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Controlled drug delivery systems

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Abstract

Conventional systems, which are widely used and known as sustained release, have the disadvantages such as harming the human body and short duration of action due to the fact that the drug goes out of the therapeutic zone. These systems can cause toxic effects by causing drug accumulation in the body. With the developing technology, controlled drug release systems have started to take the place of conventional systems. The aim of controlled drug release systems is to provide the treatment of diseases by sending the right drug in the right amount and time to the target area. Controlled drug release systems do not require excessive doses and do not cause drug accumulation in the body due to their long-term therapeutic properties. In this study, the benefits, applications and types of controlled drug release systems were investigated and presented.

Introduction

In recent years, the development of nanotechnology has inspired studies in the field of nanomedicine and studies in this field have gained acceleration. Controlled drug release systems are one of the important developments in the field of nano medicine. Intelligent drug delivery systems have important advantages in that they can only release the drug to specific areas in the body and treat the disease without causing any damage to healthy tissues [1]. In controlled drug release systems, the release rate and the amount of drug in the blood can be adjusted. In this way, the drug release can be kept stable by preventing fluctuation [2]. Controlled drug release is a treatment method that is more effective than similar drug treatments. For example, degradation or elimination of the drug over time will weaken its effectiveness. However, keeping the ideal drug concentration constant for certain periods of time will increase the effectiveness of the drug and shorten the treatment period. In addition, continuous drug use and sudden drug loading, such as in injection, have some side effects on the patient. Another problem is that the active substance cannot reach the target area by crossing the barriers in the body. Controlled drug release also has advantages such as reducing these side effects, preventing the degradation of drugs with a short half-life, and preventing undesirable side effects in local applications [3].

Controlled drug release is widely used in medicine, pharmacy, chemistry, environment, agriculture and veterinary fields. Many pesticides used in agriculture and applications related to environmental protection can be used in controlled release systems, and effective results can be obtained by using a small amount without harming the nature. In chemical processes, continuity in production can be ensured by the controlled release of expensive and waste-causing materials such as enzymes added to the fermentation medium [4].

Methods of controlled drug release systems

Controlled drug release systems have two different classifications: according to the application site and the release mechanism. In systems with a release mechanism, the main focus is on the release method, while in application site-based systems, the main target is the absorption center where the application will be performed.

Systems according to the release mechanism are examined under different headings as chemical, swelling, diffusion and dissolution-controlled systems. Diffusion-controlled systems are divided into two as membrane or matrix-controlled systems. In membrane-controlled systems, the drug is loaded onto the capsule-type membrane and the drug is released with a difference in concentration after it is taken into the body. In matrix-controlled systems, on the other hand, the drug dispersed into the polymer matrix dissolves over time and is released. In swelling-controlled systems, drug release is realized by using polymers with a hydrophilic structure. The polymer, which swells and disperses depending on time with the water it receives, distributes the drug concentration it contains to the environment. In bioerosive systems, the surface of the system erodes over time, allowing the drug to be released [2].

Controlled drug release systems according to the application site are divided into ocular, nasal, buccal, transdermal, implant, vaginal, cervical and intrauterine systems. The most widely used among these systems are transdermal and implant systems. Transdermal systems consist of a pad attached to the skin surface and a polymer matrix containing a drug, as shown in Fig. 1. The permeable layer at the bottom ensures that the drug is sent to the epidermis layer in a controlled manner, and from there, the hair follicles, intracellular or intercellular drug enters the blood circulation via capillaries. This system is preferred in nicotine addiction or in cases where long-term drug use is required, such as the treatment of persistent pain [5].

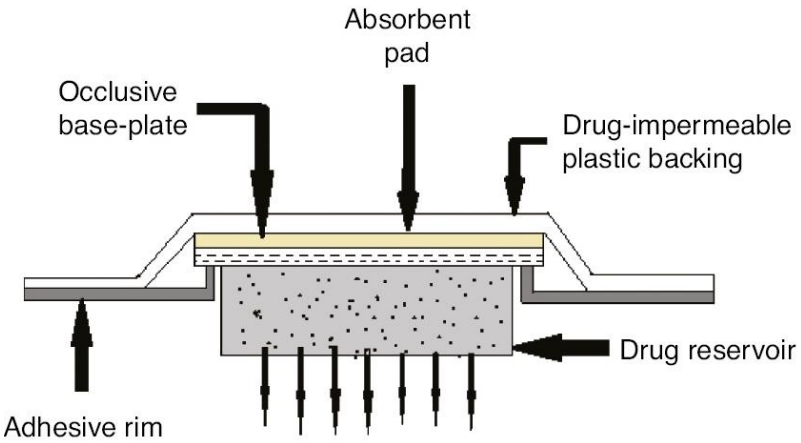

Figure 1. Matrix dispersion system [5]

Fig. 2 compares the drug plasma concentrations of conventional drug release methods and controlled drug release methods. The graph above shows the blood drug plasma concentration curves of the delayed release, immediate release, and extended release systems. According to this graph, delayed release and immediate release systems show higher toxicity and lower efficacy than extended release systems. In the graph below, the concentration curves of conventional systems and controlled drug release systems are given. According to this graph, while there was a high dose requirement in conventional systems, toxicity was also observed at high rates. Controlled drug release systems, on the other hand, have managed to keep the drug concentration in the blood stable for a long time [6].

Conclusions

In this study, the advantages of controlled drug release systems compared to other systems, as well as the types that have been put into practice, were examined. Controlled drug release systems were found to be by far the most successful system in terms of efficiency compared to traditional methods. The application of controlled drug release systems with different methods is also of great importance in terms of the wide area of use. However, since it contains advanced technology, its high cost prevents its rapid development. If this obstacle is overcome, it will completely replace traditional methods.

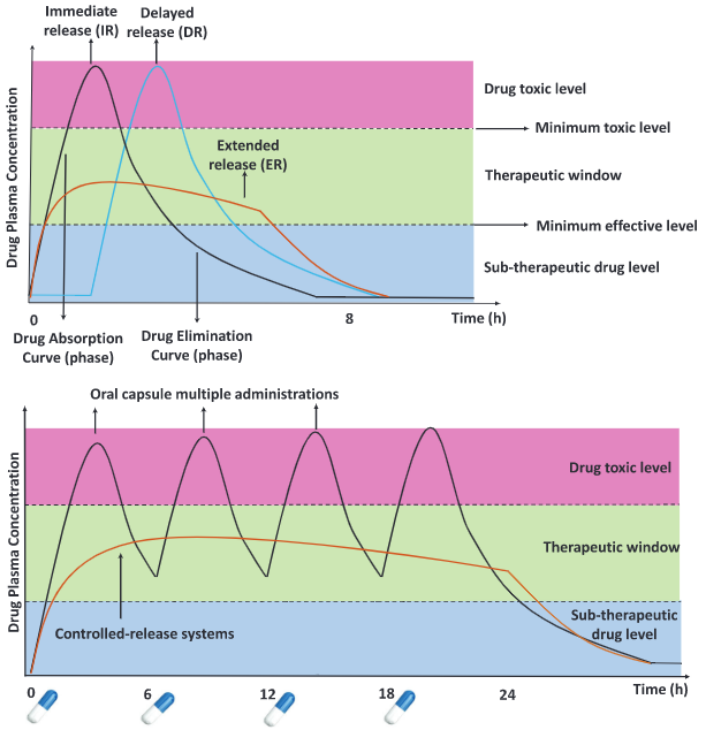

Fig. 2. Comparison of controlled drug release systems with other methods [6]

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