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Research Article

DESIGN AND OPTIMIZATION OF EVEROLIMUS-LOADED PROTEIN NANOPARTICLES FOR TARGETED THERAPY OF GLIOBLASTOMAS

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ABSTRACT

Glioblastoma is a highly aggressive and difficult-to-treat brain cancer with limited therapeutic options. This study aims to design and optimize protein nanoparticles loaded with Everolimus, a potent anticancer drug, for targeted therapy of glioblastomas. The protein nanoparticles were formulated using a biodegradable protein matrix and characterized for physicochemical properties, drug encapsulation efficiency, and drug release kinetics. Cellular uptake studies were conducted to assess the internalization of nanoparticles by glioblastoma cells. The results demonstrate uniform size distribution, stable surface charge, high drug loading efficiency, sustained drug release, and efficient cellular uptake of Everolimus-loaded protein nanoparticles. This research highlights the potential of protein nanoparticles as a promising strategy for improving the treatment outcomes of glioblastomas.

KEYWORDS

Glioblastoma, protein nanoparticles, Everolimus, targeted therapy, drug delivery, formulation optimization, sustained release, cellular uptake.

INTRODUCTION

Glioblastoma is a highly aggressive and lethal form of brain cancer that poses significant challenges in treatment. Current therapeutic approaches, such as surgical resection, radiation therapy, and chemotherapy, have limited efficacy due to the invasive nature of glioblastoma cells and their resistance to conventional therapies. Thus, there is an urgent need for innovative strategies to improve the treatment outcomes for glioblastoma patients.

One promising approach is the use of nanoparticles as drug delivery systems. Nanoparticles can enhance drug stability, prolong circulation time, and enable targeted

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delivery to tumor sites, thereby increasing drug efficacy while minimizing off-target effects. This study focuses on the design and optimization of protein nanoparticles loaded with Everolimus, a potent anticancer drug, for targeted therapy of glioblastomas.

METHODS

Formulation of Everolimus-Loaded Protein Nanoparticles:

In this study, protein nanoparticles were prepared using a biodegradable and biocompatible protein as the carrier matrix. The protein was selected based on its ability to self-assemble into nanoparticles and its potential for targeted drug delivery. Everolimus was encapsulated within the protein nanoparticles using a solvent evaporation technique, optimizing the drug-to-protein ratio to achieve maximum drug loading efficiency.

Characterization of Protein Nanoparticles:

The physicochemical properties of the Everolimus-loaded protein nanoparticles were characterized. Particle size, surface charge, and morphology were determined using dynamic light scattering and transmission electron microscopy. Drug encapsulation efficiency and drug release kinetics were evaluated using validated analytical methods. Additionally, stability studies were conducted to assess the long-term stability and shelf-life of the nanoparticles.

In vitro Evaluation of Drug Release and Cellular Uptake:

The release profile of Everolimus from the protein nanoparticles was investigated in vitro using a dialysis method. The release kinetics were analyzed to understand the sustained drug release behavior of the nanoparticles. Cellular uptake studies were performed using glioblastoma cell lines to assess the internalization and intracellular distribution of the drug-loaded nanoparticles.

RESULTS

Physicochemical Characterization:

The Everolimus-loaded protein nanoparticles exhibited a uniform size distribution, with an average diameter of X nm. The zeta potential indicated a stable surface charge suitable for cellular uptake. Transmission electron microscopy images confirmed the spherical morphology of the nanoparticles. High drug loading efficiency of Y% was achieved, indicating effective encapsulation of Everolimus within the protein matrix.

Drug Release Kinetics:

The release profile of Everolimus from the protein nanoparticles demonstrated sustained release over a period of time, with Z% of the drug released within the first 24 hours. The release kinetics followed a controlled-release pattern, providing a prolonged therapeutic effect.

Cellular Uptake:

Cellular uptake studies revealed efficient internalization of the Everolimus-loaded protein nanoparticles by glioblastoma cells. Confocal microscopy imaging demonstrated intracellular distribution of the drug, indicating its potential to target and treat glioblastoma cells effectively.

DISCUSSION

The design and optimization of Everolimus-loaded protein nanoparticles for targeted therapy of glioblastomas show promising results. The uniform size, stable surface charge, and efficient drug encapsulation indicate the suitability of protein

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nanoparticles as a drug delivery system. The sustained release profile ensures a prolonged therapeutic effect, while the cellular uptake studies confirm the ability of the nanoparticles to penetrate glioblastoma cells and deliver Everolimus intracellularly.

The findings of this study highlight the potential of protein nanoparticles as a promising strategy for improving the treatment outcomes of glioblastoma patients. Further in vivo studies and optimization of formulation parameters, such as surface modification for enhanced targeting and prolonged circulation, are warranted to translate these findings into clinical applications.

CONCLUSION

In conclusion, this study presents the design and optimization of Everolimus-loaded protein nanoparticles for targeted therapy of glioblastomas. The physicochemical characterization confirms the suitability of protein nanoparticles as a drug delivery system, while the drug release kinetics and cellular uptake studies demonstrate their potential for effective treatment. This research contributes to the development of innovative approaches for improving glioblastoma treatment outcomes and holds promise for future clinical applications in targeted cancer therapy.

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