Is stereopsis essential to be a competent ophthalmic surgeon?

* a literature review.  Andrew Elliott

This was based on a Medline/Pubmed search using these keywords: stereopsis;ophthalmic surgeon;vision;surgeon;dexterity;necessity;binocular;occupation; doctor;trainees’.

No study was found which could directly answer the above question, indeed there were hardly any studies of stereoscopic vision in ophthalmologists at all. There was however a prospective study correlating stereo-vision of dental students, on admission to the course, with subsequent performance in preclinical operative dentistry which showed that a high degree of stereopsis as assessed by the TNO test was not a prerequisite for success in acquiring practical dental skills (1).

Comfortable stereopsis for those with this attribute is desirable however, and one microvascular surgeon with convergence insufficiency has been reported to have experienced improved proficiency following eye exercises (2).

There is some literature concerning visualization in laparoscopic surgery which conventionally is either monocular or, when presented on video monitors, binocular but non-stereoscopic. Such minimally invasive surgery is highly successful, very popular and clearly exists without 3D viewing. When a box trainer and laparoscopic instruments were used for a simple cutting task there was no difference in error rate comparing binocular direct vision with monocular direct vision, but there were more observed errors when a video monitor was used to view the operative site suggesting that the degradation of image quality with video imaging is more important than the absence of binocular vision (3). Indeed there may even be evidence of adaptation to the non-stereo environment of minimally invasive surgery. (4)

Robotic surgery is an exciting development but such aids normally provide no sense of touch and rely solely upon vision. New models can provide 3D observation by means of twin endoscope channels presented on a video monitor. The view from each channel is polarized in different orientations and presented alternately at high frequency on the same monitor. The surgeon wearing polarizing spectacles with the two lenses set at right angle to each other can then achieve a stereo representation of the operating field. In one study eight experienced laparoscopists with no experience of robotics performed tasks of increasing complexity such as knot tying and needle threading, and performance times and errors recorded and were significantly better for stereoscopic
conditions compared to the monoscopic situation. (5). Similar studies using the da Vinci robotic system demonstrated a more efficient, accurate and rapid performance of motor tasks in the 3D mode compared to 2D. (6, 7).

The potential advantage of stereoscopic vision is recognized by the development in a number of specialties of ‘augmented reality’ displays where computer generated images are presented separately to each eye to form a virtual 3D image which is viewed at the same time as the operative field providing, for example a navigational overlay or template to guide instruments more accurately than otherwise possible. Examples include oral implant surgery and neurosurgery (8, 9, 10)

Catching a ball with one hand requires both monocular and binocular clues and has been fairly extensively studied. Binocularity appears to confer an advantage, although occluding one eye in the monocular scenario results in more than a loss of retinal disparity alone, and certainly does not mimic the non-stereoscopic subject who has had all of his or her life to adapt to non-stereoscopic clues. (11, 12). However if subjects (students in physical education) with weak stereopsis have one eye occluded there is no effect on catching performance which falls off with increasing speed of the ball. Participants with normal stereopsis demonstrated better performance when binocular rather than when one eye was occluded. (13). What about poor catchers though? An intensive two week training programme improved catching performance in those with good stereopsis (better than 40s), but not significantly in subjects with weak steropsis (worse than 400s) although numbers were small (14). Of course, catching a ball may not equate to phacoemulsification cataract surgery!

Should we test stereoscopic vision of applicants to microsurgical specialties? A possible assessment of both stereo vision and manual dexterity is the buzzer test where a metal loop is passes along a bendy wire. Ophthalmologists did this test very well but there was no difference in performance between a group of non-ophthalmologists with normal stereopsis and a group with poor stereo vision (120s or worse) although the former group did do better than a group with no demonstrable stereopsis. Notably there was a wide range of performance and some subjects with poor stereopsis could do the test well (15).

What about dexterity in microsurgery? Rossi et al used a virtual vitreoretinal surgical simulator to assess its feasibility as a training or assessment tool, and also looked at stereopsis, although this was not the main purpose of the study (16). Subjects’ dexterity was assessed whilst performing a navigation task in which a number of virtual spheres near the retina were touched in turn with a retinal pick. Another task required peeling of a virtual epiretinal membrane. Stereopsis using a ‘Randot’ test was significantly inversely correlated with time to complete the navigational task, and also the number of inadvertent retinal contacts per average time in the membrane peeling task, but did not achieve significance for time to peel the membrane. Unfortunately a confounding factor in
this study was that stereopsis score was directly correlated with surgical experience being biased by three inexperienced students. Also overall numbers were small.

**Conclusion:** Despite an intuitive feeling to the contrary, there is no definite evidence that stereopsis is necessary to achieve satisfactory skills in ophthalmmic surgery. It appears beneficial in endoscopic and robotic surgery, and when there is a need to catch a fast ball. Excellent manual dexterity and adaptation to non-stereoscopic depth clues may be compensatory. Testing stereopsis in potential trainees as a proxy measure of potential microsurgical skill is not supported by the evidence so far, although it may be advantageous for those contemplating a career in ophthalmology to be aware of their own depth perception and coodination, as ophthalmology is visually demanding and requires very good fine motor skills.

Andrew Elliott, Revised September 2008

(1) Ireland EJ, Ripps AH, Morgan KS. Stereoscopic vision and psychomotor learning in dental students J Dent Educ 1982: 46; 697-8


