Magnetic microsphere: as targeted drug delivery

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ABSTRACT

Magnetic microspheres as an alternative to traditional radiation methods which use highly penetrating radiation that is absorbed throughout the body. Its use is limited by toxicity and side effects. The aim of the specific targeting is to enhance the efficiency of drug delivery & at the same time to reduce the toxicity & side effects. The present paper reviews the mechanism, preparation and applications of magnetic microspheres.

Keywords: Magnetic microspheres, Targeted drug delivery, Magnet

INTRODUCTION

Tiny drug couriers with magnetic personalities could offer new solutions for patients who need drugs delivered directly to tumours, diabetic ulcers and other disease sites. Magnetic microspheres can be filled with drugs or radioactive materials to treat a variety of illnesses. Magnets applied outside the body attract the spheres to the disease site where they deliver therapeutics in a targeted way. The magnets attract the microspheres to the immediate area of the wound site and stop them there. The spheres gradually break down and release growth factors over a period of weeks, allowing blood vessels and damaged tissues to re-grow and repair.

Small amounts of drug targeted magnetically to localized sites can replace large doses of drug that, using traditional administration methods, freely circulate in the blood and hit the target site in a generalized way only. Also, drugs within the sphere are protected from breaking down during transport and, because they are targeted instead of distributed in blood, don’t harm some sensitive organs such as bone marrow. Magnetic microspheres as an alternative to traditional radiation methods which use highly penetrating radiation that is absorbed throughout the body. Its use is limited by toxicity and side effects. Loads his microspheres lods with radioactive tracers that emit beta radiation. Beta radiation consists of electrons that interact with cells within a one-centimetre range only, virtually eliminating side effects. Spheres can be made of a variety of materials. Some like albumin or gelatin are biodegradable can reside in the body without negative effect. Magnetic radioactive microspheres are applied in methods similar to non-radioactive spheres. A magnet, placed outside the body, is directed to the target site. The magnet can be a rod-shaped permanent magnet of any size or can be contained in equipment that looks like an open magnetic resonance imaging scanner. The loaded microspheres are introduced into a blood vessel, and in as little as half an hour, they gather at the target site to emit radiation that kills surrounding cancer cells. The therapeutic action usually a couple of days or weeks, depending on the material used. If necessary, the treatment can be repeated. Spheres need to be peppered with microscopic magnetic particles, such as iron, so they will be attracted to the magnet. [1,2]

Although magnetic microsphere research is in an early stage, scientists have been exploring how the spheres can treat liver and brain tumours, and first results appear promising also focused on improving magnetic microspheres so they can be used in a greater variety of treatments. It plans to investigate magnetic treatment of head, neck and lung tumours as well as finding ways to improve delivery of rheumatoid arthritis drugs to affected joints. [3]

MECHANISM OF TARGETING BY MAGNET :

The aim of the specific targeting is to enhance the efficiency of drug delivery & at the same time to reduce the toxicity & side effects. Magnetic drug transport technique is based on the fact that the drug can be either encapsulated into a magnetic microsphere or conjugated on the surface of the microsphere. When the magnetic carrier is intravenously administered, the accumulation take place within area to which the magnetic field is applied & often augmented by magnetic agglomeration. The accumulation of the carrier at the target site allow them to deliver the drug locally. Efficiency of accumulation of magnetic carrier on physiological carrier depends on physiological parameters eg. particle size, surface characteristic, field strength, & blood flow rate etc. The magnetic field helps to extravasate the magnetic carrier into the targeted area. Very high concentration of chemotherapeutic agents can be achieved near the target site without any toxic effect to normal surrounding tissue or to whole body. It is possible to replace large amounts of drug targeted magnetically to localized disease site, reaching effective and up to several fold increased
drug levels. This technique which requires only a simple injection, is far less invasive than surgical methods of targeted drug delivery. Another advantage is that particles in the magnetic fluid interact strongly with each other, which facilitates the delivery of high concentrations of drug to targeted areas. [4, 5]

**PREPARATION AND CHARACTERIZATION:**

**Characterization:**

Scanning electron microscopy is used to determine the size & morphology of magnetic particles whereas Dynamic Light Scattering is used to measure the hydrodynamic diameter Magnetic mobility (overall responsiveness or amount of velocity for a given magnetic field & field gradient) of different types of magnetic microspheres is characterized so that their behavior in patient circulation can be predicted. For this purpose stationery setup can be used on standard microscope equipped with a digital camera & computer system. There is no flow of the suspension congaing the magnetic particles. The geometry & size of the set up & magnet used can be reduced considerably.

1. Preparation of Magnetic Microspheres from Water-in-Oil Emulsion Stabilized by Block Copolymer Dispersant:

The preparation involved first the dispersion of an aqueous phase, containing magnetite nanoparticles and a water-soluble homopolymer, into droplets in an organic medium using an amphiphilic block copolymer as the dispersant. This was followed by water distillation at a raised temperature from the aqueous droplets to yield polymer/magnetite particles. The structure of the particles was then locked in by a reagent being added to cross-link the water-soluble copolymer block and homopolymer. Since the hydrophobic block of the copolymer consisted of a protected polyester, the removal of the protective moieties from the coronal chains yielded poly(acrylic acid) or other functional polymers to render water dispersibility to the spheres and to enable biomolecule immobilization.[6]

2. Microwave-assisted Preparation of Magnetic Albumin Microspheres:

A new microwave-assisted method was used to prepare magnetic Fe₃O₄ particles and magnetic bovine albumin microspheres (Fe₃O₄ is combination of two oxide Fe₂O₃ and FeO). The microwave method produced smaller particles and is faster than traditional methods. The optimum conditions to prepare the Fe₃O₄ particles were three minutes at pH 13 and 80°C. Magnetic microspheres containing albumin were synthesized based on heating times and temperatures to form microspheres with different properties. For example, heating for 4min, at 160°C, yielded smaller sized microspheres (30 μm). Confirmed by FT-IR that iron oxide particles were encapsulated in biocompatible proteins. The thermal stability of the microspheres were determined by DSC and TG. The magnetic properties were determined by UV—VISIBLE spectrophotometry and a Guoy magnetic balance. This microwave process could become a preferred method for the synthesis of magnetized protein microspheres. [7]

3. Synthesis of amphiphilic magnetic microspheres by dispersion copolymerization of styrene and poly(ethylene oxide) macromonomer:

Amphiphilic magnetic microspheres ranging in diameter from 5 to 100 μm were prepared by dispersion copolymerization of styrene and poly(ethylene oxide) vinylbenzyl (PEO-VB) macromonomer (MPEO) in the presence of Fe₃O₄ magnetic fluid. The effects of various polymerization parameters on the average particle size were systematically investigated. The average particle size was found to increase with increasing styrene concentration and initiator concentration. It also increased with decreasing stabilizer concentration and molecular weight of MPEO. The content of the hydroxyl groups localized in the microspheres ranged from 0.01 to 0.2 mmol g⁻¹.[8]

**APPLICATIONS**

Magnetic microcarrier vehicles have received considerable attention, because of their wide applications in the fields of biomedicine and bioengineering, biological and biomedical developments and trends such as enzyme immobilization, cell isolation, protein purification, and target drugs. Magnetic vehicles are very attractive for delivery of therapeutic agents as they can be targeted to specific locations in the body through the application of a magnetic field gradient. The magnetic localization of a therapeutic agent results in the concentration of the therapy at the target site consequently reducing or eliminating the systemic drug side effects. Drug discovery, molecular targeting, DNA analysis, proteomics, and understanding the pathways of cell cycle regulation.[4, 5]

**CONCLUSION:**

Targeted Drug delivery is an effective method to assist the drug molecule to reach preferably to the desired site. The main advantage of this technique is the reduction in the dose & side effects of the drug. The magnetic targeted chemotherapy has better tumour targeting, therapeutic efficacy & lower toxicity. The use of strong magnetic fields of the ferrifluid may be the factors associated with its limited implementation so by more characterization & long term toxicity study, this will be utilized as an effective targeted drug delivery system.

**REFERENCES:**


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