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An evaluation of stereoacuity (3D vision) in practising surgeons across a range of surgical specialities

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ABSTRACT

Background: Judging depth is important in surgery. Although there are several cues that permit depth perception, stereoacuity has been singled out as a possible predictor of surgical ability. However, it is not clear whether high-grade stereoacuity is necessary for a career in surgery. To help answer this, we aimed to evaluate stereoacuities in practising surgeons across a range of surgical specialities.

Methods: We recorded stereoacuity values on 66 surgeons working at a London teaching hospital using three standard stereotests: Titmus, TNO and Frisby. There were 36 Trainees and 30 Consultants, covering 12 surgical specialities.

Results: Median stereoacuities (with range) for the whole group were: 40 s arc on Titmus (40–800), 30 s arc on TNO (15–480) and 20 s arc on Frisby (20–600). Four surgeons had no recordable stereoacuity on TNO, and one was also unrecordable on Titmus. Three of these four were Consultants. Depending on the test used, high-grade stereopsis was found in 74%–83% of surgeons while reduced stereopsis was found in 2%–14% of surgeons.

Conclusion: While we found that most surgeons in current NHS practice have high-grade stereoacuity, there are also surgeons with reduced stereopsis and some with no stereopsis. The findings do not therefore support the assertion that high-grade stereopsis is a universal requirement for a career in surgery. It would be difficult to justify setting a stereoacuity criterion for entrance into a surgical training programme.

Introduction

Surgery is a visually-demanding occupation requiring fine judgements of distances and depth. The brain can use several mechanisms to judge depth, one of which is stereopsis.[1] Stereopsis is the ability to fuse two images of an object which differ slightly due to the different perspective of each eye, in order to form a single three-dimensional (3D) percept. Stereopsis is easily testable in the clinic and has often been used as the stand-alone measure of depth perception. Stereopsis is quantified as stereoacuity. It has been argued that good vision and in particular good stereoacuity ought to be a requirement for practising as a surgeon and therefore for embarking on a surgical career.[2,3] However, opinion remains divided on the matter.

Although relevant to all surgical specialities, the topic has received greatest attention among ophthalmic surgeons. A survey of UK ophthalmologists found that 80% of respondents

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felt that there should be a visual standard for ophthalmologists and of these, 94% felt that it should include stereoacuity.[3] However, less than 10% of countries have a visual standard for ophthalmologists[3] and it is estimated that only around 20% of ophthalmology residency programmes in the USA test trainees' stereoacuity.[4]

A literature review in 2008 concluded that there was no evidence to conclude that stereopsis was necessary for satisfactory performance in ophthalmic surgery.[5]

Several studies have approached this topic using surgical simulators to examine the relationship between stereoacuity and performance on generic surgical skills,[6] intraocular techniques[7–10] and laproscopic dexterity.[11] These have tended to show inferior performance for subjects with deficient stereopsis, however the subjects were generally surgery-naïve and the tasks were therefore unfamiliar. It is not clear what relevance these findings have to experienced surgeons who have performed surgical tasks for years, or for trainees who can develop their skills over a long period. It is possible that, with experience, surgeons with deficient stereopsis may utilise alternative strategies (eg motion parallax)[4] to compensate.

There therefore remains a lack of evidence about whether stereopsis is necessary for a surgical career. As a first step to explore this, our aim in this study was to determine the range of stereoacuities in a cross-section of currently-practising surgeons in the NHS, across the breadth of surgical specialities. Although unable to examine the relationship between stereoacuity and surgical competency, such an evaluation would provide a context for any proposed recommendations for visual requirements for entering into a surgical career.

Materials and methods

We certify that all applicable institutional and government regulations concerning the ethical use of human volunteers were followed during this research. Ethical approval for the study was obtained from the London Local Allocation Service of the National Research Ethics Service and institutional approval from the Research Department of St George's University. Written informed consent was obtained from all participants.

The investigators were two final year medical students (MB and SH) who underwent dedicated training by several orthoptists in the use of the stereotests until they were certified as competent by the Head Orthoptist in our department. They were then separately assessed on the use of the stereotests by an unfamiliar experienced Orthoptist trainer in another hospital who also certified their competence prior to the study.

Participants were Trainees or Consultants in surgical specialities working at St George's Hospital, London. They were approached during their working day before or after their clinical duties. All subjects completed a short questionnaire regarding their grade, speciality, and type of surgery. For the stereotesting, subjects were permitted to use their habitual refractive correction for operating (if any), but did not use operating loupes.

One investigator carried out all the stereotests while the other ensured the correct distance for each test was used (checked with a tape measure in all cases) and that the results were recorded accurately. For each subject, three stereotests were used in the same order: 1) Titmus (Stereo Fly SO-001, Stereo Optical, Chicago, IL, USA); 2) TNO (stereoscopic acuity test of the Netherlands Organisation for Applied Scientific Research, Laméris Ootech BV, Nieuwegein, The Netherlands) and 3) Frisby (Frisby Stereotest Near, http://www.frisbystereotest.co.uk). The appropriate standard instructions and techniques in the manufacturer's instructions were employed for the Titmus and the Frisby to avoid use of monocular cues.

We classed stereoacuity as high-grade at the level of better than 60 s arc, following O'Dell et al.[12] We followed O'Connor er al's definitions of reduced stereoacuity as >120 s arc for TNO and >250 s arc for Frisby.[13] We also defined reduced stereoacuity on Titmus as >120 s arc. For statistical analysis, we followed fully the methodology of O'Connor et al.[13] in dealing with unrecordable values. Statistical analysis was carried out using GraphPad Prism (version 5, GraphPad Software, La Jolla California USA, www.graphpad.com). The Wilcoxon matched-pairs signed rank test (for paired values) and Mann–Whitney test (for non-paired values) were used at the $p < 0.05$ significance level.

Results

In total 69 surgeons were approached, of whom three refused to participate, giving a 96% participation rate. Of the 66 surgeons tested, 36 were Trainees and 30 were Consultants (including one Associate Specialist). The breakdown of surgeons by specialism is shown in Table 1.

All 66 surgeons achieved a measurable stereoacuity value on the Frisby test. Four (6%) did not achieve any recordable stereoacuity on TNO, and one (1.5%) of these also was unrecordable on Titmus. Three of these four were Consultants (including the unrecordable on both TNO and Titmus) and one was a Trainee.

The ranges and medians of recordable stereoacuity values for the group is shown in Table 2.

The percentage of surgeons with high-grade or reduced stereoacuity according to the definitions described above is shown in Table 3.

When comparing individual performance on the three different tests, there was a significant difference in the

Table 1 – Numbers of surgeons by specialism.

Neurosurgery	8
Ear, nose and throat surgery	8
Ophthalmology	8
Paediatric surgery	7
Obstetric/gynaecological surgery	7
General surgery	6
Oral and maxillo-facial surgery	6
Plastic/dermatological surgery	5
Orthopaedic surgery	5
Trauma surgery	3
Colorectal surgery	2
Renal/transplant surgery	1