

## Determination of ocular dominance and its association with handedness

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### Abstract

**Purpose:** Clinical relevance of ocular dominance [OD] lies in its role in success of monovision. This study aims to determine easy and reliable methods to test OD and association of OD with handedness.

**Methods:** Prospective study of 300 patients, with best corrected visual acuity of 6/6, interocular difference of < 1Dioptre, and absence of any ocular, oculomotor or binocular abnormalities. Two subjective tests were done to determine OD - Miles [sighting dominance] and Fogging tests.

Handedness was determined by history. Ambidextrous patients and those unable to understand or giving equivocal replies, were excluded. Kappa [k] statistics [inter test agreement], and Chi-Square test and Odds ratio [association between handedness and ocular dominance] were applied.

**Results:** Mean age 35.28 years, spherical equivalent refractive error ranged +2 and -6 D. Both tests had perfect agreement [k=1]. 67.33% patients were Right Ocular Dominant (ROD) whereas 32.67% were Left Ocular Dominant. 65.67% had matched dominance of eye and hand.

No significant association between handedness and ocular dominance.

**Conclusion:** Mile's and Fogging tests are reliable and easy to perform in clinical setting. Since no direct analogy could be established between patterns of eye – hand dominance, assumption of OD cannot be made on the basis of handedness. As 94.33% patients were Right Handed whereas 67.33% were ROD, the results could not be directly extrapolated in patients with dense cataracts where OD cannot be conclusively determined.

**Keywords:** Handedness, Monovision, Ocular dominance.

### Introduction

Ocular dominance (OD) is the preference to process visual input from one eye over the other. Handedness is defined as the preferred hand used for motor activities. Ocular dominance was first described in 1953 by Giovanni Battista Porta. In normal binocular vision there is an effect of parallax, and therefore the dominant eye is the one that is primarily relied on for precise positional information. This may be especially important in sports which require aim, such as baseball and archery or shooting sports.

The optimum method for evaluating ocular dominance has been a topic of continual debate. There is no accepted gold standard.<sup>(1)</sup> Ocular dominance can be divided into sighting dominance [motor origin] and sensory dominance [sensory origin] based on the presumed origin of dominance.<sup>(2)</sup> Clinical relevance of ocular dominance is in its consideration in predicting patient satisfaction and overall success of monovision. Monovision is an optical technique applied in contact lens wear, corneal refractive surgery and cataract surgery. Pseudophakic monovision, one of the options in achieving spectacle-free distance and near vision after cataract surgery, is provided by monofocal IOLs where usually the dominant eye is corrected for distance vision and the non-dominant eye for near. This practice is based on the assumption that it is easier to suppress blur in the non-dominant eye than in the dominant eye. Determination of ocular dominance,

which may be an important factor for patient satisfaction, may not be always possible in patients with dense cataract.

### Purpose

To test and establish simple, reliable and easy to use methods to determine ocular dominance, and to study association between eye dominance and handedness. We also aimed to study that whether the results could be extrapolated in pseudophakic monovision where, in situation due to presence of dense cataract, ocular dominance cannot be conclusively determined.

### Materials and Methods

A prospective study of 300 consecutive patients attending the OPD of tertiary eye centre, was carried out. The subjects included had best corrected visual acuity of 20/20, dioptric difference of < 1 D and absence of any ocular, oculomotor or binocular abnormalities.

### Questions on handedness

Each subject was asked the question: "Are you right-handed, left-handed, or ambidextrous?" The response to each question was recorded and analyzed individually on the basis of hand used for eating, writing and combing hair. Ambidextrous patients were

excluded. Following the questions, a single examiner performed the dominance tests.

### Ocular dominance testing

Ocular dominance was determined by two separate subjective tests:

The tests were explained and demonstrated to the patients.

1. Mile's test (sighting dominance) – The subject extends both arms in front of the body and brings both hands together to make a small triangle between the thumb and the first knuckle. Then with both eyes open looks through the triangle and focuses on a single 20/50 letter at 20 ft (6m), then each eye is closed alternately, the eye viewing the object is the dominant eye (Fig. 1).
2. Fogging test – The subject fixates at a single 20/50 letter at 20 ft (6m) with both eyes open. A +2 Dioptre lens is alternately placed in front of each eye, causing blurring of the object, which is more noticeable is the dominant eye.

Patients unable to understand the tests or giving equivocal replies were excluded.



**Fig 1: One of the subjects carrying out Miles test.**

### Statistical analysis

Agreement between tests was evaluated with the Kappa statistics. The Kappa tests were interpreted as follows: Perfect agreement,  $k = 1.0$ ; Almost perfect agreement,  $k = 0.81-1.0$ ; Substantial agreement,  $k = 0.61 - 0.80$ ; Moderate agreement,  $k = 0.41-0.60$ ; Fair agreement,  $k = 0.21 - 0.40$ ; Slight agreement,  $k = 0.00 - 0.20$ .

Association between ocular dominance and handedness was calculated using both Chi – square test and Odds ratio.

### Results

300 patients, 175 males and 125 females, were tested. The mean age was 35.28 yrs and spherical equivalent refractive error ranged between +2 and -6 D. Mile's and Fogging tests had perfect agreement

[ $kappa=1$ ]. The results of ocular dominance and handedness were as shown in Table 1:

**Table 1: Ocular dominance and handedness in patients (n=300)**

	Right ocular dominance	Left ocular dominance	Total
Right handed	191	92	283 [94.33%]
Left handed	11	06	17 [5.66%]
Total	202 [67.33%]	98 [32.66%]	n = 300

**Chi – square test** – the calculated chi square value is 0.056 and is less than the table value (3.84) at 5% level of significance for one degree of freedom. Therefore no significant association was found between ocular dominance and handedness.

**Odds ratio** - OR = 1.1324

A mild positive association between handedness and ocular dominance was noted

[OR being >1]

65.67% had matched dominance of eye and hand.

34.33% patients had cross dominance [in which dominant eye is on one side and dominant hand is on the other].

### Discussion

Determination of ocular dominance can present a challenge to clinicians who must make decisions in situations calling for differential refractive correction of the two eyes such as in refractive surgery and intraocular lens implant after cataract surgery. In these situations, ophthalmologists tend to select the dominant eye for distance and the nondominant eye for near. It is presumed that it is less demanding to suppress a blurred image in the nondominant eye than in the dominant one (corrected for distance vision), thus minimizing discomfort for the observer. There is evidence to suggest that interocular suppression occurs in monovision and ocular dominance may influence one's ability to suppress anisometric blur in monovision.<sup>(3-5)</sup>

Ocular dominance tests can be broadly divided into (i) Sighting tests (e.g. Hole in the card test, Miles test, Porta test), (ii) Sensory tests (e.g., binocular rivalry tests) and (iii) asymmetry in visual acuity or contrast sensitivity. Subjects in our study had less than 1 dioptre interocular difference in refraction, so asymmetry in visual acuity was not studied. We wanted to use clinical methods which were simple and easy to perform both by the subject and the examiner; therefore binocular rivalry tests as described by Handa et al<sup>(6, 2)</sup> were not used. These forms of binocular rivalry tests can be challenging for patients to perform and may not always be reliable and feasible in a clinical setting.

Approximately two-third of the population is right eye dominant, however neither eye is dominant in a small portion of the population.<sup>(7,8)</sup> Our study showed Right Ocular Dominance (ROD) in 67.33% and Left Ocular Dominance (LOD) in 32.66% of patients. Past studies,<sup>(9,10)</sup> which used sighting dominance tests to establish ocular dominance have concluded similar results. Results by Handa et al<sup>(2)</sup> showed right-eye dominance in 75% and left-eye dominance in 25% of subjects as determined by hole-in-card test (sighting dominance) whereas the binocular rivalry test (sensory dominance) indicated right-eye dominance in 65% and left-eye dominance in 33.3%, with no clear dominance in the remaining subject (1.66%). Disagreement between results for the 2 ocular dominance tests was noted in 6 subjects (10%). In another study by Handa et al,<sup>(6)</sup> the dominant eye for sensory dominance, determined by exclusive visibility, was the same eye determined to be the dominant eye in sighting dominance, indicated by a hole-in-card test, in all patients.

The eye preferred for sighting does not indicate handedness, as each eye projects to both cerebral hemispheres (different half of the visual field) whereas each hand is represented mainly in the opposite hemisphere. In recent literature, no significant correlation between eye preference and handedness was observed.<sup>(9,11)</sup> Therefore no direct analogy between "handedness" and "eyedness" as lateral phenomenon can be established. In our study no significant association was found between handedness and ocular dominance.

However, in this study, the issue of quantification of ocular dominance has not been analyzed. It is best that the ocular dominance in patients with monovision be as low as possible, as high ocular dominance may cause severe stress in visual systems and interocular blur suppression should flexibly change in each eye at all distances. This has been studied by Ooi and He<sup>(12)</sup> and Handa et al.<sup>(6)</sup> They designed a balance technique based on binocular rivalry [sensory dominance] to quantitate ocular dominance.

### Conclusion

Sighting dominance tests is easy to perform for both patients and clinicians.<sup>(10)</sup> In our study, since the agreement between the two tests was perfect and the results corresponded to previous studies, we may conclude that a single sighting dominance test may be adequate to reliably test eye dominance.

Since no direct analogy could be established between patterns of eye – hand dominance, assumption of OD cannot be made on the basis of handedness. As two third patients were ROD and one third were LOD, and only 65.67% had matched eye – hand dominance, the results of our study could not be directly extrapolated in pseudophakic monovision where, whenever due to

presence of dense cataract, determination of ocular dominance is not conclusive.

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