New imaging methods for quantifying fundus changes in inherited retinal degenerations using spatial manipulation techniques from Geographic Information Systems

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Background & Purpose

The quantitative analysis of retinal imaging is becoming more critical as clinical trials into inherited retinal degenerations and other retinal diseases are progressing. A number of methodologies have been constructed utilising luminance data. However, special adaptations are required in order to use these methods. Geographic Information Systems (GIS) is a field specialising in manipulating spatial data to analyse and visualise geographical features. We have utilised GIS software and procedures to analyse and visualise retinal imaging in choroideremia (CHM) and retinitis pigmentosa (RP).

Methods

Several software packages were used to distinguish certain features in fundus autofluorescence (AF) images taken in patients with CHM and RP. This provided new and innovative methods for visualising the data. We were also able to perform quantitative analysis with less emphasis on luminance measures, allowing the use of distance data.

Conclusions

Cross domain working is becoming more popular and valuable lessons can be learned from other professions. Ophthalmic imaging contains a lot of spatial features which are used as markers for various measurements. Using software designed to analyse spatial data, we can draw more information from ophthalmic imagery than conventionally available. GIS software is designed to automate a number of processes previously completed manually, thus opening up analysis techniques to a wider set of applications. Fields such as GIS specialise in image analysis and have tools available that lower the bar for performing complex analysis on otherwise intractable data. The examples in this presentation demonstrate how GIS technologies can be adapted for use in ophthalmology in order to develop and perform innovative quantitative analyses and allow visualisation of different parameters in retinal disease. Developing links with the GIS field may help to enhance ophthalmology research and clinical management of patients.

FME

FME® (Safe Software, British Columbia, Canada) is a spatial data extraction transformation and loading tool, facilitating conversion of spatial data from one form to another. It allows repeatable complex data manipulation and analyses processes to be created. Examples of how this has been used in RP AF analyses are shown. FME can be used to georeference a range of images to correct for differences in orientation and magnification. A set area can be defined for analysis to ensure all images are analysed in a consistent manner across both patients and time.

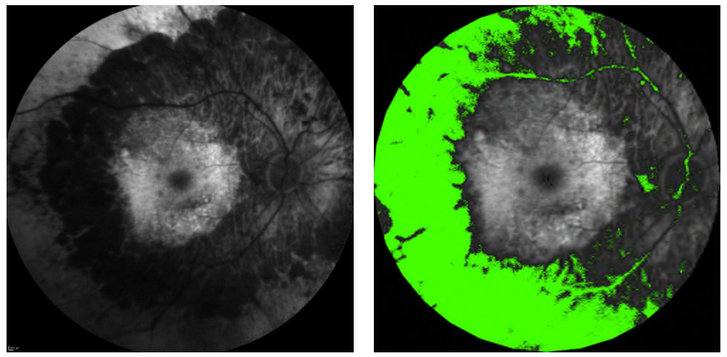

***Figure 1*: Quantification of atrophy in RP.** Areas with the lowest luminance are identified as RPE atrophy and quantified as a percentage of the image. The areas of atrophy are depicted in green.

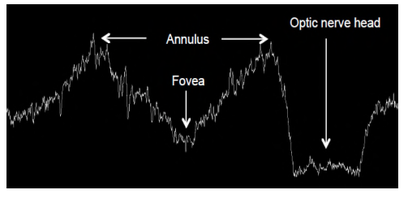

***Figure 2*: Key features can be identified by plotting the luminance across the image.** This can then be utilised in a variety of ways such as Figure 3.

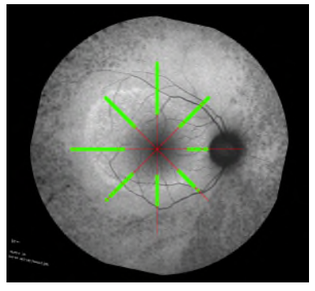

***Figure 3*: Identification of the hyperfluorescent ring in RP.** The length and radius of this can be measured in all directions.

QGIS

QGIS is an Open Source GIS available under GNU General Public License. QGIS allows users to create maps from raster data (grid of pixels) or vector (points, lines, areas). The maps can be styled in many different ways. We have used this technology to create maps of preserved AF from 50 patients with CHM in order to determine which areas of the retina are preserved until late in the disease process. This can have implications for ophthalmic surgery and help to advise patients which aspects of the visual field are likely to be preserved.

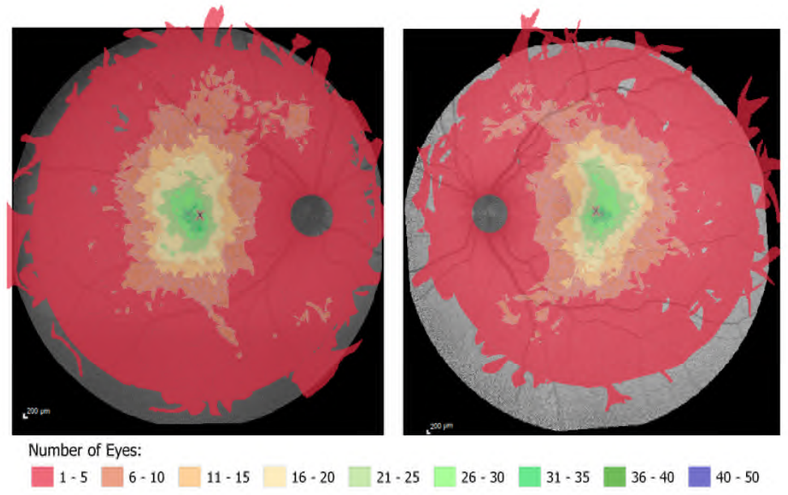

***Figure 4*: Map of AF (fundus autofluorescence) preservation.** A composite heat map image of the right eyes is presented on the left and a composite heat map image of the left eyes is presented on the right as per clinical convention in order to represent areas of residual retina in CHM.

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