Nanoparticles Using as Efficient Bioavailability in Drug Delivery System-Mini Review

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Abstract

Nanotechnology is manipulating matter at nanometer level and the application of the same to medicine is termed nanomedicine. It is a multidisciplinary field, which covers a vast and diverse array of the 21st centuries. Nanomedicine, an offshoot of nanotechnology, refers to highly specific medical intervention at the molecular scale for curing disease or repairing damaged tissues, such as bone, muscle, or nerve. The burgeoning new field of nanomedicine opened up by rapid advances in health care, creates myriad new opportunities for advancing medical science in human health care. Applications of nanotechnology to medicine are leading to novel means of drug delivery system. Much nanotechnology research is focused on the bioavailability of poorly soluble drug in several diseases. The goal of this mini-review is to highlight the principles of nanoparticle design for drug delivery and applications to different organs. In addition to breakthroughs innovative forms of treatment, this review describes therapeutic uses of nanomedicine, such as bioavailability of drug delivery systems.

Keywords: Nanotechnology; Nanomedicine; Bioavailability; Drug delivery; Nanoparticles; Applications; Treatment

Abbreviations: NPs = Nanoparticles; BBB = Blood-Brain Barrier

Introduction

Nanotechnology is an emerging interdisciplinary revolution in different therapeutic areas over the last decade, including materials science, medicine, and drug delivery system [1]. The essence of this new technology has a great and significant impact in the field of medicine, diagnosis and drug delivery [2]. In the last two decades, number of Nanoparticle-based drug delivery system developed for the treatment of cancer [3], diabetes [4], pain [5], asthma [6], allergy [7], infections [8], and so on [9]. The significant benefits using nanoscale agent are more effective and convenient routes of administration [10], lower therapeutic toxicity [11], extend the drug bioavailability [12], as well as ultimately reduce health-care costs [13]. Nanoparticles (NPs) also use for optimizing drug formulations [14], increasing drug solubility [15] and altering the pharmacokinetics to sustain the release of the drug [16], thereby prolonging its bioavailability [17]. The diverse platforms of the NPs are nanomedicine which can utilize to develop more sophisticated, cell-targeted therapies [18] and to combine different drugs into a single nanotherapeutic agent for synergistic therapeutic benefits [19].

Nanomedicine is a rapidly growing area of medical research that focused on developing NPs for prophylactic [20], diagnostic [21], and therapeutic applications [13]. Nanomedicine promises an endless range of medical applications from efficient bioavailability to drug delivery and therapeutics [22]. The promising approach of nanomedicines provide us with many biological processes [23], cellular mechanisms [24], and organic molecules [25]. Currently, nanomedicine utilized in wide-ranging areas, and these applications have a potential to revolutionize the way we may target efficiently in drug delivery system in future. Different types of NPs have a relevant position in the global agenda for future development of medical research in the 21st Century.

Nanoparticles in Ocular Drug Delivery System

The number of challenges associated with the treatment of ocular diseases. In general, the major problem in ocular therapeutics is to maintain an effective drug bioavailability at the site of action for an appropriate period of time, in order to achieve the expected pharmacological response [26]. NPs minimize side-effects and facilitate effective drug bioavailability. Nanosuspensions, solid lipid NPs, and liposomes have led to the solving of various solubility-related problems of poorly soluble as well less bioavailable drugs [27]. Nanospheres and liposomes, can provide protection for the drug encapsulated into them, and thus prolonged exposure to the drug by controlled release. To

develop a promising and suitable ocular drug delivery system [28]. Liposomes attach to the hydrophobic corneal epithelium, where they continuously release the bound drug content, improving pharmacokinetics and decreasing toxic side effects [29]. Fluconazole-loaded liposome applied to the rabbit keratitis models, results showed that therapy with liposomal fluconazole was successful at eliminating infection and was superior to the control.

Nanoparticles in Neural Drug Delivery

The blood-brain barrier (BBB) represents an insurmountable barrier for the majority of drugs including anticancer agents, antibiotics, peptides and macromolecular drugs [30]. The polymer used for the majority of nanoparticles employed for the transport of drugs across the BBB [31]. This polymer is about the most rapidly biodegrading artificial polymers [32]. The first drugs that were transported across the BBB using nanoparticles were dalargin [33]. Dalargin is a hexapeptide Leu-enkephalin analogue with the sequence Tyr-d- Ala-Gly-Phe- Leu-Arg. Liposomes" are nanoscale vesicles having a phospholipid bilayer membrane and an aqueous core [34]. Liposomes have recently developed for the treatment of brain tumors but are still in the investigational stage in that setting [35]. In a number of studies, doxorubicin bound to nanoparticles has been shown to cross the intact BBB and reach therapeutic levels in the brain as well as to prolong survival times significantly in rats with glioblastomas [36].

Nanoparticles in Cancer Drug Delivery

NPs used for anticancer drug delivery can be made from a variety of materials, including polymers, dendrimers, liposomes, viruses, carbon nanotubes, and metal such as iron oxide and gold NPs [37]. The previous study reported that doxorubicin carried out using titanium dioxide (TiO2) NPs for anticancer efficacy enhancement on human hepatocarcinoma and side effect attenuation [38]. Liposome-based transmembrane carrier systems have the ability to target intracellular delivery of vincristine. Its clinical trial data demonstrated that it has longer blood circulation half-life, higher accumulation in tumors, and more sustained drug release profiles than free vincristine. Therefore, liposomal vincristine can potentially increase the efficacy of vincristine and decrease adverse side effects of the drug [13]. Liposomal formulations of daunorubicin also approved for the treatment of metastatic breast cancer and AIDS-related Kaposi's sarcoma [39]. In vitro study, drugs methotrexate covalently linked to carbon nanotubes were shown to be more effectively internalized into cells compared with free drug alone [40].

Nanoparticles in Diabetes Drug Delivery

The NPs employed for oral insulin delivery include prodrugs (insulin–polymer conjugation), micelles, liposomes, solid lipid NPs of biodegradable polymers [41]. Nanoparticulated insulin delivery approaches mainly aim to develop drug preparations which can be orally administered and get absorbed in the intestine [42]. A large variety of new Nanoparticle is under development combining chitosan, for mucosa adhesion with other polymers such as hydroxypropyl methylcellulose phthalate for pH-sensitivity [43], alginate for improved loading capacity and activity maintenance [44], a gel formulation with the negatively charged sodium lauryl sulfate [45], or even chitosan-reduced gold [46]. The study showed that nasal administration of insulin-loaded, chitosan-reduced gold nanoparticles (GNPs) improved Pharmacodynamics activity of insulin [47]. Recently published nanoparticle preparation for oral insulin delivery includes a multilayer approach with subsequent deposition of poloxamer, chitosan, and albumin on sub-micron particles consisting of insulin, alginate and dextran sulfate [48]. They claim a 40% decrease in glucose level over 24 h and three-times better bioavailability compared to free insulin orally administered [49]. Chitosan has been used to protect protein drugs from gastric enzymes [50] and facilitate the absorption of hydrophilic macromolecules [51]. Furthermore, chitosan nanoparticles have been found to enhance the intestinal absorption of protein molecules to a greater extent than aqueous solutions of chitosan *in vivo.*

Discussion

Controlled drug delivery systems have several advantages compared to the traditional forms of drugs. A drug is transported to the place of action, hence, its influence on vital tissues and undesirable side effects can be minimized. Accumulation of therapeutic compounds in the target site increases and, consequently, the required doses of drugs are lower. This modern form of therapy is especially important when there is a discrepancy between the dose or the bioavailability of a drug and its therapeutic results [52]. Despite numerous scientific efforts, efficient ocular drug delivery remains a challenge for pharmaceutical scientists. Most ocular diseases are treated by topical drug application in the form of solutions, suspensions, and ointment [53]. These conventional dosage forms suffer from the problems of poor ocular bioavailability, because of various anatomical and patho physiological barriers prevailing in the eye [54]. NPs formulated drug provides significant bioavailability to ocular drug delivery system. Recent findings and applications of various nanoparticulate systems like microemulsions, nanosuspensions, nanoparticles, liposomes, niosomes, dendrimers and cyclodextrins in the field of ocular drug delivery and also depicts how the various upcoming of nanotechnology like nanodiagnostics, nanoimaging and nanomedicine can be utilized to explore the frontiers of ocular drug delivery and therapy. NPs utilized as drug delivery agents which use for delivering drugs to the brain across the blood-brain barrier (BBB) may provide a significant advantage to current strategies [55]. The primary advantage of NP carrier technology is that NPs mask the blood-brain barrier limiting characteristics of the therapeutic drug molecule. Furthermore, this system may slow drug release in the brain, decreasing peripheral toxicity,

increased bioavailability. NP technology appears to have significant promise in delivering therapeutic molecules across the BBB. NPs are rapidly progressing and implemented to solve several limitations of conventional drug delivery systems such as nonspecific bio distribution and targeting, lack of water solubility, poor oral bioavailability, and low therapeutic indices. To improve the bio distribution of cancer drugs, nanoparticles have been designed for optimal size and surface characteristics to increase their circulation time in the bloodstream [56]. Multifunctional and multiplex nanoparticles are now being actively investigated and are on the horizon as the next generation of nanoparticles, facilitating personalized and tailored cancer treatment. There are many ongoing investigations to improve the oral bioavailability of peptide and protein formulations. Bioadhesive polysaccharide chitosan NPs would seem to further enhance intestinal absorption of them [57].

Conclusion

New science and technologies are previously making their way into all aspects of dental practice and have changed traditional approaches to diagnostics, risk assessment, prevention, and many other procedures. Nanotechnology promising in the drug delivery system. Nanotechnology-namely safety, cost, and ethical considerations. Nanotechnology revolutionizes our approach to current therapeutic challenges like drug delivery, bioavailability and will enable us to address currently unsolvable problems. We expect that Nanotechnology with novel engineering approaches that result in optimally designed nanoparticles, we will see an increasing number of multifunctional nanoparticles in the future for drug delivery system.

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