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Fractional Er: YAG Laser as a Novel Technique for Enhancing Ocular Drug Permeation- Adwan S- Queen's University

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Ocular drug delivery is currently one of the most challenging areas in modern drug delivery due to the unique anatomy and physiology of the eye and the presence of the ocular barriers.
Ocular drug delivery has been a major challenge to pharmacologists and drug delivery scientists due to its unique anatomy and physiology. Static barriers (different layers of cornea, sclera, and retina including blood aqueous and blood–retinal barriers), dynamic barriers (choroidal and conjunctival blood flow, lymphatic clearance, and tear dilution), and efflux pumps in conjunction pose a significant challenge for delivery of a drug alone or in a dosage form, especially to the posterior segment. Identification of influx transporters on various ocular tissues and designing a transporter-targeted delivery of a parent drug has gathered momentum in recent years. Parallelly, colloidal dosage forms such as nanoparticles, nanomicelles, liposomes, and microemulsions have been widely explored to overcome various static and dynamic barriers. Novel drug delivery strategies such as bioadhesive gels and fibrin sealant-based approaches were developed to sustain drug levels at the target site. Designing noninvasive sustained drug delivery systems and exploring the feasibility of topical application to deliver drugs to the posterior segment may drastically improve drug delivery in the years to come. Current developments in the field of ophthalmic drug delivery promise a significant improvement in overcoming the challenges posed by various anterior and posterior segment diseases.

Designing a drug delivery system to target a particular tissue of the eye has become a major challenge for scientists in the field. The eye can be broadly classified into two segments: anterior and posterior. Structural variation of each layer of ocular tissue can pose a significant barrier following drug administration by any route, i.e., topical, systemic, and periocular. In the present work, we attempted to focus on various drug absorption barriers encountered from all three routes of administration. Structural characteristics of various ocular tissues and their effectiveness as barriers for the delivery of drugs and their colloidal dosage forms have been discussed. The role of efflux pumps and strategies to overcome these barriers utilizing the transporter-targeted prodrug approach have also been touched upon. Current developments in ocular dosage forms, especially colloidal dosage forms, and their applications in overcoming various static and dynamic barriers have been elucidated. Finally, various developments in noninvasive techniques for ocular drug delivery have also been emphasize.

Erbium-YAG lasers have been used for laser resurfacing of human skin. Example uses include treating acne scarring, deep rhytides, and melasma. In addition to being absorbed by water, the output of Er:YAG lasers is also absorbed by hydroxyapatite, which makes it a good laser for cutting bone as well as soft tissue. Bone surgery applications have been found in oral surgery, dentistry, implant dentistry, and otolaryngology. Er:YAG lasers are safer for the removal of warts than carbon dioxide lasers, because human papillomavirus (HPV) DNA is not found in the laser plume. Er:YAG lasers can be used in laser aided cataract surgery but owing to its water absorbable nature Nd:YAG is preferred more.

Methods:

Novel drug delivery methods have been investigated to enhance ocular drug permeation and increase the intraocular bioavailability. In this project, P.L.E.A.S.E. (Precise Laser Epidermal System; Pantec Biosolutions AG) laser technology was investigated, for the first time, to enhance ocular drug permeation.

Results:

Two effects were revealed after laser treatment of ocular tissues. At high fluenes, micropores were created with scare formation around the pores due to the photothermal effect of laser radiation. Lower fluences showed the formation of shallow pores and the disruption of the collagenous structure of ocular tissues. The effect of increasing the fluence and density of applied laser was investigated. Confocal microscopy studies revealed more intense dye distribution of rhodamine B, FITC-Dextran 70 KDa and FITC-Dextran 150 KDa after laser application. The transscleral and transcorneal permeation of rhodamine B was increased after laser application of 8.9 J/cm2 fluence and increasing the density of laser application. The transscleral water loss studies showed increased water loss after laser application which was decreased after 6 hours of application.

Conclusion:

As a conclusion, fractional Er:YAG laser is a promising and safe microporation technique that can be used to enhance the permeation of topically applied drugs. Tissue imaging,

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permeation, distribution studies and transscleral water loss studies showed that the laser application at low energies is promising for enhancing ocular drug permeation.

Biography:

Samer Adwan has completed his PhD at the age of 37 years from Queens University Belfast School of Pharmacy. He is working as assistant professor at Zarqa University School of Pharmacy. His research interest involves investigation of novel technologies and drug delivery systems for the treatment of otic and ophthalmic diseases.