DIAGRAMMATIC REPRESENTATION OF STRABISMUS

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Precise examination and recording of clinical findings is essential in the management of patients with ocular motility disorders. Examination techniques must be accurate and reproducible and documentation concise, quantitative and interpretable. Traditionally in the United Kingdom and Europe, orthoptic reports have been descriptive with limited quantitative information. Lack of standardisation in documentation limits systematic interpretation by the clinician.

The purpose of this paper is to introduce an accurate and concise method of examination and documentation of strabismus, and to present three cases to illustrate the simplicity and versatility of the system. We describe a modification of the method first introduced by Jampolsky[1] and later developed by Scott and associates[2] which allows diagrammatic representation of strabismus.

METHOD

The following ocular motility measurements are made:

1. Basic deviation.
2. Prism cover tests in nine positions of gaze.
3. Head tilts.
4. Near deviation.
5. Versions and ductions.
6. Characteristics of abnormal ocular movements: updrifts and downdrifts, upshoots and downshoots, A and V patterns.

The Basic Deviation

The prism cover test should be performed under controlled conditions to enable reproducibility. The basic deviation[1] is the angle of strabismus measured with the eyes in the primary position having ensured: full correction of refractive errors, fixation with the usually fixating eye on a distant target (6 m) and standard room lighting conditions.

Prism Cover Tests in Nine Positions of Gaze

The deviation in nine positions of gaze is determined using prism cover tests. Single prisms are used rather than prism bars. The patient fixates on a distant target and the head is moved so that the eyes take up the positions of extreme gaze. It is important that the eyes are in extreme gaze positions when performing the prism cover tests to ensure reproducibility. If the nose obscures the vision of one eye, the head can be moved so that vision is just regained. Prisms are held in front of the paretic eye. With single prisms, both the vertical and horizontal element can be neutralised by holding the appropriate prisms in one hand in front of the paretic eye.

Having performed prism cover tests in nine positions of gaze for distance, the near deviation in the primary position is determined and deviation on head tilting where appropriate.

The notation to describe the results of the prism cover test is listed in Table I. The results are recorded on the basic template (Fig. 1).

Versions and Ductions

Versions are tested using a light as a target with both eyes open, and are scored using a nine-point scoring system.[2] Normal versions score 0, overactions are graded from +1 to +4 and underactions are graded from −1 to −4. Overactions and underactions are recorded on the basic template in the primary field of action of each muscle (Fig. 2). Sclera should be concealed by the canthus in a normal

Table I. Notation for prism cover test results

E	= Esophoria
ET	= Esotropia
E′T	= Near esotropia
E(T)	= Intermittent esotropia
E(T)	= Intermittent esotropia (predominantly manifest)
E(T)	= Intermittent esotropia (predominantly latent)
X	= Exophoria
XT	= Exotropia
X′T	= Near exotropia
X(T)	= Intermittent exotropia
X(T)	= Intermittent exotropia (predominantly manifest)
X(T)	= Intermittent exotropia (predominantly latent)
HT	= Hypertropia
HYPO	= Hypotropia

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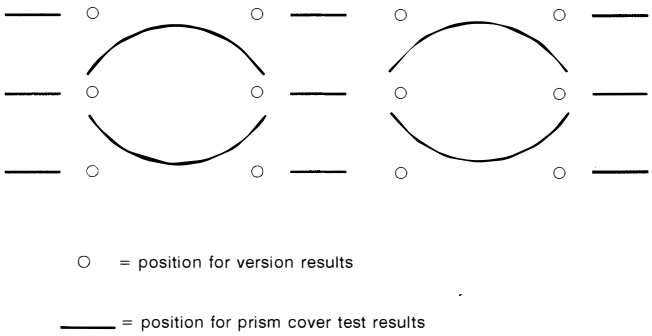


Fig. 1. *Template used for recording oculomotility findings.*

horizontal version. If sclera is just visible, the version is graded −1 and an inability to abduct or adduct the eye more than half-way into the field of action of the muscle is graded −2. Inability to abduct or adduct an eye more than a quarter-way into the field of action of the muscle is graded −3 and if the eye is unable to move at all from the primary position into the field of action of that muscle, the limitation is graded −4. Horizontal rectus overaction is graded according to the amount of cornea covered by the canthus. In extreme overaction half of the cornea is buried, which is graded +4.

Oblique overactions and underactions are graded by comparing the height of the inferior limbus of each eye. Overactions are graded from +1, representing a slight overaction, to +4 characterised by abduction of the eye in extreme oblique position (splaying out; see Fig. 3, top). Underactions of the obliques are graded from −1 (representing the smallest underaction) to −4 (denoting an inability of the eye to move vertically from the midline in the field of action of the oblique being tested). Examples of the four grades of oblique overaction and underaction are shown in Figs. 3 and 4.

If an underaction of one eye is noted on testing the versions, the fellow eye is covered and a comparison between the version and duction is made to differentiate a mechanical from a neurogenic strabismus.

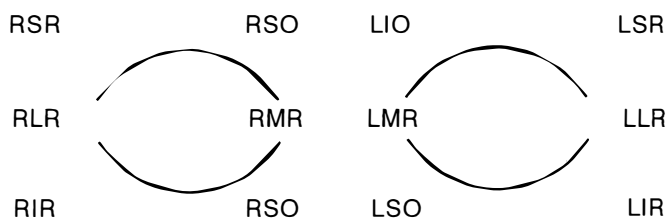


Fig. 2. *Direction of action of the six extraocular muscles of each eye.*

Characteristics of Ocular Movements

Table II shows various symbols used to describe abnormal characteristics of ocular movement:

Shading can be used to emphasise further the limitation of movement in one direction (for example, limitation of abduction in a sixth nerve palsy).

Lines can be used to emphasise A or V patterns.

Curved arrows represent updrift or downdrift in oblique overaction.

Right-angled arrows represent sudden upshoots or downshoots.

EXAMPLES

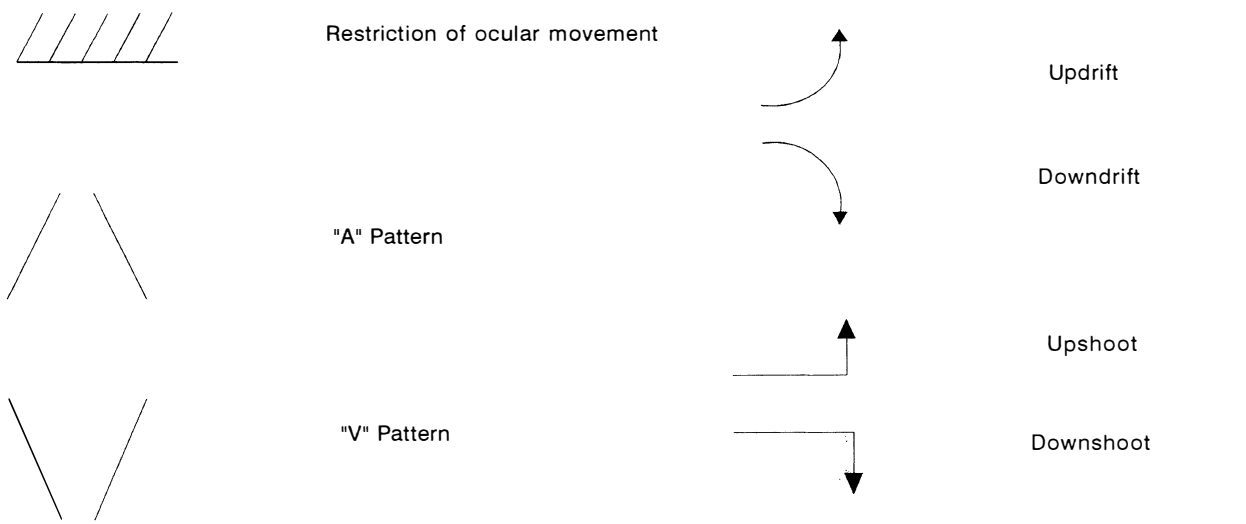
Case 1

Fig. 5a shows the results of ocular motility examination using the above method on a 20-year-old man who presented with a 1-year history of vertical diplopia following a minor head injury.

Photographs of the eye in nine positions of gaze are shown in Fig. 5b. The aim of the examination is to establish: (1) the diagnosis, (2) the extraocular muscles responsible for producing the defect and (3) the appropriate management.

1. *The Diagnosis.* By performing Parks' three-step test[3] it can be deduced that the patient has a left hypertropia in the primary position which is worse on right gaze, implicating a weakness of the left superior oblique or the right

Table II. Symbols to describe abnormalities of ocular movements



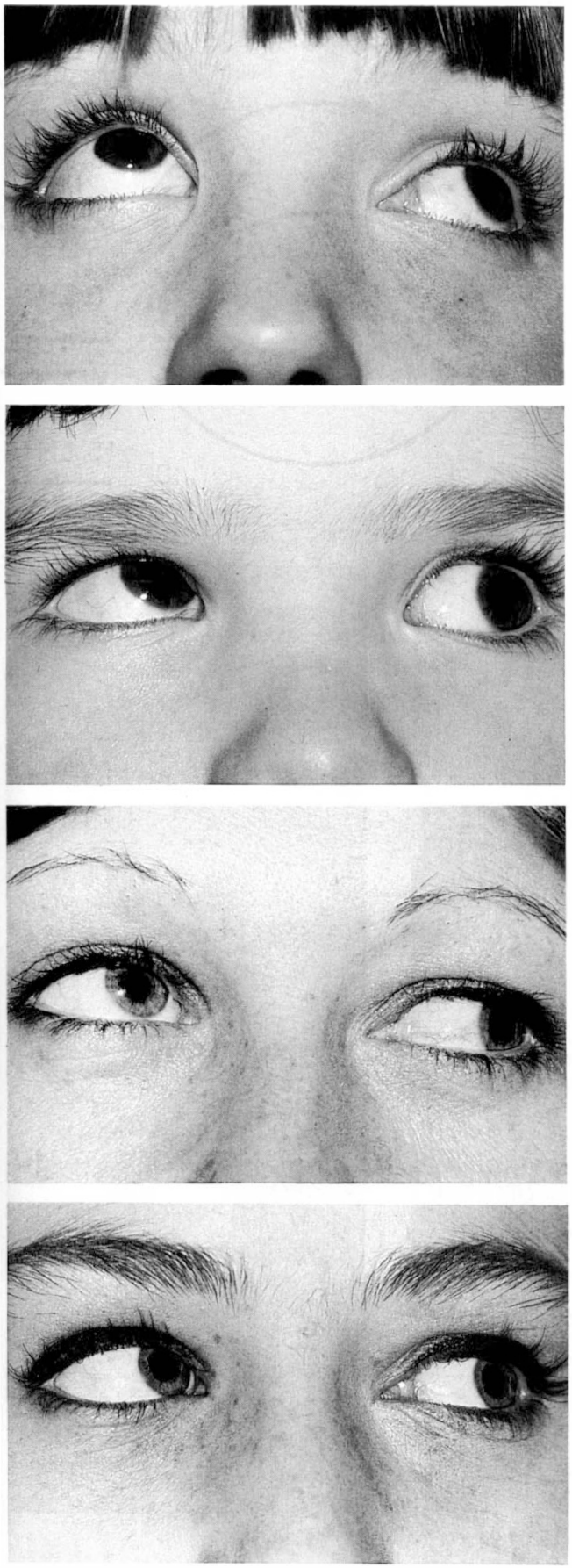


Fig. 3. *Grades of overaction of the right inferior oblique. Bottom to top: grade +1 to grade +4.*

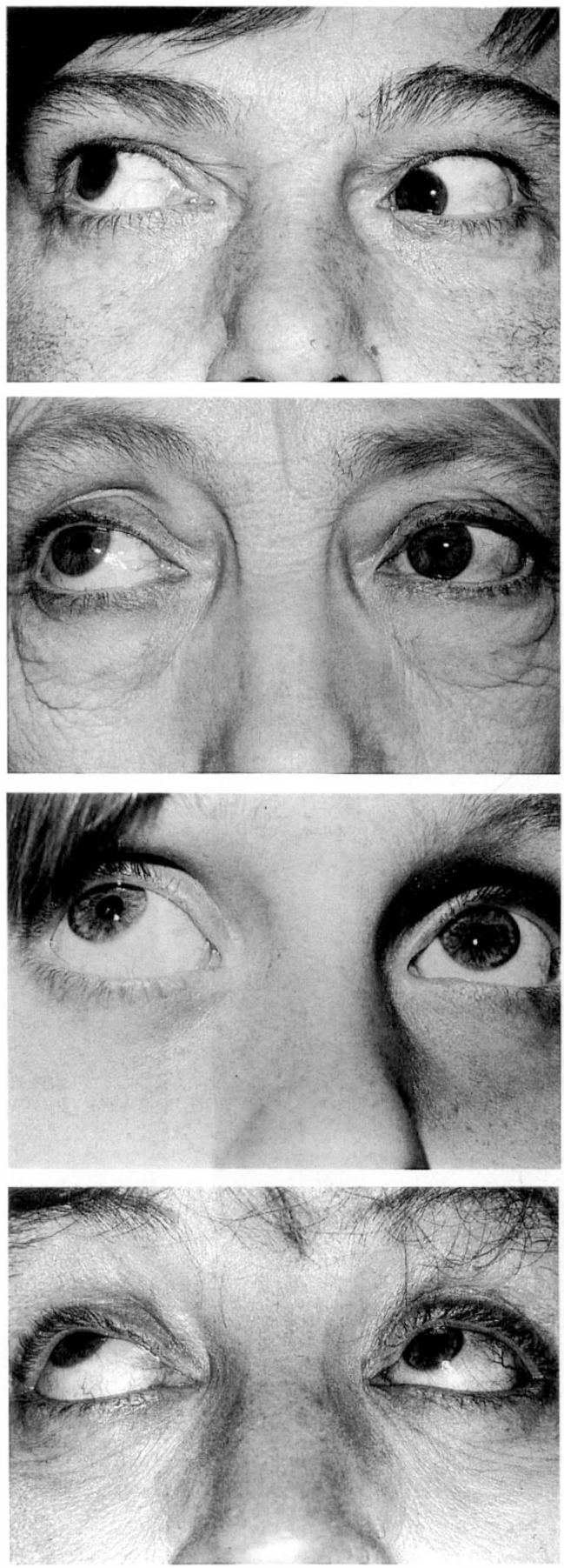


Fig. 4. *Grades of underaction of the left inferior oblique. Bottom to top: grade −1 to grade −4.*

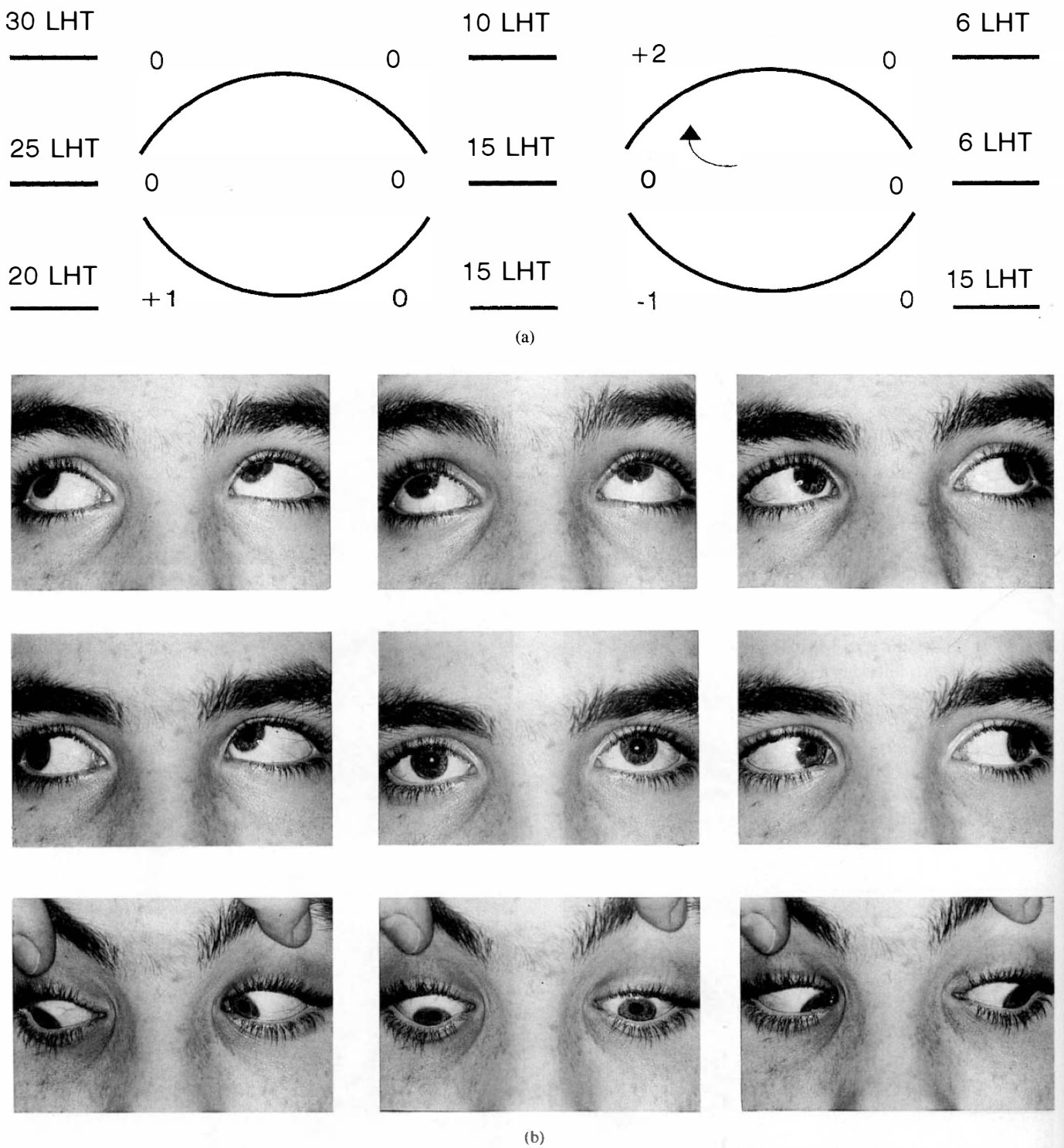
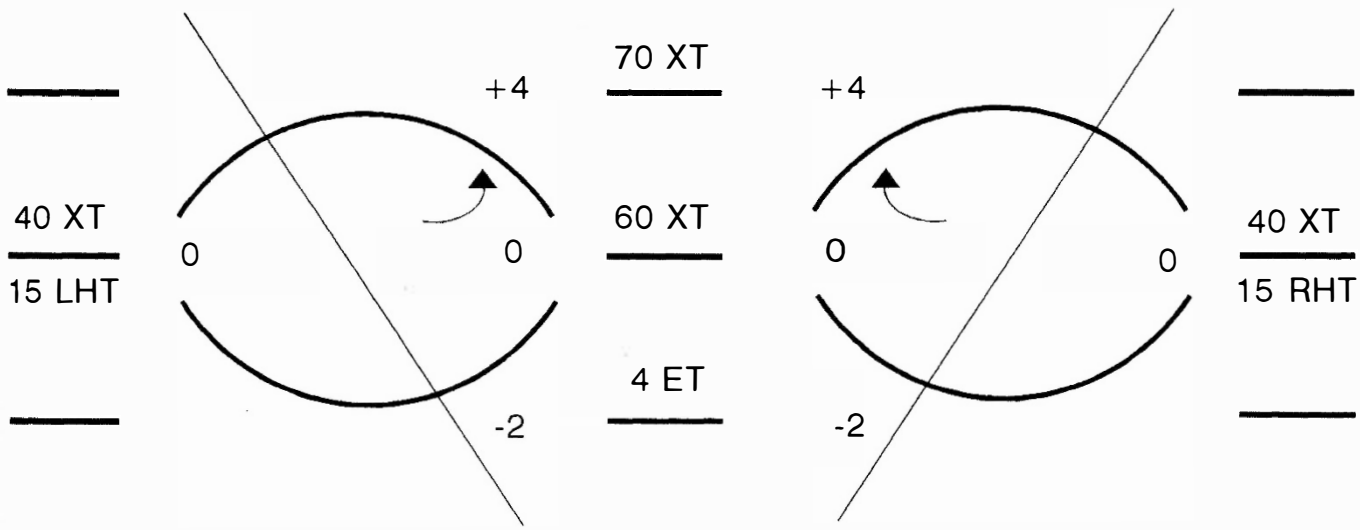
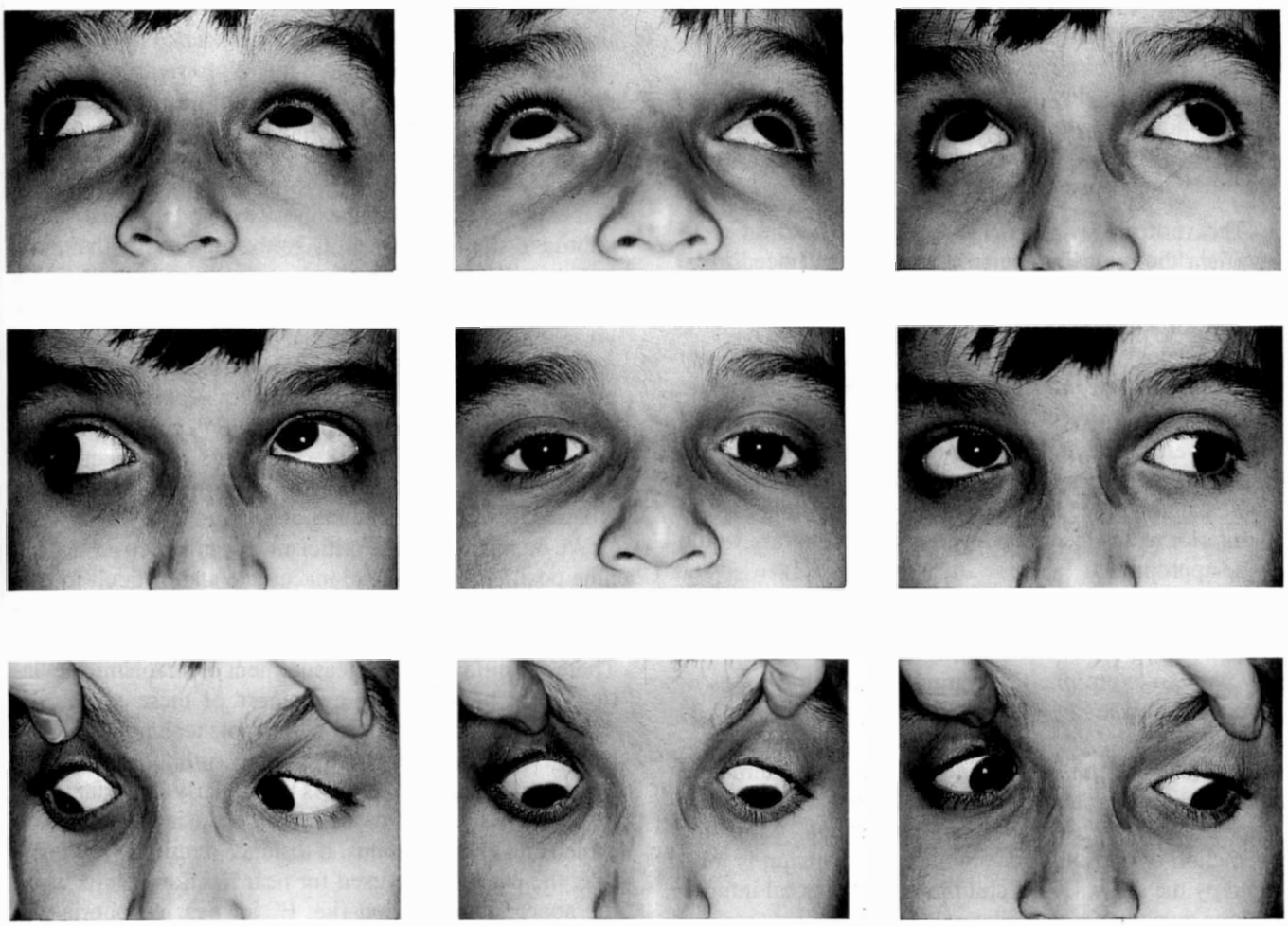


Fig. 5. *(a) Oculomotility findings of a 20-year-old man (case 1) with left superior oblique paresis (prism cover tests in prism dioptres). (b) Nine positions of gaze photographs of case 1.*



NEAR: 30 XT

(a)



(b)

Fig. 6. *(a) Oculomotor findings of a 6-year-old boy (case 2) with exotropia (prism cover tests in prism dioptres). (b) Nine positions of gaze photographs of case 2.*

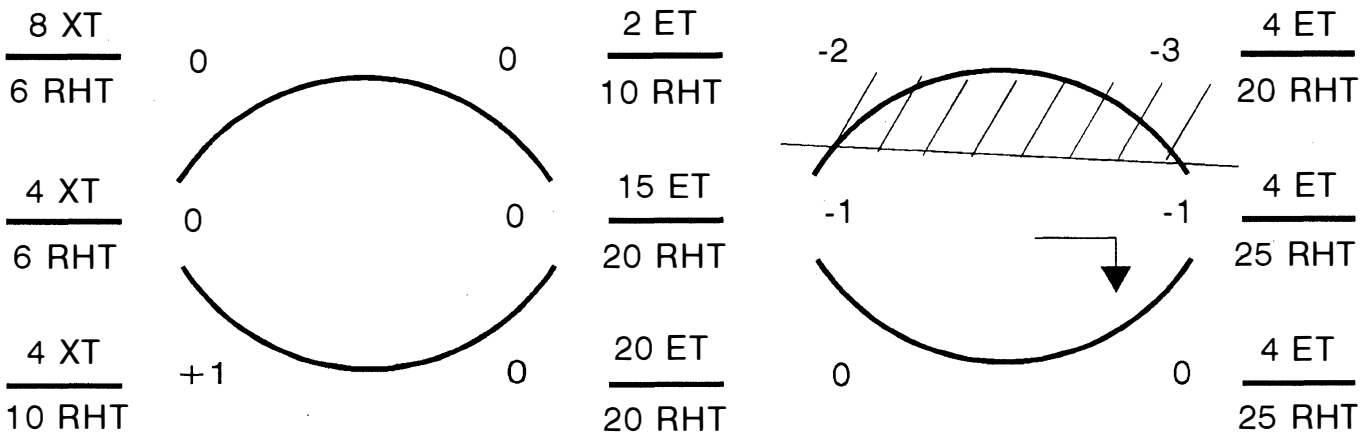


Fig. 7. *Oculomotor findings of a 40-year-old woman (case 3) with diplopia following retinal detachment surgery (prism cover tests in prism dioptres).*

superior rectus. The head tilt test confirms that the diagnosis is a left superior oblique paresis.

2. *The Muscles Responsible.* Versions show that there is underaction of the left superior oblique (−1), overaction of the ipsilateral inferior oblique (+2) and an overaction of the contralateral inferior rectus (+1). This is confirmed by the prism cover tests which show a 15 prism dioptre left hypertropia (LHT) which increases to 30 prism dioptres LHT in the field of action of the left inferior oblique. Further, the prism cover tests show that the LHT is virtually comitant in downgaze even out of the field of action of the obliques, suggesting right inferior rectus overaction.

3. *The Surgery.* When planning surgery for this patient, the following steps can be followed:

1. The vertical deviation in the primary position is 15 prism dioptres. Two vertical muscles will need to be operated upon to correct this degree of deviation.
2. The vertical deviation is incomitant in upgaze with the largest deviation in the field of action of the left inferior oblique. A left inferior oblique weakening procedure (recession or myectomy) is required.
3. The vertical deviation is more comitant in downgaze due to inferior rectus overaction. An inferior rectus weakening procedure is necessary, and in this case an inferior rectus recession on an adjustable suture would be appropriate.

Case 2

Fig. 6a shows the ocular motility record of a 6-year-old boy with an exotropia. Photographs in nine positions of gaze are shown in Fig. 6b. The diagram shows he has a 60 prism dioptre 'V' pattern exotropia with bilateral inferior oblique overaction (+4). In side gazes he has alternating hypertropia and lateral incomitance. The 'V' pattern is emphasised by the vertical lines arranged in a 'V' and the overaction of both inferior obliques in adduction is indicated by the arrows. This child required bilateral inferior oblique myectomies and bilateral lateral rectus recessions with supraplacement of the lateral recti.

Case 3

This 40-year-old woman complained of diplopia following retinal detachment surgery (which involved an external buckle placement). Fig. 7 shows the results of ocular motility examination which illustrates the method of documentation of restrictive defects. She has a restriction of elevation of the left eye and restriction of both abduction and adduction resulting in an esotropia in the primary position and an exotropia on looking to the right. From the diagram it can be seen that the restriction of upgaze is worse in abduction and associated with a downshoot of the left eye. This amount of information would be difficult to document concisely with a conventional orthoptic report.

DISCUSSION

Our experience of using the above method for the examination and documentation of strabismus at Southampton has shown it to be a practical, versatile and reproducible system. The main advantage of the system is that the underlying cause of the ocular motility problem can be determined from the information in the report, and thus problem solving can be approached in a logical, step-wise progression. Pictorial representation encourages the examiner to make both a qualitative and quantitative assessment of versions, allowing more informed decisions when assessing management options.

We do not accept the criticism that prism cover tests in nine positions of gaze are inaccurate and difficult to perform. We have found the system reproducible by the same observer on different occasions and between observers. There are pitfalls in the measurement of strabismic deviations with prisms[4–6] but awareness of these allows the development of an accurate and simple technique that can easily be mastered and performed by orthoptists and doctors alike. Distance fixation is particularly important, and in children this can be achieved by using a television screen and video cartoons. If distance fixation is not possible, the chart can be used for near fixation results using the appropriate notation (i.e. E′ for near esophoria and X′T for near exotropia).

Single prisms have many advantages compared with prism bars when performing prism cover tests in nine positions of gaze. Single prisms are larger, allowing better

distance fixation. A horizontal and a vertical prism can be held in the same hand, allowing both the horizontal and vertical component of the strabismus to be neutralised in front of the paretic eye while performing the cover test with the other hand. Furthermore, it is possible to hold a horizontal prism in front of each eye with one hand if the deviation is large, especially in children, in whom the nose presents less of an obstacle.

It must be emphasised that using prism cover tests in nine positions of gaze is not a replacement for the synoptophore or Hess chart. It is used in conjunction with them so that some of the deficiencies of Hess chart and synoptophore examination can be overcome. For instance, both the synoptophore and Hess charts measure deviation over a small field of muscle action whereas prism cover tests can be performed over the full range of ocular movement. Hess charts are more difficult to perform on younger patients. But when measuring torsion, further examination with double Maddox rods, the synoptophore or Hess charts is required. Hess charts are useful where there is a marked restriction of ocular movement and synoptophore examination is necessary for measurement of fusion potential in manifest strabismus.

The examples above show the versatility of this method of strabismus documentation in complex cases. Having the results of prism cover tests and versions on the same diagram allows the observer to cross-check the findings. For instance, if the versions show a +3 overaction of the left inferior oblique we would expect to see a left hypertropia on right gaze. This system is equally useful for documenting more straightforward squints. Versions, prism cover tests in the horizontal muscle fields of action and abnormal oblique muscle movements can be recorded on the basic template. It is not suggested that prism cover tests are performed in all nine positions of gaze in all patients; the template can be filled in as much as is necessary in the clinical situation.

The purpose of this article is to present a method of examination and documentation of strabismus. We have not attempted to address the sensory aspects of strabismus. The advantages of the examination system are that it is easy to perform even in children, it measures the full range of ocular movements and it emphasises the affected muscles. Detailed examination of ocular motility disorders should be one of the diagnostic capabilities of the ophthalmic surgeon, enabling a more fruitful dialogue between orthoptist and surgeon to the benefit of the patient.

We consider that a diagrammatic representation of ocular motility examination findings more clearly demonstrates the oculomotor deficit and enables a more logical approach to diagnosis and treatment. Standardisation of the documentation of strabismus enables better communication within ophthalmic departments. Equally important, standardisation of documentation would enable communication between different ophthalmic units and would facilitate comparison of results in publications.

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