In recent times, increased attention is being paid to the development of contact lenses with the ability to carry drugs for sustained release in the pre-corneal area to enhance their bioavailability and thus improve the efficiency of treatments. This administration method requires smaller dosages, with the consequence that systemic absorption is minimized. An additional objective is to simplify administration and improve compliance of therapeutic regimes (1).

The possibility of concurrently addressing the correction of an eyesight problem with pharmacological treatment of an ocular pathology is clearly attractive although, if it is to be used only as a sustained release system, neutral lenses could be utilized. In any case, it is necessary to improve the drug in sufficient amounts and for it to be released at the right rate. The difficulty of designing lenses with these two characteristics remained an insurmountable obstacle for many years, but new approaches have been optimized recently which open up interesting prospects to include medicated contact lenses into mainstream practice.

From a structural point of view, soft contact lenses are made of hydrogel, that is a system constituted by a three-dimensional polymer network capable of absorbing an important volume of aqueous medium. When submerged in a concentrated solution of a drug, the aqueous phase can absorb small amounts of the drug or take it into the polymer mesh by means of non-specific absorption. The improved ocular bioavailability that occurs when wearing drug-impregnated conventional contact lenses is because the renewal of the lachrymal fluid trapped between the lens and the cornea is much slower than in the uncovered surface, and also because this surface partially dehydrates during the time interval between successive blinks. As a result of this, the amount of drug which is diffused towards the corneal surface is five times higher than that released towards the external lachrymal fluid. Accordingly, the cornea remains in contact with high concentrations of the drug for longer periods of time and penetration is more efficient (2).

The research focused on taking advantage of this mechanism is aimed at producing contact lenses with the ability to absorb high amounts of drugs and to deliver them in a controlled manner. The focus is on the modification of synthesis methods utilized for manufacturing conventional lenses. The work being developed at present is concentrated along the following lines:

1. Encapsulation of the drug in nanometric particles or vesicles dispersed in the solution of the monomers which make up the lenses so that, when the polymerization occurs, said particles remain trapped in the structure. Colloidal particles are in charge of regulating the release of the drug. If the dimensions of the colloidal structures are adequate and are included in moderate proportions, the lenses will maintain optical transparency. This idea has been substantiated with the inclusion in acrylic hydrogel of microemulsions and liposomes carrying hydrophobic drugs such as lidocaine. The resulting systems release about 25% of the dosage within 24 hours and control the release of the remaining fraction for over one week in an efficient manner (2). However, this interesting approach has a couple of drawbacks: i) a low degree of stability of colloidal structures during sterilization, and ii) premature release of a significant portion of the dosage in the lens conservation liquid, which requires their storage in a medium which does not allow said release.

2. Functionalization of the hydrogel to allow for non-covalent bonds with the drug molecules, mainly through the application of molecular molding or «imprinting». This procedure aims at adap-
ting the structure of the lenses so that the drug can interact directly with the polymer chains. For example, researchers have developed contact lenses based on hydroxyethylmethacrylate and ionic comonomers exhibiting an affinity with certain anti-allergic agents such as azulene or naphazoline in order to promote their charge and control the release by means of an ionic exchange mechanism. The main drawback of these materials is that the neutralization of ionic groups usually involves important changes in volume which can cause a deterioration of the lenses’ optical properties.

3. The utilization of the molecular imprinting technique is an important progress in this line of work. The procedure consists in synthesizing the contact lens in the presence of the drug molecules which act as a mould causing monomers to arrange themselves according to their affinity. The spatial arrangement of monomers becomes permanent when the polymerization process is completed. In this way, specific receptors are created in the structure of the lens having the most adequate size and chemical groups for capturing the drug with the highest affinity. The limited number of functional monomers available and the reduced physical stability of the receptors (derived from the flexibility of the lenses) are important hurdles for the application of this technique. However, with a careful optimization of the composition and the synthesis procedures, it has been possible to develop contact lenses with improved bearing capacity and controlled delivery which provide levels of norfloxacin exceeding the MIC of numerous bacteria (4) or which enhance considerably the ocular bioavailability of timolol in animal models (5).

Ease of use and low cost of manufacturing processes have made soft contact lenses very attractive as controlled release systems for ocular drugs. Although more research is required, particularly in vivo trials, before we see medicated contact lenses in the market, said recent developments allow us to forecast that in a not too distant future they will become a very useful instrument for prolonging the permanence of drugs in the pre-corneal area, reducing their systemic absorption and improving compliance of dosage regimes.

REFERENCES