Change in posterior partial volume (PPV) is the best contractility index, observed on MRI studies. It robustly correlates with the ductions for horizontal rectus EOMs.

Horizontal rectus EOMs (MR as well as LR) have been divided into superior and inferior halves (compartments) on MRI studies. Inferior compartments are slightly larger than the superior compartments of both MR as well as LR muscles.

In lateral rectus (LR) muscle, MRI studies, the contractility for convergence as well as adduction is reported to be similar in both superior as well as inferior compartments.

In medial rectus (MR) muscle, however, the superior compartment exhibited much greater contractility in adduction than in convergence.

During vertical duction on MRI studies, no differential compartmental changes were noted in vertical recti (SR and IR). However, superior compartments of MR muscles showed changes in maximum cross-section and PPV. But no change was noted in inferior MR compartments and in LR muscle compartments.

During vertical fusional vergence (VFV), induced by a 2 PD base up prism, the LR and SO muscles are reported to exhibit differential compartmental contraction. These observations suggest that the EOM mechanisms that normally compensate for the vertical heterophoria are highly complex.

Compartmental brainstem control for the differential compartmental behaviour of the EOMs has also been reported in the neuroanatomic studies.

Compartmental involvement of extraocular muscles has also been reported in nerve palsies as below:

- *Greater atrophy of superior than inferior compartment of LR muscle* is reported in about 30% cases of abducens palsy. An ipsilesional hypotropia, suggesting preserved inferior compartment function, is also reported in some cases.
- *Hypertropia, that increases in abduction*, reported in many cases of isolated LR palsy, suggests relationship to the residual LR contraction.

ORBITAL FASCIA

The orbital fascia is a thin connective tissue membrane lining the various intraorbital structures. Recent studies have shown that this is a complex interwoven connective tissue joining the various intraorbital contents. Though the orbital fascia is one tissue, for descriptive convenience, it can be described under the heads of (Fig. 1.6):

- Fascia bulbi,
- Sleeves (fascial sheaths) of extraocular muscles,
- Extraocular muscle pulleys,
- Anterior pulley slings (intermuscular septa), and
- Fascial expansions of extraocular muscles.

FASCIA BULBI

Fascia bulbi, or Tenon's capsule, envelops the globe from the limbus to the optic disc. Its inner surface is well defined and lies in close contact with sclera to which it is connected by fine trabeculae. The outer surface of the fascia bulbi lies in contact with orbital fat posteriorly and with subconjunctival tissue anteriorly with which it merges near the limbus. Tenon's capsule is separated from the sclera by episcleral space (Tenon's space), which can be readily injected. Tenon's capsule can be divided into anterior and posterior portions:

- *Anterior Tenon's capsule* is the subconjunctival membrane that extends from the limbus to the level of penetration of the rectus muscles (About 10 mm posterior to the insertion of rectus muscles, i.e. just posterior to the equator).
- Anteriorly, it fuses with the conjunctiva 2 to 3 mm posterior to the limbus. When suturing a muscle during strabismus surgery, it is important to clear anterior Tenon's capsule off the tendon insertion to avoid complication of a slipped muscle.
- *Posterior Tenon's capsule* extends from the penetration of the recti muscles to the optic nerve and thus separates the orbital fat from the sclera.

Around the distal end of optic nerve, the posterior Tenon's capsule is fused with the dural sheath of the optic nerve. Schwalbe, however, considered it to be continuous as a membrane surrounding the dural sheath to form a till arc of contact is practically zero that is, the tangential point coincides with the anatomical insertion.

Since the power of a muscle is proportionate to its length and arc of contact, retroplacement of the insertion of muscle (recession) weakens the action of the muscle by shortening its effective length and by reducing its arc of contact in the various positions of gaze. Advancement of an extraocular muscle has a strengthening effect because of the increase in the effective length as well as its arc of contact.

4. ***Muscle plane.*** It is an imaginary plane which passes through the midpoints of origin of the muscle (O), anatomical insertion (A), functional insertion, i.e. tangential point (T) and the centre of rotation of the globe (C) (Fig. 2.5). Thus each muscle plane runs through the long axis of the muscle. The angle formed by a muscle plane with the visual direction or line of fixation depends on the position of the globe. When the line of fixation lies in or parallel to the muscle plane, the angle is zero.

The ocular muscles are paired, each pair having a common muscle plane. These pairs are the medial and lateral recti [their muscle plane coincides with the horizontal plane of the globe], superior and inferior recti [their muscle plane makes an angle of 23° with the visual line in primary position (Fig. 2.6)] and superior oblique tendon from the trochlea to globe and the inferior oblique [their muscle plane makes an angle of about 51° with the visual line when the eye is in the primary position (Fig. 2.7)].

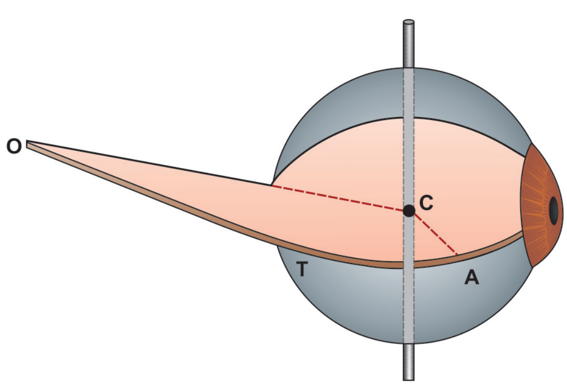

Fig . 2.5 *Schematic presentation of muscle plane (TACO).*

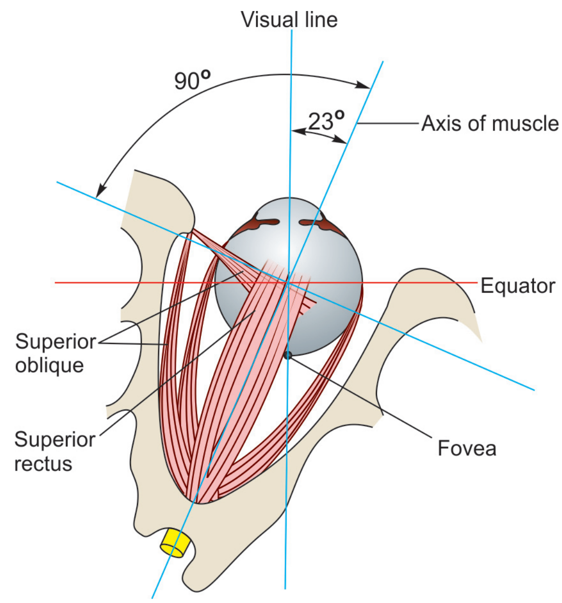

Fig. 2.6 *Relation of muscle plane of superior and inferior recti with the visual line in primary position.*

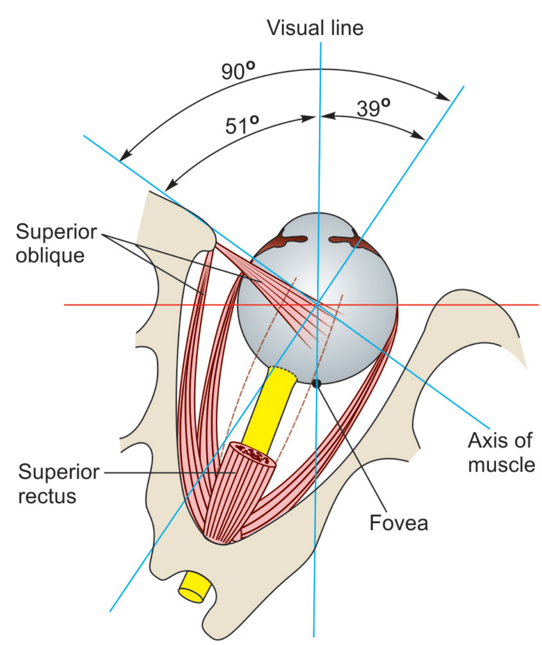

Fig. 2.7 *Relation of muscle plane of superior and inferior obliques with the visual line in primary position.*

5. ***Muscle axis of rotation.*** It is perpendicular to the muscle plane erected in the centre of rotation. The individual muscle pulling on the eye will rotate the globe around this axis through the centre of rotation.

cone in between (of 1.5 m diameter) must be unstimulated. The retinal image size for a given visual angle may vary slightly with changes in viewing distance and associated changes in accommodation of the lens, but this effect is relatively small.

COMPONENTS OF VISUAL ACUITY

In clinical practice, measurement of the threshold of discrimination of two spatially separated targets (a function of the fovea centralis) is termed visual acuity. However, in theory, visual acuity is a highly complex function that consists of the following components:

- Minimum visible,
- Resolution,
- Recognition, and
- Minimum discriminable.

MINIMUM VISIBLE

The ability to determine whether or not an object is present in an otherwise empty visual field is termed *visibility* or *detection.* This kind of task is referred to as the *minimum visible* or *minimum detectable.*

RESOLUTION (ORDINARY VISUAL ACUITY)

Discrimination of two spatially separated targets is termed resolution. The minimum separation between the two points, which can be discriminated, is known as *minimum resolvable.* Measurement of the threshold of discrimination is essentially an assessment of the function of the fovea centralis and is termed *ordinary visual acuity.* The distance between the two targets is specified by the angle subtended at the nodal point of the eye. The normal angular threshold of discrimination for resolution measures approximately 30–60 seconds of an arc; it is usually called the minimum angle of resolution (MAR). The clinical tests determining visual acuity measure the form sense or reading ability of the eye. Thus, broadly, resolution refers to the ability to identify the spatial characteristics of a test figure. The test targets in these tests may either consist of letters (Snellen's chart) or broken circles (Landolt's ring). More complex targets include gratings and checkerboard patterns.

RECOGNITION

It is that faculty by virtue of which an individual not only discriminates the spatial characteristics of the test pattern but also identifies the patterns with which one has had some experience. Recognition is thus a task involving cognitive components in addition to spatial resolution. For recognition, the individual should be familiar with the set of test figures employed in addition to being able to resolve them. The most common example of recognition phenomenon is identification of faces. An average adult can recognize thousands of faces.

MINIMUM DISCRIMINABLE OR HYPERACUITY

Minimum discriminable refers to spatial distinction by an observer when the threshold is much lower than the ordinary acuity. The best example of minimum discriminable is *vernier acuity*, which refers to the ability to determine whether or not two parallel and straight lines are aligned in the frontal plane. The threshold values of vernier acuity (Fig. 3.2) are in the range of only a few seconds (2–10) of arc. Hyperacuity should not be confused with the threshold for the minimum visible, where merely the presence or absence of a target is being judged. The mechanism subserving hyperacuity is not clearly known, but so much is clear; no contradiction is involved with the optical and receptor mosaic factors that limit ordinary visual acuity.

MEASUREMENT OF VISUAL ACUITY

As discussed earlier, the visual acuity is a highly complex function that consists of:

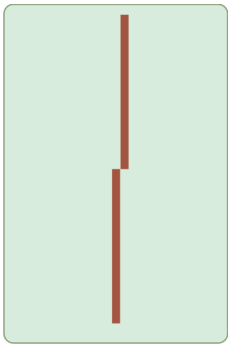

Fig. 3.2 *Typical target configuration for detecting vernier acuity.*

Great Britain in 1952 devised another near-vision chart. It consists of 'Times Roman' type fonts with standard spacing (Fig. 3.19). According to this chart, the near vision is recorded as N5, N6, N8, N10, N12, N18, N36 and N48.

3. ***Snellen's near-vision test types.*** Snellen introduced the so-called 'Snellen's equivalent for near vision' on the same principles as his distant types. The graded thickness of the letters of different lines is about 1/17th of the distant-vision chart letters. In this event, the letters equivalent to 6/6 line subtend an angle of 5 minutes at an average reading distance (35 cm/14 in.).

The unusual configuration of letters of this chart, however, cannot be constructed from the available printers' fonts. It can only be reproduced by a photographic reduction of the standard Snellen's distant-vision test types to approximately 1/17th of their normal size. Further, such a test has never become popular.

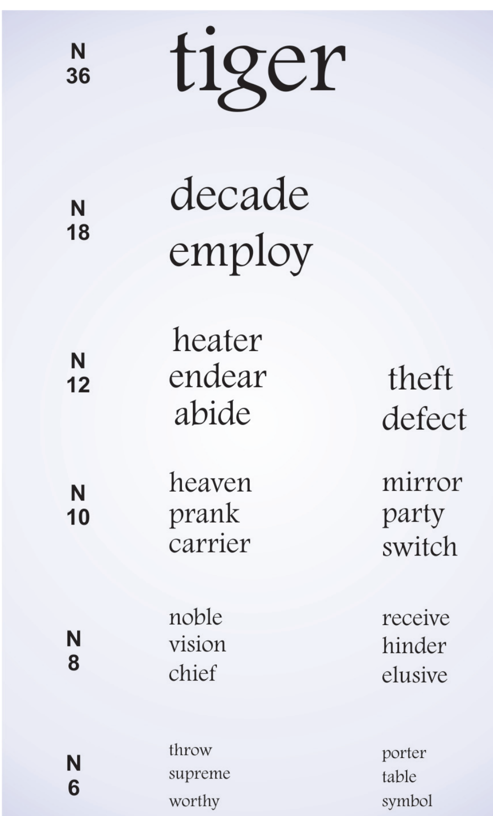

Fig. 3.19 *Near-vision chart.*

The graded sizes of pleasing types of passages from literature, the reading of which helps in the interpretation, are habitually employed.

4. ***Lea near-vision cards.*** This test assesses a child's functional vision at near distances. It can also be used to familiarize child with testing procedure before introducing a distance test. It consists of cards measuring 8" × 10" (20.3 cm × 25.4 cm) which contain proportionally spaced (logMAR) lines on one side and more tightly-spaced symbols on the opposite side. Line sizes range from 20/400 to 20/10 (6/120 to 6/3) equivalent, 0.05 to 2.00. Response key is printed on test card. Testing distance is about 16 inches/40 cm.

Procedure of testing

For testing the near vision, the patient is seated in a chair and asked to read the near-vision chart kept at a distance of 25–35 cm, with a good illumination thrown over his or her left shoulder. Each eye should be tested separately. The near vision is recorded as the smallest type that can be read comfortably by the patient. A note of the approximate distance at which the near-vision chart is held should also be made. Thus near vision (NV) is recorded as:

- NV 5 J_1 at 30 cm (in Jaeger's notation)
- NV 5 N_5 at 30 cm (in Faculty's notation)

Near-vision equivalents in different notations

These are shown in Table 3.5.

CONTRAST SENSITIVITY

INTRODUCTION

Contrast sensitivity is the ability to perceive slight changes in luminance between regions that are not separated by definite borders and is just as important as the ability to perceive sharp outlines of relatively small objects. It is only the latter ability that is tested by means of the Snellen's test types. In many diseases, loss of contrast sensitivity is more important and disturbing for the patient than is the loss of visual acuity. Further, contrast sensitivity may be impaired even in the presence of normal visual acuity.