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Ultrawide Field Imaging in Retinal Diseases

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ABSTRACT

Following the invention of the ophthalmoscope, research continued into the possibility of capturing a larger area of the retina. By the end of the 1920s, it was possible to scan a 30-degree field, and this was accepted as standard. Devices capable of showing a 50-60 degree retinal field subsequently entered the market. However, only a very small part of the retina could still be visualized using these. Devices capable of scanning a wider field were developed after 1975, and it has recently become possible to visualize a 200-degree retinal field (representing approximately 80% of the retina). Visualizing the retinal periphery is important in diagnosing, monitoring, and assessing the efficacy of treatment in several diseases. Thanks to these devices, the retinal periphery can be scanned and assessed in detail in diabetic retinopathy, vasculitis, and peripheral degeneration, etc. In addition, images including the retinal periphery permit better evaluation in telemedicine, which has become increasingly employed in recent years. The purpose of this study was to assess and describe the advantages of Ultrawide Field (UWF) imaging in various retinal diseases.

Introduction

The Development of Imaging Devices

Following the invention of the ophthalmoscope by Hermann von Helmholtz in 1851, the first fundus camera was placed on the market by Zeiss in 1926. The field provided by that device was approximately 20 degrees [1]. The field capable of being visualized subsequently increased to 30 degrees, and this became recognized as standard in retinal imaging. Stereophotographs consisting of Seven Standard Fields (7SF) showing an approximately 90-degree retinal field were developed in the ETDRS and recognized as the standard Ultrawide Field (UWF), and were used for classification in studies concerning Diabetic Retinopathy (DR) [2,3]. It is important to analyze the peripheral retina and document the findings obtained in order to evaluate the disease more accurately such as Diabetic Retinopathy (DR), venous occlusions, retinal and choroidal masses, uveitis (including vasculitis), peripheral retinal degeneration, retinal detachment, Retinopathy Of Prematurity (ROP) and tumors [4,5]. The first wide-angle camera system capable of also visualizing the equator was developed in 1975 by Pomerantzeff. This system is capable of capturing a 148-degree retinal field by means of a contact lens and scleral transillumination [6]. Retcam (130 degree) (Clarity Medical System, Inc., Pleasanton, CA, USA) entered the market in 1997 [7]. After Panorett-100 (Medibell Medical Vision Technologies Haifa, Israel) which is capable of capturing an approximately 100-degree retinal field with a contact lens and scleral illumination [8], Optos (Optos PLC, Dunfermline, UK) (200 degree) and the Heidelberg Spectralis (Heidelberg Engineering Inc., Heidelberg, Germany) (150 degree) devices entered the market [9,10]. After the development of wide-angle imaging systems, there have been some changes in the approach to retinal diseases. In this article, we aimed to emphasize the importance and properties of wide angle imaging in some retinal diseases.

Common Areas of use of Ultrawide Field Imaging

Diabetic Retinopathy: DR is the leading cause of vision loss in all age groups. Retinal imaging and evaluation of the photographs taken are of great importance in the monitoring of retinopathy. The course of pathologies can be objectively evaluated using color fundus photographs and fluorescein angiography [3]. Although DR affects the macula, it may cause serious pathologies in the retinal periphery. [11] showed that peripheral lesions missed at standard imaging can be detected using wide field imaging. In addition, they showed that retinopathy was more severe than indicated with standard imaging in 20% of cases. Price et al. [12] compared UWF

scanning with ETDRS 7SF imaging and determined DR at more severe levels in 19% of cases [11]. Wessel et al. [13] showed the presence of ischemia and Neo-Vascularization (NV) that could not be captured in seven standard fields at FA in 10% of cases, but which could be visualized in the periphery with UWF. UWF imaging has come to occupy an important place in determining peripheral diabetic lesions in ophthalmological practice, and is important for improved evaluation of the disease. The Diabetic Retinopathy Research Network protocol AA study aims to assess DRP progression with a combination of FFA and peripheral findings on colored photographs, and the results are expected to be published in 2020 [14].

Retinal Vascular Diseases: Vascular occlusions are the second most common retinal pathologies after DR. Branch Retinal Vein Occlusion (BRVO) and Central Vein Retinal Occlusion (CRVO) are particularly common conditions. Ischemia, the most important factor affecting the prognosis of the disease, can accompany these pathologies, and the therapeutic approach varies depending on the degree of ischemia. UWF imaging offers a number of advantages over standard imaging in vascular pathologies. In particular, it permits determination of peripheral perfusion and analysis of the diffusion of ischemia in a single frame at FFA. Imaging performed by recording the retinal periphery has an important effect on the course of the disease and treatment planning [15]. Peripheral ischemia and NV in retinal vein obstructions can easily be shown with UWF imaging devices. Correlation has been shown between peripheral ischemia and macular edema in BRVO or hemicentral RVO [5].

Inflammatory Diseases of the Retina: Inflammatory diseases are known to affect both the posterior pole and the periphery of the retina. Peripheral pathologies can be clearly recorded using UWF scanning and all pathologies can be shown on a single frame. Sheathing, non-perfused fields and hyperfluorescent spots in vasculitis can all be revealed more clearly in this way. UWF scanning has been described as a particularly important tool in the diagnosis, monitoring and treatment of Behçet-related retinal vasculitis [16].

Retinopathy Of Prematurity: ROP is one of the important diseases seen in preterm infants. It is possible to show and capture wider visualization of retina with the devices capable capturing wide angle. In this way, vascular development in infants can be shown and monitored in a single frame. Therefore, potential medicolegal problems can be prevented in this way [17].

Peripheral Retinal Degenerations and Tumors: Various studies have reported that wide-field FFA and FAF imaging can facilitate the diagnosis and follow-up of these diseases. Another important issue is that peripheral retinal degeneration is common and some of these pathologies, such as lattice, snail track and white without pressure, can lead to tears in the retina [18]. The importance of UWF imaging in both primary and metastatic lesions (malignant melanoma, von Hippel Lindau, RPE adenoma, and metastasis) of the retina and choroid has been emphasized in many studies [19,20].

Retinal Detachment

Another clinical condition requiring careful evaluation of the periphery of the retina is retinal degeneration and retinal detachment. UWF scanning permits a relatively greater width of image compared to ophthalmoscopy, together with easier visualization and documentation of existing holes in detachments, which generally assume the form of tears. In addition, several tears can be visualized simultaneously on UWF images [21]. Similarly, UWF images provide valuable information for assessing dimensions in retinal dialysis, since the extent of retinal detachment may vary [22]. UWF imaging systems will elicit more powerful data and permit more accurate assessment of the peripheral retina. One study reported that 100% of peripheral retinal tears were identified in 65 patients with acute posterior vitreous detachment using the Staurenghi lens system. However, the authors also reported that this method could not replace clinical examination [23].

Age-Related Macular Degeneration

Age-Related Macular Degeneration (AMD) may involve various lesions in the retinal periphery. Accompanying changes in the periphery can be better revealed and their characteristics better evaluated with FAF and colored images using UWF scanning. Witmer et al. [24] determined FAF anomalies in the periphery in 63.6% of patients with AMD, compared to 35.7% for the control group, the difference being statistically significant. They reported that characterization of different peripheral phenotypes might be important for the diagnosis and treatment of AMD subtypes. Madhusudhan et al. [25] recently reported an association between peripheral leakage shown at UWF and active neovascular AMD in some patients compared to eyes without active neovascular AMD.

Conclusion

In conclusion, wide-field imaging provides provide more comprehensive information about the retinal periphery, which is important for the screening, diagnosis, monitoring, and treatment of many vision-threatening eye diseases such as DR, ROP, central or branch vein obstructions, uveitis, and tumors. In particular, it provides more diagnostic information in telemedicine, which is now becoming increasingly widely employed, than does standard imaging. The short scanning time, lower storage, and the ability to show several pathologies in the same frame will assist the physician make more accurate decisions. In our opinion, UWF scanning systems will lead to new interpretations of many diseases in the soon future and will make a revision of telemedicine systems essential.

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