Australian Orthoptic Journal 1987; 24: 13-15

SINGLE VS. MULTIPLE PINHOLE — DOES IT MAKE A DIFFERENCE?

LINDA McKENZIE DipAppSc(Linc), DOBA
School of Orthoptics, Lincoln Institute of Health Sciences, Vic.

Abstract
The visual acuity of 29 subjects was tested using a single pinhole, a multiple pinhole and the best corrected visual acuity. Statistical analysis showed no significant difference in the visual acuity achieved using a single or multiple pinhole. It was also shown that a significant difference exists between the visual acuity obtained by pinhole and the best corrected visual acuity.
Key words: *Visual acuity, single pinhole, multiple pinhole.*

INTRODUCTION
The pinhole, an opaque disc perforated by a small hole in the centre, is used to determine the extent of visual acuity reduction caused by a refractive error. Recently there has been increased usage of the multiple pinhole. The aim of this study was to determine whether there is any significant difference in the visual acuity obtained with a single or multiple pinhole, and to compare these results to the best corrected visual acuity.

METHOD
Subjects
The subjects were 29 adults with a refractive error, from an outpatients ophthalmology clinic.

Procedure
The visual acuity of the subjects was tested using a single pinhole, a multiple pinhole and best corrected visual acuity. Visual acuity was tested using Clement Clarke perspex illuminated charts numbers 107 and 108 with reverse letters and a mirror at 3 metres. These charts contain the same eight letters in different combinations. Measurements of visual acuity were made using a Rayner trial lens single pinhole and a multiple pinhole supplied by Parke-Davis. The latter had 17 pinholes arranged in two concentric circles with one central hole, all were 1 mm diameter. The pinholes were placed in an Oculus Universal trial frame and were correctly centred. The other eye was occluded with a black disc.

The pinhole visual acuity was tested with the right eye first. Half the subjects were tested with a single pinhole first and the other half with a multiple pinhole first. The visual acuity charts were changed between the right and left eyes. These variations minimised the effects of learning on the test results. The best corrected visual acuity was then obtained for each eye by a subjective refraction.

For the purposes of this paper, the subjects selected were those who obtained pinhole visual acuity of the total 6/12 line or better for both eyes. This level was used to minimise the possibility of ocular pathology, and thus restrict the sample to patients with refractive error only.

Reprint requests: Linda McKenzie, School of Orthoptics, Lincoln Institute of Health Sciences, 625 Swanston Street, Carlton, Victoria 3053.

TABLE 1
Results of Visual Acuity Testing

	Right Eye		Left Eye	
	Mean (±SD)	Range	Mean (±SD)	Range
Single pinhole	12.5 (±7.4)	0-29	13.3 (±6.6)	3-25
Multiple pinhole	13.7 (±8.1)	3-28	14.2 (±7.0)	0-27
Best visual acuity	20.2 (±8.0)	5-29	18.2 (±8.7)	5-29

The refractive error of the subjects ranged from −4.00D to +4.25D spherical equivalent, with various powers of cylindrical correction to a maximum of 3.50D.

For statistical analysis the visual acuity was expressed as the number of letters seen on the 9, 6, 5 and 4 lines which contained 6, 7, 8 and 8 letters respectively. Hence a total of 29 letters could be obtained. This process had inherent problems in that not all the letters and increases are equal. However, since these levels of vision involving visual angles of 1.5′, 1′, 0.83′ and 0.67′ are not as disparate as at the poorer levels of visual acuity, these shortcomings were considered acceptable.

RESULTS

The results of visual acuity testing are shown in Table 1.

Statistical analysis using ANOVA with a 3×2 crossed repeated measures design showed no significant difference in variance between right and left eyes or the interaction effect. However a significant difference in variance was observed due to the visual acuity testing conditions ($F=23.35$, $df=28$, $p<0.001$).

Since there was no significant difference between right and left eyes, further analysis was performed on the data for right eyes alone. A further ANOVA reconfirmed the significant effect of the testing condition ($F=21.55$, $df=28$, $p<0.001$). This difference was then analysed using a post-hoc test. The *t*-test showed no statistically significant difference between visual acuity using a single or multiple pinhole, but a significant difference between pinhole visual acuity and best corrected visual acuity for both single pinhole ($t=6.51$, $df=28$, $p<0.001$) and multiple pinhole ($t=4.76$, $df=28$, $p<0.001$).

DISCUSSION AND CONCLUSIONS

The problems of statistical analysis of visual acuity results when tested and recorded as a Snellen fraction are due to the fact that this measurement is not ratio data, as the size change from one line to the next is not equal at each stage. This problem has been highlighted by Ferris et al,[1] who described a new visual acuity chart on the same principle as a Log MAR chart, where the progression from line to line is geometric both in letter size and spacing. The visual acuity score is then either calculated by adding up all the numbers read, or it can be recorded as a Snellen equivalent. Hence, these charts allow for easier data analysis. With this particular set of data there were further statistical considerations caused by the fact that many measures were taken from the same individuals and hence were correlated. Therefore repeated measures analyses were required.

It appears from the results that when assessing visual acuity of patients with refractive error there is no significant difference between the results achieved using a single or multiple pinhole. The means of 12.5 and 13.7 in the right eye are visual acuities of 6/6 (−1) and 6/6 respectively. It was also noted that none of the subjects commented that the multiple pinhole was easier, nor were any subjects particularly quicker with one or the other.

It is to be noted however, that the best corrected visual acuity is greater than that obtained with a pinhole, i.e., a mean of 20.2 letters which is visual acuity of 6/5 (−1), one line better. This is due to the pinhole effect of diffraction, caused by the bending of light as it strikes an edge. The effect of increased visual acuity due to the central unrefracted rays only passing to the retina is partly off-set by the decreased vision caused by diffraction. Safir,[2] states that a 1 mm pinhole allows a subject with a 5 dioptre refractive error to see 6/12, whereas an emmetrope has vision reduced to 6/7.5.

In conclusion, it appears that there is no significant difference to be expected in visual acuity results using a single or multiple pinhole in subjects with no significant ocular pathology. It should also be remembered that the best corrected visual acuity is likely to be better than the pinhole visual acuity.

References

1. Ferris FL, et al. Visual acuity charts for clinical research. Am Orthopt J 1986; 36: 14.
2. Safir A. Refraction and clinical optics. Hagerstown: Harper and Row, 1980.