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Communication

Application of smartphone-based infrared thermography devices for ocular surface thermal imaging

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ABSTRACT

Infrared thermography (IRT) is a well-known imaging technique that provides a non-invasive displaying of the ocular surface temperature distribution. Currently, compact smartphone-based IRT devices, as well as special software for processing thermal images, have become available. The study aimed to determine the possible use of smartphone-based IRT devices for real-time ocular surface thermal imaging. This study involved 32 healthy individuals (64 eyes); 10 patients (10 eyes) with proliferative diabetic retinopathy (PDR) and absolute glaucoma; 10 patients (10 eyes) with PDR, who underwent vitreoretinal surgery. In all cases, simultaneous ocular surface IRT of both eyes was performed. In healthy individuals, the ocular surface temperature (OST) averaged 34.6 ± 0.8 °C and did not differ substantially between the paired eyes, in different age groups, and after pupil dilation. In our study, high intraocular pressure was accompanied by a decrease in OST in all cases. After vitreoretinal surgery in cases with confirmed subclinical inflammation, the OST was higher than the baseline and differed from that of the paired eye by more than 1.0 °C. These results highlight that smartphone-based IRT imaging could be useful for the non-invasive detection of OST asymmetry between paired eyes due to increased intraocular pressure or subclinical inflammation.

1. Introduction

Infrared thermography (IRT) allows real-time non-invasive imaging of the temperature distribution in the surface tissues of the human body [1]. IRT is a well-known diagnostic technique that has found application in various fields of medicine. IRT is used in cardiac surgery to control the thermal parameters of the surgical area [2]; in plastic surgery to identify perforators in planning flap reconstruction, intraoperatively to assess perfusion and postoperatively for flap monitoring, for burn depth analysis [3]; in vascular surgery to assess foot and limb perfusion [4]; in dermatology for skin cancer detection [5]; in ophthalmology in patients with glaucoma to evaluate filtering bleb function after the surgery [6]. Nevertheless, despite all the accumulated experience of using IRT in medicine, this diagnostic technique remains insufficiently studied. Unfortunately, the widespread use of this imaging technique is limited by the extreme cost of IRT devices.

Currently, digital mobile devices such as smartphones and tablets are widely used in medical practice. Smartphones are helpful tools for mobile communication, clinical photography, patient monitoring, telemedicine, and education [7,8]. Smartphone-based imaging is reported for noninvasive monitoring and diagnosis, photodynamic therapy, endoscopy, in vivo microscopy, and surgery [9]. In ophthalmology, a wide range of smartphone applications are available for the evaluation of visual acuity, visual fields, colour vision, astigmatism, pupil size, Amsler grid test, imaging and image processing, amblyopia treatment, IOL power calculations, low vision assistance, ophthalmic education and more [10]. Digital mobile devices equipped with high-quality cameras make it possible to take anterior segment and fundus photographs, record videos, process images, store images and share information remotely [11]. The innovative role of smartphone technology makes their use in ophthalmology increasingly popular [12].

In recent years, modern IRT devices have become more accessible and easier to use. Compact IRT devices for docking with a smartphone have been developed, as well as special software for obtaining and processing thermal images. The technical characteristics of these devices provide fast and accurate real-time imaging of thermal patterns on the

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