Introductory Remarks

The functions of lateral and medial rectus pose no problems in understanding the intricate motions of the eyeball. They move the eyeball laterally or medially, respectively. The functions of superior and inferior obliques to a large extent, and superior and inferior recti, to a lesser degree pose problems for students in solving the medical board related questions. It is the purpose of this supplement to provide tips on how to resolve the ambiguities and successfully pick the correct options on the exam.

The problem mainly stems from several contributing factors:

1. When acted alone and in a single eye, each muscle acts primarily in a particular fashion. Superior rectus raises (and to some extent adducts); inferior rectus depresses (and to some extent adducts); inferior oblique raises (and abducts); and superior oblique depresses and abducts. In other words in isolated fashion, the two obliques abduct and the two recti (superior and inferior) adduct. As a general rule basic anatomists are more interested in these functions. Also, for most part older generations of medical board test items have had more questions related to these isolated functions.

2. Complexities arise from getting into account the angle of insertion of each muscle onto the eyeball, synergistic action of each muscle with respect to the other muscles of the same eye, and their integrated function when yoked to the muscle of the other eye. As a general rule clinicians are more interested in these functions. Also, for most part new generations of medical board test items have more questions related to these integrated functions.

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Isolated Functions of Superior and Inferior Rectus

<table>
<thead>
<tr>
<th>Superior Rectus</th>
<th>Inferior Rectus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up &amp; In</td>
<td>Down &amp; In</td>
</tr>
</tbody>
</table>

Note: This mnemonic is only useful when you consider the function of SO in isolated eye and when superior oblique acts alone and independent of all other ocular muscles. This function is of interest to basic anatomists and not to the clinicians.

Isolated Functions of Superior and Inferior Obliques

<table>
<thead>
<tr>
<th>Superior Oblique</th>
<th>Inferior Oblique</th>
</tr>
</thead>
<tbody>
<tr>
<td>Down &amp; Away</td>
<td>Up &amp; Away</td>
</tr>
</tbody>
</table>

From skies (superior) you look down! From bottom (inferior) you look up!

Mnemonic is only for oblique muscles!

Rectus is CoRect (ie. Superior rectus is correctly looking to superior side!)

Isolated (Singular) Anatomical Functions

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superior Rectus</td>
<td>Upward (1°) and medial rotation (2°)</td>
</tr>
<tr>
<td>Inferior Rectus</td>
<td>Downward (1°) and medial rotation (2°)</td>
</tr>
<tr>
<td>Superior Oblique</td>
<td>Downward and Lateral/Temporal (Away)</td>
</tr>
<tr>
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</tr>
</tbody>
</table>

Table shows the functions of the four muscle when they perform in isolated fashion and independent of all other muscles in a single eye.

Note: At times the suffix “duction” is used when the reference is made to the function of a particular muscle on the eyeball in an isolated (singular/one-eye) manner. For example, when we say “superior oblique abducts” we are referring to the isolated function of SO only in one eye.
Two Old Board-Type Questions

1. Which of the following options correctly describes the function of Superior oblique muscle?

A. Depresses and rotates medially  
B. Depresses and rotates laterally  
C. Elevates and rotates medially  
D. Elevates and rotates laterally  
E. Depresses the eyeball

2. Which of the following options correctly describes the function of superior rectus muscle?

A. Elevates the eyeball  
B. Depresses the eyeball  
C. Elevates and rotates laterally  
D. Depresses and rotates laterally  
E. Elevates and rotates medially

Answer: From the language of both questions we can imply that we are dealing with purely basic anatomy or old type board questions. The best answer for 1 is [B] and for 2 is [E].

Mechanism of Action of Superior and Inferior Recti

The primary function of Superior Rectus is to elevate the eyeball. However, as you see in the diagram, it does not travel back straight from its site of insertion on the upper part of the eyeball to its origin at the back of the orbit (AKA. Annulus of Zinn). In other words it does not follow directly the visual axis. Therefore there is a 23-25° angle between the visual axis and axis of SR. This deviation causes the secondary action of SR, that is intortion (i.e. adduction or nasal rotation). Inferior rectus also follows a similar path but from the inferiors aspect of the eye. By the same reasoning in addition to depression, it also (secondarily) rotates the eye nasally.

In clinical testing when you ask the patient to look laterally (temporal side) the visual field and course of the two recti are aligned. In other words, in this position the superior rectus would be in its best scenario for raising the cornea, and inferior rectus, for depressing it.

The angle of insertion and location of the pulley of superior and inferior oblique also provide a similar situation for these two muscles. The optimal position for the two obliques to raise or depress the eyeballs is attained only when the patient is first asked to look medially. In this position the ability of the SO to depress and IO to elevate is maximally tested by the physician.

Four of The Clinical Cardinal (Diagnostic) Positions

| Left and Down | Right Superior Oblique and Left Inferior Rectus |
| Right and Down | Right Inferior Rectus and Left Superior oblique |
| Right and Up | Right Superior Rectus and Left Inferior Oblique |
| Left and Up | Right Inferior Oblique and Left Superior Rectus |

Note: There are 9 cardinal positions. The four cited positions (above) are the ones utilized in testing SO, IO, SR and IR.

Mnemonic for Clinical Testing Positions

MOLaR! 
Medial direction tests the Obliques  
Lateral direction tests the Recti!  
Medial, Oblique; Lateral Rectus!

Cardinal Testing Position of Superior and Inferior Obliques

For Superior Oblique Pupils should be down and nasal  
For Inferior Oblique Pupils should be up and nasal

Notice: Please replace this test with the lower left panel information on pp. 25 of your "Bare Minimum".

*Notes: A pupil that is deviated nasally first and then downward confirms that SO is functioning well on that eye (i.e. SO has moved that eye downward properly). If after attaining the nasal position the patients fails to move down his/her eye, we may conclude SO palsy for that eye.

Test-taking Strategy: The eye that is deviated medially optimally tests the obliques. If a patient reports diplopia in the medial position, the problem must be related to one of the two obliques; superior or inferior.

Tips: If a question includes statements such as “a patients fails to…” or “a patient reports diplopia when asked to look to …” most likely you are dealing with the cardinal gaze situations. As an illustration look at the following question:

Concept of Cardinal Positions of Gaze

In clinical settings often we are required to test patients for the actions of superior and inferior recti and superior and inferior obliques. These actions are more complicated when the patient is directed to look vertically upward or downward, or horizontally inward and outward.

Due to the positions of superior and inferior rectus (see the above diagram) only when the patient is directed to look laterally (temporal side) the visual field and course of the two recti are aligned. In other words, in this position the superior rectus would be in its best scenario for raising the cornea, and inferior rectus, for depressing it.

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Tips: If a question includes statements such as “a patients fails to…” or “a patient reports diplopia when asked to look to …” most likely you are dealing with the cardinal gaze situations. As an illustration look at the following question:
Due to complaint of frequent episodes of diplopia an ophthalmologist is examining a patient. Examination reveals that the patient experiences diplopia only when he attempts to look upward and to the right. No other significant ophthalmologic finding is observed. This patient is most likely suffering from paresis of which of the following ocular muscles?

(A) Right inferior oblique and/or left superior rectus
(B) Right superior oblique and/or left inferior rectus
(C) Left inferior oblique and/or right superior rectus
(D) Left inferior oblique and/or right medial rectus
(E) Right lateral and/or left medial rectus

The best answer is [C]

**About the Obliques**

The primary function of Superior Oblique due to its insertion pattern is intorsion/rotation around visual axis. This movement is not changing the position of pupil. Also, as the SO contracts, the back of the eyeball is raised and the front depressed (secondary function). Finally, SO also causes some abduction (tertiary role).

In testing the actions of SO (in clinical settings), ophthalmologist asks the patient to first look medially. In this position the ability of SO to depress the eye is maximally tested. The same principle applies to the IO. This time by asking the patient to look medially we are maximally testing the ability of IO to raise the eyeball.

**Summary of Two Key Gaze Positions**

In looking to the right and up, the left inferior oblique and right superior rectus work cooperatively (are yoked together).

In looking to the left and down, the right superior oblique and left inferior rectus work cooperatively (are yoked together).

**Drill Scenarios**

1. You are examining two patients. Your first patient attains the following gaze position with no problem. The second patient, however, reported diplopia when she attempted to attain the following gaze. What pair of muscles would most likely have a palsy in the second patient?

2. During an eye examination you noticed that when you asked your patient to look straight ahead (i.e. primary eye position), his eyes attained the “A” position. However when you asked him to look directly downward his eyes took the “B” position. What ocular muscle(s) palsy may explain these findings?

3. What eye muscles are responsible for elevation?

4. In testing the eye muscles of a patient, the eye that is abducted (turned temporally) will test which two muscles?

5. A female patient with multiple sclerosis is presented with internuclear ophthalmoplegia. What would be the most likely characteristic deviation of her left eye?

**Answers**

1. Right Inferior Oblique & Left Superior Rectus
2. The failure of left eye depression is an indication of either left inferior rectus or left superior oblique muscle palsy.
3. SR and IO
4. SR or IR
5. Internuclear ophthalmoplegia (medial longitudinal fasciculus) causes bilateral lower motor neuron deficit of nerve III. As you may recall from the mnemonic of (SO/LR)\(^3\) all muscles of the eye are innervated by the nerve III except SO and LR. Therefore, these would be the only two muscles that can mechanically operate the eyes. Lateral rectus deviates both eyes (to the temporal/lateral side). Hence, the left eye turns to the left side. Superior oblique tends to move the eyes downward and laterally (in the absence of medial rectus). Hence, the left eye of the patient tends to tilt downward and to the left—that is to the direction that is directed by the two intact eye muscles.