· Clinical Research ·

Comparison of axial length measurements with RS-1 spectral domain optical coherence tomography and OA-2000 biometer

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Abstract

● **AIM:** To determine the utility of the RS-1 spectral domain optical coherence tomography (SD-OCT), which incorporates an “OCT Analysis Correction Parameter” for approximating axial length, in comparison with measurements obtained from the OA-2000.

● **METHODS:** Twenty-five right eyes of healthy individuals were included. Two horizontal line scans were conducted using the RS-1, and OCT Analysis Correction Parameters were recorded. Axial length was measured twice per eye using the OA-2000. Correlation between devices was assessed using Pearson correlation coefficient, coefficient of repeatability (CR%), and Bland-Altman analysis.

● **RESULTS:** High correlation was found between axial length measurements from RS-1 and OA-2000 (r=0.986, P<0.0001). The coefficient of repeatability was 1.56% for RS-1 and 0.115% for OA-2000. Mean axial length was 25.12±1.38 mm for RS-1 and 24.90±1.54 mm for OA-2000, with RS-1 showing a statistically significant larger value (paired t-test, P=0.0009).

● **CONCLUSION:** The axial length measurements of RS-1 demonstrate a strong positive correlation with those from the OA-2000. This indicates that it could potentially be used to forecast scan ranges and choose suitable databases according to axial length categories.

● **KEYWORDS:** axial length; spectral domain optical coherence tomography; RS-1; OA-2000

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INTRODUCTION

Optical coherence tomography (OCT) has revolutionized the field of ophthalmology by providing high-resolution, cross-sectional imaging of the retina, facilitating the diagnosis and management of various retinal diseases and glaucoma[1-16]. The ability to visualize and quantify structural changes within the retina *in vivo* is indispensable for clinicians and researchers alike. However, the accuracy of OCT imaging and interpretation relies heavily on the geometry of the eye, particularly axial length, which can significantly affect the scan range and, consequently, the diagnostic outcomes[17-20]. Differences in axial length among individuals cause variations in the magnification effect during OCT imaging, which can lead to significant discrepancies in both qualitative and quantitative assessments of various ocular conditions[19,21-22]. Traditional methods of axial length correction involve the use of separate biometric devices to measure axial length. This axial length is then manually factored into the OCT analysis to adjust imaging parameters accordingly[23]. Although effective, this process can be cumbersome and time-consuming, requiring patient transfer between devices, thereby increasing the duration of the examination and the patient’s discomfort.

The recent development of the RS-1 spectral domain optical coherence tomography (SD-OCT) system by (NIDEK Co., Ltd., Gamagori, Japan), represents a significant advancement in this context. The RS-1 system integrates an innovative feature that calculates an “OCT Analysis Correction Parameter”, analogous to axial length, directly at the same time of the OCT scan imaging. This parameter is instrumental in adjusting the scan range automatically to accommodate variations in eye size, thus ensuring qualitative and quantitative assessment of retinal structural analysis by OCT.

Furthermore, the RS-1 SD-OCT system includes a built-in normative database that accommodates both normal and long axial lengths[24-25]. This database enhances the system’s ability to accurately identify retinal abnormalities by comparing patient data against a wide range of normative data. Such an integrated approach not only streamlines the workflow in clinical settings by eliminating the need for multiple instruments but also potentially increases the accuracy of diagnoses in patients with abnormal axial lengths.

In this paper, we explore the utility and accuracy of the RS-1's axial length measurement feature by comparing its performance with that of the OA-2000, a dedicated optical biometer.

PARTICIPANTS AND METHODS

Ethical Approval The research protocol was approved by the institutional review board of Shinshu University (Shinshu University School of Medicine Ethics Committee Approval No.6086). The IRB waived written informed consent, and informed consent from patients was substituted by the opt-out method.

Participants This study was conducted at Shinshu University Hospital with a cohort consisting of 25 right eyes from 25 healthy individuals, with an average age of 38.6±11.3y. They underwent examinations between December 2023 and January 2024. The inclusion criteria were adults over 18 years old, possessing no history of ocular disease, no prior eye surgeries except for cataract extraction and intraocular lens implantation, or no systemic diseases known to affect the eye. Best-corrected visual acuity was measured using the Landolt C chart. Eyes with corrected visual acuity less than 1.0 were excluded.

OCT Imaging and Axial Length Measurement Each participant underwent imaging on the RS-1 SD-OCT and axial length measurements using both the RS-1 and the OA-2000 optical biometer (Tomey, Nagoya, Japan)[26]. The RS-1's built-in software calculates an "OCT Analysis Correction Parameter", an estimated axial length used to predict the scan range automatically. The value is displayed in increments of 0.1 mm and 0.01 mm with RS-1 and OA-2000, respectively. Two horizontal line scans were performed on each participant's right eye using the RS-1 to obtain this correction parameter equivalent to axial length. In addition, the axial length was measured twice with the OA-2000.

Statistical Analysis Data analysis was conducted using Pearson correlation coefficients and intraclass correlation coefficient to assess the correlation and agreement between axial length measurements obtained from the RS-1 and the OA-2000. The coefficient of repeatability (CR%) was calculated and Bland-Altman analysis was conducted for each device to evaluate measurement consistency. Paired *t*-test was conducted to assess the difference in axial length measurements between two devices using the first measurement in each device. We used IBM SPSS Statistics ver.29.0.0.0 (241) for calculation of intraclass correlation coefficient and GraphPad Prism ver. 10.0.2 for Windows by GraphPad Software for the other analyses. Statistical significance was set at a *P*-value of less than 0.05.

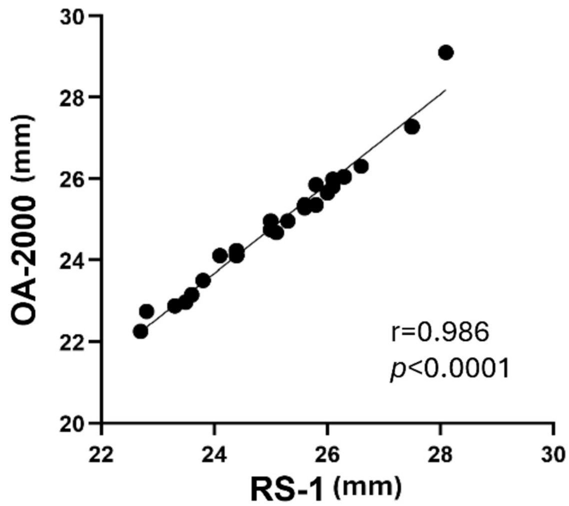

Figure 1 Pearson correlation analysis The Pearson correlation coefficient between axial length measurements from RS-1 and OA-2000 was 0.986 (*P*<0.0001), indicating a very high correlation. The intraclass correlation coefficient was 0.984 (0.928 to 0.995).

RESULTS

Correlation and Agreement between Measurement Devices The study revealed a strong positive correlation between axial length measurements obtained from the RS-1 SD-OCT and the OA-2000 optical biometer. The Pearson correlation coefficient was 0.986 (*P*<0.0001; Figure 1), indicating a very high degree of linear correlation between the two measurement methods. The intraclass correlation coefficient between the two types of axial length measurements was 0.984 (0.928 to 0.995).

Coefficient of Repeatability and Bland-Altman Analysis The Bland-Altman analysis and plots, used to evaluate the agreement among each device, showed each device measurement repeatability (Figure 2). The coefficient of repeatability, which assesses the precision of each device, showed that the OA-2000 had a CR% of 0.115%, demonstrating extremely high repeatability. In comparison, the RS-1 exhibited a CR% of 1.56%.

Differences in Axial length Measurements between Two Devices The mean axial length was 25.12±1.38 mm for the RS-1 and 24.90±1.54 mm for the OA-2000, with the RS-1 showing a statistically significant larger value (paired *t*-test, *P*=0.0009; Figure 3).

DISCUSSION

The introduction of the RS-1 SD-OCT system marks a significant advancement in retinal imaging. Its ability to simultaneously measure axial length and conduct OCT scans has streamlined clinical workflows, reducing patient burden without compromising quality. This integration is particularly revolutionary as it allows for real-time adjustment of scan

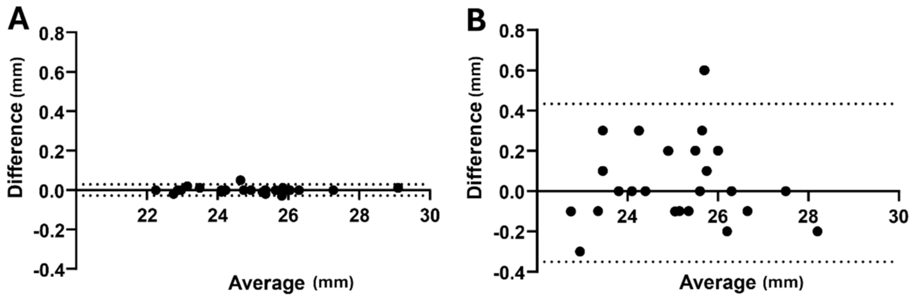

Figure 2 Bland-Altman analysis The coefficient of repeatability (CR%) for OA-2000 was 0.115%, showing high repeatability (A); while for RS-1, it was 1.56% (B), indicating significantly lesser repeatability compared to OA-2000.

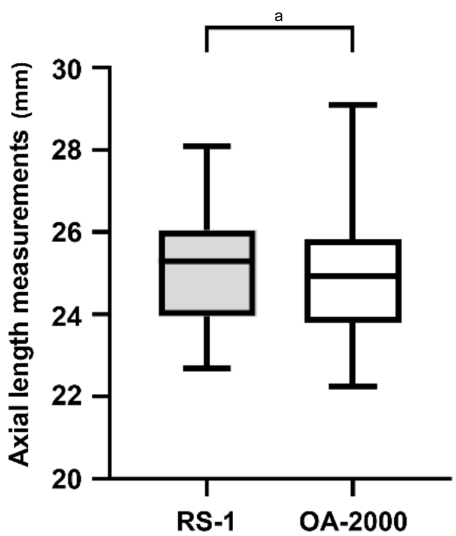

Figure 3 Differences in axial length measurements between two devices The mean axial length±standard deviation for RS-1 was 25.12±1.38 mm, and for OA-2000, it was 24.90±1.54 mm. The measurements from RS-1 were significantly greater (paired *t*-test, [a]*P*=0.0009).

widths based on axial length, which is critical for achieving accurate imaging results.

In our study, we compared axial length measurements or estimations obtained from the RS-1 and OA-2000 devices. Both devices showed a strong correlation in axial length estimations; however, the RS-1 tended to produce slightly longer axial length measurements.

Sanchez-Cano *et al*[27] have reported that changes in the optical system of the eye, OCT, and their working distances, other related factors, cause changes of magnification; however, their study used the Stratus 3000 OCT, so the results do not necessarily fully correspond to those obtained with SD-OCT measurements. The difference of results likely arises from the inherent measurement techniques of each device. The RS-1 uses estimated values based on OCT images and anterior segment (corneal reflection points and working distance) images, while the OA-2000 is designed for precise data acquisition and is generally used in pre-surgical planning for cataract surgery. Although there are methods to estimate axial length using the corneal curvature radius and refractive index, the RS-1 does not require input of either of these data[28-29]. Notably, OA-2000 measurements align with those from other axial length measurement devices, such as the IOLMaster-500 and Lenstar-LS900, indicating its precision[30].

When considering the use of the built-in normative databases within the RS-1 system, the clinical impact of differences in axial length cannot be ignored. Axial length influences SD-OCT thickness measurements and is considered a risk factor for normal-tension glaucoma and primary open-angle glaucoma[31]. In our study, discrepancies in axial length measurements affected the selection of the appropriate database in 3 out of 25 cases (12%), all of which had axial lengths near the 26 mm threshold. This may be due to a combination of two factors: the overestimation of axial length by the RS-1 compared to the optical biometer, which can incorrectly assign patients near database group thresholds, and the lower repeatability of measurements in the RS-1 than OA-2000, which may result in incorrect database selection for individual patients. Such discrepancies are critical as they can lead to false-positive diagnoses or incorrect identification of high myopia in normal eyes as glaucomatous. However, the boundary between the normal and long axial length normative databases can impact OCT scan interpretation, potentially affecting clinical outcomes. Misjudgments in database selection can lead to diagnostic errors or overlooked pathological conditions. Relying solely on axial length predictions obtained through RS-1 could lead to the mistaken exclusion of patients with a normal axial length from the normative database, potentially causing clinicians to overlook genuine glaucomatous changes. For patients with axial lengths near the threshold that determines database selection, it is advisable to remeasure axial length using a dedicated optical biometer, such as the OA-2000, to ensure appropriate database selection.

Limitations of this study include a small sample size and the fact that all samples were from normal eyes, which might lead to measurement discrepancies in clinical conditions. Without further validation, these findings may not be universally applicable. Future research should focus on evaluating RS-1 performance in a larger cohort that includes eyes with various retinal pathologies to fully understand its applicability in clinical settings.

In conclusion, axial length measurements from the RS-1 and OA-2000 exhibit a high positive correlation, and our study suggests the utility of RS-1 in clinical practice. It also implies the need for careful interpretation of its measurements, especially around the critical thresholds used for database selection.

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Conflicts of Interest: Fujihara H, None; **Kakihara S,** None; **Hirano T** has received speaker honoraria from Novartis, Bayer, Canon, Kowa Pharmaceutical, Senju Pharmaceutical, Chugai Pharmaceutical, Santen Pharmaceutical, and NIDEK Co., Ltd.; **Murata T** has received consulting fees from Chugai Pharmaceutical Co., Ltd., and speaker honoraria from Bayer, Chugai Pharmaceutical Co., Ltd., Novartis, Canon, Kowa Pharmaceutical, Senju Pharmaceutical, Kyowa Kirin, Santen, ZEISS, and NIDEK Co., Ltd.

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