



Image Analysis For Diagnosing Uveitis From OCT Images

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PURPOSE

The purpose of the project is to develop an algorithm for diagnosing anterior uveitis automatically from OCT (Optical Coherence Tomography) scans. The algorithm must automatically identify, and count the number of cells in the anterior chamber of the eye. This is to be used for diagnosing and treating the population of Greenland for anterior uveitis.

ANTERIOR UVEITIS DIAGNOSIS

Inflammation of the eye can occur in the eyelid, the anterior chamber or posterior chamber, Figure 1. We are concerned with anterior uveitis - inflammation in the anterior chamber.

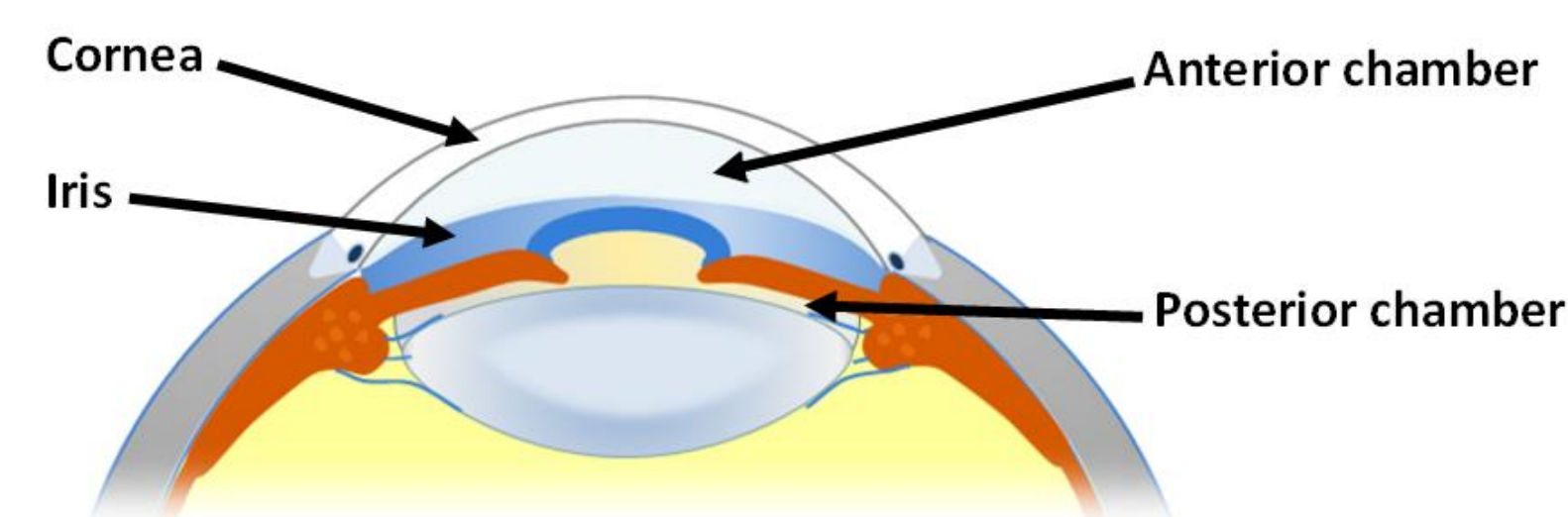


Figure 1: Basic anatomy of the eye

Symptoms are typically a red irritated eye, bloodshot with clearly visible blood vessels, Figure 2 left.

It is diagnosed by an ophthalmologist performing a slit lamp examination. A slit lamp examination shows the blood vessels and cells in the eye clearly, Figure 2 right.

Currently, there is no healthcare personnel in Greenland able to diagnose anterior uveitis.

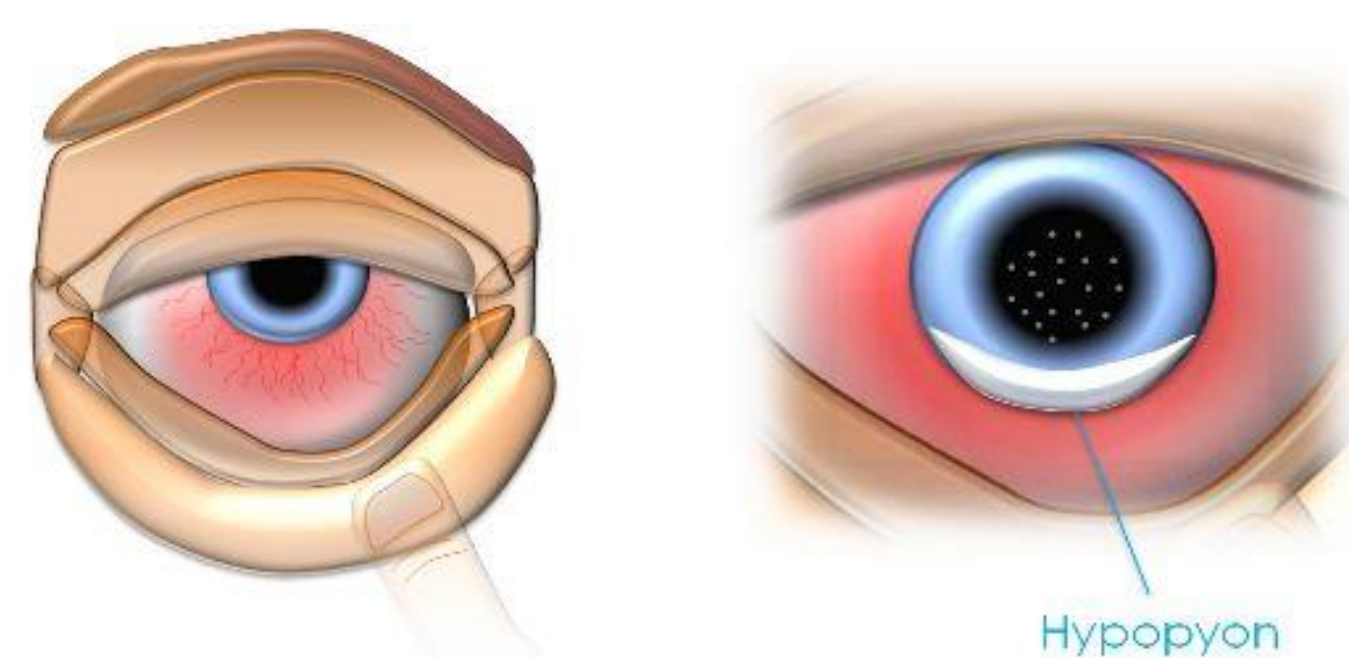


Figure 2: Left: visible symptoms for anterior uveitis. Right: anterior uveitis displayed by slit lamp examination, hypopyon is a deposit of inflammatory cells present in severe cases.

If a patient is suspected to have anterior uveitis a mobile phone picture will be sent to Rigshospitalet – Glostrup. If the suspicion is confirmed the patient will be evacuated to Denmark for further treatment.

An OCT scan is an alternative to the slit lamp. The OCT captures a still image of the eye's chamber, compared to the slit lamp which can only be done in real time by an ophthalmologist.

IMAGE CAPTURE

We used an DRI OCT Triton, Swept source OCT displayed below. OCT is normally used to depict retina which covers the back of the eye. With an additional lens it's possible to display the anterior chambers of the eye. OCT technology is similar to ultrasound or sonar. It's an interferometric modality and uses light waves to give a noninvasive tomography of the eye. The OCT scanner registers the depth of the eye by collecting reflections from the light and then measure the time difference. In MATLAB we have developed a specific algorithm has been developed to identify and count the cells present in the anterior chamber.

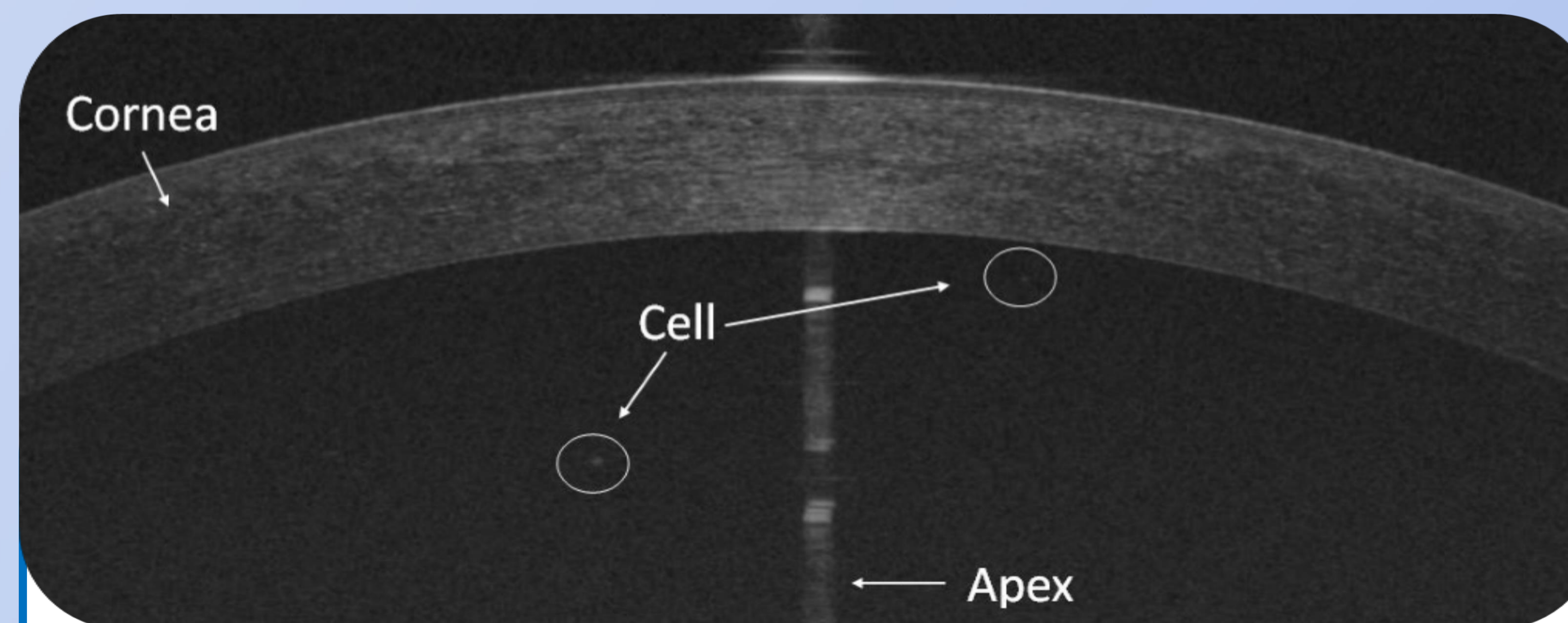


Figure 3: Original OCT scans showing two cells, cornea, and apex, manually marked with white arrows.

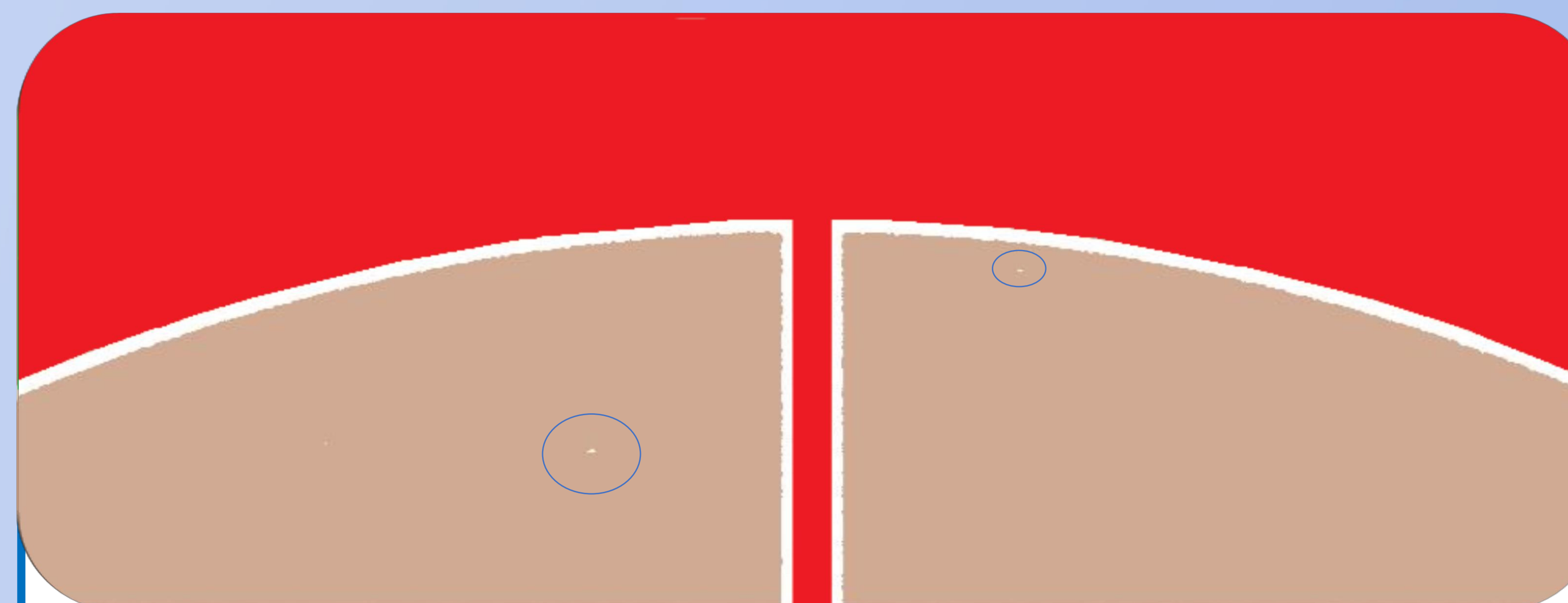


Figure 4: OCT scan from Figure 3, after being processed in MATLAB. The automatically identified inflammatory cells are for visualization marked with blue circles.

IMAGE PROCESSING

There are four main functions in the algorithm

- **Parabola fit:** is fitted to the lower edge of the cornea. Everything above the parabola is removed from the analysis, so only the anterior chamber is considered. Figure 4.
- **Apex removal:** is done by finding the bright vertical band. If there is a notable band it's removed from analysis.
- **Dispersion filter:** runs over the process matrix, and finds the places in the binary image with a notable higher pixel value.
- **Blob analysis:** uses the size of the objects in the image to identify cells.

RESULTS

Figure 3 shows an original OCT scan of an eye with anterior uveitis. The final output of the algorithm is shown in Figure 4. The green area is automatically removed from the analysis. Cells are detected only in the brown area. The algorithm identified two cells. The output correlates nicely with the ophthalmologist assessment. Ophthalmologist use SUN (standardized of uveitis nomenclature) grading to determine severity of inflammation, shown in Table 1. In this case two cells were found, corresponding to a 0.5+ SUN grading, equivalent to the ophthalmologist SUN grading. Slit lamp and OCT can be difficult to compare because the OCT scans and the slit lamp shows different layers of the eye. Therefore the OCT will usually show a greater number of cells than the slit lamp.

Grade	Cells in the field
0	<1
0.5+	1-5
1+	6-15
2+	16-25
3+	26-50
4+	>50

Table 1: SUN grading scheme

CONCLUSION

The algorithm supports that it is possible to use OCT scans to diagnose anterior uveitis. The algorithm has been proven functional to identify if any cells are present in the anterior chamber. Therefore it can assist ophthalmologist in making the correct diagnosis in the future.

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