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Case Report / Приказ болесника

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Prognostic value of optical coherence tomography in chronic chiasmal compression

Прогностичка вредност оптичке кохерентне томографије код хроничне хијазмалне компресије

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SUMMARY

Introduction Sellar and parasellar region lesions, such as pituitary adenoma often lead to the compression of the optic chiasm. Consequentialy, visual field (VF) defects and loss of visual acuity (VA), is a common complaint in these patients. The aim of this study is to evaluate if optical coherence tomography (OCT), measuring retinal nerve fibre layer (RNFL) and ganglion cell complex thickness (GCC), offers a reliable prediction of visual outcome in patients with chronic chiasmal compression from a pituitary macroadenoma.

Case outline We present a case of chronic chiasmal compression from a pituitary macroadenoma with an initial binocular visual field defect and low values of OCT parameters binocularly. The average value of RNFL on the right eye pre/postoperatively was 48/79 μm, while on the left eye it was 56/63 μm. The average value of GCC pre/postoperatively was 47/46 microns on the right and 45/46 microns on the left eye. Six weeks after surgical optochiasmal decompression macular GCC on both eyes and RNFL on the left eye remained largely unchanged, while RNFL of the right eye exhibits increases in thickness, as the postoperative consequence of the removal of conduction block. Neither visual field, nor visual acuity shows postoperative improvement.

Conclusion Irreversible damage of GCC and RNFL by longstanding compression results in poor visual outcome after surgery. Ganglion cell layer of the macula is a more accurate and reliable indicator of postoperative visual outcome.

Keywords: optical coherence tomography; macular ganglion cell layer; peripapillary retinal nerve fiber layer; visual outcome; suprasellar mass

САЖЕТАК

Увод Супраселарне експанзивне лезије као што су макроаденоми хипофизе притиском на оптичку хијазму доводе до пада видне оштрине и испада у видном пољу најчешће на оба ока. Данас се употребом оптичке кохерентне томографије може утврдити степен оштећења и могућност постоперативног побољшања видне функције. Циљ рада је да се кроз приказ болесника са макроаденомом хипофизе и хроничном компресијом оптичке хијазме испита да ли мерењем дебљине слоја нервих влакана ретине (*RNFL*) и макуларног слоа ганглијских ћелија (*GCC*) оптичком кохерентном томографијом (*OCT*), добијамо објективну и реалну процену постоперативног стања видне функције.

Приказ болесника Презентовали смо болесника са макроаденомом хипофизе и хроничном компресијом оптичке хијазме са иницјалним бинокуларним испадом видног поља, падом видне оштрине и веома ниским вредностима дебљине *RNFL* и *GCC* на оба ока**.** Средња вредност дебљине *RNFL* преопреативно/ постопертивно, на десном оку износила је 48/79 микрона, а на левом 56/6 микрона. Средња вредност дебљине *GCC* преоперативно/ постоперативно била је на десном оку 47/46, а на левом 45 /46 микрона. Видно поље на оба ока не показује постопертивно побољшање, као и видна оштрина.

Закључак У овом случају изражено оштећење ганглијских ћелија макуле и нервних влакана оптичког нерва услед хроничне компресије потврђено је *OCT* парметрима – *RNFL* и *GCC*. Дебљина *GCC* у односу на дебљину *RNFL* је бољи показатељ могућности постоперативног побољшања видне функције.

Кључне речи: оптичка кохерентна томографија; слој ганглијских ћелија макуле; слој ретиналних нервних влакана; исход видне функције; супраселарни тумор

INTRODUCTION

Compressive optical neuropathies are among the most important anterior optical pathways diseases that can lead to severe impairment of visual function. Compressive optic

neuropathy (CON) is a group of diseases that are caused by mechanical comperssion of retinal ganglion cell (RGC) axons of the optic nerve. Chiasmal lesions may be caused by pituitary adenoma, craniopharyngioma, meningioma, cysts, and aneurysm.

Surgical removal of the lesions is an important aspect of clinical management. One of the primary indications for surgical management of chiasmal compression is progressive loss of visual function. Surgical treatment enables decompression of optochiasmatic complex, prevents further visual function deterioration, and enables visual acuity improvement at the same time. Visual recovery after surgical tretment of chiasmal compression occurs in stages with the removal of the conduction block, followed by secondary remyelination and restoration of axoplasmic flow over months to years [1].

Pituitary adenoma, is the most common anterior optical pathways diseases. As a consequence, visual impairment, including visual field (VF) defects and loss of visual acuity (VA), is a common complaint [2, 3].

Several predictors for the improvement of visual function after decompression of the anterior visual pathway have been studied, including duration of symptoms, age, preoperative visual acuity, tumor size, optic disc pallor, funduscopic appearance of the retinal nerve fiber layer were evaluated in the past, with coflicing results [3–6].

With the development of optical coherence tomography (OCT), more objective measurements of optic nerve damage and more objective prediction of visual outcome after treatment of pituitary adenomas have become available [7–19].

The aim of this study is to evaluate if optical coherence tomography (OCT) offers a reliable prediction of visual outcome in a case report of chronic chiasmal compression from a pituitary macroadenoma. We used objective parameters were the thickness of the retinal nerve fiber layer (RNFL) and the thickness of ganglion cell complex (GCC).

CASE REPORT

A 65-year-old woman presented with an eight month history of malaise, weakness, frontal headaches, and blurred vision in both of her eyes. Complete neuro-ophthalmic examination, including the visual acuity test (Snellen charts), color vision test, visual field analysis (Humphrey Field Analyzer (Carl Zeiss Meditec, Inc. Dublin, CA, USA) Full field 120 point suprathreshold test, ocular motility test, dilated stereoscopic fundus examination and OCT measurements of retinal nerve fiber layer (RNFL) and the macular ganglion cell-inner plexiform layer (GCIPL) thickness, was done.

OCT imaging was conducted after pupil dilation (administration of 1% Tropicamide eye drops), using the Cirrus OCT (OCT-3, OCT software version 6.0; Carl Zeiss Meditec Inc. Dublin, CA, USA). RNFL Optic Disc Cube 200×200 and Macular Cube 512×128 scan protocols were used. The ganglion cell analysis algorithm was used to determine macular GCIPL thickness within 14.13 mm^2 elliptical annulus area centred on the fovea. Six sectoral (superior, superonasal, inferonasal, inferior, inferotemporal, and superotemporal) GCIPL thickness values were used for analysis. The Cirrus SD-OCT algorithm calculates the peripapillary RNFL thickness at each point on the circle of 3.14 mm^2 centered on the optic disc. Four-quadrant (superior, nasal, inferior, and temporal) RNFL thicknesses were used for analysis.

The patient had normal ocular position and motility with pupils of equal sizes. Dilated fundus examination revealed atrophic optic nerve head in the right eye and subatrophic optic nerve head in the left eye.

On examination, her visual acuity (Snellen) was 0.03 in the right eye and 0.6 in the left eye, and there was a mild right relative afferent pupillary defect and red desaturation in the right eye.

Visual field testing demonstrated preservation of the central 30 degrees in the nasal half of the left visual field and total visual field loss in the right eye.

Due to the concern of a chiasmal lesion, MRI of the endocranium was performed and revealed a pituitary macroadenoma measuring 28 × 37 × 36 mm. The tumour extended supra,

para i infrasellary and throughout both cavernous sinuses, with pronounced compressive effect on prechiasmal part of both optic nerves and chiasma itself. (Figure 1)

Additionally, there were multiple endocrinological disorders observed, including dropout of thyroid, adrenocorticotropic, somatotropic and gonadotropic function. Patohystologic examination confirmed the case of gonadotropic adenoma, a neuroendocrine hypophyseal tumour.

Neurosurgical treatment involved subtotal tumor resection.

Optical coherence tomography (OCT) showed pronounced thinning of RNFL (Table 1, Figure 1) and macular GCC binocularly (Table 2, Figure 4)

Nuclear magnetic resonance examination six weeks after surgical treatment revealed a larger residual lesion in the right sellar region and within the right cavernous sinus, with minimal growth of the tumor inside left cavernous sinus. Visual acuity also stayed unchanged. OCT parameters - macular ganglion cell complex on both eyes and RNFL thickness of left eye remained largely decreased, as on initial presentation, while RNFL showed signs of improvement as the consequence of postoperative removal of conduction block (Figure 3 and 5). The visual field defect was unchanged binocularly (Figures 6 and 7).

All procedures performed in this report were in accordance with the ethical standards of the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. Written consent to analyze and publish all shown material was obtained from the patient and the approval for the study was given by Ethics Committee of the Eye Clinic, Clinical Centre of Vojvodina.

DISCUSSION

Tumors of sellar, suprasellara and parasellar region, which compose 30% of all intracranial tumors according to multiple authors, are a complex neurosurgical problem even today. This is mainly the consequence of their close anatomical relations with the vital

structures of this region – a.carotis interna and her branches, hypothalamus, infundibulum and pituitary gland, with optic nerves and their chiasma.

Individual variations of chiasmal position and the inclination of its oblique plain, determine the duration of "quiet stage" of the growth of pituitary adenoma needed for the deterioration of visual function. The gradual, slow progression of visual function decline, headaches, a mild endocrine disorder result in the late physician involvement, with already enlarged tumors of uncertain prognosis for visual recovery.

In recent years it has been established that patients who have objectively measurable RNFL loss and loss of retinal ganglion cell complex (GCC) at the time of surgery for chiasmal compressive lesions are less likely to have recovery of VA or VF after surgery [9–16]. Thinner preoperative RNFL and macular GCC thickness was found to be associated with worse visual acuity (VA) and VF after surgery. This also supports the notion that preserved OCT RNFL and macular GCC thickness confers a good visual outcome.

In this case, chronic chiasmal compression caused not only conduction block, but also a significant atrophy of retinal ganglion cells that was confirmed with OCT parameters that remained mostly decreased.

Although our study's follow up period was only 8 weeks, the results proved to be comparable with the findings of Danesh-Meyer et al. [11 abstract], that showed in the series of 40 cases with chiasmatic compressive lesions, with OCT and visual field analysis, that pre and post decompression treatment in patients with thin RNFL did not demonstrate significant improvement in VA and visual field. Min Sun et al. [5] Jing Zhang et al. [15], as well as Jonathan [16] found with preoperative and postoperative RNFL thickness analysis that eyes with visual defects but normal preoperative RNFL thickness showed a significantly greater improvement in postoperative visual function than those with thin preoperative RNFL thickness. Similarly, Jacob et al. [6] demonstrated that circumpapillary RNFL thinning measured by OCT decreased the patient's chances of recovery of initial visual field defect 3 months after treatment.

Some researchers also explored the predictive value of RNFL thicknesses in different quadrants [2, 6, 15, 17, 20]. Chiasmal compression is well-known to cause more thinning of

the nasal and temporal sectors of peripapillary retinal nerve fiber layer (RNFL) thickness, [2, 17] and predominantly nasal hemiretina thinning of macular GCC [20], something we weren't able to confirm in our patient due to extreme thinning of RNFL and GCL in all sectors.

While a majority of the research have focused on measuring the peripapillary retinal nerve fiber layer (pRNFL) [6, 12, 15], recent data suggest the ganglion cell layer–inner plexiform layer (GCL-IPL) of the macula may be a more accurate and reliable biomarker of vision [7, 8, 10, 17, 18]. GCC thinning, according to numerous authors, remained relatively unchanged before and after decompression [17–20], found in our patient, as well. Consequently, patients with GCC loss before decompression had decreased chances of recovery of postoperative VF [17–20], the fact we can agree based on the postoperative visual field in our patient.

RNFL and GCC thickness measured by OCT have been identified as useful prognostic indicators in the preoperative assessment of chiasmal compression and became an important aspect of the pre-treatment evaluation of pituitary tumors. OCT analysis may be an objective method to diagnose and follow patients with chiasmal lesions.

In the patient involved in our study, chronic chiasmal compression led to pronounced axonal damage, manifested in significant RNFL and GCC thinning and poor postoperative recovery of visual function. Ganglion cell layer of the macula proved to be a more accurate and reliable indicator of postoperative visual outcome.

Conflict of interest: None declared.

REFERENCES

1. Danesh-Meyer VH , Yoon JJ, Lawlor M, Savino JP.Visual loss and recovery in chiasmal compression (abstract) .Prog Retin Eye Res. 2019;73:100765. doi: 10.1016/j.preteyeres.2019.06.001.Epub 2019 Jun 14. PMID: 31202890
2. Poramaet L, Chirapapaisan N, Kemahayung S, Srikong M.Variable structure and function relationship of compressive optic neuropathy at the time of diagnosis. Clin Ophthalmol. 2019; 22(13):1599-608. doi: 10.2147/OPTH.S215115. eCollection 2019. PMID: 31686773
3. Grković D, Bedov T. Vidna oštrina nakon hirurškog lečenja adenoma hipofize. Srp Arh Celokup Lek. 2013; 4(5-6):296-303
4. Wang MTM, King J, Symons RCA, Stylli SS, Daniell MD, Savino PJ, Kaye AH, Danesh-Meyer HV. Temporal patterns of visual recovery following pituitary tumor resection: A prospective cohort study. J Clin Neurosci. 2021 Apr;86:252-259. doi: 10.1016/j.jocn.2021.01.007. Epub 2021 Feb 16. PMID: 33775337.
5. Min S, Zhi-Qiang Z, Chi-Yuan M. Sui-Hua C. Xin-Jian C. Predictive factors of visual function recovery after pituitary adenoma resection: a literature review and meta-analysis.Int J Ophthalmol. 2017; 10(11): 1742–50.doi: 10.18240/ijo.2017.11.17, PMID: 29181320
6. Jacob M, Raverot G, Jouanneau E, Borson-Chazot F, Perrin G, Rabilloud M, Tilikete C, Bernard M, Vighetto A. Predicting visual outcome after treatment of pituitary adenomas with optical coherence tomography. Am J Ophthalmol. 2009;147(1):64-70. doi: 10.1016/j.ajo.2008.07.016. Epub 2008 Sep 6. PMID: 18774545
7. Vuong NL, Hedges RT . Ganglion cell layer complex measurements in compressive optic neuropathy. Curr Opin Ophthalmol. 2017;28(6):573-8. doi: 10.1097/WNO.0000000000000489, PMID: 28187079
8. Tieger MG, Hedges TR, Ho J, Erlich-Malona NK, Vuong LN, Athappilly GK, Mendoza-Santiesteban CE. Ganglion cell complex loss in chiasmal compression by brain tumors. J Neuroophthal. 2016;37:7–12 doi: 10.1097/WNO.0000000000000424, PMID: 281923
9. Benjamin Uy, Bayard Wilson B, Wi Jin Kim WJ, Prashant G, Bergsneider M.Visual outcomes after pituitary surgery. Neurosurg Clin N Am 2019;30(4):483-9. doi: 10.1016/j.nec.2019.06.002, PMID: 31471055
10. Horton CJ.Ganglion cell complex measurement in compressive optic neuropathy. J Neuroophthalmol. 2017; 37(1): 13–15. doi: 10.1097/WNO.0000000000000489
11. Danesh-Meyer HV, Wong A, Papchenko T, Matheos K, Stylli S, Nichols A, Frampton C, Daniell M, Savino PJ, Kaye AH. Optical coherence tomography predicts visual outcome for pituitary tumors (abstract). J Clin Neurosci. 2015; 22: 1098–104. doi: 10.1016/j.jocn.2015.02.001. Epub 2015 Apr 16.
12. Danesh-Meyer HV, Papchenko T, Savino PJ, Law A, Evans J, Gamble GD. *In vivo* retinal nerve fiber layer thickness measured by optical coherence tomography predicts visual recovery after surgery for parachiasmal tumors. Invest Ophthalmol Vis Sci. 2008;49:1879–85. doi: 10.1167/iovs.07-1127. Epub 2008 Feb 8.
13. Micieli AJ, Newman JN, Valérie Biousse V. The role of optical coherence tomography in the evaluation of compressive optic neuropathies Curr Opin Neurol. 2019;32(1):115-23. doi: 101097/WCO.0000000000000636, PMID: 30418197
14. Lee J, Woo Kim S, Dong Wook Kim D, Joo Youn Shin J, Moonjung Choi M, Min Chul Oh M, Seung Min Kim SM, Eui Hyun Kim EH, Sun Ho Kim SH, Suk Ho Byeon SH. Predictive model for recovery of visual field after surgery of pituitary adenoma (abstract). J Neurooncol. 2016;130(1):155-64. doi: 10.1007/s11060-016-2227-5. Epub 2016 Jul 30. PMID: 27476080
15. Zhang J, Zhang S, Song Y, Chenjing Zhu C, He M, Ren Q Baoyin Shan RQ, Wang Z,Yunhui Zeng Y, Xu J.Predictive value of preoperative retinal nerve fiber layer thickness for postoperative visual recovery in patients with chiasmal compression. Oncotarget. 2017 Aug 29; 8(35): 59148–55. doi: 10.18632/oncotarget.19324, PMID: 28938625
16. Lee GI, Park KA, Son G, Kong DS, Yeul Oh S. Optical Coherence Tomography Analysis of Inner and Outer Retinal Layers in Eyes With Chiasmal Compression Caused by Suprasellar Tumours Acta Ophthalmol. 2020; 98(3):e373-e380. doi: 10.1111/aos.14271. Epub 2019 Oct 10. PMID: 31602819
17. Yum HR, Park SH, Young H, Park L, Shin SY. Macular Ganglion Cell Analysis Determined by Cirrus HD Optical Coherence Tomography for Early Detecting Chiasmal Compression. PLoS One. 2016; 11(4): e0153064. doi: 10.1371/journal.pone.0153064 PMCID: PMC4822859: 27049647
18. Tieger GM, Hedges RT, Ho J, Natalie K Erlich-Malona KN, Vuong NL, Athappilly KG, Mendoza-Santiesteban CE. Ganglion Cell Complex Loss in Chiasmal Compression by Brain Tumors. J Neuroophthalmol. 2017;37(1):7-12 doi: 10.1097/WNO.0000000000000424, PMID: 281923
19. Moon J-S, Shin SY . Segmented Retinal Layer Analysis of Chiasmal Compressive Optic Neuropathy in Pituitary Adenoma Patients. Graefes Arch Clin Exp Ophthalmol. 2020; 258(2):419-25. Abstrakt doi: 10.1007/s00417-019-04560-3.Epub 2019 Dec 18. PMID: 31853626
20. Ah Reum Jeong AR , Kim E-Y, Kim. NR Preferential Ganglion Cell Loss in the Nasal Hemiretina in Patients With Pituitary Tumor. J Neuroophthalmol. 2016; 36(2):152-5. doi: 10.1097/WNO.0000000000000331.PMID: 26714238

Figure 1. Nuclear magnetic resonance scan of the endocranium with optochyasmal compression

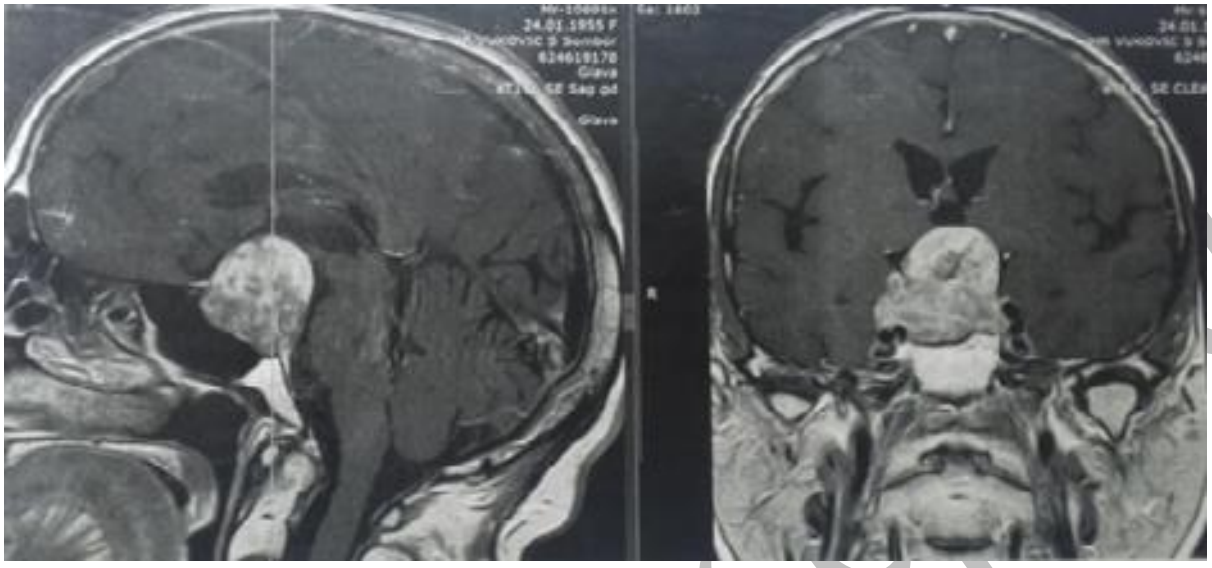

Figure 2. Preoperative retinal nerve fiber layer (RTNL) thickness

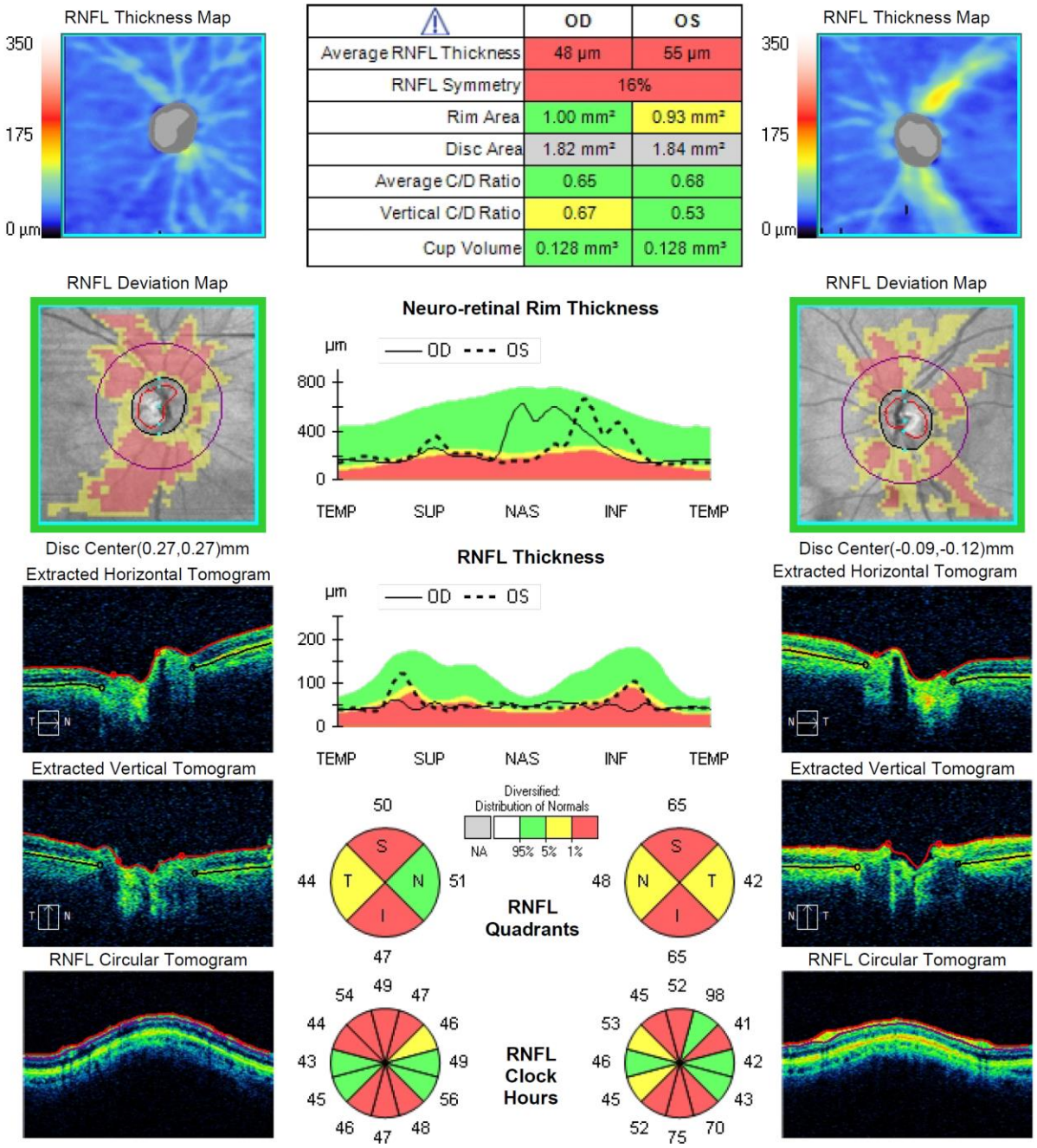

Figure 3. Postoperative (retinal nerve fiber layer) RNFL thickness

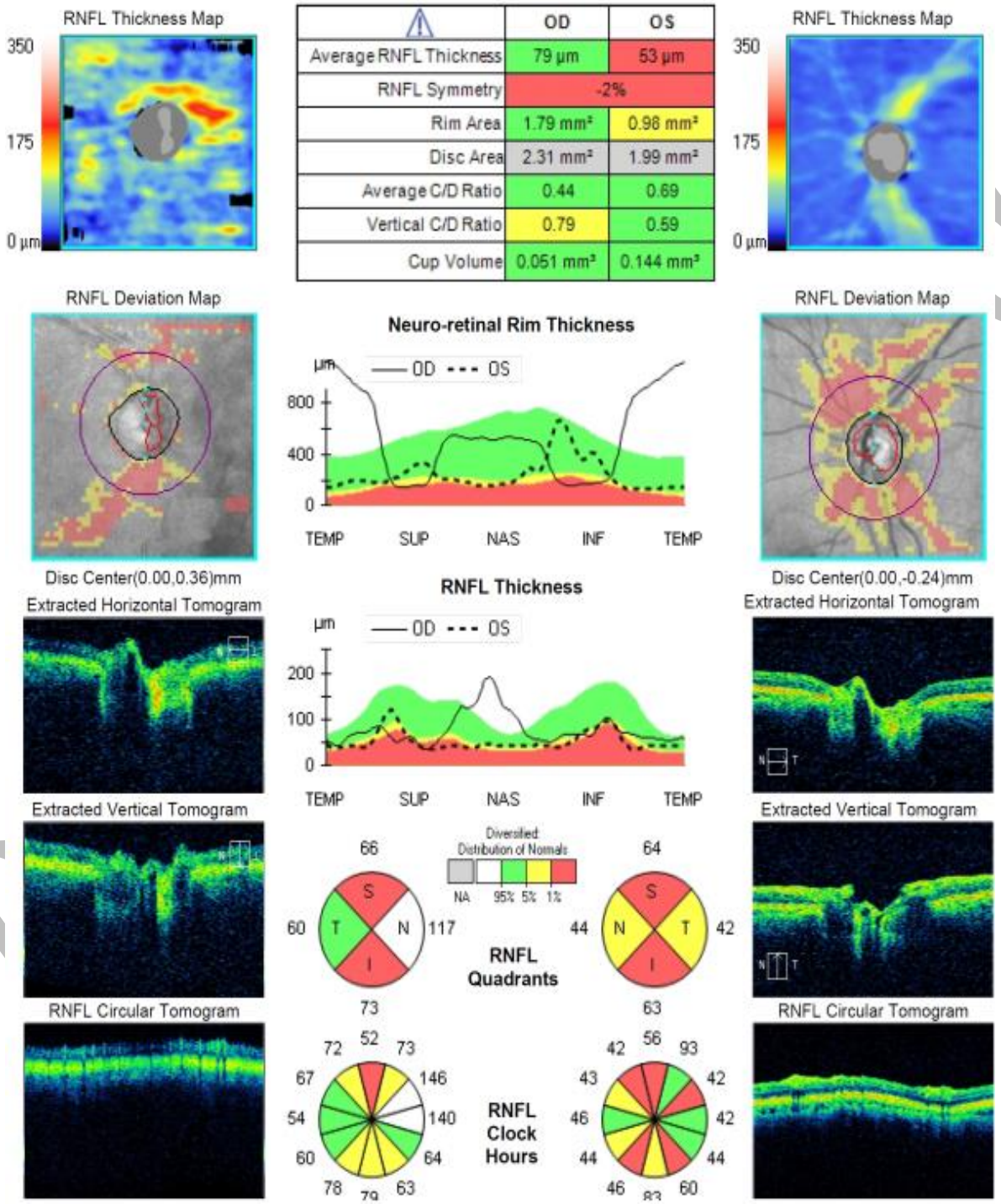

Figure 4. Preoperative ganglion cell complex thickness

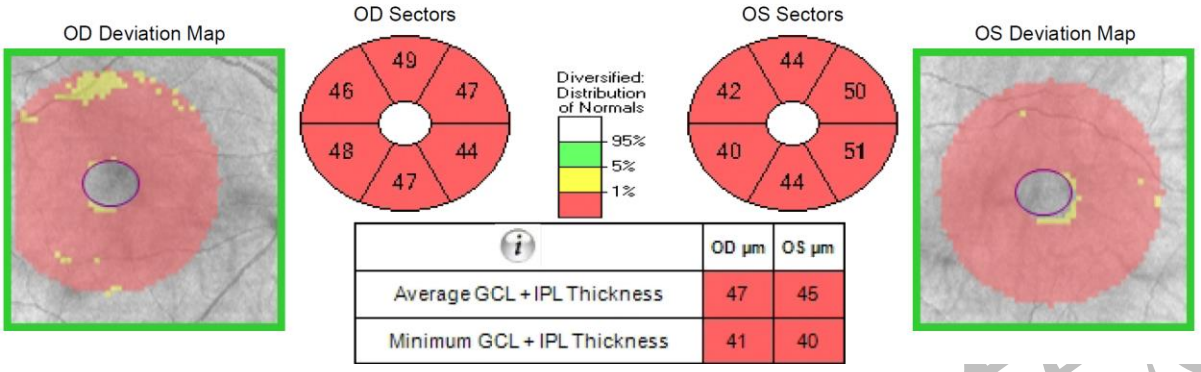

Figure 5. Postoperative ganglion cell complex thickness

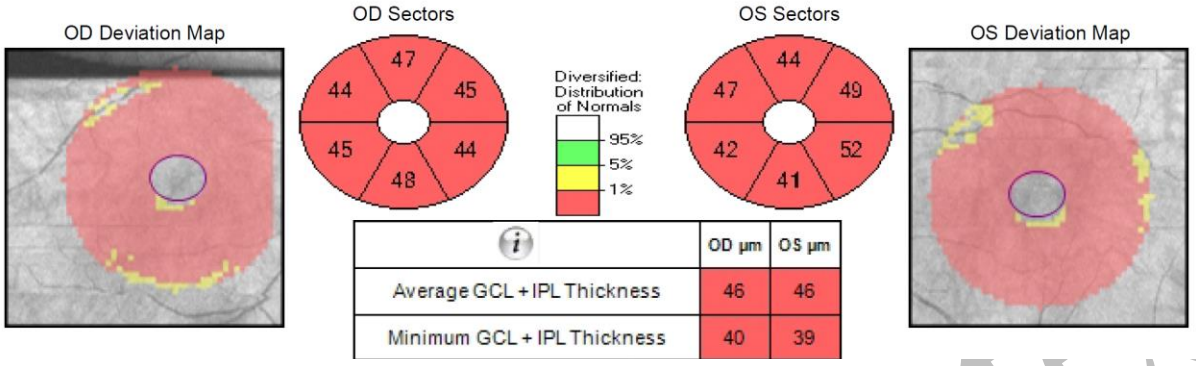

Figure 6. Full-field 120-point perimetry test of the left eye preoperatively

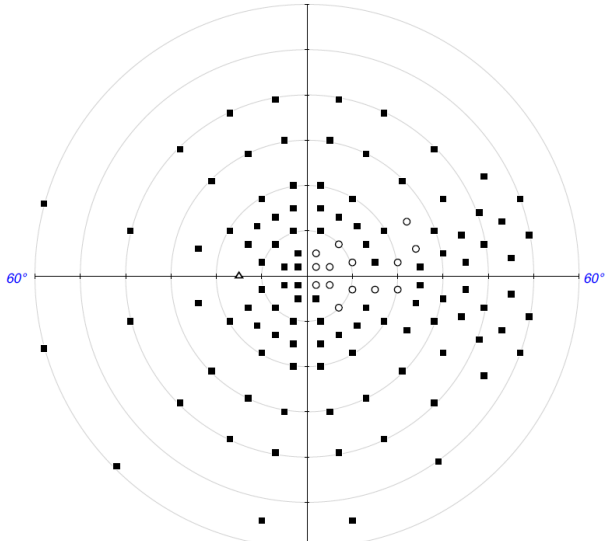

Figure 7. Full-field 120-point perimetry test of the left eye postoperatively

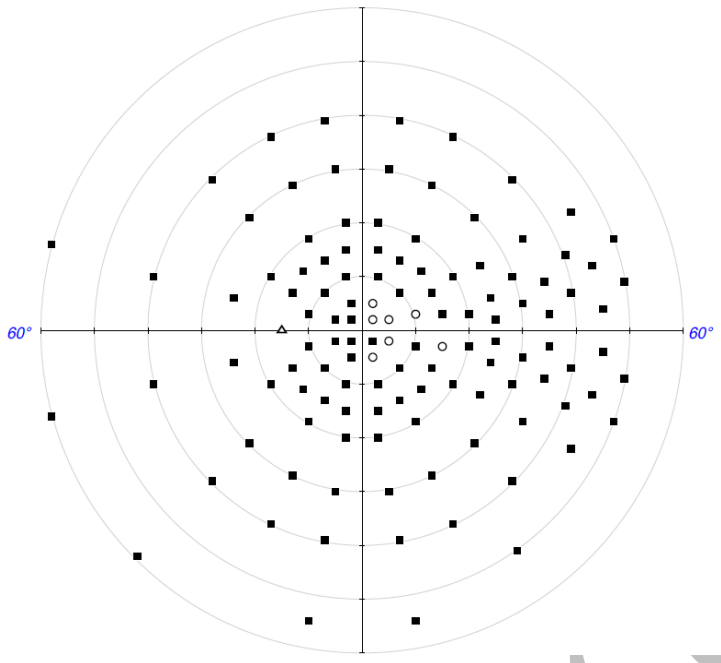

Table 1. Thickness of the retinal nerve fiber layer [μm]

Parameter	Preoperative		Postoperative	
	right eye	left eye	right eye	left eye
Average thickness	48	55	79	53
Superior quadrant	50	65	66	64
Inferior quadrant	47	65	73	63
Nasal quadrant	51	48	117	44
Temporal quadrant	44	42	60	42

Table 2. Thickness of the macular ganglion cell layer [μm]

Parameter	Preoperative		Postoperative	
	right eye	left eye	right eye	left eye
Average thickness	47	45	46	46
Superior sector	49	44	47	44
Inferior sector	47	44	48	41
Superonasal sector	46	42	45	47
Inferonasal sector	48	40	44	42
Superotemporal sector	42	50	44	49
Inferotemporal sector	45	52	45	52

