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Review Article

Biodegradable polymeric micro/nanoparticles for oral single-dose vaccines prospects, and future

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ABSTRACT

Within the great advances in the biomedical sciences and the emerging of a new infectious diseases, there has been a constant need for a parallel improvement in the vaccination strategies and approaches toward the ease of administration or what is called a single-dose vaccine platform, and the key factors in this regard are the antigen carriers, and the biodegradable polymeric micro/nanoparticles may be the most powerful candidates. This review will focus on the potentials and limitations of these biodegradable micro/nanoparticles as a tool for a single-dose oral vaccine, taking into consideration the physiological barriers in addition to the micro/particles characteristics in such a way to shed light on the future of these vaccine delivery systems.

Keywords: Single-dose vaccine, Oral vaccination, Biodegradable polymers, Micro/nanoparticles

INTRODUCTION

Biodegradable polymeric micro/nanoparticles have recently gained a great deal of interest as a carrier for many drug molecules in addition to biomolecules like antigens.[1]

The mucosal route for antigen delivery is considered one of the preferable strategies due to the possibility of initiating the immunoresponse.[2,3]

The vaccine uptake by the gastrointestinal tract has many challenges and limitations such as enzymatic and non-enzymatic digestion in addition to the mucosal barriers,[4] and the delivery cargo is considered as the key factor in the delivery process.[5]

Biodegradable polymeric micro/nanoparticles (carefully tailored) may represent one of the promising strategies for the improvement the vaccine delivery through the mucosal route.[6]

The ideal cargo candidate should have the ability to selectively presents the antigen, initiate the dendritic cells reaching to deliver antigen into these cells[5] that are described as the bridge between innate and adaptive immunity.[7]

M cells that are situated in the top of the epithelium of the Peyer's patches are considered the regulating factor for the mucosal immunoresponse by regulating the presentation of the antigen to the lymphocytes and macrophages.[8]

METHODOLOGY

A number of published articles and relevant data were collected and screened and linked in order to get the conclusions and to give hints about the areas that should be focused on in the future.

DISCUSSION (EXPERIMENTAL DATA)

On light of data indicating the feasibility of non-replicating antigen delivery systems in initiating mucosal immune response, Kofler *et al*. found that orally *in vivo* (mice) micro-spheres loaded with antigen (LW 50020, an immunomodulator consisting of lysates of seven common respiratory pathogens) and prepared form the biodegradable polymers poly lactic-co-glycolic acid (PLGA) and poly-lactic acid (PLA) were able to induce an immunity response (after they were taken up into intestinal Peyer's patches) and this uptake was strongly connected to the size and the surface properties of the formulated micro-spheres[9] and these finding support the comes with the same context of Ren *et al*. who found that (D,L-lactide)-polyethylene glycol copolymer micro-spheres loaded with antigen (*Helicobacter pylori* lysates or Cystografin) were able to initiate the immunoresponse in the gastrointestinal mucous membrane after the oral administration (in mice).[10]

Delgado *et al*., also found in his study to investigate the impact of the presence of poly lactic-co-glycolic acid (PLGA) in oral micro-spheres formula for vaccine delivery that PLG based micro-spheres prepared in combination with Eudragit L100-55 stabilized and carboxymethyl-ethyl cellulose, were able to increase the immunoresponse in mice through the oral route.[11]

Moreover Yan *et al*. mentioned that chitosan nano-spheres loaded with New Castle plasmid deoxyribonucleic acid vaccine for chicken immunization was able to make an improvement in the immunoresponse through mucosal vaccination in addition to a prolong release of the loaded vaccine,[12] and to verify the efficacy of the combination of PLGA and chitosan, Alkie *et al*. used chitosan coated PLGA nanoparticles loaded with an inactivated antigen in chicken through the nasal and ocular mucosal route that the results revealed an improve in the immunity response in comparison with the PLGA nanoparticles, the thing that highlights the idea of the advantages of using a combinations of biodegradable polymers in formulating the micro/nano-particles to increase the vaccine performance.[13] Here with the idea of combination, Biswas *et al*., in a study of designing nanoparticles for oral measles vaccine delivery (in mice), found that alginate coated chitosan (low medium weight) nano-particles (oral route) revealed a good protection for the antigen, a considerable immunoresponse in addition to sustain release.[14] The efficiency of sodium alginate micro-spheres as an oral vaccine delivery system was also revealed by Xu *et al*. Through a study on Grass carp reovirus, two groups, one was vaccinated with alginate micro-spheres loaded with the virus antigen, and the other was a control, the results showed that survival of the vaccinated group with encapsulated vaccine in sodium alginate was the highest.[15]

CONCLUSION

It is clear that biodegradable polymeric based micro/nano-particles can be a platform for single oral vaccines delivery, and that there is a need for more intensive efforts for a deep investigation of its physicochemical properties and to study the influence of these characteristics on the resultant micro/nanoparticles uptake, immunity initiating, and prolonged release of the loaded antigen, and this possibly could be achieved by the studying the interaction of these micro/nanosystems with intestine mucosal lymphoid tissues at the molecular level.

Ethical approval

Institutional Review Board approval is not required.

Declaration of patient consent

Patient's consent not required as there are no patients in this study.

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Conflicts of interest

There are no conflicts of interest.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

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