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Review Article

Review of the magnetic field drug delivery system in medicine

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ABSTRACT

One of the most serious medical problems is the side effects and side effects of the drug, such as anticancer agents. Drugs must be administered in large quantities, locally, and temporarily to correct this problem within the human body. MDDS is one of the technologies that enable them, where ferromagnetic drug implanted in the bloodstream is transported to the diseased part by placing a magnet at outside. As a result, the magnetic field accumulates in the infected area and demonstrates its action as a site-specific drug delivery system. Here, we discuss the purpose, use, and classification of magnetic drug delivery systems.

Introduction

The magnetic drug delivery system was first introduced in the 1980s but was greatly improved in the 2000s [1]. In the drug delivery system, a magnetic field containing seeds containing fine ferromagnetic particles is inserted into the bloodstream and circulated by an external magnet. That means we control the movement of the seed-bearing magnetic field by placing a magnet at the outer surface of the body.

In this system, the drug can be blocked by the external magnetic field in the body. Therefore, we can find a large dose of the drug in an area with a targeted disease. Therefore, we can reduce toxicity in normal muscle. The MDDS is therefore broad-based and one of the most promising of DDS [2]. The magnetic drug delivery system is a way in which we can reduce the side effects of a drug by bringing the drug to a diseased area and increasing the therapeutic effect. Because in this case, we were given the required dose of medicine to the required part of the body. So, this system can reduce the side effects which are caused by the drug [3].

The magnetic drug delivery system may promise programs for the treatment of some diseases like sudden hearing loss, cancer, nervous system diseases, etc., You need the right magnetism to successfully release the drug at target site [4].

The magnetic drug delivery system can deliver drugs to specific areas without disrupting the reticuloendothelial (RES) system. In the magnetic drug delivery system, various biocompatible and biodegradable polymers are used to cover the magnetic particles and the drug [5].

The concept of MDDS

The methods which were following designed as an MDDS method. A stream of blood transports the medicine to the patient. The magnet is placed near the intersection of the arteries on the body's surface. Magnetic force is used to administer the medicine on purpose. By repeating this wandering, the medicine was eventually delivered to the afflicted part. When this notion is implemented, the procedure that follows will be carried out. Primarily, the magnetic field of the seed is injected into the body by intravenous injection. The medicine travels from the artery to the heart (right atrium), then from the right ventricle to the lungs, pulmonary artery, and heart through the pulmonary artery (left atrium). As seen in Figure 1, blood travels throughout the body from the left ventricle through the aorta. With the superconducting magnet positioned outside the body in the area that connects the blood arteries, the magnetic field that exits the left ventricle travels in a specific direction. This wandering occurs twice or

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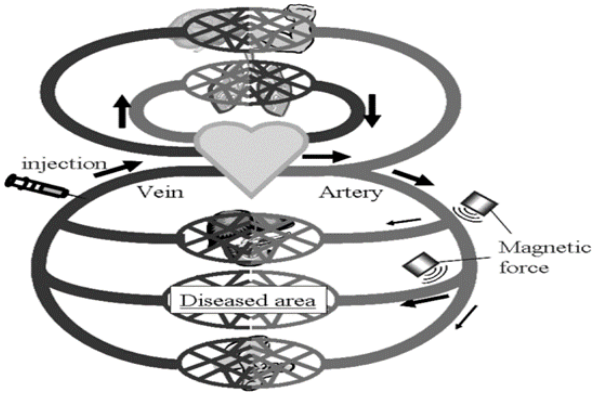
more times. Furthermore, the magnet is put in the diseased area, which causes the medicine to collect in the infected area due to the magnet's force



[2].

Fig.1. In MDDS, a path that sends the medicine to the sick area

Principle

The seed magnetic field, which contains small ferromagnetic particles, is introduced into the circulation of blood, and is directed to the external field of magnet in the MDDS. That is, the field of magnetism by placing the magnet at outer surface of the body, is used to control the movement of the magnetic seed tree [2].

This medication delivery system is a strategy to decrease the side effects of drugs and to increase the effectiveness of treatment by bringing the drug to a specific infected area. Because we were able to bring the right amount of medicine to the right part of the body. As a result, this method of medication delivery can decrease the side effects of the medicine [3].

Applications

Magnetic nanoparticles can be delivered via vasculature and concentrated in a specific location of the body by the help of magnetic field, according to Freeman et al. in 1960 [6]. In 1963, Meyers described the use of magnetic metal particles as a separate agent and isotope in a dog's lymphatic and circulatory system [7]. In 1976, Pilwat and Zimmerman tested the magnetic erythrocyte for cytotoxic release. medicines. Senyei et al [8] developed microspheres of albumin containing magnetite of superparamagnet in the 1970s and used a magnetic field to effectively store them against Vivo capillary flow conditions [9]. Widder et al. saw tumour shrinkage and no embolism in mice when they employed magnetic albumin microspheres carrying doxorubicin [10].

Polymer matrices containing chemicals and magnetic beads have also been used to produce new drug delivery methods. When the oscillating magnetic field is supplied to the pulsatile delivery device, the holes open, and the drug is released [11]. In 1994, Hafeli et al. created biodegradable poly [lactic acid] microspheres with magnetite and a beta emitter of focused light, which were effectively employed on subcutaneous tumors [12]. Lubbe et al. successfully used ferrofluid with the drug as an anti-tumor agent in the Vivo-free mouse model. Another successful experiment used a magnetic field to inject ferrofluid Chemicell bound to mitoxantrone into rat tumors [13]. Lubbe et al. perform the first phase of clinical trials All patients tolerated ferrofluid well, and nanoparticles were shown to concentrate close to plants [14].

In 1997, the first enterprise, FeRx Inc, completed a phase I / II experiment in which carbon-coated particles of carbon (0.5-5 m) and adsorbed doxorubicin were deposited and stored in the target locations [15]. McBain et al. to provide a comprehensive evaluation of the latest testing of magnetic drug delivery to patients [16].

Applications for genetic therapy

Magnetic nanoparticles can be used in gene therapy. The transfer of DNA to cells can lead to the development of therapeutic proteins that can be used to treat cancer. Short-term disruptive RNA (siRNA) can be used to temporarily suppress selective gene expression [genetic mutation], and any gene that causes disease may be silenced [17]. However, when DNA is simply injected or consumed, it slows down and is unable to break into previous cellular targets [18] There are three main ways in which genes can be programmed to produce genes: the viral vectors utilization is very effective. but it has serious side effects. Electroporation, in which cells are electrically stimulated to promote absorption, is also very effective but causes a large number of cell death as well as non-viral transfection agents, which facilitate the entry of nucleic acids into cells in some way and maintain cell function but not function properly [19].

Mah et al. published the first magnetic-specific DNA delivery investigation in 2000 [20]. The surface of the magnetic microsphere was covered by a recombinant adeno-associated virus (rAAV) that produces a green fluorescent protein. When the magnetic field was introduced, 1 percent of the vector-microsphere formation had a 100% free vector transfer efficiency. Hughes et al. use paramagnetic streptavidin particles linked to the adjoining retrovirus to form "infectious, disruptive, and retroviral vector particles" [21].

Nonviral vectors are also developed to improve nucleic acid transfer efficiency. Magnetofection combines genes with magnetic nanoparticles to deliver a magnetic acid-directed magnetic acid [22]. Except that plasmid DNA creates cationic polymer complexes - mainly polyethyleneimine [PEI] - that may attach and shorten DNA coated with magnetic nanoparticles, the idea is the same as for other transfusion agents like lipofection 2000 to generate a magnetically regulated behaviour known as a "magnetoplex" [23] The mechanism by which genes enter a cell through magnetoplex have been found to be similar to those of common reagents. [24, 22].

Cai et al. Nickel-based carbon nanotube is used to attach to DNA as a "spear" for piercing cells, leading to better transmission of the virus [25]. Regarding genetics, Oz Biosciences has created four distinct types of cationic nanoparticle [26]. The development is also being investigated using pulsing fields, which have been shown to increase the number of transferred cells compared to vertical fields, according to Kamau et al [27].

Limitations

There are two major limitations in the administration of magnetic drugs. First, vehicle particles can be removed from the rotation very quickly. Second, given the nanoparticles' tiny size and consequently low magnetic field strength, the intensity, and gradient of the magnetic field that must be created in order to achieve a successful network environment [28] against hydrodynamic forces caused by, for example, blood flow [29], can be very high. As a result, there is a need for large magnetic particles that can still flow into capillaries without causing embolism [24]. Large particles, on the other hand, have a restricted capacity to enter tissue and cell membranes.

Magnetic field sources

A magnet is a substance or thing that generates a magnetic field. This

magnetic field is undetectable, however it's far responsible for the magnetic discipline: the force that attracts or repels other ferromagnetic elements. Permanent magnetic materials are available in a variety of materials, from household appliances and electronics to terminals near large computers. Demand for permanent electronics has increased as a result of modern requirements for reduced and more efficiency of electrical and equipment of electronic. Permanent magnet is another component of an object that retains its magnetic properties over time. Magnetic resonance and magnetic field are known as magnetic fields. Iron, nickel, cobalt, other rarely occurring earth metals and alloys (e.g., Alnico), and other naturally available minerals like lodestone are within you. Permanent magnets are constructed of "solid" ferromagnetic materials that are intended to remain durable, while "soft" materials such as soft metal, are attracted to magnets but do not always attract magnets.

An electromagnetic coil that acts as a magnet when the power cord runs through it but stops working like a magnet when the curse is turned off. The electromagnetic core is usually wrapped around the ferromagnetic core, like metal, to expand the coil produces a magnetic field. Because magnetic fields have very low sensitivity to human muscles, there is little that can be done about them. When an external ferromagnetic body is present in a human muscle, however, it interacts with the magnetic field, providing a substantial safety concern. If a pacemaker is implanted in the patient's chest, further caution must be exercised to keep it away from the magnet. As a result, MRI, which is a magnetic imaging technology, cannot be used to diagnose a patient with an installed device. Ceramic magnets, commonly known as ferrite magnets, are composed of a mixture of iron oxide powder and barium/strontium carbonate ceramic. Inexpensive magnets [or cheaper magnets] can occur due to lower material costs and production technology. The resulting magnets are not rusty but are fragile, requiring similar treatment for conventional pottery. Alnico magnets, for example, are created by scattering or incorporating a combination of aluminum, nickel, and cobalt with metals as well as small amounts of additional metals to enhance the magnetic properties. Casting produces large magnets and allows for the creation of complex forms, while sintering provides the best mechanical features. Alnico magnets are rust-resistant and have very soft physical properties than ferrite, although they are not as wanted as metal magnets. The permanent magnet formed by a mixture of neodymium, iron, and boron is known as a neodymium magnet. They are the most powerful magnets ever created (Fig. 2). Samarium-cobalt magnets have been available since the early 1970s. One atom of the earth's rare samarium atom and five atoms of cobalt from these magnetic alloys in the samarium cobalt (abbreviated as SmCo5). This magnetic alloy of samarium cobalt usually comprises 36% samarium and some cobalt by weight [30].

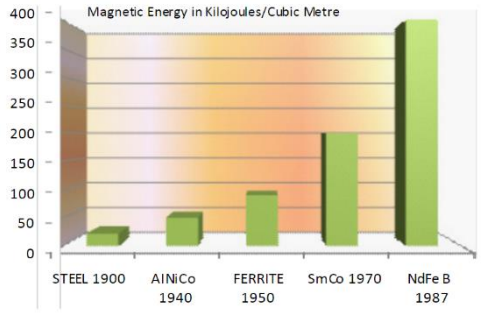


Fig.2. Comparison of the magnetic field of commonly used permanent magnets.

MDDS classification

Magnetic carrier drug delivery systems are further subdivided to achieve the delivery of controlled and targeted drugs

i. Magnetic nanoparticles
ii. Magnetic microspheres
iii. Magnetic liposomes
iv. Magnetic emulsions

I. ***Magnetic nanoparticles***

Associated with the internal magnetic field and Physico-chemical properties due to its efficient coating, magnetic nanoparticles have shown great promise in loading drugs. These particles, with a diameter less than 100 nm, are applied to magnetic fields and are controlled by various substances such as metal, nickel, and cobalt. Improved performance is available under a value of approximately 10-20 nm.

Above the inhibitory temperature, these nanoparticles exhibit high magnetic activity and act as paramagnetic atoms with low resonance. They can be employed in a variety of ways, such as MRI, vascular different agents, diagnostic agents, such as theranostic in cancer treatment, genetic engineering, tissue engineering, cell division, bioseparations, and cell tracking, and theranostic in cancer treatment, genetic guidance., tissue engineering, classification of bioseparations, and cell tracking [31].

ii. Magnetic microspheres

Microparticles are made up of a variety of high-density magnetic fields that can effectively carry non-magnetic substances into the magnetic field, like cells, antibodies, medicines, nucleic acids, and enzymes. These are small in size, less than 4 feet high, allowing for rapid flow rate by capillaries without embolism. They are made of biocompatible proteins or polymers that are synthesized where the drug is attached and are designed to be used in the form of a depot near the target by placed the appropriate magnet close together. Assist in the manufacture of medicines and the prevention of toxins by preventing the transport of unwanted drugs to unintended organs [31].

iii. Magnetic liposomes

Magnetic liposomes consist of a bilayered composite structure with lipid and liquid layers arranged in different configurations. These are structures of nanometric biocompatible shaped vesicular that are used to combine therapeutic solvents in water and oil. Active compounds dissolved in water are deposited in a liquid line of magnetic liposomes, while active lipid-soluble compounds are deposited in the lipid layer as shown in Fig.3. Generally, Magneto liposomes can be divided into two types: those with iron oxide in the liquid layer and those with iron oxide implanted in the lipid layer following stabilization with laureth [31].

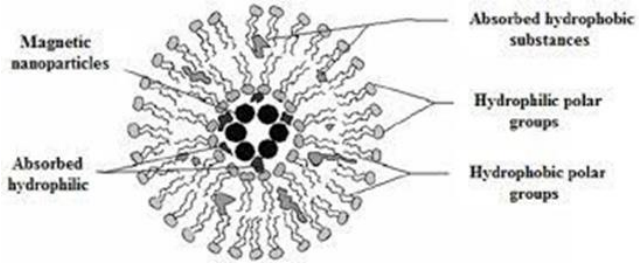


Fig.3. the formation of a magnetic liposome

iv. Magnetic emulsions

A colloidal system made up of two soluble liquids is known as an emulsion (water and organic solvent) which are then dissolved in emulsifying agents (polymers or surfactants). When water is based as a continuous outer layer,

it forms an oil in a water-based emulsion, however, when it depends as a dispersed internal phase, it forms distorted water in the oil-based emulsion. A magnetic emulsion is a type of emulsion in which the inner layer consists of ferrofluids with a stable distribution of magnetic nanoparticles [31].

Conclusion:

The biocompatibility and selective identification of magnetic nanoparticles in a cell or tissue suitable under the supervision of an external magnetic field continues to define their use as drug delivery technologies. Advances in current technology have accelerated the development of magnetic nanoparticles as drug delivery systems to deliver drugs to sub-tumour hypoxic environments over the past decade, resulting in the development of various nano-magnetic structures such as liposomes, metallic/non-metallic, and polymeric nanoparticles. These novel drug delivery technologies have increased the capacity to provide drugs that were previously difficult to administer via traditional therapy. This approach will reduce disruptive processes while also reducing side effects in healthy muscles, which are two major concerns in traditional cancer treatment. The topic of magnetic drug delivery is still in its infancy, and research into improved magnetic drug delivery devices and the integration of multi-functional ligands is bringing it closer to the clinic. Concerns regarding their elimination and long-term toxicity will keep them out of clinical studies until then.

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Conflict of Interest

The author[s] confirm that this article content has no conflict of interest.

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