学 位 論 文 の 要 旨

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学 位 論 文 名　Discrepancy in Specular Microscopy-Measured Central Corneal Thickness Between Both Eyes of a Patient

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論 文 内 容 の 要 旨

INTRODUCTION

Individual differences in central corneal thickness (CCT) affect the intraocular pressure (IOP) measurement using applanation and other tonometers. The IOP readings are lower than the true IOP value with thinner corneas and vice versa. Underestimation of the IOP in patients with primary open-angle glaucoma with thin corneas may lead to misdiagnosis of normal tension glaucoma, while overestimation of the IOP in normal subjects with thick corneas may lead to misdiagnosis of ocular hypertension . Other than errors in the IOP measurement, the CCT itself predicts development or progression of POAG .Therefore, measurement of the CCT has become essential for managing glaucoma. The clinically relevant accuracy and/or reproducibility of CCT measurements has been reported previously with various contract and non-contact devices including specular microscopes , the rotating Scheimpflug camera Pentacam , ultrasound pachymeters , the scanning slit topographer Orbscan , ultrasound biomicroscopy , and optical coherence tomography (OCT) . Because of its non-contact methodology and even better reproducibility than contact ultrasound pachymetry, specular microscopy has been used widely to measure the CCT in clinical settings and epidemiologic studies. In the current retrospective multicenter review of medical records, we found that the CCTs measured by various specular microscopes can differ between both eyes of a patient systematically. This discrepancy has not been seen with ultrasound pachymetry or the Pentacam. In this study, CCTs were measured using three specular microscopes, ultrasound pachymeter, and rotating Scheimpflug camera and were compared among devices or compared between both eyes with each device.

MATRRIALS AND METHODS

In this retrospective studies, CCT data were collected from 1,358 eyes of 679 subjects in whom the CCTs were measured using one of three specular microscopes (EM-3000, SP-3000P, or NSP-9900) in four centers (study 1) and 216 eyes of 108 subjects in whom the CCTs were measured using a specular microscope (EM-3000), ultrasound pachymeter (AL-3000), and rotating Scheimpflug camera (Pentacam) in one center. The CCTs from the right and left eyes were compared among devices or compared between both eyes with each device.

The study protocol was approved by the Ethics Committee of Shimane University and written informed consent was obtained from all subjects.

RESULTS AND DISCUSSION

In study 1, the CCTs were significantly thicker in the right than left eyes with the EM-3000 (mean right eye minus left eye value, +8.3±17.0 μm; P<0.0001), but thicker in the left than right eyes with the SP-3000P (-1.9±15.1 μm; P=0.0833) and with the NSP-9900 (-3.5±22.1 μm; P=0.0424). In study 2, the CCTs also were significantly thicker in the right than left eyes with the EM-3000 (+7.8±19.4 μm; P<0.0001), but virtually identical in both eyes with the AL-3000 (-0.4±14.5 μm; P=0.7715) and Pentacam (-0.1±17.6 μm; P=0.9739). In both studies, the CCTs varied among devices in both eyes. The current results of different CCTs among devices in studies 1 and 2 agreed with the result of the previous reports. Other than confirming different CCT values among the devices, we found a difference in the CCTs between both eyes when the CCT was measured by three specular microscopy models . With Topcon SP-3000P device, the difference did not reach statistically significant (p=0.0833). Using Topcon SP-2000P, the Tajimi study and its related studies reported 2 to 3 μm thicker CCTs in left eyes than right eyes . By our own calculation using t-test, the both eyes differences in these studies reached statistically significant (P=0.0001-0.0190). Thus, the Topcon device also can differ in the CCTs between both eyes. The CCTs were identical between both eyes with the Pentacam and ultrasound pachymetry in the current and previous studies . Thus, the difference in the CCTs between both eyes was seen systemically with specular microscopy devices. The Pentacam system measures the CCT on the series of Scheimpflug images that obtained by a rotation of camera on the axis though the corneal apex . Ultrasound pachymetry measures the CCT at the examiner-determined center of the cornea that perpendicular to the corneal surface. Slit lamp-based detection of corneal topography is the common rationale of the CCT measurement by specular microscopy . With this type of device, reflection peaks from the inner and outer corneal surfaces were detected by the detector that positioned on the opposite side of the light source. From the obtained peak width, the CCT then is calculated by the trigonometric function with a conversion coefficient. This rationale allows the proper CCT estimation when the cornea

is evenly thick around the corneal center. Accordingly, factor of the laterality lies only in the rationale of specular microscopy might associate with the discrepancy. We found that the thicker/thinner side of CCTs changes in each model of specular microscopy. Previous studies have shown that both the peripheral (4.5 mm from the center) and mid-peripheral (2.75 mm from the center) corneal thicknesses were thicker nasally than temporally using ultrasound pachymetry ,the pericentral cornea was thicker in the nasal quadrant compared with the temporal quadrant with topographic analysis using OCT . Thus, it is reasonable to suggest that if the light passes through the nasal cornea, a thicker CCT value is obtained than when the light passes through the temporal cornea. However, based on the information provided by the manufacturers, the light source is placed on the right side of the subjects in all three specular microscopy devices tested. Accordingly, laterality of the light path does not explain the mechanism of thicker/thinner side of CCTs changes in each model of specular microscopy, and therefore, the mechanism still needs to be clarified in the future.The CCT data analyzed in the current study were collected retrospectively from the subjects in study 1 who underwent preoperative examinations for cataract surgery or subjects in study 2 who underwent glaucoma diagnostic examinations at a university hospital. Thus, the methods or examiners of the CCT measurements were not predetermined among subjects or centers, and the background, including the ocular and systemic history, refractive errors, or IOP, also were not homogenous among the subjects. However, in study 1, the population scheduled for cataract surgery was expected to not different greatly among centers given the similar age and gender distributions among the devices . In study 2, the differences in the individual backgrounds were irrelevant since the same subjects with glaucoma underwent repeated measurements of the CCTs with different devices. Consecutive collection of a large amount of data should eliminate individual variations in CCTs between both eyes. Thus, we believe that the current comparisons of the CCTs between the device groups and between both eyes were scientifically reasonable.Collectively, the CCTs measured by specular microscopy differed between the right and left eyes. The discrepancy, 8.3 μm at most, may not be critical for the management of each individual patients, however, may affect the clinical studies that set the CCTs as outcome measures. Generally, the device is calibrated using a model eye in which the corneal thickness is homogenous. To avoid differences in CCTs in both eyes, the manufacturers are recommended to calibrate the specular microscopic devices with human subjects rather than the model eye and are advised applying the different conversion coefficients for each right and left eye.

CONCLUSION

The CCTs measured by specular microscopy differed between both eyes although the mechanism of this discrepancy was unknown.