Comparison of optic disc image assessment methods when examining serial photographs for glaucomatous progression

Chris J Barry, Robert Eikelboom, Yogesan Kanagasingam, Ludmila Jitskaia, William Morgan, Phillip House, Max Cuypers

Abstract

Aim—To assess serial, simultaneous stereo optic disc images by four methods for glaucomatous progression.

Methods—Using varying techniques, two ophthalmologists assessed serial optic disc images of 52 eyes from 27 patients with a mean duration between images of 18 months. The neuroretinal rim width was qualitatively assessed by four assessment methods and compared with quantitative rim measurements made using PC based software.

Results—The highest sensitivity of 83% was achieved using computerised stereo chronoscopy.

Conclusion—Stereo chronoscopy improved the detection of subtle optic disc changes when compared with simpler assessment techniques.

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Observation of the optic disc is a key factor in the management of glaucoma and can be aided by using serial optic disc photographs. Stereo photography and stereoscopic viewing give an enhanced perception of disc topography assisting the interpretation of small changes in the disc structure. Stereo chronoscopy is a tool that can be used to view serial stereo pairs of images. The images need to be aligned so that they are superimposed and viewed alternately. Any changes which have occurred between imaging sessions appear to “flutter” while the rest of the image is stable when the serial images are flickered. Stereo chronoscopy has been shown to improve the sensitivity of detection of small disc changes \cite{1–4} but has not gained acceptance owing to stereo base fluctuations from sequential stereo imaging.

Simultaneous stereo photographs, in which one frame records both stereo views at the same moment in time, eliminates or reduces variations in the stereo base. We have previously described an optical/mechanical device and personal computer (PC) based methods of stereo chronoscopy to view simultaneous stereo images. \cite{5,6} In this study, the ability to detect changes in neuroretinal rim width from simultaneous stereo images was assessed using stereo chronoscopy and two simpler comparative methods. The stereo chronoscopy software also included the facility for manual neuroretinal rim measurements (stereo chronometry) and was used as the gold standard.

Method

Two ophthalmologists compared the serial simultaneous stereo optic disc images of 52 eyes from 27 patients by four methods (time between images 18 months, range 9–27 months).

Pupils were dilated and subjects were assessed at the slit lamp using a hand held 60D lens to observe the optic disc. Photographs taken at a previous attendance were inserted into a half frame stereo viewer (3d Reel Enterprises, USA) adjacent to the slit lamp eyepieces.

The serial slides were alternatively loaded into a half frame stereo viewer and the slides assessed for any change. An optical, stereo flicker comparator was designed and built based on the Pulfrich model.\cite{7} Figure 1 is a schematic diagram of the comparator. The comparator was placed over a light box and two photographic slides placed in the slide stage. Movement of a shutter allowed each slide to be viewed alternately. The right slide holder could be moved in the horizontal plane to align the right slide with the left slide. Both slide light paths are brought to a common path via a two way mirror and viewed with an attached commercial half frame stereo viewer. The stereo viewer was...
adapted with rotating prisms to allow an adjustment for differing interpupillary distances. The eyepieces were replaced by telescopic viewing devices which increased the magnification and were independently adjustable for optimal focusing.

The photographic optic disc slides were scanned and digitised using a Polaroid Sprint-Scan 35 (Cambridge, MA, USA) in 24 bit colour. Software was developed to align the images so that the images could be superimposed. The program then generated an interlaced image from the stereo pair to produce one single image. The observer wore 3D stereo goggles which contain liquid crystal display (LCD) shutters (3DMax, Kason Electronics, Anyang, Korea) synchronised to the monitor. The observer saw the left image of the stereo pair with the left eye and right image with the right eye forming a stereo view. Two images were presented in rapid sequence on the monitor, with switching controlled from the keyboard by the user.

The computer stereo software also incorporated the facility for manual, stereo, neuroretinal rim measurement (stereo chronometry). An electronic, predefined template marked with 18 points was placed over the image as a guide for measurements; the template was transferred to the second serial image maintaining the alignment. The vertical disc height was measured for each disc and a magnification factor used where appropriate. Using the mouse pointer, the operator identified the inner and outer neuroretinal rim margins at each of the 18 measurement points. The inner rim was defined as the junction between neural tissue and the scleral ring. The inner rim margin was defined as the junction between the disc floor and upward slope of the rim. The measurements were repeated a further four times.

The five radial measurements from each point were compared from the earliest image to the most recent using a two tailed Student’s t test (Sigma Stat Jandell Scientific, San Rafael, CA, USA). A conservative judgment for rim change was determined empirically as two differences between two sets of five measurements. The computer stereo software also incorporated the facility for manual, stereo, neuroretinal rim measurement (stereo chronometry). An electronic, predefined template marked with 18 points was placed over the image as a guide for measurements; the template was transferred to the second serial image maintaining the alignment. The vertical disc height was measured for each disc and a magnification factor used where appropriate. Using the mouse pointer, the operator identified the inner and outer neuroretinal rim margins at each of the 18 measurement points. The outer rim was defined as the junction between neural tissue and the scleral ring. The inner rim margin was defined as the junction between the disc floor and upward slope of the rim. The measurements were repeated a further four times.

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