CASE REPORT / ПРИКАЗ БОЛЕСНИКА

Prognostic value of optical coherence tomography in chronic chiasmal compression

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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 are common complaints in these patients. The aim of this report is to evaluate if optical coherence tomography, 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 VF defect and low values of optical coherence tomography 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 exhibited increases in thickness, as the postoperative consequence of the removal of the conduction block. Neither VF nor visual acuity showed postoperative improvement.
Conclusion Irreversible damage to the 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

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 is a group of diseases 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 the progressive loss of visual function. Surgical treatment enables decompression of the optochiasmatic complex, prevents further visual function deterioration, and enables visual acuity (VA) improvement at the same time. Visual recovery after surgical tretment of the chiasmal compression occurs in stages, with the removal of the conduction block, followed by secondary remyelination and restoration of the axoplasmic flow over months to years [1].

Pituitary adenoma is the most common anterior optical pathways' disease. As a consequence, visual impairment, including visual field (VF) defects and loss of 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 VA, tumor size, optic disc pallor, funduscopic appearance of the retinal nerve fiber layer (RNFL), 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 report is to evaluate if OCT offers a reliable prediction of visual outcome in a case of chronic chiasmal compression from a pituitary macroadenoma. We used objective parameters of the thickness of the RNFL and the thickness of the ganglion cell complex (GCC).

CASE REPORT

A 65-year-old woman presented with an eight-month-long history of malaise, weakness, frontal headaches, and blurred vision in both of her eyes. Complete neuro-ophthalmic examination, including the VA test (Snellen charts), color vision test, VF analysis (Humphrey field analyzer;

Received • Примљено: October 28, 2020
Revised • Ревизија: June 30, 2021
Accepted • Прихваћено: July 1, 2021
Online first: July 6, 2021

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Carl Zeiss Meditec Inc., Dublin, CA, USA), full field 120 point suprathreshold test, ocular motility test, dilated stereoscopic fundus examination, and OCT measurements of the 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 the 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 calculated 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, the patiet's VA (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.

VF testing demonstrated preservation of the central 30° in the nasal half of the left VF and total VF loss in the right eye.

Due to the concern of a chiasmal lesion, magnetic resonance imaging of the endocranium was performed and revealed a pituitary macroadenoma measuring 28 × 37 × 36 mm. The tumour extended supra, para, and infrasellary and throughout both cavernous sinuses, with pronounced compressive effect on the prechiasmal part of both optic nerves and the 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.

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 the left cavernous sinus. VA also stayed

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

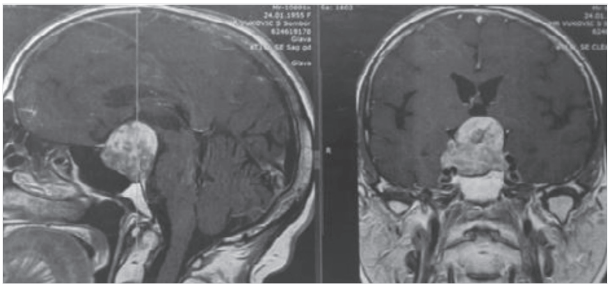

Figure 1. Nuclear magnetic resonance scan of the endocranium with optochyasmal compression

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

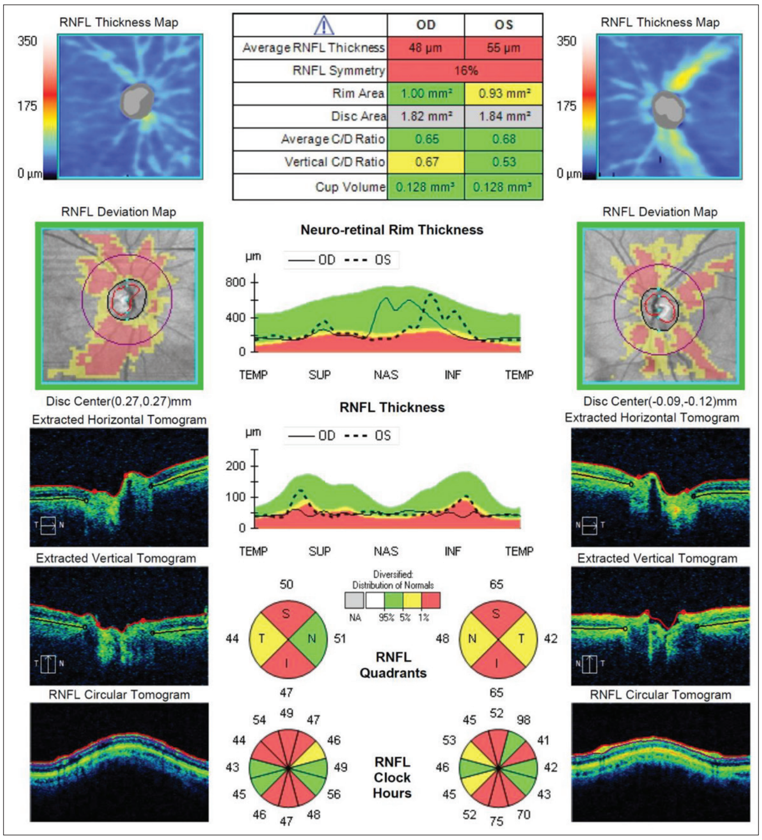

Figure 2. Preoperative retinal nerve fibre layer (RTNL) thickness

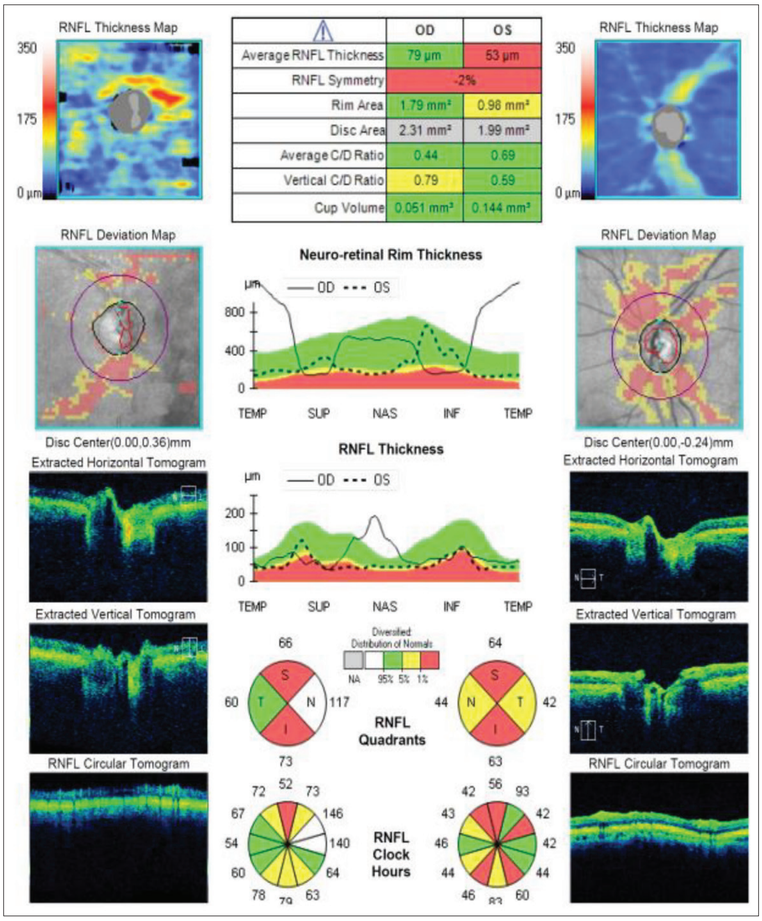

Figure 3. Postoperative retinal nerve fibre layer (RNFL) thickness

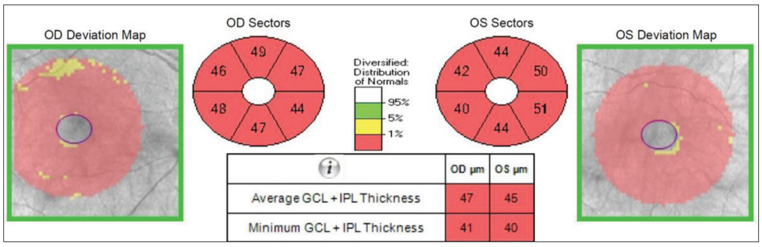

Figure 4. Preoperative ganglion cell complex thickness

GCL – ganglion cell layer; IPL – inner plexiform layer

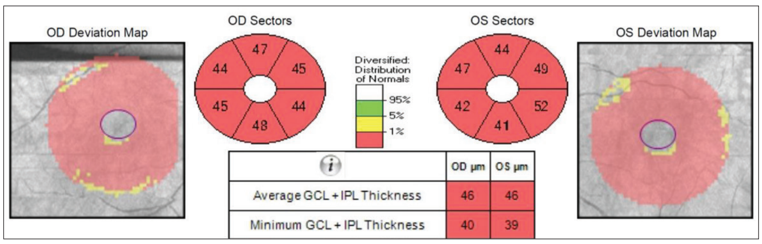

Figure 5. Postoperative ganglion cell complex thickness

GCL – ganglion cell layer; IPL – inner plexiform layer

unchanged. OCT parameters – macular GCC on both eyes and RNFL thickness of the left eye remained largely decreased, as on initial presentation, while RNFL showed signs of improvement as the consequence of postoperative removal of the conduction block (Figures 3 and 5). The VF 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 the sellar, suprasellar, 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 – the internal carotid artery and its branches, the hypothalamus, the infundibulum and the pituitary gland, with the optic nerves and their chiasma.

Individual variations of the chiasmal position and the inclination of its oblique plain determine the duration of the "quiet stage" of the growth of pituitary adenoma needed for the deterioration of the visual function. The gradual, slow decline of the visual function, 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 an objectively measurable RNFL loss and the loss of retinal 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 were found to be associated with poorer VA and VF after surgery. This also supports the notion that preserved OCT RNFL and macular GCC thickness confer a good visual outcome.

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

Although our study's follow up period was only eight weeks, the results proved to be comparable with the findings of Danesh–Meyer et al. [11], which, in a series of 40 cases with chiasmatic compressive lesions, with OCT and VF analysis, showed that pre- and post-decompression treatment in patients with thin RNFL did not demonstrate significant improvement in VA and VF. Min et al. [5], Zhang et al. [15], as well as Lee

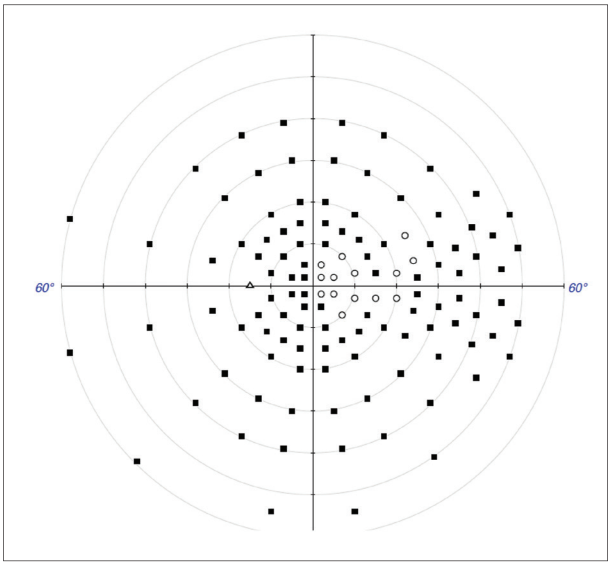

Figure 6. Full-field 120 point perimetry test of the left eye preoperatively

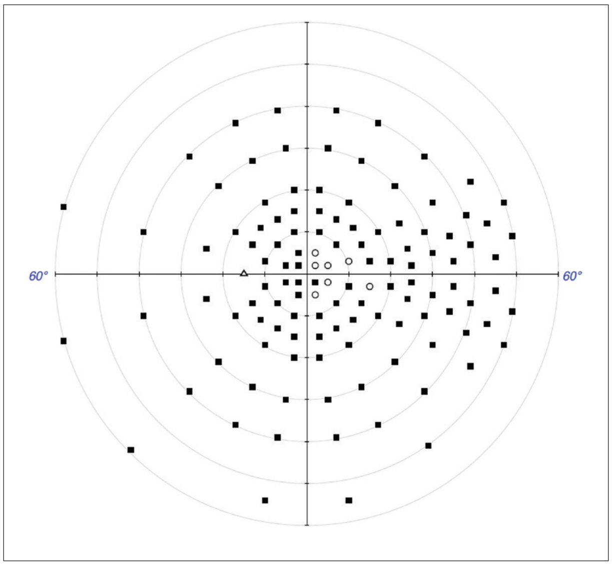

Figure 7. Full-field 120 point perimetry test of the left eye postoperatively

et al. [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 VF defect three 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 the peripapillary RNFL thickness, and predominantly nasal hemiretina thinning of macular GCC, something we were not able to confirm in our patient due to extreme thinning of RNFL and GCL in all sectors [2, 17, 20].

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

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 from our report, 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.
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.
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, et al. Temporal patterns of visual recovery following pituitary tumor resection: A prospective cohort study. J Clin Neurosci. 2021;86:252–9.
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.
6. Jacob M, Raverot G, Jouanneau E, Borson-Chazot F, Perrin G, Rabilloud M, et al. Predicting visual outcome after treatment of pituitary adenomas with optical coherence tomography. Am J Ophthalmol. 2009;147(1):64–70.
7. Vuong NL, Hedges RT. Ganglion cell layer complex measurements in compressive optic neuropathy. Curr Opin Ophthalmol. 2017;28(6):573–8.
8. Tieger MG, Hedges TR, Ho J, Erlich-Malona NK, Vuong LN, Athappilly GK, et al. Ganglion cell complex loss in chiasmal compression by brain tumors. J Neuroophthal. 2016;37(1):7–12.
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.
10. Horton CJ. Ganglion cell complex measurement in compressive optic neuropathy. J Neuroophthalmol. 2017;37(1):13–5.
11. Danesh-Meyer HV, Wong A, Papchenko T, Matheos K, Stylli S, Nichols A, et al. Optical coherence tomography predicts

visual outcome for pituitary tumors (abstract). J Clin Neurosci. 2015;22(7):1098–104.
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(5):1879–85.
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.
14. Lee J, Kim SW, Kim DW, Shin JY, Choi M, Oh MC, et al. Predictive model for recovery of visual field after surgery of pituitary adenoma (abstract). J Neurooncol. 2016;130(1):155–64.
15. Zhang J, Zhang S, Song Y, Zhu C, He M, Ren Q, et al. Predictive value of preoperative retinal nerve fiber layer thickness for postoperative visual recovery in patients with chiasmal compression. Oncotarget. 2017;8(35):59148–55.
16. Lee GI, Park KA, Son G, Kong DS, Oh SY. 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.
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.
18. Tieger GM, 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 Neuroophthalmol. 2017;37(1):7–12.
19. Moon JS, 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.
20. Jeong AR , Kim EY, Kim NR. Preferential Ganglion Cell Loss in the Nasal Hemiretina in Patients With Pituitary Tumor. J Neuroophthalmol. 2016;36(2):152–5.

Прогностичка вредност оптичке кохерентне томографије код хроничне хијазмалне компресије

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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 могу 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 нервних влакана ретине и макуларног слоја ганглијских ћелија оптичком кохерентном томографијом добијамо објективну и реалну процену постоперативног стања видне функције.

Приказ болесника Приказали смо болесника са макроаденомом хипофизе и хроничном компресијом оптичке хијазме са иницијалним бинокуларним испадом видног поља, падом видне оштрине и веома ниским вредностима дебљине слоја нервних влакана ретине и макуларног слоја ганглијских ћелија на оба ока. Средња вредност дебљине слоја нервних влакана ретине преоперативно/постопертивно на десном оку износила је 48/79 микрона, а на левом 56/6 микрона. Средња вредност дебљине макуларног слоја ганглијских ћелија преоперативно/постоперативно била је на десном оку 47/46, а на левом 45/46 микрона. Видно поље на оба ока не показује постоперативно побољшање, као ни видна оштрина.

Закључак У овом случају изражено оштећење ганглијских ћелија макуле и нервних влакана оптичког нерва услед хроничне компресије потврђено је параметрима оптичке кохерентне томографије – слојем нервних влакана ретине и макуларним слојем ганглијских ћелија. Дебљина макуларног слоја ганглијских ћелија у односу на дебљину слоја нервних влакана ретине 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