Comparative analysis of two retinal fractures with ultrabroad-angle fundus photography systems

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Abstract. The aim of the present study was to compare the performance of the Opel Panorama 200 and Zeiss Clarus 500 (Carl Zeiss AG) systems in diagnosing retinal fractures. Human subjects were selected from 298 fundus examinations (531 eyes) in ophthalmology from February 2021 to June 2021, including 68 patients with retinal fissures (95 eyes). All fundus tests were performed with Opel Panoramic 200. Zeiss Clarus 500 (Carl Zeiss AG) fundus photography, slit-lamp full retinal lens (Ocular Mainster Wide Field; Ocular Instruments), and retinal laser photocoagulation was performed for all affected eyes. The diagnostic sensitivity of the two examination methods was compared, and their sensitivities for posterior retina, peripheral nose, crystal eye, cataract, positive experiment, and myopia testing were compared. In all, 68 patients (95 eyes) were clinically examined and treated 112 laser times. For retinal fractures, the Opel Panorama 200 used a check sensitivity of 89.5%, and the Clarus 500 check had a sensitivity of 94.7%, with the difference being non-significant (P=0.358). Moreover, Clarus 500 diagnosed the sensitivity of the temporal periphery significantly higher than that of Opel Panorama 200 (P=0.048). Opel Panorama 200 displayed statistically significant sensitivity compared with Clarus 500 diagnosis with crystalline and crystal fewer eyes (P>0.05); Clarus 500 sensitivity for cataract diagnosis (crystal turbidity level 3 and above) was significantly higher than that of Opel Panorama 200 (P=0.033). Opel Panoramic 200 displayed significant sensitivity to ocular myopia and medium to moderate myopia (P>0.05). Clarus 500 diagnosed high myopia with a significantly higher sensitivity than Opel Panorama 200 (P=0.045). Opel Panorama 200 and Zeiss Clarus 500 displayed the same level of sensitivity to retinal fissures, with improved sensitivity in refractive turbidity and for retinal fissures located in the far periphery of the temporal side.

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Introduction

Comprehensive and objective information acquisition and analysis of the fundus and anterior segment of the eye are particularly important for the early diagnosis of pathological changes, such as retinal tears, degeneration, hemorrhage and detachment (1). The detection of anterior segment-related diseases, such as cataracts and myopia, provides an important basis for clinical treatment decisions (2). In the past decade, retinal imaging technology has developed rapidly, significantly improving the probability of early diagnosis and treatment of fundus diseases and improving the prognosis and visual function of patients. In particular, the emergence of ultrawide-angle camera technology enables simultaneous imaging of the posterior pole and peripheral regions of the retina in one image, which simplifies the diagnosis process of fundus diseases (3). The first ultrawide-angle camera system used in ophthalmology clinics is the Optos Panorama 200 image system (Optos), which has a sensitivity rate of 70-80% for peripheral retinal microscopic holes (4). The just-launched Zeiss Clarus 500 (Carl Zeiss AG) imaging system (Carl Zeiss Meditech AG) ultra-wide-angle camera system has superior advantages; however, there remains no comparative study of these two ultrawide-angle imaging systems (5). The present study compared the sensitivity of the Auberg Panorama 200 and the Zeiss Clarus 500 for microscopic tears in the peripheral retina, as well as the sensitivity of retinal tears under aphakia, lens opacity, or intraocular lens to explore the clinical role and significance of the ultrawide-angle camera system and to provide clinical evidence and new diagnostic ideas for the diagnosis of peripheral retinal diseases.

Materials and methods

Research objects. The present study was a prospective observational study of 298 patients, including 174 men and 124 women aged between 8 and 90 years old. A total of 531 eyes were examined at Xi'an Purui Eye Hospital (Xi'an, China) from February 2021 to June 2021. Of these, 68 patients (95 eyes) were diagnosed with retinal tears. Slit-lamp examinations were performed in all eyes, and patients with keratopathy or previous ocular trauma or ocular surgery, and intraoperative surgical complications were excluded. All patients underwent optometry, intraocular pressure, and visual acuity examinations, and they all voluntarily participated in this study and signed informed consent forms. The present study (approval no. XPR-2021-0007) was approved by the Xi'an Bright Eye Hospital Ethics Committee (Xi'an, China).

Inspection method. The conjunctiva, cornea, anterior chamber, pupil, and lens of all eyes were examined by the same deputy chief physician of the ophthalmology clinic using a Zeiss SL30 slit microscope (Carl Zeiss AG). Midorie eye liquid was used to dilate pupils one time for 5 min, three times in total. The pupils were dilated to 8 mm in diameter, and images of the affected eyes were captured with Opel Panorama 200 and Zeiss Clarus 500 (Carl Zeiss AG). The examination results were analyzed by two senior attending physicians with fundus specialty. All eyes were examined with slit-lamp pan retinoscopy (Ocular Mainster Wide Field; Ocular Instruments). All eyes with retinal tears were treated with retinal laser photocoagulation.

Observation indicators. The aim of the present study was to compare the sensitivity and specificity of two ultrawide-angle fundus photography systems for the diagnosis of retinal tears and to compare the sensitivity of the two ultrawide-angle fundus photography systems in the diagnosis of the retinal posterior pole, temporal periphery, nasal periphery, phakic eyes, cataract, emmetropia, moderate to low myopia, and severe myopia. The following has to be noted: Sensitivity=number of true positive cases/(number of true positive cases + number of false negative cases) x100.0%. Specificity=number of true negative cases/(number of true negative cases + number of false positive cases) x100.0%.

Statistical analysis. Statistical analysis was performed using SPSS 13.0 software (SPSS, Inc.; IBM Corp). First, a normality test of the data was conducted, and the paired t-test was used for the data that displayed normal distribution. Non-parametric tests were used for data that did not meet the conditions, while all enumeration data were expressed as cases (percentages), and the McNemar's chi-square test was used for comparison between groups. $P<0.05$ was considered to indicate a statistically significant difference.

Results

Comparison of the value of the two systems in the diagnosis of retinal tears. The Opel Panorama 200 has a sensitivity of 89.50% and a specificity of 95.40% for the diagnosis of retinal tears; the Zeiss Clarus 500 (Carl Zeiss AG) system had a sensitivity of 94.70% and a specificity of 98.90% for the diagnosis of retinal tears. There was no statistically significant difference in the diagnostic sensitivity and specificity between the two systems ($P>0.05$). The details are shown in Table I.

Comparison of the sensitivity of the two systems in diagnosing the temporal, nasal and posterior poles. The sensitivity of the Opel Panorama 200 in diagnosing the temporal side was 86.00%, and that of the Zeiss Clarus 500 system in diagnosing the temporal side was 93.00%; the sensitivity of the Opel Panorama 200 in diagnosing the nasal side was 93.10%, while that of the Zeiss Clarus 500 system in diagnosing the nasal side was 96.60%; and the sensitivity of the Opel Panorama 200 in diagnosing the posterior pole was 100.00%, and the sensitivity of the Zeiss Clarus 500 system in diagnosing the posterior pole was 100.00%. There was no significant difference between the two systems in diagnosing the nasal and posterior poles ($P>0.05$). The sensitivity of the Zeiss Clarus 500 system in diagnosing the temporal side was significantly higher than that of Opel Panorama 200 ($P<0.05$) (Table II).

Comparison of the sensitivity of the two systems to retinal holes in aphakia and cataracts. The sensitivity of Opel Panorama 200 for diagnosing phakic eyes was 89.50%, and that of the Zeiss Clarus 500 system for diagnosing phakic eyes was 94.20%; the sensitivity of Opel Panorama 200 for diagnosing aphakia was 88.90%, and that of the Zeiss Clarus 500 system for diagnosing aphakia was 88.90%. The sensitivity of the Opel Panorama 200 in diagnosing cataract eyes was 80.60%, and that of the Zeiss Clarus 500 system in diagnosing cataract eyes was 91.70%. There was no significant difference between the two systems in diagnosing aphakia ($P>0.05$). The sensitivity of the Zeiss Clarus 500 system in diagnosing cataract eyes was significantly higher than that of Opel Panorama 200 ($P<0.05$) (Table III).

Comparison of the diagnostic sensitivity of the two systems in refractive error. The sensitivity of the Opel Panorama 200 in diagnosing emmetropia was 92.90%, and that of the Zeiss Clarus 500 system in diagnosing emmetropia was 100.00%; the sensitivity of the Opel Panorama 200 in diagnosing moderate and low myopia was 91.60%, and the sensitivity of the Zeiss Clarus 500 system in diagnosing moderate and low myopia was 96.70%. The sensitivity of Opel Panorama 200 in diagnosing severe myopia was 80.10%, and the sensitivity of the Zeiss Clarus 500 system in diagnosing severe myopia was 85.70%. There was no significant difference in the sensitivity of the two systems in diagnosing emmetropia and moderate to low myopia ($P>0.05$). The sensitivity of the Zeiss Clarus 500 system in diagnosing severe myopia was significantly higher than that of the Opel Panorama 200 ($P<0.05$) (Table IV).

Discussion

Retinal tears in individuals with moderate to high refractive errors are still the main risk factors for rhegmatogenous retinal detachment. Because patients have only a flash of light or have no symptoms, it is difficult to diagnose, and the opportunity for treatment is missed. Retinal detachment in the later stage will endanger visual function, and the prognosis is not favorable. Therefore, early and accurate diagnosis and timely laser treatment are important means of reducing the harm caused by retinal tears (6,7). Handheld fundus cameras remian the main diagnostic method for fundus diseases worldwide. These cameras are widely used in the initial screening of fundus diseases because of their easy portability and simple operation. However, handheld fundus cameras have limitations like a narrow field of view, low resolution and potential for misdiagnosis (8,9). This is why

Table I. Comparison of the diagnostic value of two systems for retinal tears.

	Opel		Zeiss	
	Positive	Negative	Positive	Negative
Pathological result				
Positive	85	10	90	5
Negative	17	419	5	431
Total	102	429	95	436
		Sensitivity		Specificity
χ^2		2.205		1.056
P-value		0.148		0.232

Table II. Comparison of the sensitivity of the two systems for diagnosing the temporal, nasal, and posterior poles.

	Temporal		Nasal		Posterior poles	
	Opel	Zeiss	Opel	Zeiss	Opel	Zeiss
True positive	49	53	27	28	9	9
False negative	8	4	2	1	0	0
Total	57	57	29	29	9	9
χ^2		3.941		0.003		0.000
P-value		0.042		0.925		1.000

Table III. Comparison of the diagnostic sensitivity of the two systems in aphakia and cataracts.

	Phakic eyes		Aphakia		Cataract eye	
	Opel	Zeiss	Opel	Zeiss	Opel	Zeiss
True positive	77	81	8	9	29	33
False negative	9	5	1	0	7	3
Total	86	86	9	9	36	36
χ^2		0.869		0.565		4.205
P-value		0.554		0.651		0.044

Table IV. Comparison of the sensitivity of the two systems in the diagnosis of refractive errors.

	Emmetrope		Low to moderate myopia		Severe myopia	
	Opel	Zeiss	Opel	Zeiss	Opel	Zeiss
True positive	13	14	55	58	17	18
False negative	1	0	5	2	4	3
Total	14	14	60	60	21	21
χ^2		0.776		0.447		3.805
P-value		0.587		0.875		0.050

pan-retinoscopy remains the primary diagnostic method for retinal tears. It has the advantages of a wide field of view, strong three-dimensional sense, deep depth and clear vision. This technology requires a long learning curve and is difficult to master and promote in a short time. Currently, it is only used as a means for surgeons to determine the diagnosis, select the surgical method, and estimate the prognosis of the surgery. Before the operation, the patient needs to be fully dilated and under topical anesthesia, and the operation requires favorable cooperation from the patient. The rough operation has discomfort and risks, all of which have prevented the widespread use of pan-retinoscopy (10). The ultrawide-angle fundus imaging system is a new fundus examination method emerging with the development of imaging technology. Its advantage is that it can obtain fundus image information up to more than 200˚ in the natural state with small pupils (11). It can display important structures, such as the retina and choroid, and can integrate them to form a comprehensive fundus color image, which can extract 80.0% of the retinal area image information. The ultrawide-angle fundus imaging system has been used in the diagnosis and follow-up of fundus diseases, such as diabetic retinopathy, due to its advantages of non-invasiveness, wide angles and non-mydriasis (12).

The Opel Panorama 200 is currently the main clinical ultrawide-angle fundus imaging system. The Virtual Point™ laser scanning technology used (13) covers >80.0% of the retina (14), and it distinctly shows the retina, choroid and other important structures of the fundus (12). The Zeiss Clarus 500 system is the world's first ultrawide-angle fundus imaging system that can simultaneously provide true fundus color and high-resolution images, with a single shooting range of 133˚ (15) and a 200˚ shooting range in ultrawide-angle mode, which is not only restoring the comprehensive and real information of the lesion to the greatest extent but also reduces the contact between doctors and patients through the non-contact mode and improves the efficiency of diagnosis and treatment (13). At present, two ultrawide-angle fundus imaging systems, the Opel Panorama 200 and Zeiss Clarus 500 systems, have certain applications in fundus diseases, especially diabetic retinal diseases (16); however there is a lack of systematic reports on their diagnostic effects in retinal tears. Falavarjani *et al* (17) found that in the examination of the sugar net, the retinal imaging under the Opel Panorama 200 imaging system was distorted, and the displayed hemorrhage range was larger than the actual hemorrhage range. Similar results were obtained in the present study. Both the Opel Panorama 200 and Zeiss Clarus 500 systems can obtain a 200˚ fundus range; however, the Opel Panorama 200 has a wide range of artifacts and distortions in peripheral retinal imaging. The Opel Panorama 200 misdiagnosed the condition as a small hemorrhage, while the Zeiss Clarus 500 system obtained clear peripheral retinal images. Price *et al* (18) considered that the Zeiss Clarus 500 system was superior to the Opel Panorama 200 system in the display of small diseases. However, Kernt *et al* (19) and Neubauer *et al* (20) both suggested that the color separation technology of Opel Panorama 200 could make up for these shortcomings. For the observation of rare diseases, such as children's fundus disease (21), sickle retinopathy (22) and familial amyloidosis (23), the two ultrawide-angle fundus imaging systems did not show significant differences. This might be caused by too few observed samples. In the present study, it was revealed that the two ultrawide-angle fundus imaging systems have high diagnostic sensitivity for retinal tears, and the Zeiss Clarus 500 system has higher diagnostic performance in temporal retinal tears, cataracts, and severe myopia.

In conclusion, Opel Panorama 200 and Zeiss Clarus 500 have the same sensitivity for analyzing retinal tears, Zeiss Clarus 500 has improved sensitivity under refractive opacity, and Clarus 500 has improved sensitivity for retinal tears in the temporal and far peripheral regions.

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Availability of data and materials

The datasets used and/or analyzed during the present study are available from the corresponding author upon reasonable request.

Authors' contributions

YG and HY played a central role, contributing to various aspects of the research, from conceptualization to visualization, and taking the lead in writing. YG and CJG had a significant role, particularly in the methodology and supervision of the project. CJG and JW focused on data collection, data analysis, and contributed to editing and visualization. YG and HY confirm the authenticity of all the raw data. All authors read and approved the final version of the manuscript.

Ethics approval and consent to participate

The present study was approved (approval no. XPR-2021-0007) by the Xi'an BRIGHT Eye Hospital Ethics Committee (Xi'an, China). All patients underwent optometry, intraocular pressure, and visual acuity examinations, and they all voluntarily participated in the present study and signed informed consent forms.

Patient consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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