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Review Article

A Systemic Review on Ophthalmic Hydrogel in Contact Lenses

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ABSTRACT

There has been a recent advances in the field of microbiology where hydrogels contact lenses can be extend as the new ophthalmic drug delivery. Rather than the conventional eye drops, these hydrogels can minimize the side effect also prolonged the residence time of drug. Hydrogels are three-dimensional, hydrophilic, and polymeric networks capable of absorbing great volume of water and biological fluid. Hydrogel becomes the leading material for contact lenses because its biocompatibility and transparent characteristic. The purpose of this article is to review on few types of ophthalmic hydrogel in contact lenses and its application.

Keyword: hydrogel, contact lense, drug delivery, ophthalmic

INTRODUCTION

There has been an uncountable medical disease and problems, which becoming a great challenge to numerous scientists, researchers and doctors. A lot of studies have been conducted in finding the cure. Pharmaceutical industry has becoming the major contributor to the solution of medical problems where treatment such asthma, diabetes and other diseases can no longer depend on conventional pharmaceutical formulation. In the world of Pharmaceutical Sciences, advanced drug delivery formulations has been seen to have a significant future. These formulations are designed by the pharmaceutical scientist and molecular designer to meet in such manner. There have been numerous studies where hydrogels contact lenses may demonstrated to be the next drug delivery system. Hydrogels are three-dimensional, hydrophilic, and polymeric networks capable of absorbing great volume of water and biological fluid[1,2]. Hydrogel can be classified into three groups, which are according to the nature of the side groups (neutral or ionic), mechanical and structural characteristics (affine or phantom networks), and physical structure of the networks (amorphous, semicrystalline, hydrocolloidal aggregates, supermolecular-structure, and hydrogen-bonded structure)[1]. Hydrogels can be made from virtually any water-soluble polymer, including an extensive range of chemical compositions and physical bulk attribute. Other than that it can be formulated in slabs, nanoparticles, microparticles, coating and films. Hence it is conventional used in clinical practice and experimental medicine for wide range of applications[3]. Hydrogels unique properties have lead to the attention of its use in drug delivery system for oral, rectal, ophthalmic, epidermal and subcutaneous application[4]. Therefore, this review will be focusing more on ophthalmic hydrogel in contact lenses. In ophthalmic drug delivery, the physiological limitation applied by the protective mechanism of the eye forces to the low absorption of drugs result in short period of action[4]. Saettone (1987) stated that after the drug is administered to the eye cavity, within 4-20 minutes, the effective tear drainage and blinking action of the eye in the drug concentration is reduced to 10 times[5]. Unabsorbed drug by the cornea is either absorbed by the conjunctiva or flows through the upper and the lower canaliculi into the lacrimal sac[6]. Therefore, most administered dose passes via nasolacrimal duct into gastrointestinal tract (GI), causing to side-effects[5]. Semi-solid formulations like ointment and suspensions can be retained in the eye eventhough gives uncomfortable feeling to patients. However hydrogels has elastic properties that act as an ocular drainage-resistant device in conjunction offering better feeling with slight gritty sensation to the patients[4]. For example, due to their facility in dosing as liquid, in-situ-forming hydrogels are more appealing as an ocular drug delivery. Furthermore it has long period retention property as a gel after dosing as observes by Cohen *et al*. (1997) in his in-situ-gelling system of alginate with high guluronic acid content for ophthalmic delivery of pilocarpine. The duration of the pressure-reducing effect of pilocarpine is up to 10 hours compared to 3 hours when pilocarpine nitrate was dosed as a solution. An evaluation of Gelrite® in-situ gels by Carlfors *et al*. (1998) suggested that when administered in the eye there is a high rate of long precorneal contact times[7,8].

Types of Hydrogel Formulation

There are a number of formulations for a hydrogel delivery. Each has its own specific application and function. While different from the conventional delivery system, each has its own advantages over the other, and can be used to simplify for certain types of ocular diseases. Therefore, modification has been made from the conventional one (e.g. extending drug delivery system) so that it can ease the compliance of patients to drug therapy. The following are the types of hydrogel formulation and

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its application and the merits of using the intended formulation.

Hydrophilic/Hydrophobic Copolymer Hydrogel

Hydrogels are water-swollen polymeric materials that able to absorb large amount of water but do not dissolved in water. In 1960s, poly-hydroxyethyl methacrylate (pHEMA) hydrogels were first introduced as soft contact lenses for ophthalmic drug delivery.[9] The limitations of pHEMA in application of long time therapy and low potential capacity to load drugs, hydrophobic monomer such as 4-vinlyprydine (VP) or ionic monomer such as N-(3-aminopropyl) methacrylamide (APMA) was added to pHEMA hydrogels[10]. These would increase the interaction betweem hydrogel and drugs so that the drugs hardly diffuse out the hydrogel[9]. Andrade Vivero *et al*. reported where the incorporated monomers showed astonishing increased amount of loaded drugs (ibuprofen up to 10-fold or diflofenac up to 20 fold) without changing the vicoelastic properties and the state of water of hydrogel[10]. In order to increase the oxygen permeability that is necessary for maintaining the cornea's health, silicon-containing hydrogel contact lens materials were introduced[11]. Paradiso *et al*. used hydrophobic monomer containing silicon (3-tris (trimethyl silyloxy) silypropyl 2-methylprop-2-enoate), hydrophilic monomer (vinylpyrrolidone, NVP) and hydrogel macromer (hydroxyethyl methacrylate) to synthesize daily disposable contact lenses and transport ophthalmic drug (levofloxacin and chlorhexidine). It was found that the sustained drug released for levofloxacin was complete in < 2 hours and the drug released for chlorhexidine is up to 36 hours. The results also those silicone hydrogel materials are adequate for the preparation of daily disposable therapeutic contact lenses[11]. Other research done where silicone hydrogel contact lenses as extended delivery of ophthalmic drug found that the sustained drug release process of hydrogels can varied from 20 days up to more than 3 months rely on the compositions of the silicone hydrogel components whether it is hydrophobic and hydrophilic[12]. Kim *et al*. also reported that the properties of silicone such as mechanical properties, ion permeability, equilibrium water content, transparency, and surface contact angles were suitable for contact lens application[12]. The advantage of using silicone hydrogel contact lenses is they can increase oxygen permeability but it can also decrease the water content due to its stiffness where it can be unbearable to patients because the cornea is soft[9].

Colloid-Laden Hydrogel

Colloidal carriers have been use for ophthalmic drug delivery. These colloidal systems consist of micro-/nanoparticles, micro-/nanoemulsions, nanosuspensions, and liposomes[13]. It is appeared that drug carriers via nanotechnology are favorable in controlling the release of drug, enhancing drug permeation, and targeting drug[14]. Gulsen and Chauhan reported that pHEMA that has been encapsulated with ophthalmic drug in microemulsion drops and dispersed the drug-laden in the hydrogel were transparent and the gels release the drugs for a period of over 8 days[6].

Liposomal Hydrogel

In 1970s, liposomes have been investigated as a system for the drug delivery or targeting of the drugs to the specific sites in the body. It shows that some liposomal drug delivery systems indicated superior pharmacological properties and liposome could be formulated from variety of lipid and lipid mixtures with different composition[15]. Hosny investigated the effective prolonged-released liposomal hydrogel formulation containing ciprofloxacin. He prepared liposome consisting of soybean phosphatidylcholine (PC) and cholesterol (CH) using reverse-phase evaporation and added additives such as stearlaymine (SA). He found that hydrogel containing liposomes with lipid content PC, CH, and SA in molar ration 5:3:1, respectively showed the best released and transcorneal permeation with percentage permeation of 30.6%. This result suggested that the degree of encapsulation of ciprofloxacin into liposomes and prolonged in vitro released depend on composition of the vesicles[15].

CONCLUSION

In conclusion, using hydrogel contact lenses can be the alternative way as therapeutic devices for ophthalmic drug delivery. Different types of hydrogel gives different efficacy of drug released profiles. Hence the ideal based contact lenses should include large capacity of loading amount of drug and extended period of time for drug delivery.

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