Chapter 10

Solid Lipid Nanoparticles as Carrier for Ocular, Pulmonary, and Nasal Administration

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Abstract

Solid lipid nanoparticles (SLNs) have become a promising nanocarrier that can be used to deliver drugs in a non-invasive manner because of its biocompatibility, biodegradability, and the propensity to increase drug stability and bioavailability. Different modes of administration have different physiological barriers that tend to restrict effective delivery of the drug through the traditional dosage forms, including ocular, pulmonary, and nasal routes. The SLNs have immensely beneficial properties to address these hurdles, through enhancing drug absorption, increasing residence time at the site of action and being controlled or targeted to release drugs. This chapter gives an in depth review on the uses of solid lipid nanoparticles as carriers in administering drugs to the eye, lungs and nose. It explains the anatomical and physiological aspects of every route, formulation strategies, drug absorption mechanisms and treatment results obtained with the help of SLN-based systems. Also, recent research developments, safety issues, and regulatory outlooks are pointed out, as well as the contemporary challenges and opportunities.

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1. INTRODUCTION

Lipid nanoparticles are a major development in drug delivery systems, as they have become popular as versatile alternatives to traditional drug delivery vehicles like emulsions, liposomes and polymeric nanoparticles in the late 20th century [1]. Of them, Solid Lipid Nanoparticles are considered as the sub-micron colloidal carriers that consist of biodegradable physiological lipids, with a notable benefit of being better biocompatible and having a lower toxicity profile than polymer-based systems [2,3]. The biocompatibility is explained by the fact that medications are confined in the carrier as they have minimal direct exposure to the physiological environment [4]. Introduced in 1991, SLNs are typified by a median size of 50-1000 nm, which comprises of a lipid mesh dispersed in an aqueous medium, which is coagulated by surfactants [5].

1.1 Overview of Solid Lipid Nanoparticles

These nanoparticles capitalize on the advantages of polymeric nanoparticles, fat emulsions, and liposomes and avoid most of the drawbacks of these delivery systems, such as low levels of drug solubility, high metabolism rates, and off-target distribution [6,7]. Their peculiar structure enables an augmented encapsulation of drugs and regulated release kinetics as well as increased bioavailability through diverse pathways of administration [8,9]. Such careful description of these properties, including the size of particles, zeta potential, and morphology is critical to maximize their therapeutic effectiveness and safety [7]. In particular, the solid lipid matrix provides a high level of stability, which suppresses aggregation and promotes extended release of encapsulated drugs, which in turn supports the effects of therapy [10]. Moreover, lipidic structure and low size allow solid lipid nanoparticles to