Advantages of Anterior Segment Optical Coherence Tomography Evaluation of the Kayser–Fleischer Ring in Wilson Disease

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Purpose: To present anterior segment optical coherence tomography (AS-OCT) findings of the Kayser–Fleischer (KF) ring in Wilson disease (WD) and to discuss the potential advantages of evaluating the KF ring by AS-OCT.

Methods: This is a retrospective case series of 7 patients with WD with the KF ring seen in our institute during the study period (August 2015 to June 2016). All patients underwent slit-lamp examination of the cornea and AS-OCT (Optovue RTVue Premier). In 2 patients, the length of the KF ring was measured using the gray scale of AS-OCT.

Results: The KF ring on the gray scale of AS-OCT was visualized as a hyperreflective deep corneal layer at the level of Descemet membrane in all eyes. The OCT color scale revealed the KF ring as a greenish/greenish yellow/yellow/orange band. The gray scale of AS-OCT could easily measure the length of the KF ring in patients 6 and 7.

Conclusions: AS-OCT is an alternative method of evaluating the KF ring in WD, which can be used in combination with slit-lamp examination. The KF ring can be easily measured using the gray scale of AS-OCT. Further studies are required to study the potential advantages of AS-OCT including assessing the density of the KF ring, as a tool to assess response to treatment in WD, in differentiating the KF ring of WD disease from copper deposits in other situations and pigmented corneal rings in non-Wilsonian liver disease.

Key Words: Kayser–Fleischer ring, Wilson disease, slit-lamp examination, optical coherence tomography

MATERIALS AND METHODS

This is a retrospective case series of 7 patients with WD with the KF ring seen in our institute during the study period from August 2015 to June 2016. The Ethics Committee of the Krishna Institute of Medical Sciences Foundation and Research Center (KFRC) approved the study. Patient 1 was an 8-year-old female child with chronic liver disease and portal hypertension. The rest of the 6 patients had dysarthria and tremors. Patient 3 had additional vitamin-resistant rickets. Patient 4 was a 27-year-old woman with a history of 3 abortions. Patient 5 had dystonia and dysphagia. Patient 6 presented with an additional history of joint and bone pains. Patient 7 had psychiatric symptoms.

All patients underwent SL examination of the cornea and AS-OCT (Optovue RTVue Premier). AS-OCT of Optovue RTVue is converted from a retinal scanner using 830 nm. The cornea-anterior module lens was attached to the OCT machine, and corneal OCT images were obtained. In patients 6 and 7, the length of the KF ring was measured using the gray scale of AS-OCT. With the patient’s eye aligned, the cursor was brought to the center of the superior, inferior, temporal, and nasal cornea. In patient 6, measurements were made by both SL (Haag-Streit...
FIGURE 1. A, Slit lamp—slit view of patient 7 showing thin yellowish green deposits in the inferior corneal periphery. B, Slit lamp—diffuse view of patient 6 showing a thick yellow-brown deposit in the superior corneal periphery.

FIGURE 2. A, AS-OCT gray scale analysis of patient 6 showing hyperreflectivity (arrow) at the level of DM. B, Color scale of AS-OCT of patient 6 showing orange-yellow band (arrow) at the level of DM.

RESULTS

Three patients were females and the remaining 4 were males. The age of the patients ranged from 8 to 40 years. On SL examination, the KF ring was seen as greenish/yellowish green/yellowish brown deposits at the level of DM. In 6 of 7 patients, the KF ring was seen as greenish/yellowish deposits, whereas in 1 patient, patient 6, it was seen as yellowish brown deposits. The KF ring was thin in 2 patients (Fig. 1A) and was thick in the rest of the 5 patients (Fig. 1B). The KF ring on the gray scale of AS-OCT was visualized as a hyperreflective deep corneal layer at the level of DM in all eyes (Figs. 2A, 3A). The color scale of AS-OCT showed the KF ring as a greenish/greenish yellow/yellow/yellow-orange band at the level of DM (Figs. 2B, 3B).

In patient 6, the length of the KF ring measured on the gray scale of AS-OCT in the superior, inferior, temporal, and nasal cornea in the right eye was 2.57 mm, 1.77 mm, 1.23 mm, and 720 μm, respectively. With SL, the KF ring was seen as greenish/yellowish deposits. The KF ring was thin in 2 patients (Fig. 1A) and was thick in the rest of the 5 patients (Fig. 1B). The KF ring on the gray scale of AS-OCT was visualized as a hyperreflective deep corneal layer at the level of DM in all eyes (Figs. 2A, 3A). The color scale of AS-OCT showed the KF ring as a greenish/greenish yellow/yellow/yellow-orange band at the level of DM (Figs. 2B, 3B).

In patient 7, the length of the KF ring on the gray scale of AS-OCT in the right eye of the superior, inferior, temporal, and nasal cornea was 1.9 mm, 1.77 mm, 1.2 mm, and less than 1 mm. A similar measurement in the left eye of the superior, inferior, temporal, and nasal cornea was 1.74 mm, 1.43 mm, 1.13 mm, and 714 μm, respectively. The corresponding measurements on SL were 1.8, 1.1, 1 mm, and less than 1 mm.

DISCUSSION

The KF ring has been considered an important diagnostic criterion for WD. Electron microscopy studies have identified copper bound to sulfur-containing moiety in electron-dense granules seen throughout the cornea in patients with WD. It is 10–20 times higher in the corneal periphery. These granules are arranged in multiple discrete layers with the smallest granules closest to the endothelium.

AS-OCT has been found to be useful in eye clinics practicing corneal and anterior segment surgeries. According to the manufacturer of OCT used in this study (Optovue RTVue Premier), gray scale images are intensity image of backscattered light from the cornea and may vary with several factors including alignment on the cornea, curvature, and location of the B-scan within OCT. Color scale images do not reflect tissue reflectivity, and normalization is not done by the company to account for the various factors accounting for image brightness.

Methods of examination of the KF ring include naked eye examination, direct ophthalmoscope examination, gonioscopy, and SL examination of the cornea. AS-OCT is an alternative method of looking at the KF ring. The KF ring on the gray scale of AS-OCT seems as a hyperreflective layer in the corneal periphery at the level of DM. Localized deep stromal opacities resulting from various causes (infection, injury, and inflammation), copper deposits in other situations, and pigmented corneal rings in non-Wilsonian liver disease are differential diagnosis for the localized hyperreflective layer in the deep peripheral cornea. Studies are required to differentiate the KF ring of WD from deep corneal opacities and other deposits.

Detection of the KF ring on SL requires experience of a clinician. An ophthalmologist, who has not seen the KF ring on SL before, may miss an early KF ring. However, in a suspected case, hyperreflectivity of a deep corneal layer in the periphery on AS-OCT may alert the clinician to do careful SL examination to look for the early KF ring.
FIGURE 3. A, AS-OCT gray scale analysis of patient 7 showing hyperreflectivity (arrow) at the level of DM. B, Color scale of AS-OCT of patient 6 showing orange-yellow band (arrow) at the level of DM.

FIGURE 4. AS-OCT gray scale analysis of patient 6 showing measurement of the KF ring (superior cornea of the right eye).
A difficult method of measuring the KF ring and calculating the KF ring score has been suggested by Esmaeli et al. Standard narrow-beam direct-illumination SL photographs (×20 magnification) were taken at 6-o’clock and 12-o’clock vertical corneal meridians in each eye. After masking and randomizing the photographic slides, a single observer measured the length of the KF ring at 6-o’clock and 12-o’clock vertical corneal meridians using a Castroviejo caliper under ×4 magnification. The average KF ring score was obtained by summation of all vertical length measurements in both eyes as per the number of meridians examined by SL photomicrographs. Nasal and temporal rings were not measured because of technical difficulty using SL photographs in these meridians. With the eye aligned properly and cursor positioned, the KF ring can be easily measured using the gray scale of AS-OCT. Even nasal and temporal measurements could be obtained, and when the measurement is less than 1 mm, the KF ring measurement in microns is given on the gray scale. An average KF ring score can be easily obtained by adding the measurements in all 4 quadrants and dividing it by 4.

There are other possible potential advantages of AS-OCT in evaluating the KF ring in WD, although this study has not looked at these aspects. AS-OCT can possibly determine the density of the KF ring and hence help us to assess the severity of disease. AS-OCT can be a good tool to assess response to treatment in WD. Further studies are required to confirm the advantages mentioned above.

To conclude, AS-OCT is an alternative method of evaluating the KF ring in WD, which can be used in combination with SL examination. The KF ring can be easily measured using the gray scale of AS-OCT. Further studies are required to study the potential advantages of AS-OCT including assessing the density of the KF ring, as a tool to assess the response to treatment in WD, in differentiating the KF ring of WD from copper deposits in other situations and pigmented corneal rings in non-Wilsonian liver disease.

REFERENCES