MACULAR OEDEMA
OCT provides quantitative anatomic information
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In an address delivered at this year’s EURETINA Winter Meeting, Prof John Marshall, Institute of ophthalmology in association with Moorfields eye Hospital, London, introduced a novel approach to measuring the impact of macular oedema by suggesting that visual acuity may be predicted more accurately by evaluating the vertical elements that pass between the plexiform layers, elements often resembling the columns of a cathedral. According to Prof Marshall, introduction of such techniques may be used prior to future trials of regimens for the treatment of macular oedema, thereby allowing clinicians to exclude patients that are unlikely to recover visual acuity, regardless of the mode of intervention.

Prof Marshall opened his address by suggesting that clinicians and researchers might consider viewing optical coherence tomography (OCT) as much as a device capable of producing hard numbers for analysis and research as it is already used as a clinical tool.

Prof Marshall presented visual acuity as having four major factors: image formation which is optical, image transduction which is based on the photoreceptor matrix, image transmission which is predominantly optical, image transduction which is predominantly in the inner retina. Because both histology and OCT section tissue by effectively cutting slices they give rise to the so-called cystic arrangement of oedema which is in reality an artefact. The fluid is usually within a single space and the apparent cysts arise because Muller’s fibre remnants are found passing through the fluid between the two plexiform layers and appear in sections to divide up the fluid-filled space into compartments.”

Prof Marshall further explained that by contrast, in conditions such as retinitis pigmentosa, where the pigment epithelium is a deficit, there is a pooling of fluid predominantly in the outer retina particularly in the macular region where the fluid pools between the fibres within the fibre layer of Henle. Finally, in conditions like AMD the fluid goes through the pigment epithelium but now can’t get out through an aged, changed Bruch’s membrane and one sees things like pigment epithelial detachments.

Prof Marshall told delegates that the two plexiform layers act as areas of high resistance and fluid predominantly pools between them as can be seen on OCT and other image analysis tools. In the context of cystoid macular oedema, there’s nothing in the holes except fluid and so analysing the holes in terms of pattern location etc is a little pointless. What needs to be analysed is what tissue remains, and not more tissue has been lost. Any analysis of the system’s structure, and of the changes in the system in relation to disease, shows that the key players to examine are the photoreceptor cells, bipolar cells and ganglion cells. As the bipolar cells provide the only through-cable allowing the lights to be switched on then the Muller’s fibres are the only structural component passing between plexiform layers providing passage and protection for the bipolar axons. Prof Marshall and his research group have a particular interest in the pillars and analysing them in terms of predicting potential outcome in terms of visual performance in cases of macular oedema. Prof Marshall proposed that it is in the location of the pillars where any residual bipolar cells are going to be and that these bipolar cells will be essential for maintaining vision. The reason the literature reports a mild correlation with increasing thickness is because as the macula swells more of the bipolar axons are strained and eventually snap. Oedema pools between the two plexiform layers pushing them apart and eventually breaking the bipolar cell axons, unless they are protected by being adjacent to Muller cells. Protection by Muller cells is the key to the correlation between measurement of the structures and VA.

Prof Marshall described how his team Analysed the OCT images “in a systematic fashion to see how many fibres there are, what is their minimum diameter and what is their eccentricity, because the number of fibres tell you the potential number of surviving bipolars, the minimum diameter tells you the maximum number of bipolar cells that could be there and their eccentricity gives you information as to their connectivity to the centre”.

significant changes can occur. For example, in diabetes, with the leaky capillaries predominantly pooling fluid in the inner retina. Because both histology and OCT section tissue by effectively cutting slices they give rise to the so-called cystic arrangement of oedema which is in reality a deficit, there is a pooling of fluid predominantly in the outer retina particularly in the macular region.