**Expert Review**  The Cover Test

Rongxuan Lim* and Peggy Frith#

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**Abstract**  The cover test is indispensable when assessing a patient with a suspected squint. This article reviews how the cover test is performed and also the limitations of the cover test. Further, information is provided on how to interpret the clinical signs derived from the cover test. Indeed, much about the squint nature, fixation pattern and fusion strength of the patient can be learnt from the cover test alone. **Word Count:** 1701 words (excluding abstract and references)

**Key words:** eye examination, cover test, ocular misalignment, strabismus, squint

**Address for correspondence:** rongxuan.lim@chch.oxon.org

**Author affiliations:** * Foundation Year 1 Doctor, John Radcliffe Hospital, Oxford. #Consultant Ophthalmologist, Oxford Eye Hospital, UK.

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**Introduction**

The cover test is a component of the full assessment (see Table 1) of a patient with suspected ocular misalignment. Crucially it enables the examiner to confirm the presence, direction and magnitude of the ocular misalignment. This helps with formulating a management plan for the clinical problem. This article focuses on how the cover test is performed and tips for a successful examination.

**Literature Search**

Major Ophthalmology and Orthoptics textbooks were consulted and a Pubmed search for relevant articles was conducted.

**Terminology**

The visual axis or line of vision is an imaginary line from the fovea to the nodal point of the eye and to the fixation point (see Figure 1). The normal situation for most people is orthotropia, when using both eyes a subject’s visual axes intersect at the point of fixation, O.

In orthophoria, this perfect alignment is still preserved when binocular vision is interrupted by covering one eye. Even among “normal” subjects with no ophthalmic complaints, orthophoria is not common [1] as most people have a slight degree of latent malalignment.

Ocular misalignment is also known as strabismus or squint. However, patients may sometimes mean something different when complaining of a “squint”, so it is good practice to always clarify such terms with patients.

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**Figure 1 Visual axis and optical axis. O: fixation point, F: fovea, N: nodal point, AB: optical axis, OF: visual axis. Modified from [1].**
Heterotropia, also known as manifest or obvious strabismus/squint, is a misalignment that is present under binocular viewing conditions - using both eyes to fixate. Heterophoria or latent strabismus/squint is misalignment that is only apparent when fusion of the two eyes is prevented by covering one eye. Intermittent heterotropia presents when control of a latent squint is lost sometimes and the squint becomes present even when using both eyes. Figure 2 shows the terminology used to refer to ocular misalignments.

Comitant/concomitant strabismus refers to a squint that does not vary in magnitude with direction of gaze nor the fixating eye, usually due to a squint in childhood. In incomitant/noncomitant strabismus, the magnitude of deviation varies with direction of gaze or fixating eye. Most incomitant strabismus are acquired by paralysis or restriction, making neurological or orbital disease more likely [2].

Prerequisities for The Cover Test
There are a number of factors relating to the patient and the equipment which must be in place for the cover test to be performed properly. These are outlined below.

Patient Factors
Accurate fixation and co-operation are essential. The cover test presupposes accurate foveal fixation and will not be successful if the patient is unable to reliably fixate due to poor visual acuity (<6/60) or gross eccentric fixation.

Reasonable attention and co-operation of the patient is required. When examining young children, it is essential that the examiner takes effort to form the necessary rapport with the child [2]. Examining a squinting child is a highly skilled task, best learned from an experienced orthoptist.

Equipment Factors
Three factors are important here: the type of occluder, the type of fixation target and the type of prisms.

Figure 2 Positions of manifest squints. (a) Orthotropia (b) Esotropia (c) Exotropia (d) Right hypertropia (e) Left hypotropia (f) Left incyclotropia (g) Left excyclotropia. Modified from [1].
Several different forms of opaque occluders are commercially available (see Figure 3). A Spielmann occluder is translucent and the patient is only able to see diffuse light without contours through the occluder. It is sufficient to suspend fusion and allows the examiner to observe any eye movement behind the occluder. However, as it is more expensive than opaque occluders, it is not commonly used in clinical practice.

Figure 3 Occluders. Left: Two opaque occluders. Right: A Spielmann occluder. (Courtesy of the Orthoptic Department, Oxford Eye Hospital)

Letter charts can be used for an adult. For distance viewing, a Snellen chart placed at 6m is usually employed. If the patient’s visual acuity permits, a 6/9 visual acuity symbol should be used as the fixation target [1]. This produces a precise fixation point; if a large letter is used, the distance between different parts of the letter could be substantial and the patient’s fixation point can vary throughout the test, giving rise to measurement errors. For near viewing, the patient is asked to hold a reading card at a comfortable reading distance (usually 33-40cm) and to fixate on an alphabet on the card. When examining preliterate children, a picture or small toy can be used as both distance and near fixation targets (see Figure 4).

Figure 4 Fixation targets for preliterate children. (Courtesy of the Orthoptic Department, Oxford Eye Hospital)

Although a penlight is sometimes used to assess the symmetry of corneal reflections as a preliminary screening test for strabismus (see section: “Performing the examination”), it should not be used as a fixation target as it does not control the amount of accommodation during testing [1].

The prisms used may be loose or in the form of prism-bars with graded strength of prisms, both vertical and horizontal (see Figure 5).

Figure 5 Prisms. Top: Loose prism set. Bottom: Prism bars, vertical and horizontal. (Courtesy of the Orthoptic Department, Oxford Eye Hospital)
Preparation
Start by washing your hands or using alcohol gel. Introduce yourself to the patient and confirm their identity, obtain consent to examine them and collect the necessary equipment.

The patient and the examiner should sit facing each other at an arm’s length distance (see Figure 6).

Figure 6 Positions of the examiner and the patient when performing the cover test. The examiner (right) and the patient (left) are sitting facing each other at an arm’s length distance. The examiner places an opaque occluder in front of the patient’s left eye. With her other hand, the examiner holds up a near fixation target for the patient to fixate.

Performing the examination
The full cover test consists of three parts (although some examiners advocate starting by using the corneal reflections to gain some preliminary idea about the squint, both its direction and size – see Table 2 and Figure 7):

1. Cover test
2. Alternate cover test
3. Prism cover test

Figure 7 Hirschberg test to determine the direction and estimate the angle of squint - left esotropia. (a) Orthotropia: bilateral light reflex centered on pupils (b) 15 degrees esotropia: light reflex at the edge of left pupil (c) 30 degrees esotropia: light reflex in between left pupil margin and limbus (d) 45 degrees esotropia: light reflex at limbus. Modified from 1, 4.
1) **Cover test**

The patient is instructed to fixate on the target at all times. An occluder is then placed in front of one eye and the non-covered eye is observed (Figure 8). This is repeated with the second eye. If either non-covered eye shifts to take up fixation, a manifest squint is present. The direction of the shift will determine if an exo-, eso-, hypo- or hyper-tropia is present - if the eye moves in, an exotropia of that eye is present.

The occluder is then removed, restoring binocularity. At this point, if the recently uncovered eye immediately shifts to take up fixation, there is strong dominance of this eye and amblyopia should be suspected in fellow eye. If the test is negative on occluding the first eye, the procedure is repeated with the fellow eye. Should the test be negative with both eyes, the patient does not have a manifest squint and the alternate cover test is performed to look for a latent squint.

2) **Alternate cover test**

This test demonstrates the sum of manifest and latent squints by breaking the fusion of two eyes looking together. If the cover test determines no manifest squint, the alternate cover test demonstrates any latent squint.

The patient is again instructed to fixate on the target at all times. An occluder is placed in front of one eye for 2 s, and then switched over to the other eye for 2 s, and then back again. This alternate occlusion is repeated for several cycles and the examiner observes any movement of the just uncovered eye.

The principle behind the alternate test is as follows- if a latent squint is present, the just covered eye will drift away from its usual visual axis (Figure 9). The examiner does not usually see this if an opaque occluder is used. When the occluder is removed, that eye demonstrates a re-fixation shift that the examiner can detect (Figure 9). The speed and smoothness of this re-fixation shift indicates the strength of fusion [3].

![Figure 8 Cover test. (a) Patient has exotropia on inspection, with left eye fixating. (b) Left eye is covered with occluder. Right eye shifts nasally to take up fixation. (c) Occluder is removed and right eye continues to fixate for some time. (d) Occluder removed and left eye takes up fixation immediately - strong left eye dominance.](image-url)
3) Prism cover test

Prisms are used to measure the squint demonstrated in the alternate cover test. First, the squint magnitude is estimated from the alternate cover test and a prism with power underestimating this magnitude is selected. This prism is placed in front of one eye, with the prism apex pointing in the same direction as the deviation (e.g., apex pointing nasally for an eso-deviation). Simultaneously, an occluder is placed in front of the fellow eye.

With the prism in place, do the alternate cover test again. This should decrease the amplitude of re-fixation eye movement observed compared to when no prism was used. The prism strength is increased until no re-fixation shift is observed. This prism strength is equivalent to the size of the squint. Usually, the prism power is further increased such that the re-fixation movement direction is reversed. Following which, the prism power is then decreased again to the point where no re-fixation shift is observed to confirm the earlier measurement.

Completing the Examination

For a comprehensive examination, each step of the cover test is performed at near fixation (33-40cm) and distance fixation (6m), with and without refractive correction, in the primary position of gaze (patient look straight forward). Comparison of these four figures will indicate the contribution of accommodation to the patient’s strabismus [1] as is especially important in children with esotropia.

To determine comitance/incomitance, the test is performed in the nine diagnostic positions of gaze with each eye fixating in turn. This is described in more detail elsewhere [9]. If weakness of an oblique-acting muscle is suspected, the cover test should also be performed in left and right head tilt positions.

Finish your examination by informing the patient that your examination is complete, thanking them for their cooperation and ensuring they have possession of any glasses they may have been wearing before the examination. Finally ensure they are comfortable and wash your hands.

Limitations of The Cover Test

The cover test relies on the patient maintaining accurate fixation and the observer being skilled. In situations where accurate fixation is not possible, as for babies, the corneal reflection test (Table 2) may be used to estimate the size of any manifest squint.

Small amplitude squints may not be picked up by the examiner. Ludvigh [5] showed that under optimal
conditions (co-operative patient, experienced examiner and good lighting), eye movement corresponding to 2 diopters in prism strength was the smallest deviation that can be detected.

Cyclodeviations cannot be measured with the cover test and other methods of detecting ocular misalignment will need to be used [3].

References

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Conflicts of interest
None declared
1 History, especially of double vision - horizontal, vertical and tilting effect on gaze
2 Determine visual acuity (VA) in each eye
3 Measure refractive error
4 Inspect eyes and head position
5* Determine presence of ocular misalignment
6* Measure misalignment, direction and degree
7 Ocular motility
8 Suppression and level of stereopsis (depth perception)
9 Pupil dilation and fundoscopy to detect cause of reduced vision such as retinal scar, retinoblastoma, and hence ocular misalignment

* Where the cover test is usually performed

Table 1 Full assessment of suspected ocular misalignment. Modified based on [1].

<table>
<thead>
<tr>
<th>Test Description</th>
<th>Details</th>
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<tbody>
<tr>
<td>Hirschberg test</td>
<td>Hirschberg found that each mm of cornea light reflection displacement from the centre is equivalent to 7 degrees of ocular deviation from the visual axis. Further, estimations of squint amplitude can be derived from the position of the light reflection in relation to the pupil, iris and limbus (du Bois-Reymond) [1] (Figure 7).</td>
</tr>
<tr>
<td>Krimsky test</td>
<td>Prisms are placed in front of the fixating eye until corneal light reflections in both eyes are symmetrical. This gives a more precise measurement of the squints than the Hirschberg test.</td>
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Table 2 Corneal reflection test.