

Characterization Of Macular Edema From Various Etiologies By Optical Coherence Tomography

Thesis
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ANATOMY

General architecture of human retina:

The retina is the innermost coat of the three coats of the eye. It consists of two primary layers: an inner neurosensory retina and an outer retinal pigment epithelium (RPE).

These layers can be traced embryologically to the inner and outer layers of the invaginated optic cup. Between the neural retina and the PRE is a potential space called the subretinal space, across this space, the two layers must adhere. ⁽⁹⁾

As seen in the cross-section by light microscopy, **Figure (1)**, the retina is represented by 10 layers from the sclera to the vitreal side, they are:

- 1- Retinal pigment epithelium (RPE).
- 2- Photoreceptor layer of rods and cones (R&C)
- 3- Outer limiting member (OLM).
- 4- Outer nuclear layer (ONL).
- 5- Outer plexiform layer (OPL).
- 6- Inner nuclear layer (INL).
- 7- Inner plexiform layer (IPL).
- 8- Ganglion cell layer (GCL).
- 9- Nerve fiber layer (NFL).
- 10- Inner limiting membrane (ILM).

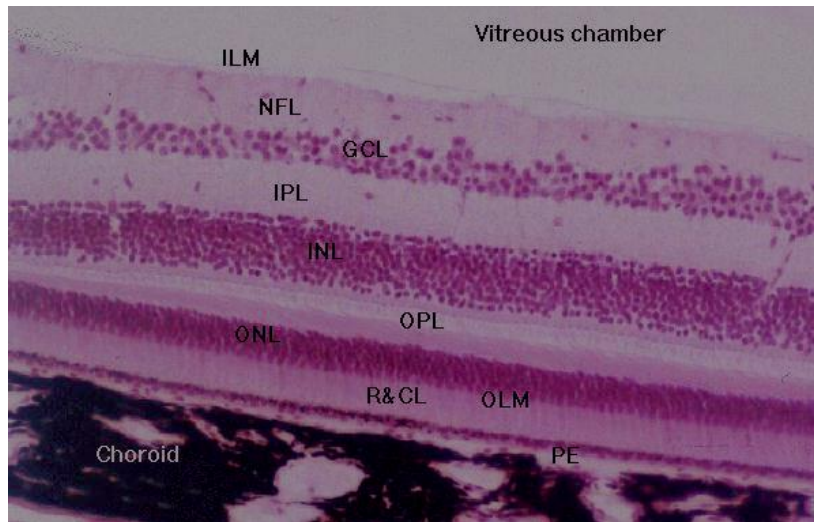


Figure (1): microscopic anatomy of retinal layers

At the fovea, the only layers that are present are the retinal pigment epithelium (RPE), the photoreceptors (cones only), and the external limiting membrane. There are also the outer nuclear layer (which contains the nuclei of the cone cells), the inner fibers of the photoreceptors (the so-called the Henle's fiber layer) and the internal limiting membrane. (10)

Topography of the retina:

The retina proper is a thin, delicate layer of nervous tissue that has a surface area of about 266mm^2 . The major landmarks of the retina are the optic disc, the retinal blood vessels, the area centralis with the fovea and the foveola, the peripheral retina (which includes the equator) and the ora serrata. The retina is thickest near the optic disc where it measures 0.56mm . It becomes thinner toward the

periphery, the thickness reduced to 0.1mm at the equator and to 0.1mm at the ora serrata. (10)

The Macula lutea:

The macula lutea is an oval zone of yellow coloration within the central retina, in red free light and in darkly pigmented individual it is seen as a horizontally oval zone that includes the fovea.

The yellow coloration is probably derived from the presence of the carotenoid pigment, xanthophylls in the ganglion and bipolar cells. (11)

The Area centralis:

The area centralis or the central retina is divided into the foveola and the fovea, with a parafoveal and a perifoveal ring around the fovea. This region of the retina is located in posterior fundus temporal to the optic disc, it is demarcated approximately by the upper and lower temporal arcades, and has an elliptical shape horizontally. With an average diameter of about 0.6mm, the area centralis corresponds to approximately 10 degrees of the visual field and it is adapted for accurate diurnal vision and color discrimination. (9)

The Fovea:

The fovea, which marks the approximate center of the area centralis, is located at the posterior pole of the globe, 2mm temporal to the center of the optic disc and about 0.1mm below the horizontal meridian.

It has a diameter of 1.8mm (which represents 0 degrees of the visual field) and an average thickness of 0.2mm, **Figure (2)**.

At the center of the fovea, the layers of the retina are thinner so that a central concave indentation is present, the foveola is produced the downward sloping border which meets the floor of the foveal pit is known as the clivus. (12)

The Foveola:

The foveola, which measures 0.2mm in diameter and 0.12mm in thickness, represents the area of the highest visual acuity in the retina, even though its span corresponds to 1 degree of the visual field only. This is due to the presence of cone photoreceptor only and its avascular nature, the foveola usually appears deeper red than the adjacent retina because of the rich choroidal circulation of the choriocapillaries, which shines through it, **Figure (2)**

Also because the RPE in this area is darker and more pigmented with tall and narrow cells. The color of the fovea persists and is even accentuated as the so-called (cherry-red spot) when the surrounding retina becomes cloudy as occurs after obstruction of the central retinal artery and in certain metabolic storage diseases. Foveal avascular zone (FAZ) is present within the fovea and measures approximately 0.6 mm in diameter. (12)

The Umbo:

It is known also as the clivus, it is a small central concavity in the floor of the foveola observed clinically as a point corresponding to the normal light reflex but not solely responsible for this reflex. (13)

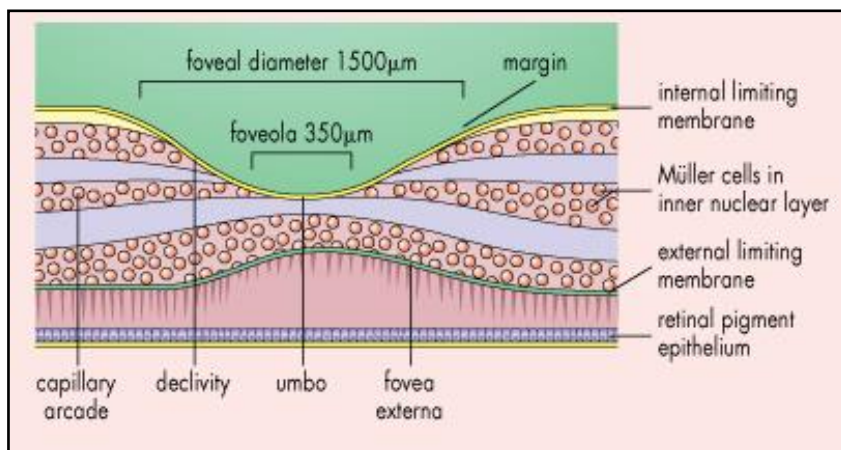


Figure (1): foveal margin, foveola and umbo. (13)

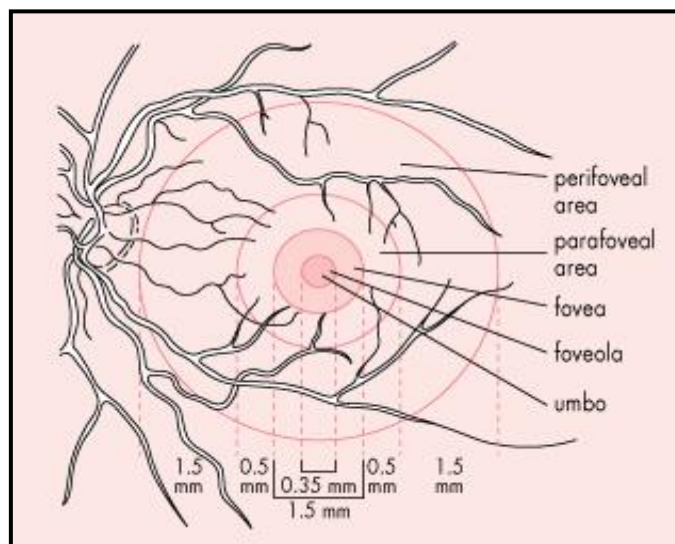


Figure (۳): the macula has the following components from center to periphery: Umbo, foveola, parafovea, and perifovea. (۱۳)

THE PERIPHERAL RETINA:

The peripheral retina increases the field of vision and is divided into four regions: the near periphery, the mid-periphery, the far periphery and the ora serrata. The near periphery occupies a circumscribed region of ۱,۵ mm around the area centralis, and the mid-periphery is a ۳ mm wide zone around the near periphery.

The far periphery is a region that extends from the optic disc ۹-۱۰ mm on the nasal side and ۱۶ mm on the temporal side in the horizontal meridian. This asymmetry is due to the location of the optic nerve head on the nasal side of the globe.

The most anterior region of the retina is the ora serrata, which consists of dentate fringe and denotes the termination of the retina. (۱۴)

The ora serrata is ۳,۱ mm wide temporally, ۰,۷-۰,۸ mm wide nasally and is located ۶,۰ mm nasally and ۷,۰ mm temporally from the limbus, ۶-۸ mm from the equator and ۳ mm from the optic nerve on the nasal side. (۱۵)

VASCULAR SUPPLY OF THE MACULA:

The macula is divided into 2 layers according to blood supply:

a) Outer layer (RPE and photoreceptors): these layers are supplied by diffusion from choriocapillaries network. It is derived from posterior ciliary arteries (choroidal circulation).

b) Inner layer: These layers are supplied by capillary network of central retinal artery (CRA), which is the first branch of ophthalmic artery (Retinal circulation). (16)

Choriocapillaries are thicker over the posterior pole than the periphery and thicker over the macula than any other part. Choroidal capillaries are larger in diameter than retinal capillaries. They are formed only of a basal membrane and a single layer of endothelial cells, which are fenestrated, **Figure (8,9).**

In 10-20% of population a variable portion of the papillomacular bundle is supplied by one or more of cilioretinal arteries derived from ciliary circulation, occasionally large cilioretinal artery may supply the entire macular region. Existence of macular supply from the ciliary origin constitutes beneficial malformation in central retinal artery occlusion. (15)

Retinal capillaries in extramacular retina are present in two layers: deep one at the outer part of inner nuclear layer and superficial one at nerve fiber layer. While three layers of capillary nets supply the peripheral macular region, as another superficial layer is present at inner boundary of inner nuclear layer. In the perifoveal region, retinal capillary bed is reduced to one layer. (12)

Retinal capillaries consist of endothelial cells encircled by basement membrane and surrounded by pericyte. Stained preparations showed endothelial cell nuclei (pale staining, oval) and internal pericyte nuclei (dark staining, round). In normal retina the two nuclear types are distributed in ratio of 1:1. (13)

BLOOD RETINAL BARRIER (BRB):

As in the brain the neural retina is protected from large molecular toxic substances by a barrier. The outer retinal layers are protected by zonulae occludens between the retinal pigment epithelial cells (outer BRB). The inner retinal layers are protected by zonulae occludens between retinal capillary endothelial cells (inner BRB) the permeability of the retinal blood vessels is important because there is barrier between the circulation and the retina.