

Editorial: Photogrammetry of the optic disc

Research into methods of clinical examination and early detection of chronic simple glaucoma is once more shifting its emphasis towards new techniques for the testing and recording of visual fields. In the early 1970s the pendulum swung well away from these subjective forms of visual assessment towards a more objective approach, and interest centred around the examination of the pathological optic disc, its local vasculature and related nerve fibre layer. During this period the techniques of photogrammetry received a certain amount of consideration in the quantitative evaluation of optic disc cupping.

Photogrammetry may be defined as the science or art of obtaining reliable measurements by means of photography. It depends on accurate instrumentation and recording devices and is the province of the map-maker, the surveyor, the geologist, and the space scientist. It already has several applications in medicine, including orthodontics, plastic surgery, and radiology. It is a science because it has its foundations in applied mathematics aided by the use of sophisticated apparatus and modern computerised techniques. It remains an art because in many instances it still relies on the skill and judgment of the individual observer making measurements.

The accurate assessment of the depth of the optic disc and the extent of pathological cupping has been the goal of glaucoma workers for many years, and its value in early detection was re-emphasised in 2 recent Doyne memorial lectures.^{1,2} Any method that measures changes of optic disc volume would prove very helpful to our understanding of the pathogenesis of disc cupping and would also serve as a useful index of the progress of glaucoma and its response to therapy.

The work of Armaly³ on cup/disc ratios and subsequent attempts to apply quantitative measurements to disc cupping coincided with the rebirth of interest in stereoscopic fundus photography that was stimulated by the development of the stereoscopic fundus camera by Donaldson⁴ and the image separator by Allen and coworkers.⁵ Several authors applied the techniques of photogrammetry to 3-dimensional photographs of the optic disc using the Allen image separator to provide stereoscopic pairs,^{6–8} but this method proved too inaccurate because of the constant difficulty in maintaining a fixed stereoscopic base between the separate exposures. It was soon supplanted by simultaneous

stereophotography using twin-prism devices initially^{9–11} and later employing the Donaldson stereoscopic fundus camera when it became more generally available¹² (and see Rosenthal *et al.* in this issue). It was possible with these instruments to take simultaneous stereoscopic photographs of the optic disc and thus eliminate many of the errors that featured in previous forms of measurement.

The problems associated with the actual recording of disc depths from stereophotographs, however, still remain. Until recently the photogrammetrist, examining stereoscopic pairs with optomechanical stereoplotting machines or using digital methods, had no reliable technique for calibrating the readings in terms of the geometry of the optic disc or of verifying the accuracy of the calculated disc cup volumes, and the methods described in this issue by Rosenthal *et al.* are a welcome and necessary attempt to improve on this accuracy. Comparative and sequential studies on the evolution of disc changes are now possible, but continued research is needed into patients with glaucoma to evaluate these methods' true significance.

The main disadvantage of stereophotogrammetry is that it is a laborious and time-consuming procedure requiring expensive equipment and experienced observers to undertake stereoplotting—it may be necessary to take several hundred readings from a single stereoscopic pair of disc photographs—and the cost and time involved in using the technique are prohibitive in the conventional clinical situation.

Other simpler nonstereo methods of estimating disc depth and the extent of cupping do exist. They include light-sectioning techniques with multiple-slit illumination of the disc in order to display its contours,^{13,14} and qualitative assessments may be made with a stereoscopic comparator¹⁵ or by the technique of stereochronoscopy.¹⁶ But all these methods lack sufficient accuracy to allow reproducible measurements to be made.

If optic disc photogrammetry is to prove valuable in the clinical assessment of disc cupping, it must be developed into a simple and relatively inexpensive technique that can provide accurate quantitative as well as qualitative measurements of the various 3-dimensional parameters that characterise the developing glaucoma cup. Perhaps some of the new advances in computer technology will facilitate the actual measurements themselves and replace the work of the individual stereoplotter, but until these requirements can be met the technique is unlikely

to remain anything more than a lengthy and laborious research investigation.

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