1. Aim

To facilitate the interpretation of optic disc photographs by computer analysis of the image color information.

2. Hypothesis

Localized changes in the optic disc color are related to the depth of the cupping. While the subjective interpretation of such images is imprecise, the computer analysis should provide objective and accurate quantitative information.

Figure 1: A colormap of an optic disc image, illustrating the topographic value of the color information
3. Methods

Standard color optic disc photographs were obtained from 18 caucasian patients (36 eyes) with open angle glaucoma or ocular hypertension, using a Zeiss Visucam Lite camera. The images were analyzed with a new software technique which estimates the cup/disc ratio based on the image color information. The computer programs used were Gimp 2.6 (for image manipulation) and R 2.8.0, for digital analysis of the color information with algorithms of our own design and for statistical testing.

First, a regular retinal photo is cropped around the optic disc edges, like in the image above. Then, the color information in the cropped area is extracted in digital format. Each optic disc image has an average of 12000 pixels and each pixel has 3 color channels (red, green and blue). Each color channel for one pixel can have more than 200 different values, so there is a lot of hidden information in an optic disc photograph, inaccessible to the human eye, but readily available to the computer.

The digital color information in the 36 eyes was then analyzed with our own computer program which estimates the vertical linear cup disk ratio and the area cup disk ratio. To assess the validity of the computed values, a comparison was made with HRT data for the linear and area cup/disc ratio. The statistical analysis of the results was performed with the Pearson correlation test and linear regression models.
4. Results

The computed values for the area cup/disk ratio and linear vertical cup/disk ratio were relatively well correlated with the HRT values for the same parameters, as shown in figure 5.

![Area C/D ratio plot](image1)

![Linear vertical C/D ratio plot](image2)

**Figure 5: Relationship between computed values and HRT values for area and linear vertical C/D ratio**

The Pearson correlation test between our computed values and the HRT measurements had the following results:

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Pearson correlation</th>
<th>95% Confidence Intervals</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area C/D ratio</td>
<td>0.426</td>
<td>0.108 - 0.664</td>
<td>0.01072</td>
</tr>
<tr>
<td>Linear Vertical C/D ratio</td>
<td>0.481</td>
<td>0.176 - 0.701</td>
<td>0.00342</td>
</tr>
</tbody>
</table>
We performed a locally weighted polynomial regression of the two measured parameters to see if there are differences between patients with confirmed glaucoma and those with ocular hypertension. The results are shown in figure 6.

This analysis suggests a particularly good correlation between computed and HRT values for an area cup/disk ratio greater than 0.43, while the linear vertical cup/disk ratio shows a relatively uniform correlation across the spectrum of values.
5. Conclusions

• The software analysis of the optic nerve head images is a simple and promising tool which can help the clinical evaluation of the optic disc glaucomatous damage.

• There is a statistically significant correlation between our computed values for the area C/D ratio and linear vertical C/D ratio and HRT measurements of the same parameters.

• The computed area cup/disk ratio is very well correlated to the HRT measurements for values greater than 0.43.

• Further studies are necessary to assess the correlation with visual field changes over a longer period of time and in a larger group of patients.

Figure 7: University Hospital Bucharest