

EVALUATION OF LEVEL OF STEREOPSIS OF OPHTHALMOLOGISTS

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ABSTRACT

PURPOSE: To evaluate the status of stereopsis among ophthalmologists.

METHOD: A cross sectional study was conducted involving 42 ophthalmologists including post graduate residents, medical officers, senior registrars, associate professors and head of department working at Ophthalmology department Mayo Hospital Lahore. Their best corrected visual acuity (BCVA) was recorded. Gross stereopsis was checked by Lang 2 pencil test, Lang 1 and Lang 2. Moderate level of stereopsis was assessed by a standard Frisby test at 40 cm. TNO stereo test was used to find out the level of fine stereopsis. Qualitative and Quantitative values were recorded. A bead task was also performed under monocular and binocular conditions. Participants had to thread fixed number of small beads in a small needle in a 50sec time duration with a help of needle holder and forceps. Results were recorded on a self-designed proforma.

RESULTS: Gross stereopsis was assessed by Lang 2 pencil test present in all participants. 7.1% had stereopsis of less than 550 seconds of arc on Lang 1 and less than 200 seconds of arc on Lang 2. On Frisby stereo test normal stereopsis of 85 seconds of arc was present in 88.1%. Reduced stereopsis of 170 seconds of arc was found in 9.5% and 2.4% had no stereopsis on Frisby. Only 16.7% Ophthalmologists have normal 60 seconds of arc stereopsis on TNO. Borderline stereo acuity of 120-240 seconds of arc was present in 57.1%. Reduced stereopsis of 480 seconds of arc was found in 7.1%. While 19.0% of the ophthalmologists had no quantitative value of stereo acuity and were stereo blind. Bead task was performed under monocular and binocular conditions. Correlation was significant between TNO and number of beads with one eye ($p<0.001$) ($r=0.565$) and no. of beads with two eyes ($r=0.706$) ($p<0.001$). Lang 2 and number of beads with one eye ($r=-0.342$) ($p=0.027$) and number of beads with two eyes ($r=-0.475$) ($p<0.001$) also showed significant correlation. No significant correlation was present between Frisby test and bead task ($r=-0.231$) ($p=0.141$).

CONCLUSION: Most of the ophthalmologists had good stereopsis and they performed the bead task better as compared to those with reduced stereopsis.

KEY WORDS: Stereopsis, Ophthalmologists, Stereo acuity, Bead task, Monocular and Binocular conditions

INTRODUCTION

Stereo vision is described as "a glory of nature".¹ Stereopsis is defined as the perception of the depth and three-dimensional structure of the visual information received from both eyes by individuals with normal binocular single vision.² Since the eyes of humans and many animals are located on different sides of the head, binocular vision causes two different images to be projected onto the retina of the eye. The difference lies mainly in the horizontal position of the object relative to the two images. These static differences are called horizontal inequality, or more commonly, binocular inequality. Brain processes these disparities in the visual cortex

and produces a sense of distance and depth perception and 3D viewing.^{3,4} For humans, stereo vision seems to be particularly useful in manual tasks of visual guidance.⁵ Among the many visual tasks related to sports, stereo vision is one of the most important functions.⁶

Stereopsis is vital for many professions such as fire fighters, police officers, military personnel, train operators and air craft pilots in many countries.⁷ It is of vital importance for ball players who need to judge the position and trajectory of the ball and for tennis players especially when driving a ball.⁸ It has a positive impact on mid-distance driving performance and is therefore essential for the safe operation of motor

vehicles.⁹ Three-dimensional depth perception is essentially required to drive and park cars, pour a cup of tea, spread needles, sew and knit, go up and down stairs, touch or hold things, perform stitching and surgery.¹⁰

In the medical field, the use of virtual learning environments (VLE) is increasing. The implementation of stereopsis in VLE is not only beneficial to the movement execution in endoscopic surgery, but also affects the creation of visual spatial mental representation. The contribution of stereo vision in visual space learning is a novel discovery, which has great practical value.¹¹ The study of anatomy has undergone revolutionary changes through digital technology, that results in significant advancements in reality, portability, scalability, and user satisfaction. There are big differences in the study of pelvic anatomy with and without stereopsis on physical model, mixed reality, virtual reality, and computer monitor.¹²

Currently, surgical microscopes are equipped with stereo telescopes for depth perception.¹³ However, depth perception under the operating microscope is only suitable for surgeons with appropriate stereo vision. In the past, some ophthalmology residents reportedly encountered difficulties in surgical procedures. Difficulties worry residents' operational skills and attribute them to lack of stereopsis.¹⁴

Ophthalmologists who work with the aid of microscope should have a normal stereopsis for the accomplishment of their task during intra ocular surgery. Because it is visually demanding field and the microsurgery is being performed by them. According to international standard a surgeon should have a normal range of stereopsis from 40-60 seconds of arc to perceive depth especially in intra ocular surgery.¹⁵ From the clinical point of view the stereopsis was

categorized into different levels that are normal of 20 seconds of arc, borderline of 40 seconds of arc, and reduced 400 seconds of arc.¹⁶

Surgery is visually demanding profession. Ophthalmologists having good stereopsis perform well as compared to those having reduced stereopsis. The stereo accuracy test seems to be a suitable solution for those ophthalmology residents. In practice, some ophthalmologists are with reduced stereo acuity. It is time for the profession to set a minimum standard of visual functions to practice ophthalmology. As a profession we owe it to the public to produce the highest quality ophthalmic surgeons in our training programs.^{17,18}

MATERIALS AND METHODS

42 ophthalmologists working at eye department Mayo Hospital Lahore were enrolled. Their best corrected visual acuity was recorded. Level of stereo acuity was checked by Lang two pencil test, Lang 1, Lang 2, Frisby and TNO stereo test at 40cm. A bead stringing task was performed under monocular and binocular conditions to correlate the level of stereopsis and task performance. Task involved threading ten small beads into small needle in a 50sec of time duration with the help of needle holder and forceps. Results were recorded on a self-designed proforma. Qualitative variables like gender were presented as frequency and percentages and for other variable suitable statistical techniques (SPSS) applied. Descriptive statistics was used to represent the results. All the data was presented in forms of frequencies, percentages and tables.

RESULTS

Among those 50% were male and 50% were

female. There were 64.3% persons age ranges between 25-30 years, 16.7% were between 31-35 years, 9.5% were between 36-40 years and the 9.5% aged more than 40. Among them 64.3% were post graduates, 14.3% were Associate Professors, 7.1% were senior registrar, 9.5% were medical officers, and 4.8% were Head of Department. 90.5% of them were having 6/6 best corrected visual acuity and the 9.5% having BCVA less than 6/6. Their distance vision was recorded using a LogMAR chart. Gross stereopsis checked on Lang 2 pencil test was present in all the participants. 92.9% showed 550 seconds of arc and 7.1% showed stereopsis of less than 550 seconds of arc on Lang 1 stereo test. On Lang 2 stereo test 92.9% scored 200 seconds of arc and 7.1% scored less than 200 seconds of arc. Both Lang 1 and Lang 2 test were performed at 40cm distance. For Moderate stereopsis we used Frisby test at 40 cm. 88.1% scored 85 seconds of arc, 9.5% scored 170 seconds of arc and 2.4% of them had no stereopsis on Frisby test. Fine level of stereopsis was assessed using TNO stereo test. Qualitative stereopsis was present in 95.2%. Absence of qualitative stereopsis was reported in 4.8% had no stereopsis on Qualitative plates. According to the international standard of stereo acuity 16.7% ophthalmologists had normal stereopsis on TNO that is 60 seconds of arc. Borderline stereopsis (120-240 seconds of arc) was present in 57.1% ophthalmologists. Reduced stereopsis of value 480 seconds of arc was reported in 7.1% and surprisingly 19.0% ophthalmic surgeons had no stereopsis on TNO stereo test (Table 1). Statistical analysis showed that there is significant correlation of 0.05 was present between Lang 2 test and no. of beads with one eye ($p=0.027$) and 0.01 with no. of beads with both eyes ($p=0.001$). Level of significance present between TNO and no. of

beads with one eye was 0.01 ($p=0.001$) (Table 2). Binocular bead task and stereoacuity on TNO was significant at 0.01 level ($p=0.001$) (Table 3). But no significant correlation was present between Frisby test and no. of beads with one and both eyes.

DISCUSSION

Nibourg studied the extent to which stereo depth perception affects the performance of tasks performed under the operating microscope. Medical students of stereo sufficient (≤ 240 arc sec) and stereo deficient (≥ 480 arc sec) groups were included. A bead stringing task was performed by them under an operating microscope. They also performed a task on a cataract surgery simulator. The stereo normal subjects also performed the bead stringing task under artificial stereo deficient conditions (binocular and monocular viewing). The stereo-normal group performed both tasks faster as compared to the stereo-deficient group and artificially stereo-deficient group ($p=0.24$). Stereo-sufficient subjects performed bead task faster with stereoscopic viewing than under artificial stereo-deficient conditions with binocular viewing ($p=0.011$). The conclusion is that using stereo vision can achieve better initial performance on certain tasks related to the use of operating microscopes or cataract surgery simulators.¹⁴ In the study of Biddle they checked the stereopsis of 66 surgeons but they found 6% of them had no stereopsis. High grade stereopsis was present in 74%-83% surgeons and the reduced level of stereopsis was found in 2%-14% of surgeons. They used Frisby, Titmus and TNO test for the measurement of stereo acuity.^{19,20} For the assessment of stereopsis there are clinical tests of stereo acuity but some fine motor tasks could be performed to correlate the level of stereopsis and the skills of task performance of

the participants. There are some tasks that can be used to judge stereo acuity like threading beads onto needle, Purdue pegboard, pouring fixed amount of water from jug into the different cylinders.²¹ After assessing stereo acuity on clinical tests we assigned a task to the participants. A non-standard task of threading very small beads into a small needle was performed by all of them under monocular and binocular conditions. Small white beads were given in a tray. They used a needle holder to hold the needle in non-dominant hand and a forceps for picking beads in dominant hand. 50 seconds was given to them to thread beads into the needle.

Those persons having normal or border line stereopsis performed the task well and threads more beads into the needle in the given time but those having absent or reduced stereo acuity could not accomplish the task in the given time and their number of beads into the needle was also less. But some of them with reduced stereopsis performed the task very well. They might have been developed adaptation to the monocular cues. Edward and his colleagues enrolled 30 participants with normal stereopsis and 15 participants with absent stereopsis. Both groups performed simulated surgical task and pea-on-a-peg motor skills tasks. The task involved placing small plastic balls on columns of various heights using laparoscopic grasper. The task was performed under direct vision and via a monitor. Each condition was repeated monocular and binocularly. Time allowed was 50 seconds and three attempts were given. It was found that in free space under direct vision the stereo normal group placed more balls on average with both eyes open (12.1 ± 0.30) compared with one eye occluded (9.9 ± 0.44) in the allocated time of 50 seconds. The difference of mean was (2.22) and

($p < 0.001$). The stereo absent group placed an average of (9.1 ± 0.50) balls binocularly compared with (8.5 ± 0.55) balls monocularly ($p = 0.018$). The stereo normal group performed significantly better than the stereo absent group under binocular and monocular conditions.²² In this study we found there are ophthalmologists with different levels of stereo acuity. Performance of bead task also varies according to the level of their stereopsis and significant correlation was present between bead task and stereopsis values.

CONCLUSION

Most of the ophthalmologists had good stereopsis and they performed the bead task better as compared to those with reduced stereopsis.

RECOMMENDATIONS

1. Set some visual standards for the enrollment in ophthalmology.
2. National standards of stereopsis should be set for residents of ophthalmology.
3. Stereopsis should be checked according to the international standards.
4. Combine stereo testing with motor dexterity testing.
5. Set a surgical trial on a surgical simulator.

Table 1: Stereopsis values on TNO stereo test

Stereopsis values	Frequency	Percentage
60"	7	16.7
120"	16	38.1
240"	8	19.0
480"	3	7.1
<480"	8	19.0
Total	42	100

Stereopsis of 60 seconds of arc was present in 16.7%, 120 seconds of arc in 38.1%, 240 seconds of arc in 19.0%, 480 seconds of arc in 7.1% and less than 480 seconds of arc in 19.0% ophthalmic surgeons.

Table 2: Crosstab of binocular bead task and TNO stereo test:

		No. of beads with both eyes									Total	
		1	2	3	4	5	6	7	8	9	10	
Stereopsis value TNO	60"	-	-	1	-	-	3	1	1	-	1	7
	120'	-	-	-	-	1	4	4	4	2	1	16
	240	-	-	-	1	-	2	3	1	-	1	8
	480	-	-	1	1	1	-	-	-	-	-	3
	<480"	3	2	2	1	-	-	-	-	-	-	8
Total		3	2	4	3	2	9	8	6	2	3	42

Correlation between TNO stereo test and binocular bead task is significant at the level of 0.01.

Table 3: Crosstab of monocular bead task and TNO stereo test:

		No. of beads with one eye					Total
		0	1	2	3	4	
stereopsis value TNO	60"	-	2	2	3	-	7
	120'	-	1	5	5	5	16
	240	-	2	2	3	1	8
	480	-	3	-	-	-	3
	<480"	3	4	1	-	-	8
Total		3	12	10	11	6	42

Correlation was significant between monocular bead task and TNO stereo test at the level of 0.01.

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