**RELATION OF MACULAR AND OTHER HOLES TO
THE INSERTION OF THE INFERIOR OBLIQUE***
**WITH A NOTE ON THE TOPOGRAPHY OF THE POSTERIOR SURFACE
OF THE GLOBE**

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THE macular region, like the peripheral retina, is liable to cystic degeneration, especially in high myopes and in old people. This gives a honeycomb appearance and on rupture of the cyst or cysts by slight or severe trauma a depression is produced which may be confined to the inner layers of the retina or form a macular hole. A hole may occur in a normal macula immediately after trauma or after an interval during which probably cystic degeneration has developed. A macular hole may also be formed in the process of retraction of the vitreous if the macula is previously diseased or affected. These holes are always round or oval with a punched appearance. Multiple holes are rare. They may or may not be accompanied by retinal detachment.

It seems that relationship exists between the formation of a macular hole and the contraction of the inferior oblique muscle (el Massri, 1958). In about five out of nine cases, the hole is accompanied by a peripheral tear or an area of degeneration at about 7 to 8 o'clock in the right eye or 4 to 5 o'clock in the left. At operation the peripheral tears were seen to be situated over the lateral end of the insertion of the inferior oblique. The central point of the macula, the fovea, lies about 2 mm. nasal to the inner end of this insertion, and is thus closely related to it. It was therefore deduced that contraction of the inferior oblique might influence the formation of a macular hole, a peripheral tear, or both. In a study of 72 cases of retinal detachment, Stagni (1953) found that the tear was at the site of insertion of the superior oblique in 51, of the inferior oblique in seven, of the inferior rectus in three, and of the medial rectus in one.

The continuous pull of a muscle on the sclera opposite a degenerate or cystic retina may help to produce a tear. A contraction of the inferior oblique, which has no tendon and is muscular up to its insertion (some of its fibres being inserted deep in the sclera), pulls on the rather thin sclera of a high myope and predisposes to the formation of a tear in a susceptible retina at its temporal insertion, and to that of a hole opposite or near the other end (*i.e.* at the macula). The outer edge of the macula is very near the insertion (1.5 mm.); the fovea is 2 mm. from it.

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This relation between a macular hole and a peripheral tear may be of practical importance. In any case with a macular hole, the examiner should search for a peripheral tear at 7 to 8 o'clock in the right eye, and at 4 to 5 o'clock in the left, and *vice versa*. Also, after exposing the macular region at the nasal end of the inferior oblique insertion, exposure of the temporal end of the muscle insertion helps in localizing the site of the other tear. If the retina there does not contain any tear or hole but only shows degeneration, one or two cauteries over this area would be sufficient protection.

As stated by Stagni (1953), most of the tears were opposite the superior oblique insertion as well as opposite the insertions of other muscles, especially if there was degeneration due to myopia, old choroido-retinitis, or senility. Probably lateral movements do not predispose to tearing because rotation in or out does not have much effect on the contour of a highly myopic eye. Movements up or down and in or out, especially if the eye is long, cause some distortion of the contour at the insertions of the oblique muscles and probably predispose to formation of tears at these sites.

An inferior oblique myotomy thus could be suggested as a prophylactic measure to prevent the formation of tears or holes or to prevent recurrences. A myotomy in these cases will have only a slight effect on the vertical movements in patients who rarely practice them after they have been advised to keep their eyes always straight. If the patient is one-eyed, myotomy of any of the obliques will have no effect on the position of the eye.

TOPOGRAPHY OF THE POSTERIOR SURFACE OF THE GLOBE

Since the publication of my two papers on retinal detachment (el Massri, 1958, 1960), other examples have confirmed these observations. Further investigation of the relation of the macula to the inferior oblique insertion revealed conflicting descriptions of the topography of the posterior surface of the globe.

Salzmann (1912) described the gross anatomical relations on the posterior surface of the eyeball as follows:

"The *m. obliquus inferior* has the shortest tendon of all the eye muscles (often practically none at all). One therefore, often sees cross-sections of muscle-fibres clinging to the outer surface of the sclera on the temporal side in horizontal sections through the posterior half of the eye; they belong to the *m. obliquus inferior*, and give one data as to which is the temporal side. The insertion line is 9.4 mm. long and forms a bow with its convexity upward, but often shows gross irregularities, such as angular serrations or dehiscences. It lies for the most part below the horizontal meridian and makes an angle of some 19° with it. The posterior (nasal) end of the insertion comes to within 5 mm. of the sheath of the optic nerve, the anterior (temporal) end lies in about the same meridian as the lower end of the insertion of the *rectus lateralis*.

The optic nerve, with its sheaths, forms a triangular rounded cord some 5 mm. in diameter. It is inserted to the nasal side, so that the centre of its insertion surface lies some 3 mm. medial to and 1 mm. below the posterior pole.

On both sides of the optic nerve (nasal and temporal to it) the *arteriae ciliaris posteriores longae* are visible as bluish stripes. They hold pretty closely to the line of the horizontal meridian and their line of union, therefore, goes slightly above the axis of the optic nerve. The point of entrance of the *arteria ciliaris posterior longa medialis* lies some 3.6 mm. from the optic nerve, somewhat nearer the optic nerve than that of the *arteria ciliaris posterior longa lateralis*, 3.9 mm. away.

The vortex veins (*venae vorticosae*) are usually four in number and lie grouped in two pairs (an upper and a lower). The points of exit of the upper pair lie on the respective sides of the vertical meridian, displaced somewhat nasally, and 7 mm. (the superior nasal vein, V_1) to 8 mm. (the superior temporal vein, V_2) behind the equator. The latter lies very close to the insertion of the *m. obliquus superior*. The lower pair (V_3 and V_4) show a similar relationship to the vertical meridian, but lie, however, somewhat further forward (5.5 to 6 mm. behind the equator)."

Salzmann (1912) showed these anatomical landmarks (Fig. 1, opposite), but the positions of the structures do not exactly match his description. For example, the lateral long posterior ciliary artery is shown to be nearer the optic nerve sheath than the medial long posterior ciliary artery; the reverse being correct. Again, the macula is not marked at all. He uses the term 'optic nerve' in the text when what is really meant is the 'optic nerve sheath' because no measurements could be taken either after enucleation or during operation except from the sheath. Also the macula is mentioned when the author means the fovea, because the macula cannot be used as a landmark unless the structures are related to its upper, lower, lateral, or medial margin.

Duke-Elder (1938) put the fovea at about 3.5 mm. from the temporal side of the optic disc (*i.e.* two disc diameters) and about 0.8 mm. below the horizontal meridian. If we know that the centre of the disc is 1 mm. below the horizontal meridian, it means that the fovea will be on a line above the optic disc centre. But he also stated that the upper margin of the macula was on a level with the middle of the disc, which could never be the case if the first statement is correct. Perhaps he means that the fovea is 0.8 mm. below a line passing through the centre of the disc, and not the horizontal line.

Wolff (1954) mentioned that the centre of the optic nerve was just *above* the horizontal meridian; he underlined the word "above" and in a drawing of the posterior surface of the globe put the macula on the horizontal line just on the temporal side of the vertical meridian and made the line of the inferior oblique insertion cross the horizontal meridian (Fig. 2, opposite). Again, he probably meant by a "horizontal line" one which passes horizontally through the fovea.

Wolff also stated that the nasal end of the inferior oblique insertion was about 5 mm. from the optic nerve and thus lay *practically over the macula* (only 2.2 mm. from it: Poirier, 1911).

According to Whitnall (1932), the nasal end of the inferior oblique insertion is about 5.2 mm. from the optic nerve sheath in normal eyes, but about 7.1 mm. in myopes. Whitnall's drawing (Fig. 3, opposite) shows the inferior oblique insertion in a different position from that marked by Wolff and does not indicate the position of the macula.

Traquair (1949) agreed that the fovea was below the centre of the optic disc, stating that the centre of the blind spot lay 1.5° or more below the horizontal line.

Here of course he meant the horizontal line on which lies the centre of fixation corresponding to the fovea.

These variations impelled me to draw my own chart of the posterior surface of the globe (Fig. 4). Here the positions of the different structures are shown with due regard to the macula, the nasal insertion of the inferior oblique, and the lateral long posterior ciliary artery. The close relationship of the macula to the inferior oblique insertion supports the hypothesis regarding the aetiology of macular holes suggested above.

[Courtesy of University of Chicago Press, Chicago.
FIG. 1.—Posterior surface of the globe, after Salzmann (1912).

FIG. 2.—Posterior surface of globe, after Eugene Wolff, "Anatomy of the Eye and Orbit" 4th ed. (1954), by permission.

[Courtesy of Humphrey Milford, Oxford.
FIG. 3.—Posterior surface of globe, after Whitnall (1932).

FIG. 4.—Posterior surface of globe, as drawn by the author.

N Nasal
T Temporal
SO Superior oblique insertion
IO Inferior oblique insertion

ON Optic nerve surrounded by sheath
VV Vortex veins, one in each quadrant
MPCA Medial long posterior ciliary artery
LPCA Lateral long posterior ciliary artery
X Macula

The actual measurements in Fig. 4 were taken as follows:

- Superior** *Line of insertion:* 10.7 mm. long.
 Oblique: *Temporal end:* 14.6 mm. from optic nerve sheath.
 Nasal end: 7.5 mm. from optic nerve sheath.
- Inferior** *Line of insertion:* 9.4 mm. long.
 Oblique: *Nasal end:* 6 mm. from optic nerve sheath (average 5.2 mm. in normal eyes and 7.5 mm. in high myopes) and 2.2 mm. from fovea (Whitnall, 1932).
- Equator:** 7 mm. from ora serrata, 19 mm. from fovea, and 14.6 mm. from limbus.
- Vortex** *Nasal superior:* 7 mm. behind equator.
- Veins:** *Temporal superior:* 8 mm. behind equator.
 Nasal inferior: 5.5 mm. behind equator, or 13.5 from macula.
 Temporal inferior: 6 mm. behind equator, or 13 mm. from macula.
- Fovea:** 3 mm. to temporal side of optic disc from inside, 2.5 mm. from optic nerve sheath in normal eyes, and 1 mm. below centre of optic disc.
- Macula:** 1 to 3 mm. in diameter.
- Optic Nerve** (within its sheath): Diameter in the orbit about 4 mm. [3 to 4 mm. (Whitnall) and 5 mm. (Salzmann)].
- Entry of Medial Long Posterior Ciliary Artery:** 3.6 mm. from sheath of optic nerve.
- Entry of Lateral Long Posterior Ciliary Artery:** 3.9 mm. from optic nerve sheath.

Fig. 4 shows the exact relations of the fovea, the macula, the nasal end of the inferior oblique insertion, the optic nerve sheath, and the lateral long posterior ciliary artery. Apart from the question of the aetiology of macular holes, this structural relationship will be seen at operation. The macula, with its central point the fovea, will be seen midway between the nasal end of the inferior oblique insertion and the optic nerve sheath and about 1 to 1.5 mm. below the point of entry of the lateral long posterior ciliary artery.

Summary

A theory connecting the formation of macular holes with the pull of the inferior oblique muscle is advanced. The presence of another hole or tear opposite the temporal end of the inferior oblique insertion has been observed and some practical clinical data are suggested. The exact topography of the posterior surface of the globe is described and a diagram presented to facilitate the approach to different structures in this region.

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