Medical Hypothesis, Discovery & Innovation in Optometry

Short communication

Anterior-segment optical coherence tomography for the detection and therapeutic monitoring of corneal disorders

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ABSTRACT

Background: Over recent years a revolutionary trend happened on imaging technologies to diagnose and monitor treatment of a varied group of ophthalmic pathologies. Recent reports have analyzed the microstructural changes of various ocular surface and corneal disorders, particularly ocular surface squamous neoplasia (OSSN) and keratoconus using anterior-segment optical coherence tomography (AS-OCT). Aim of this short communication is to elaborate on clinical applications AS-OCT for the detection and therapeutic monitoring of corneal disorders.

Methods: We performed an English literature search without a time limit and intending to identify articles related to the AS-OCT applications in the detection and therapeutic monitoring of corneal disorders. The most relevant articles were selected. practical points of selected papers and advantages and disadvantages of AS-OCT were retrieved from them and summarized.

Results:.Many records reported the AS-OCT applications for diagnosing many ocular surface disorders, the microstructural changes of different inflammatory, infectious, degenerative, and dystrophic corneal disorders. Its applications in identifying disease activity and therapeutic monitoring of various corneal pathologies, including stromal edema associated with angle-closure glaucoma, Fuchs endothelial dystrophy, infectious keratitis, and bullous keratopathy, are promising. The percentage of diagnostic sensitivity, specificity, and accuracy of artificial intelligence methodologies applied to AS-OCT imaging analysis today has reached 94% to 100%. Moreover, AS-OCT is very useful for analyzing the extension of scar and leukoma depth for surgical planning of partial or total corneal transplantation.

Conclusions: There is a clear prospect for expanding application of corneal OCT imaging technology, a rapid, non-invasive, and now a promising lower-cost device, which is becoming an in-office standard-of-care tool for the assessment of different corneal and ocular surface pathologies.

KEYWORDS

anterior-segment optical coherence tomography, AS-OCT, ocular surface disorders, corneal disorders, ocular surface squamous neoplasia, OSSN, keratoconus

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In recent years there has been a revolutionary avenue on imaging technologies to diagnose and monitor treatment of a varied group of ophthalmic pathologies, particularly posterior segment degenerative and inflammatory disorders like age-related macular degeneration, glaucoma, and macular edema [1]. Recent reports have analyzed the microstructural changes of various ocular surface and corneal disorders, particularly ocular surface squamous neoplasia (OSSN) and keratoconus using anterior-segment optical coherence tomography (AS-OCT) [2, 3]. Contrary to the traditional point of view proclaimed by certain corneal specialists that corneal pathology can be entirely assessed by direct slit-lamp visualization, arguing that imaging technology like AS-OCT is, in most cases, unnecessary and costly [4], recent investigators are demonstrating that AS-OCT has a place in examination of many ocular surface disorders [5]. In the last couple of years, AS-OCT imaging technology has been the subject for analyzing the microstructural changes of different inflammatory, infectious, degenerative, and dystrophic corneal disorders [5-8].

Many recent publications demonstrate the tendency to develop machine learning algorithms, efficient enough to help the clinician diagnose and detect disease activity and therapeutic monitoring of various corneal pathologies, including stromal edema associated with angle-closure glaucoma, Fuchs endothelial dystrophy, infectious keratitis, and bullous keratopathy [9, 10]. The percentage of diagnostic sensitivity, specificity, and accuracy of artificial intelligence methodologies applied to AS-OCT imaging analysis today has reached 94% to 100%, depending on the study [9-13]. However, corneal AS-OCT in its current stage is not exempt from limited capabilities. Table 1 shows the actual advantages and disadvantages of AS-OCT technology for clinical applications.

In the way of overcoming conventional spectral-domain AS-OCT, the recent development of the ultra-high resolution-optical coherence tomography (UHR-OCT), capable of taking over 50,000 A-scans per second at an axial resolution of 2 to 4 µm with scan widths of 5 to 12 mm, will soon revolutionize the corneal imaging technology to an unimaginable level of clinical applications. This device can provide fine imaging of the tear film and individual corneal layers, distinguish endothelium from the descemet membrane, and visualize corneal nerves and epithelial stem cells within the limbal epithelial crypts [14].

Therefore, the established concept that corneal AS-OCT adds no benefit to the experienced clinician in assessing most corneal disorders seems to be changing for good. There are particular instances where the aid of in-depth and en-face detailed tomographic images of the cornea are most helpful for diagnosing subtle recurrent epithelial and stromal edema in patients with active herpetic stromal keratitis (HSK) with significant scarring that hinder its direct slit-lamp visualization. Moreover, AS-OCT is very useful for analyzing extension of scar and leukoma depth for surgical planning of partial or total corneal transplantation [6, 17, 18].

In summary the arrival of a commercially available UHR-OCT will permit us a routinary detail visualization of the invasiveness of OSSN lesions, corneal nerves in neurotrophic keratopathy, acanthamoeba keratitis cysts, intracorneal foreign bodies, and corneal scarring extent after a chemical burn or herpetic keratitis [14-16, 19]. Additionally, it will help us measuring the corneal epithelium and bowman´s layer vertical thickness accurately for timely detection of subclinical keratoconus [18], preoperative screening in laser refractive surgery [20], and measuring the descemet's endothelium complex thickness for evaluating the severity of endothelial cell loss after cataract surgery [21]. Finally, UHR-OCT ideally replaces the clinician direct slit-lamp visualization of the keratoprosthesis-cornea interface in the assessment for potential sight-threatening complications [22].

There is an air of conviction of a paradigm shift that corneal OCT imaging technology, a rapid, non-invasive, and now a promising lower-cost device [23], is becoming an in-office standard-of-care tool for the assessment of different corneal and ocular surface pathologies.

ETHICAL DECLARATIONS

Ethical approval: This study was a short communication, and no ethical approval was required.
Conflict of interest: None.

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Table 1. Advantages and disadvantages of AS-OCT imaging technology for clinical applications.

Advantages	Disadvantages
***In-vivo* analysis [1-4]**	Limited availability [14]
Non-invasive procedure [1, 4, 15]	Reduced brand diversity [4, 5]
Rapid image acquisition [4, 5]	Limited image resolution [2, 16]
Reproducible results [5, 6]	Image distortion related to tissue refractive index [6]
Comparable results [6]	Need for high-trained personal [5]
Safe procedure [1, 5]	High sensitivity to movement [17]

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