XIII. "On the Centre of Motion in the Human Eye." By J. L. Tupper. Communicated by S. J. A. Salter, F.R.S. Received May 15, 1874.

(Abstract.)

The paper of which this is a short abstract premises that its argument is conditional, that it adopts all the fundamental optical conditions as they are received, that the received centre of motion is not one of these, but is supposed to be legitimately derived from them, and that the author disputes this and proposes :—

1st. To show that this conclusion is inconsistent with its premises, and that a different though indefinite conclusion is thence derivable ;

2nd. By experiment, to develop and reduce that conclusion to a definite form ;

3rd. To verify it by anatomical induction.

The latest investigations (those of Prof. Donders) have placed the centre of motion nearly two millimetres behind the centre of the globe, and in the cornea's axis. The process of proof assumed that the centre of motion is equidistant from the outer and inner margins of the cornea, and, moreover, that the eye's visual line (ordinarily at 6° with the cornea's axis) will, by mere rotation, in turn coincide with three or more radii of the same circle ; or that, without moving the head, we can successively sight the lines on a graduated circular arc, seeing them as so many points.

The paper first proves, by a geometrical diagram, that if the eye, by simple rotation, can thus see the radii of a circle, the centre of motion must be in the visual line, not in the cornea's axis, as hitherto supposed ; proves next, by pairs of sights set up on the radii of a circle, and actually seen as so many points, that the centre of motion *is*, in fact, in the visual line ; and proves, lastly, by measuring (mechanically) how far the front of the cornea is from the converging point of the radii thus sighted, that the centre of motion is about $\frac{9}{25}$ of an inch, instead of $\frac{14}{25}$ of an inch, behind the cornea's anterior surface.

Then follows a twofold anatomical corroboration of these conclusions by examination,

1st, of the living eye ;

2nd, of the dissected eye.

(1st) If the eye rotated on a point in the antero-posterior diameter (or cornea's axis), then any two points equidistant from the cornea's centre would in turn occupy the same point in space, as assumed by Prof. Donders. The first experiment shows that two such corresponding points will not, as the eye turns, fall into the same place ; whilst other examinations of the living eye show not only that *symmetrically situated* points move *asymmetrically*, but move asymmetrically in such a way as would occur if the centre of motion were external to the antero-posterior axis,

or somewhere in the visual line behind the nodal point, a position which agrees with that assigned to the centre of motion by the preceding analysis.

(2nd) The dissected organ exhibits an asymmetrical attachment of the recti muscles, so that a vertical plane cutting these attachments is further from the external than from the internal margin of the cornea.

The circumference of this plane would be a circle, and the attachment of the globe's suspensory ligament, that resists the backward traction of these muscles, is found also to be a circle parallel to, and one line further back than, the former circle. The latter may be considered the base of a cone, whose vertex is the optic foramen, in the surface of which cone the recti muscles are situate. The base is therefore kept in equipoise by the symmetrical arrangement of the contracting muscles behind and the resisting suspensory ligament in front; so that the contraction of a single rectus, as it draws back the ligament on one side, increases its forward traction on the other side, and moves any two opposite points of the cone's base equally in opposite directions, or rotates it on its centre, a centre which is thus the anatomical centre of motion.

But however the recti are situate (and act) symmetrically with the base of this cone, the base is oblique with respect to the cornea (not at right angles to its axis), and consequently its centre will be on one side of the cornea's axis; and again, since the cone's base is further from the *outer* than from the *inner* margin of the cornea, its centre will be *outside* the cornea's axis. Now that part of the visual line where the preceding experiments have placed the centre of motion is *outside* the cornea's axis, while the base of the cone, whose centre has thus proved to be the anatomical centre of motion, is found to pass through the visual line $\frac{9}{25}$ of an inch behind the cornea, exactly in accordance with the results of the experiment with sighted radii of a circle.

Lastly, the obliquity of the cone's base with the base of the cornea proves to be a consequence of the hitherto unexplained want of lateral symmetry in the attachment of the recti muscles, thus explained as a most important means of adjusting the eye's visual line to the object; while some further peculiarities in the insertion of the recti, demonstrated in the author's dissections, conspire to attain the same end.

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