Editorial

Enhanced Depth Imaging-optical coherence tomography technique and the lamina cribrosa in glaucoma

La tecnología “Enhanced Depth-Imaging” con tomografía de coherencia óptica y la lámina cribosa en el glaucoma

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The importance of the lamina cribosa in the pathogeny of glaucoma is well known, although exploration utilizing the “Enhanced Depth-Imaging” (EDI) technique with spectral domain optic coherence tomography (DS-OCT) is quite recent. Initially, it was used to assess and quantify choroidal thickness1-3 and now it has facilitated a quantum leap in qualitative, quantitative and dynamic in vivo examination of the lamina cribosa.

The lamina cribosa is a hyper-reflective structure with well defined limits and traversed by multiple hypo-reflecting columns which, in the interface section, match low reflective-ness orifices (Fig. 1).

In addition to the descriptive aspects, we are able to quantify lamina cribosa thickness as well as that of the overlying prelaminary tissue and the cup depth (Fig. 1) together with the anterior and posterior limits. The latter measure is the least reproducible of all.

The thickness of the lamina cribosa is significantly greater in normal subjects than in ocular hypertensives, and thicker in these then in glaucoma patients. The degree of thinning significantly correlates with the severity of glaucoma and increases together with glaucomatous damage.4 On the other hand, with similar functional damage thickness is diminished in normotensive glaucoma (NTG) and in pseudoexfoliative glaucoma when compared to primary open angle glaucoma5,6.

Likewise, within NTG, the lamina cribosa is thinner in the presence of optic disc hemorrhages. These findings allow us to assume that said thinning, besides being a consequence of glaucomatous damage, could also have a prognostic significance, i.e., that the thinnest laminae are more vulnerable to glaucomatous progression.

In addition to the functional correlation, there is a direct structural correlation between lamina cribosa thickness and peripapillary retina nervous fiber layer thickness according to which if said the layer is thin the lamina cribosa will also be thinner, thus supporting the diagnostic value of said parameter.

Recently, the discriminating capacity of lamina cribosa thickness for diagnostic purposes has been assessed, with the conclusion that it is similar to the conventional parameters of retina nervous fiber layer examination with OCT in primary open angle glaucoma and superior in early forms of NTG7.

The lamina cribosa is not a static structure and responds to intraocular pressure (IOP) changes both when it increases

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and decreases. After sudden induced IOP increases, cup excavation increases can be observed, mainly at the expense of preliminary tissue thinning.  

Logically, IOP reduction produces the opposite effect. Several studies have demonstrated diminished cup depth after consecutive IOP reduction due to medical treatment, trabeculectomy or drainage devices.  

Recently, we have also observed cup reduction after non-perforating deep sclerectomy. The reversibility of the cup is due on the one hand to the anterior displacement of the lamina cribosa and on the other to the thickening of the preliminatory tissue, which reinforces the hypothesis of the active buffer role of this structure (Fig. 2).  

In general lines, said changes become more extreme with large IOP reductions as well as in young subjects and with low glaucomatous damage. Other not so clearly defined variables which could influence in these changes are sex, the degree of openness or depth of the cup, axial length or corneal hysteresis.  

On the other hand, it should be remembered that the relationship between cup depth and glaucomatous damage is age-dependent, so that with equal damage the cup becomes deeper at a younger age, i.e., response capacity diminishes with age.  

From the viewpoint of configuration, even though the lamina cribosa can adopt several patterns, the most common is the “W” shape. This finding is justified because thinning is more common in the vertical poles. However, said thinning is not necessarily homogeneous and it is common to see small focal depressions and/or holes in glaucoma patients. Their presence is more frequent in NTG, in the presence of disc hemorrhages or notches in the neuroretinal ring, myopia magnus and in severe glaucoma. Said focal thinnings could only be a consequence or could also increase vulnerability to damages. In this sense, 75% of the eyes with congenital central depressions (congenital overall thickness defects similar to focal acquired holes) develop open angle primary glaucoma in adulthood.  

High penetration OCT (HP-OCT/Swept-source SS-OCT/) utilizes a bigger wavelength (1.050 nm vs 840 nm), and provides data on number, density, area and volume of pores, area and volume of lamellae or pore/lamellae ratio and can provide 3-D maps of pores and strands comprising the lamina cribosa. This multimodal technique has enabled a description of pore diameter reduction and lamellar thickening together with the evolution of glaucoma. These findings demonstrate the potential value of studying the lamina cribosa not only in the diagnosis of glaucoma but also for assessing its progression.  

Other lesser-known EDI-OCT parameters are number, diameter and direction of vessels as well as the subarachnoid space, which could be relevant when considering the vascular

Fig. 1 – Left: hyper-reflective plate corresponding to the lamina cribosa, traversed by low reflectiveness columns and defined by the anterior (dotted line) and posterior limits (black arrows). Taking as reference alignment joining both ends of the pigment epithelium, cup depth can be determined (blue arrow) as well as that of the rest of structures. Right: “in face” section of the same eye: hyper-reflective plate with multiple low reflectiveness orifices.

Fig. 2 – Clear cup reduction (162 μm) observed one month after EPNF, at the expense of lamina cribosa anterior displacement (position A pre-surgery to B post-surgery) and of preliminary tissue thickening.
influence or transluminal pressure gradient in the pathogenicity of glaucoma.22

In summary, OCT-EDI has revolutionized the lamina cribrosa exploration and is a very promising new technique which naturally needs time to establish the actual role played by the lamina cribrosa in the diagnosis and follow-up of glaucoma, as well as the influence of various factors and the prognostic implications of the above commented findings.

REFERENCES