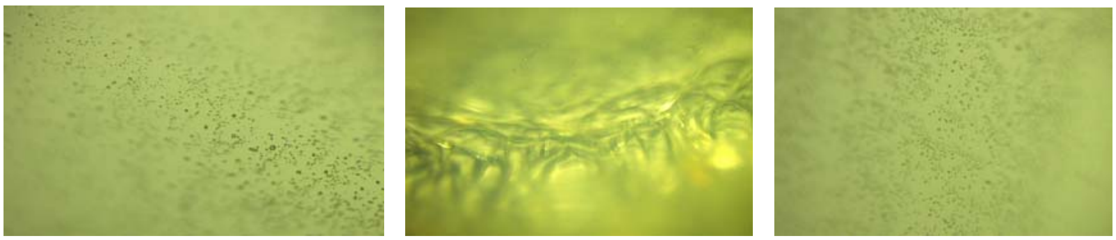

*Fig. 4. Contact lens immersed in cold soluble coffee.*

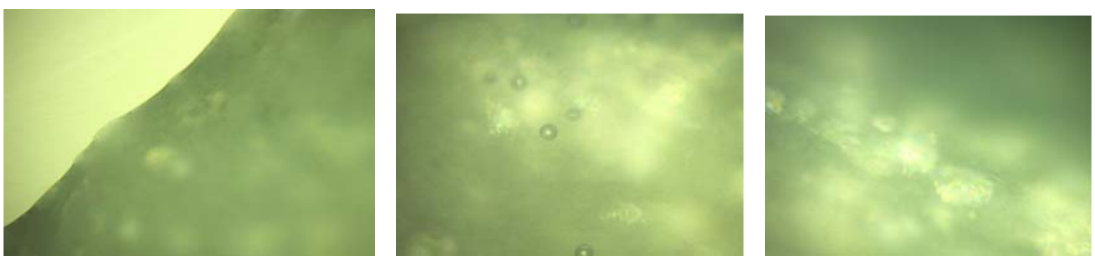

*Fig. 5. Contact lens immersed in oxidant.*

*Fig. 6. Contact lens immersed in rivanol.*

*Fig. 7. Contact lens immersed in drinking milk.*

*Fig. 8. Contact lens immersed in cooking sun flower oil.*

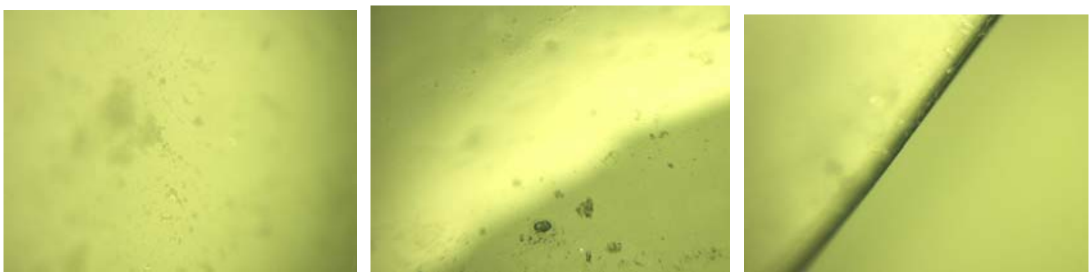

*Fig. 9. Contact lens immersed in ethylic alcohol.*

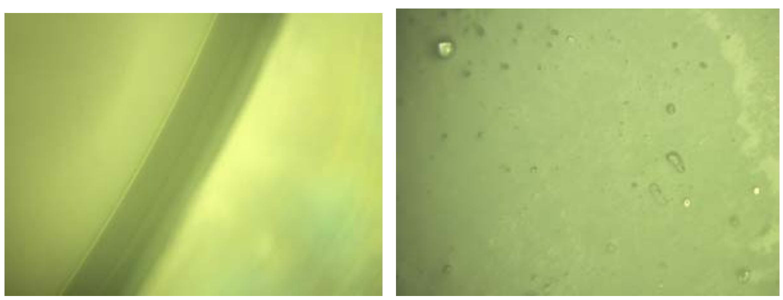

*Fig. 10. Contact lens immersed in medicinal alcohol.*

The lens immersed in medicinal mineral water (Fig. 3) has normal aspect, shape, edges with consistent mineral deposits, visible with the naked eye. It keeps its initial shape after removing it from the solution but transparency is average with slightly whitish aspect.

The contact lens in cold soluble coffee (Fig. 4) has strong color changes, an elongated shape with sandy deposits, slightly opaque yellowish aspect, visible with the bare eye. It loses shape at the edges, tending towards a plane shape with respect to the initial one, after removing it from the solution the malleability being lower than in the beginning.

The contact lens in oxidant exhibits (Fig. 5) color changes, compressed and torsion shape, much smaller volume as initially, opaque fluid milky aspect, visible with the bare eye. It does not keep its shape at the edges in comparison to the initial shape after removing it from the solution, malleability being lower in a significant way, fact that makes its handling by the examiner more difficult. Transparency is diminished, there is pigment within the lens mass, it gets a slippery aspect being very difficult to handle.

The contact lens in rivanol (Fig. 6) has drastic color changes in its structure, the color being yellow-greenish and uniform, elongated shape with viscous conglomerate deposits visible with the bare eye, entirely plane aspect. It does not keep its shape neither at the edges nor generally, in comparison to the initial shape after removing it from the solution. Malleability is drastically diminished, fact that makes almost impossible its handling by the examiner, it has very low transparency, with pigment within its mass, it gets a slightly fluid-viscous aspect being very difficult to handle.

The contact lens in drinking milk (Fig. 7) presents strong color changes in its structure, is opaque and uniform, with mucous deposits and fungal flora in a viscous layer, visible with the bare eye, plane aspect within its mass. It does not keep its shape at all neither at the edges nor generally, in comparison to the initial shape after removing it from the solution (3 minutes interval), malleability being drastically lower, fact that makes almost impossible its handling by the examiner. The transparency is nearly absent with pigment within its mass, and exhibits a viscous aspect.

The contact lens in sun flower oil (Fig. 8) is slightly elongated, has apparently normal edges, slightly gelatinous deposits, is visible with the naked eye. It is characterized by no color changes and is opaque. It slightly changes shape at the edges after removing it from the solution (10 minutes interval), malleability being a little lower than initially, fact that makes the handling by the examiner more difficult. Slightly changed transparency is observed. No elasticity and minimum flexibility is characteristic. The aspect is slippery.

The contact lens in ethylic alcohol exhibits no color changes, with slightly fluid and metallic (Fig. 9) deposits visible with the bare eye, plane aspect in bulk, but more concave as in medicinal alcohol and flagellate. It does not keep its shape neither at the edge nor generally, being enlarged in volume in comparison to the initial shape after removing it from the solution (2 minutes interval) but it shrinks fast and breaks, malleability being drastically reduced, fact that makes almost impossible its handling by the examiner. The transparency is medium, it gets a plastic aspect and even breakable, the lens breaks after removing it from the recipient.

The contact lens in medicinal alcohol (Fig. 10) light color changes – average within the mass, uniform color slightly bluish, with light fluid deposits, visible with the bare eye, plane aspect within the mass. It does not keep its shape at all, neither at the edges, nor generally, being expanded in volume in comparison to the initial shape after removing it from the solution (2 minutes interval), malleability being drastically lowered, average transparency, with mass pigment, gets plastic aspect, stretched in the beginning, then it rises and decreases its volume being very difficult to handle.

## 5. Conclusions

By this experiment we achieved the visual and dimensional analysis through images acquisition from the digital microscope of the contact lenses samples immersed in different solutions in order to emphasize the effectsof the solutions on the contact lenses. Highlighting the effects of various substances upon the contact lenses structure, shape, colors and dimensions is an excellent mean of understanding and avoiding their use, even accidentally by the optometrists or every day users.

**Acknowledgments**

The researches are partly financed in the frame of the Grant PNII-Idei 722 and 744 with CNCSIS Romania. The investigations and simulations were developed using equipment belonging to the Research Platform CAPACITATI, from Precision Mechanics and Mechatronics Department of the University Transylvania Brasov, Romania.

## References

[1] J. V. Aqavella, G. N. Rao, Ophthalmology**87**, 1151 (1980).
[2] A. Bronner, La correction de l'aphakie, Ed. Masson, Paris, 205, 1983.
[3] P. Cernea, Treaty of Ophtalmology, Ed. Medicala, Bucharest, 98, 1997.
[4] D. Chiselita, Ocular Refraction. Report, Iasi, Ed.UMF, Iasi, 71, 1995
[5] W. T. Dribe, Survey of Ophthalmology **27**, 259 (1983).
[6] I. Fatt, Int. Contact Lens Clinic **8,** 7 (1981).
[7] J. Kanski**,** Clinical ophthalmology, Ed. Livingstone, London 121, 1992
[8] Lowther GE, Int. Contact Lens Clinic **8**, 7 (1981).
[9] J. Y. Pastorino, Surveillance D'un Porteur de Lentilles, Collection Scientifique, Laboratoirs Carrion **9-12**, 14 (1987).
[10] M. Guillon, B. Barthelemy, Cours de contactologie, Opto-Com, France 2005.
[11] F. M. Wilson, Optics, Refraction and Contact Lenses, American Academy of Ophthalmology, San Francisco, 223, 1992.
[12] www.cibavision.ro, www.bausch&lomb.ro, www.optimed.ro.

*Corresponding author: constantin.opran@ltpc.pub.ro