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Normative percentage score for the field of binocular single vision

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Abstract

Aim: **To establish the mean value for the field of binocular single vision (BSV) on the Goldmann perimeter in a visually normal population.**
Methods: **This was a prospective study on a visually normal, asymptomatic population. One hundred and nineteen participants completed the study. The field of BSV was evaluated using the III4e target on the Goldmann perimeter, and scored using the Sullivan template. Subgroup analysis was performed according to age to assess for age-related changes to the score.**
Results: **A score of 100% was rarely recorded for the participants. The overall population mean score was 94.43% (SD 4.25%; median 94.00%). One-way ANOVA test revealed a statistically significant reduction in the field of BSV with increasing age ($p = 0.000$). Correlation testing was performed (Pearson rank correlation $r = -0.44$).**
Conclusion: **Age-related normal scores were produced and show strong evidence of a reduction in the field of BSV with increasing age.**

Key words: Field of binocular single vision, Goldmann perimeter, Normative data, Sullivan scoring template

Introduction

Binocular single vision (BSV) is the ability to use both eyes simultaneously in an area of overlap, so that each eye corresponds to a common single vision.[1] BSV describes the normal use of the eyes together and allows us to achieve stereo-acuity. This may be established for straight-ahead viewing but can also be plotted in different directions of gaze as the field of BSV. The field of BSV can be plotted on a perimeter or using the cervical range of motion (CROM)[2] to represent the areas of the binocular field in which BSV is maintained and those in which there is diplopia. The field of BSV can be physiologically reduced by the contours of the face and pathologically in the presence of ocular motility defects resulting in diplopia.

A field of BSV is commonly plotted when a patient presents with a mechanical or neurogenic restriction to movement which causes diplopia in certain positions of gaze. The resultant chart provides a permanent and repeatable[3] record of the area of BSV. By scoring the field of BSV for chronological visits, changes in the severity and extent of diplopia can be monitored.

The first scoring template to be used in conjunction with a plotted field on the Goldmann perimeter was designed in 1987.[3] The original template consisted of 55 segments, each containing a numerical value of 1 to 4 depending on the position in the field. The total possible score for this template was 124. This template was later used in a research study to determine the correlation between the field of BSV score and the patient's own subjective assessment.[4]

This template was modified in 1992,[5] verified using a cross target. The modified template contained 50 segments valued from 1 to 3, again depending on their position in the field. The total score for this template is 100. More weighting is given to the primary position and depression, and less scoring emphasis on elevation and peripheral gaze. This is known as the Sullivan template.[5]

Although Newcastle and other centres use the Sullivan template to grade the severity of diplopia in patients with ocular motility problems (Fig. 1) it has not been possible to compare the scores calculated to a normal population for the III4e target.

Methods

Prior to commencement of the study institutional and Local Research Ethics Committee approval was obtained.

Participants were recruited prospectively from the local university, hospital staff and volunteers among the general public. All potential participants attended the orthoptic department for a baseline assessment of ocular motility and to be screened against the inclusion criteria outlined below.

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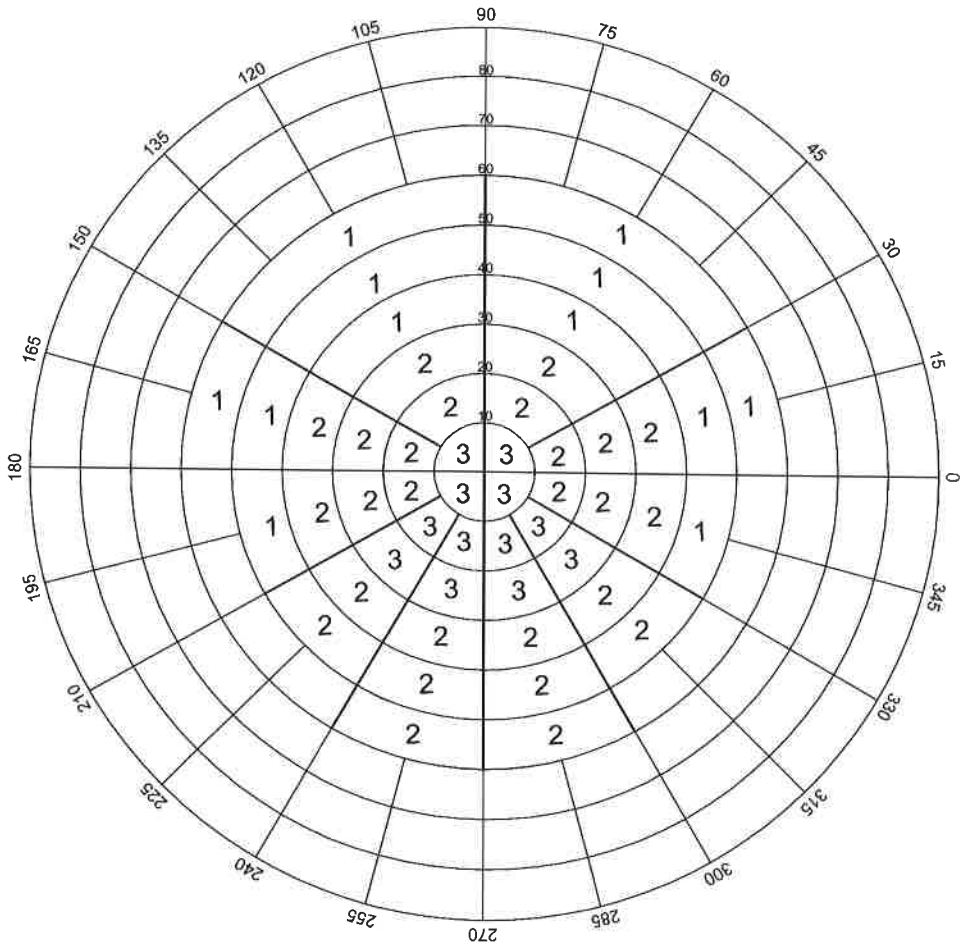

Fig. 1. Suggested scoring template[5] verified using the cross target.

Inclusion criteria

The inclusion criteria for the study were:

- age over 18 years;
- visual acuity of 0.300 logMAR (6/12 Snellen) unaided in order to accurately view the light target (III4e);
- no manifest squint;
- no known visual field defect (assessed by confrontation testing in clinic);
- presence of BSV (assessed using Worth's four lights and a TNO stereo-acuity test minimum of 480");
- ability to perform the Field of BSV on the Goldmann perimeter.

Exclusion criteria

The exclusion criteria for the study were:

- presence of a manifest deviation;
- ocular motility anomaly:
  - V pattern measuring more than 15^{Δ};
  - A pattern measuring more than 10^{Δ};
  - under- or over-action of the extra-ocular muscles graded as more than ± 1;
- visual field defect;
- absent binocular single vision;
- presence of suppression/constant diplopia.

Standard Goldmann perimeter charts were pre-marked with the Sullivan template.[5] Throughout the test the participant was asked to sit in front of the illuminated white bowl and look at the light target (size III4e). Head movement was minimised using the head strap and chin rest. The participant was asked to follow the light source into different positions of gaze, around a full 360° area along 15° segment intervals and to indicate when they appreciated diplopia. This point was then marked onto the Goldmann perimeter chart. On extremes of gaze the observer verified the patient was still binocular by ensuring both eyes were viewing the target.

The percentage score for the field of BSV was calculated by placing the template over the perimeter chart.

Results

One hundred and twenty-five participants were recruited. Six were found not to meet the inclusion criteria. One participant was excluded due to uncorrected anisometropia, 1 due to a decompensating near exophoria and 4 due to presence of longstanding partially accommodative esotropia with suppression. The mean age of the included participants was 46.39 years (range 19–82 years), of which 82 were female and 37 were male.

Table 1. Population normal values split according to age group

Age group (years)	Mean value (%)	SD (%)	Median (%)
25 and under ($n = 25$)	97.08	2.84	98.00
26–35 ($n = 20$)	95.60	3.36	95.00
36–45 ($n = 16$)	95.38	3.32	94.00
46–55 ($n = 21$)	93.71	3.71	94.00
56–65 yrs ($n = 13$)	93.62	4.72	96.00
66–75 ($n = 14$)	91.86	4.13	92.50
76 and over ($n = 10$)	90.30	5.75	88.00

The overall population mean score on the field of BSV was 94.43% (SD 4.25, 95% CI 93.67% to 95.19%, median 94.00%). The number of participants assessed in each age cohort is shown in Table 1, together with the mean percentage value, standard deviation and median. A one-way ANOVA test found a statistically significant reduction in the field of BSV with increasing age ($p = 0.00$). Correlation testing (Pearson rank correlation) was in agreement with this ($r = -0.44$)

Comments

Previous studies have described differing methods for the assessment and calculation of the field of BSV.[2–5] The testing of the field of BSV is known be repeatable with an inter-observer difference of 4%.[3]

To the best of our knowledge this is the first attempt to establish population normative data using the Sullivan template for differing age groups. Our results present an overall population mean score on the Goldmann perimeter with the III4e target using the Sullivan template. The data suggest that it is not uncommon for visually normal adults to score less than 100% on BSV field-testing. In addition we found a decreasing field with increasing age. Of the 119 participants included in the study only 16 (13.45%) achieved the 100% value; 37.50% of those who achieved 100% were in the age group 25 years and under.

Elevation is thought to decline with age but this is contentious. Some authors' report an age-related decline for elevation[6] whilst others show no age-related changes for healthy subjects.[7] In this study, where the field of BSV was less than 100% the deficit was in up-gaze without exception. This was due in some cases to participants not being able to view the target. A useful expansion of this study would be to assess field of BSV scores to uniocular fields of fixation to see whether there is an association between decreasing field of BSV and reduced elevation.

Recent studies comparing different methods for documenting diplopia[2,8] have shown good comparability with the scored field of BSV plotted on the Goldmann perimeter. A study comparing the Goldmann perimeter with the CROM[8] has shown 64% of patients have comparable scores on the two methods. The main cause of any disparity between the two methods was thought to be due to poor ability to fuse the light target in the Goldmann perimeter. This difficulty when performing the field of BSV on the Goldmann has long been recognised.[5] However, despite these documented problems with plotting the field of BSV, the Goldmann perimeter is widely used and having normative data will be clinically useful.

Clinical impact

With the population average score now known to be less than 100% it can be stated that a certain amount of diplopia plotted on the chart is normal if the deficit is usually in up-gaze and the patient is not symptomatic. Having normative data available will allow clinicians to better evaluate outcomes from treatment, taking into account the patient's age and pre-treatment score.

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