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Biophotonics Techniques for the Functional Monitoring of Diabetes Mellitus Complications

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Abstract

Diabetes complications are a major public health issue that has a significant financial impact. As a result, the length and quality of a patient's life will improve, as will the financial costs of their treatment, if complications are identified and prevented early. The purpose of this article is to examine the most recent cutting-edge biophotonics technologies used to identify diabetes mellitus complications and evaluate the efficacy of their treatment. Capillaroscopy, laser Doppler flowmetry and hyperspectral imaging, laser speckle contrast imaging, diffuse reflectance spectroscopy and imaging, fluorescence spectroscopy and imaging, optical coherence tomography, optoacoustic imaging, and confocal microscopy are among the technologies used to evaluate the structural and functional properties of biological tissues.

Keywords: Coprocytobiologyl • Cytological • Preservation • Cancer

Introduction

Consequences of diabetes are now considered one of the most significant issues in modern healthcare due to the disease's rising prevalence. Experts say that almost every person with diabetes will have at least one or more complications in their lifetime. Diabetes can cause anything from acute, life-threatening conditions like ketoacidosis or severe hypoglycemia to chronic, debilitating complications that affect a lot of organs and organ systems like retinopathy, nephropathy, neuropathy, and cardiovascular disease. Long-term exposure to high glucose levels in the body leads to the development of diabetes's chronic complications. They are linked to problems in the nervous and cardiovascular systems. In the end, these complications may result in severe vision loss and blindness, end-stage renal disease that necessitates hemodialysis or transplantation, the formation and infection of diabetic ulcers, amputations, heart failure, stroke, and other similar outcomes. Presently, it has been demonstrated that the presence and severity of chronic complications of diabetes, as well as the quality of their treatment, determine the length of time and health-related quality of life of diabetic patients. As a result, it is imperative that diabetic complications be detected and prevented as soon as possible.

Methods based on biophotonics offer a potential solution to this issue. Skin's optical properties, which are directly related to its blood supply, oxygenation level, and chromophores, can be studied using a variety of imaging and spectroscopy techniques. The various applications of biophotonics in studies of DM complications are presented. [1].

Description

Capillaroscopy is an easy way to look at the vascular bed's morphology and how it changes as the disease progresses. A microscope with a lower or higher magnification is typically used for capillaroscopic studies to obtain panoramic views of the capillary bed or enlarged views of individual capillaries and their groups, respectively. Because the capillary arc runs parallel to the skin, most of the research is done in the nail bed. Since the capillaries in some areas of the skin are perpendicular to the surface, it is possible to monitor the blood flow in these areas when it has increased sufficiently. To increase skin transparency, the hand is typically placed at heart level on the examination table and a drop of immersion oil is deposited on the nail bed during the study. Capillaroscopy; studies of the inner surface of the lower lip are also common, despite the fact that they are associated with more significant methodological difficulties.

Microcirculation has been studied through capillaroscopy. Despite its wide range of applications, this method has historically been used most frequently in research on vascular disorders in rheumatic diseases. In addition, the number of visualized capillaries in the nail bed, the density of the capillary network, the presence of tortuous capillaries and hemorrhages, and the diameters of the arterial and venous parts of the capillary can all be estimated with the help of capillaroscopy. These are crucial diagnostic parameters for determining the cardiovascular system's condition. Static images of the capillary network are typically recorded and then analyzed to determine these parameters.

High-speed cameras and side lighting are included in modern video capillaroscopy systems. These systems typically have between two and four high-brightness LEDs with wavelengths ranging from 520 to 530 nm. Blood absorbs light in this wavelength range, resulting in the highest possible contrast between the images of the capillary network. One of the many conditions that can cause changes in the physiology and morphology of the capillary bed is diabetes. The capillaroscopy method has been used in numerous studies to document the microvascular changes that diabetic patients exhibit. Tortuosity, dilated capillaries, and a decrease in the density of the capillary network are distinguishing characteristics among these changes [2-5].

Conclusion

In the study of diabetes complications, optical noninvasive diagnostic technologies hold great promise and have the potential to facilitate clinical assessment. It is possible to diagnose the efficacy of diabetes treatment, monitor changes in tissue innervation, and assess the state of the microvasculature using bio photonics techniques. The presence and concentration of various chromospheres, as well as changes in the structure and operation of various body systems can be evaluated using a variety of spectroscopic and imaging methods. These parameters include the amount of blood that is delivered to the tissues, the degree of oxygen saturation, and so on. In this review, we

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looked at how various bio photonic techniques are used. They are all capable of identifying certain diabetes-related disorders and appear promising for the early diagnosis and prevention of complications. The majority of these methods, on the other hand, haven't yet become commonplace in clinical practice. Some technologies, like optical coherence tomography (OCT), are currently used in a lot of different parts of medicine, and more technological advancements will make it more useful. Despite having a substantial scientific foundation, other technologies like LDF are not widely utilized in the clinic due to methodological difficulties. The widespread utilization of optical technology in clinical settings is likely in the not-too-distant future, given recent advancements in the optical non-invasive diagnosis of diabetes complications. We assume that technologies like speckle-contrast, fluorescence, and hyper spectral imaging are the closest to widespread application in clinical practice and can already be used by attending physicians.

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Conflict of Interest

There are no conflicts of interest by author.

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