An Aid for the Diagnosis of a Vertical Muscle Paresis

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The identification of the involved muscle in a patient with a single vertical muscle paresis causing a cyclovertical deviation has always been a problem. Because the oblique muscles and the vertical rectus muscles influence torsion as well as elevation and depression, depending upon the horizontal position of the eye, it is often difficult to determine which muscle is paretic. I shall review the examination of the muscles and describe a simple aid for determining the paretic muscle. I shall also describe how the use of this aid may organize and simplify the approach to the patient with a vertical muscle paresis.

In 1871 Nagel suggested that the cause of ocular torticolis was the torsion caused by the superior muscles of one eye and the inferior muscles of the other eye acting against weak antagonists. This was supported by Hofmann and Bielschowsky in 1900 who at the same time incorrectly explained head tilting as an attempt at bringing the two vertically deviated eyes into horizontal alignment so as to relieve vertical diplopia. In 1935 Bielschowsky explained his error and described his head tilting test. He did not feel, however, that the test applied to all the vertical muscles, but only to the obliques. Since then the relationships between vertical rectus muscle paresis and abnormalities on head tilting have been firmly established.

Parks, in 1958, made a substantial contribution to the diagnosis of vertical muscle paresis with his three-step examination. The steps reduced the possible offending muscles from eight to four, then to two, and finally to one. The examination is based on the functional anatomy of the vertical muscles. The oblique muscles exert torsion on the globe when the eye is abducted and cause vertical movement when the eye is adducted. The vertical rectus muscles cause torsion in adduction and vertical movement in abduction. Parks’ examination has the advantage of being simple, organized, and accurate. However, it has the disadvantages of requiring a certain amount of rote memory, calculation, and reasoning in order to make the correct diagnosis. This is not a problem for anyone using the test routinely, but it is frequently uncomfortably difficult and confusing for someone using the test only occasionally. Schwarting, in 1968, went so far as to design a digital computer to aid in making the correct diagnosis.

The first step of the examination is determining which eye has a hypertropia in the primary position. Both eyes in a patient with a paresis of a vertical muscle will have vertical deviations. An eye will have a hyperdeviation if the paretic muscle is a depressor, ie, the inferior rectus or the superior oblique. It will have a hypodeviation if the paretic muscle is an elevator, ie, the superior rectus or the inferior oblique. In either case the contralateral eye will appear to be deviated in the opposite direction. Knowing which eye has the hyperdeviation and which eye has the hypodeviation reduces the possible paretic muscles from eight to four.

The vertical deviation must be worse in the field of gaze in which the paretic muscle has its main vertical action, since the ipsilateral
Fig. 1: On head tilt the eyes undergo torsion to maintain their rotational alignment.

antagonist will be acting without the usual opposing tone of the paretic muscle. A vertical worse deviation on the left gaze must be caused by a paresis of one of the muscles causing vertical movement in left gaze, i.e., the left vertical rectus and the right oblique. For example, a paretic left inferior rectus would result in an unopposed action of the left superior rectus and a hypertropia would result when gazing to the left. Since these muscles have little vertical function on gaze to the right, the hypertropia would be diminished or eliminated when looking in this direction. Thus, step two is determining whether the deviation is worse on gaze to the right or to the left, and this knowledge reduces the possible paretic muscles from four to two.

The third step involves the torsional activity of the vertical muscles. The superior muscles (rectus and oblique) are intortors. The inferior muscles are extortors. A vestibular reflex causes torsion of the eyes when the head is tilted to maintain the rotational alignment of the eyes, i.e., to keep the 12 o'clock axis vertical no matter how the head tilts. For example, if the head tilts to the left, the left intortors, the superior muscles, act to intort the left eye while the right extortors, the inferior muscles, act to extort the right eye (Fig. 1). Since these muscles are also elevators and depressors, a vertical deviation will result if one of the muscles is paretic. A worse deviation on the left head tilt identifies the left superior rectus or superior oblique, or the right inferior rectus or inferior oblique as being the paretic muscle. Similarly a deviation greater on right head tilt implicates the right superior rectus or oblique, or the left inferior rectus or oblique. The third step, then, is determining the direction of head tilt resulting in the greater vertical deviation. From this information the possible paretic muscles are reduced from two to one and the diagnosis is made.

The three-step examination for the identification of vertical muscle paresis requires command not only of the functional anatomy of the muscles, but it also requires a certain degree of calculation and deduction to make the proper diagnosis. I have simplified the calculations allowing the correct diagnosis to be made as quickly and as simply as possible. Using my method the reasoning behind each step is unstated but intuitively obvious. My basic design is a diagram of the eyes with the vertical fields of action of the muscles indicated. These can be easily identified by remembering that the eyes are directed into a field of gaze by the similarly named rectus and the oppositely named oblique. For example, to look into the right superior field of gaze one requires the right superior rectus and the left inferior oblique. Looking into the left inferior field of gaze requires the left inferior rectus and the right superior oblique (Fig. 2). In practice I use two capital Hs. The crossbar represents the eye and the vertical bars represent the actions of the vertical muscles. The reader may wish to develop his/her own abbreviations.

When I determine the vertical deviation in step one, I circle the muscles in each eye opposite to the vertical deviation. In a left hyper-/right hypo-deviation, I circle the left depressors and the right elevators (Fig. 3).

When I determine the horizontal field of
worse deviation, I circle the muscles acting when the eyes are pulled to that side. For example, if the deviation is worse on left gaze, I circle the left recti and the right obliques (Fig. 4).

Finally, when I determine the direction of head tilt giving the worse deviation, I draw a diagonal oval around the muscles of each eye in the same direction as I view the patient’s head, surrounding two of the muscles. For example, a deviation worse on right head tilt results in an oval sloping down from left to right—just as I view the patient. This encircles the right superior muscles (the intorters) and the left inferior muscles (the extorters) (Fig. 5).

Examination of the diagram reveals only one muscle circled three times and the diagnosis is made. The preparation of the diagram and the making of the circles takes seconds. Time is not wasted in calculation, or in remembering which muscles have been either included or excluded by previous testing. One does not have to repeat various steps to recall which muscles were eliminated earlier. Each step is done once and the results and implication of each step is immediately and permanently recorded.

One does not have to recall in which fields of
gaze the muscles have vertical or torsional activity. It is obvious from the diagram. One does not have to recall an assortment of left, right, superior, inferior, rectus, or oblique muscles at each step. It is all on your diagram. Even the torsional activity of the superior and inferior muscles on head tilt to either side is obvious from the diagram. You can predict the preferred head position of any patient with a single vertical muscle paresis as it will be opposite to the circles made on the diagram in steps two and three. And finally, scrap paper is less expensive than a computer.

**SUMMARY**

I have described a simple method involving a diagram and circles for dealing with the results of the three-step examination of the vertical muscles used in diagnosing a single paretic muscle. It may prove beneficial for those who evaluate these muscles infrequently as using the diagram allows immediate appreciation of the functional anatomy of the muscles, the physiologic implications of each step of the examination, and a permanent record of the selection through elimination of the paretic muscle.
REFERENCES