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SECONDARY SINUSOGENIC NEURITIS AND OPTIC NERVE ATROPHY

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Cases of sinusogenic damage to the optic nerve are difficult to statistically process due to the variety of manifestations in the initial period and differences in the course, which does not make it possible to make a timely diagnosis, as well as standardize treatment. All this leads to the development of irreversible damage to the optic nerve, and therefore is relevant for study.

The aim *of the study was to investigate signs of optic nerve atrophy caused by secondary neuritis combined with sinusitis using optical coherence tomography (OCT).*

Research methods. *8 patients (16 eyes) aged 18-32 were examined at the Ivano-Frankivsk National Medical University with progressive optic nerve atrophy caused by secondary neuritis combined with sinusitis. The visometry, ophthalmoscopy, computer perimetry and OCT were used.*

Result. *Eight patients with optic nerve atrophy caused by secondary neuritis combined with sinusitis examined by OCT. The optic nerve damage in the early period (up to half a year) characterized by the appearance retinal neural fibers layer (RNFL)'s white sectors combined with red-yellow sectors on the side of the lesion. It could be evidence of edematous -degenerative processes.*

Later, after more than a year, RNFL's yellow-red sectors appeared on the side of the lesion and white on the opposite side. The finding characterizes the development of atrophy of the optic nerve and involvement of the opposite side.

Conclusion. *To improve the diagnosis of optic nerve atrophy caused by secondary neuritis combined with sinusitis, the use of OCT parameters will help to obtain a more complete picture of the condition of the optic nerve and determine the optimal treatment plan*

Keywords: *optic neuritis, optic nerve atrophy, OCT, RNFL*

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1. Introduction

Optic neuritis and/or neuropathy secondary to sinus disease is an uncommon complication of sinusitis, with few reports in the literature.

Theories regarding the effect of sinus pathology on the optic nerve remain controversial. Some scientists completely deny such lesions. While others are deeply studying and improving methods of treatment of sinusogenic damage to the optic nerve [1].

Diseases of the paranasal sinuses have been reported to cause a condition mimicking demyelinating optic neuritis [2] with acute visual loss and pain on eye movement or may cause progressive neuropathy and optic atrophy due to compression [3].

Cases of sinusogenic damage to the optic nerve are difficult to statistically process due to the variety of manifestations in the initial period and differences in the course, which does not make it possible to establish a diagnosis in a timely manner, as well as to standardize treatment. All this leads to the development of irreversible damage to the optic nerve, and therefore is relevant for study.

The aim of the study was to investigate signs of optic nerve atrophy caused by secondary neuritis combined with sinusitis using optical coherence tomography (OCT).

2. Materials and methods of the research

During 2020–2023, 8 patients (16 eyes) aged 18–32 years (average age 25±7.2 years) who applied for a neuro-ophthalmological consultation at the associated with progressive atrophy of the optic nerve caused by secondary neuritis combined with sinusitis were studied.

All subjects gave their informed consent to the processing of personal data. The conclusion of the commission on bioethics of the Ivano-Frankivsk National Medical University, protocol No. 125 dated March 24, 2022, was received.

Consultations of patients were carried out at different times from the beginning of the first manifestations of neuritis (Table 1).

Damage to the nasal sinuses was confirmed according to magnetic resonance imaging (MRI).

Visometry, ophthalmoscopy and data analysis of computer perimetry (Optipol Technology, Threshold, F-

50) and OCT (Hutvitz, Disc 3D), conducted at the Lux Vision Ophthalmological Clinic.

Table 1

Distribution of patients by the period between the appearance of the first symptoms of neuritis and the neuro-ophthalmological consultation

The period between the appearance of the first symptoms and the consultation	Number of patients, (n=8)
Up to half a year	5 (62.5±17.1 %)
1 year	1 (12.5±11.7 %)
More than 1 year	2 (25±15.5 %)

Optical coherence tomography (OCT) was performed. The method of visual OCT of the nerve makes it possible to perform a cross-section and assess the structure of the nerve fiber layer (NFL).

The research is conducted using laser technology that is safe for health. The device sends a small beam of light into the eye, which is reflected in the visual system and enters the optic nerve. The laser reads the level of light reflection from different layers of the retina and displays the received data in the form of a colour map or cross-section.

The obtained data can be analysed using special software that allows you to measure the thickness of the tissues, assess their condition, detect changes and compare the data with previous measurements.

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The results are displayed as sectors of different colours. The colour of the sector can indicate the level of NFL in a certain area of the optic nerve. Under conditions of normal thickness, which does not differ by more than 5 % from the statistical average, the sectors have a green colour. The yellow colour on the OCT image represents a deviation in the thickness of the nerve fiber layer of more than 5 % from the average, and the red colour shows an even greater deviation from the normal value, usually more than 20 %. White sectors indicate the absence of reflection of the light sent by the device to the nerve fibers. This can be due to various defects in the structure of the eye tissues, which usually include holes or cracks in the nerve layer or swelling or infiltration of nerve fibers.

A normal distribution was used to calculate mean values, so parametric methods such as Pearson correlation and regression analysis in MS Excel were used.

3. Results

Eight patients aged 18–32 years, with progressive atrophy of the optic nerve caused by secondary neuritis combined with sinusitis were studied.

According to MRI data (n=8), inflammation of the maxillary sinus was confirmed in 6 patients (75±15.3 %), polysinusitis in 3 (37.5±17.1 %), polysinusitis in 2 subjects (25±15.3 %) – the main and ethmoidal and in 1 (12.5 ±11.7 %) – the frontal sinus (Table 2). In 4 patients (50±17.7 %), thickening of the mucous membrane was detected, in 3 (37.5±17.1 %) – a polyp, and in 1 (12.5±11.7 %) – a violation of pneumatization and catarrhal exudation of the sinuses nose.

Table 2

Distribution of patients according to the frequency of inflammation of the nasal sinuses

Sinus	Number of patients, (n=8)	Percentage error
Maxillary	6 (75 %)	15.3
Frontal	1 (12.5 %)	11.7
Sphenoid	2 (25 %)	15.3
Ethmoid	2 (25 %)	15.3
Paranasal	3 (37.5 %)	17.1

Optic neuritis, which had a monophasic course, was diagnosed in 5 patients (62.5±17.1 %), and recurrent in 3 (37.5±17.1 %). In 1 patient (12.5±11.7 %), progression was not observed, while in the rest it worsened. Damage to the opposite side was observed in 5 patients (62.5±17.1 %).

At the time of the consultation, according to the NFL sector analysis on the side of the lesion (n=8), 4 people (50±17.7 %) had red-yellow sectors, indicating a thickness reduction from 5 to 20% compared to the average statistical norm, in 1 patient (12.5±11.7 %) – white sectors, which indicate the absence of reflection of the light sent by the device to the nerve fibers. In 3 patients (37.5±17.1 %) – red-yellow and white sectors were combined.

On the side opposite to the lesion in the NFL, white sectors were found in 3 patients (37.5±17.1 %), in 3 (37.5±17.1 %) – a combination of white and red-yellow sectors, and in 2 (25±15.3 %) – green sectors, the thickness of fibers which did not differ from the average statistical norm by more than 5 %.

Patient M., who came to the neuro-ophthalmology consultation at the earliest, 3 months after the onset of symptoms of neuritis, had white sectors on both eyes (Fig. 1).

Patients O. (Fig. 2) and R., who received a consultation 4 months after the appearance of clinical symptoms of neuritis, had combined white and red-yellow sectors on both eyes. Patient F. (Fig. 3), who also received a neuro-ophthalmologist's consultation 4 months after the onset of neuritis symptoms. At the same time, the sectors were also white and red-yellow on the affected side, and green on the opposite side.

In patient A. (Fig. 4), who came to a neuro-ophthalmology consultation 4 years later, after the appearance of symptoms of neuritis, only red sectors were noted on the side of the lesion, and white on the opposite side.

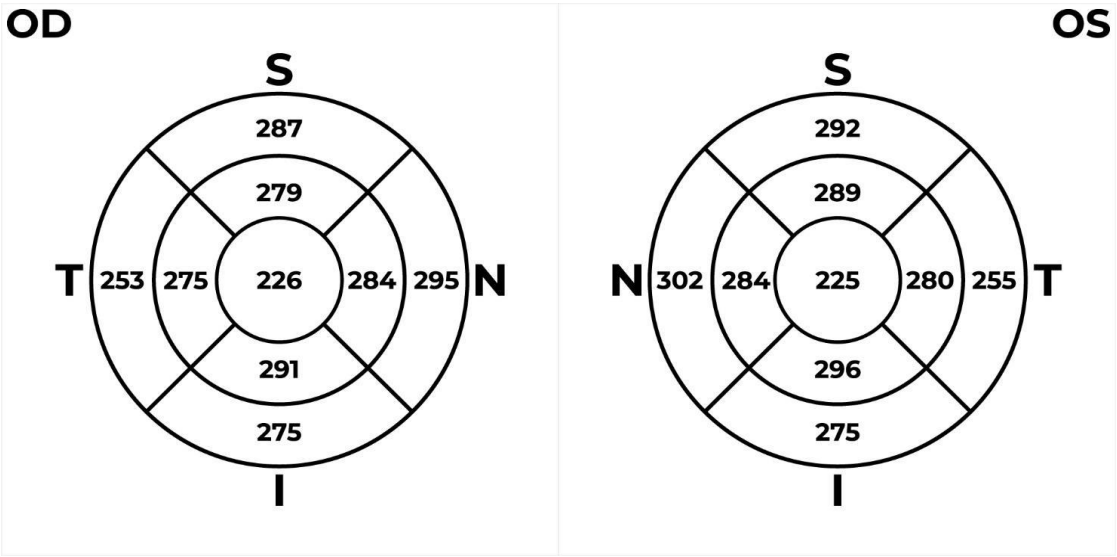

Fig. 1. Sectoral analysis of patient M.'s NFL, 3 months after the onset of neuritis symptoms. According to the MRI, thickening of the mucous membrane of both maxillary sinuses was confirmed

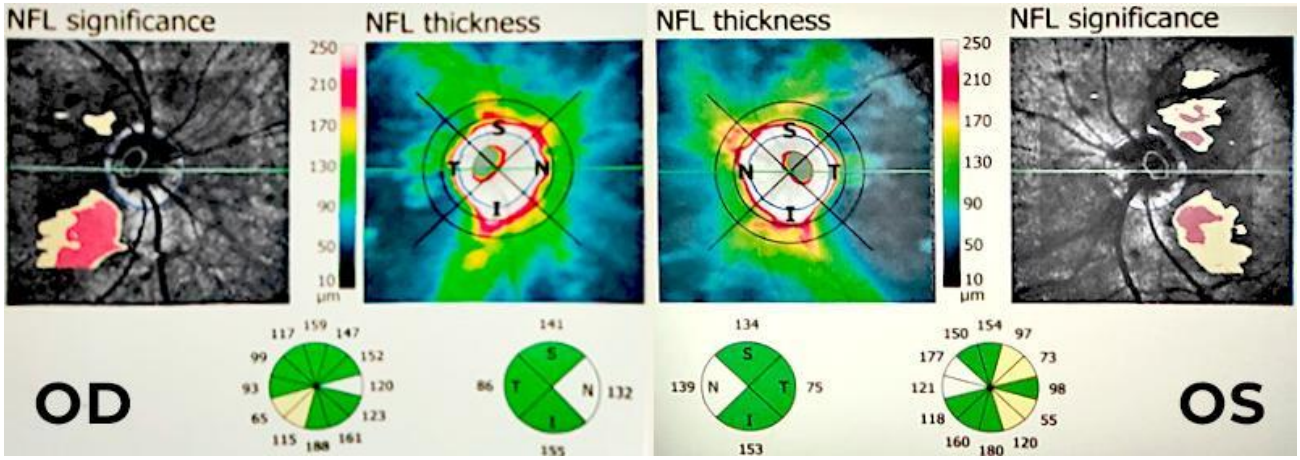

Fig. 2. Sectoral analysis of patient O.'s NFL, 4 months after the onset of neuritis symptoms. According to MRI data, thickening of the mucous membrane of both maxillary and ethmoid sinuses was confirmed

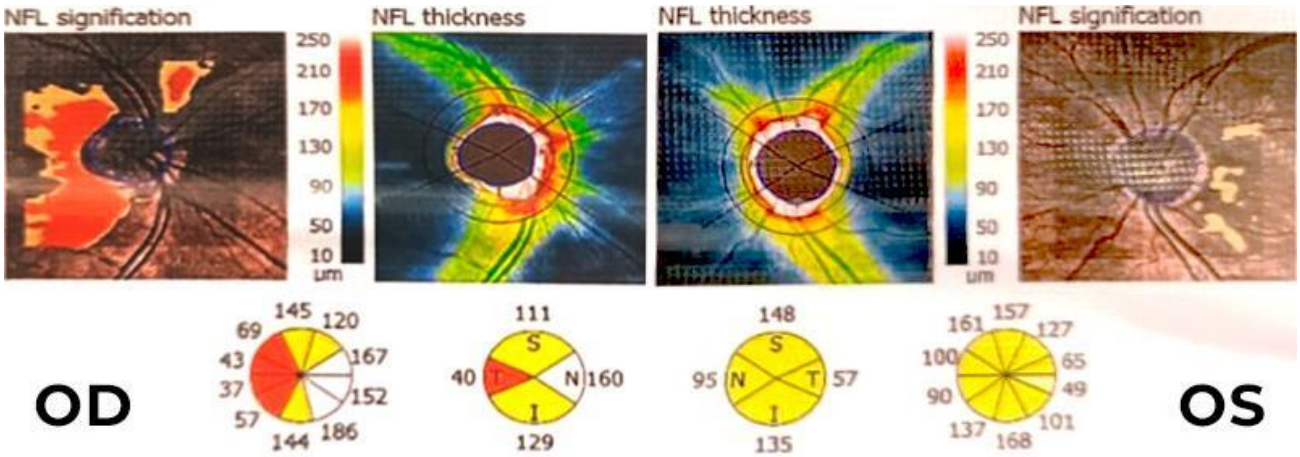

Fig. 3. Sectoral analysis of patient F.'s NFL, 4 months after the onset of neuritis symptoms. According to MRI data, thickening of the mucous membrane of both maxillary and ethmoid sinuses was confirmed

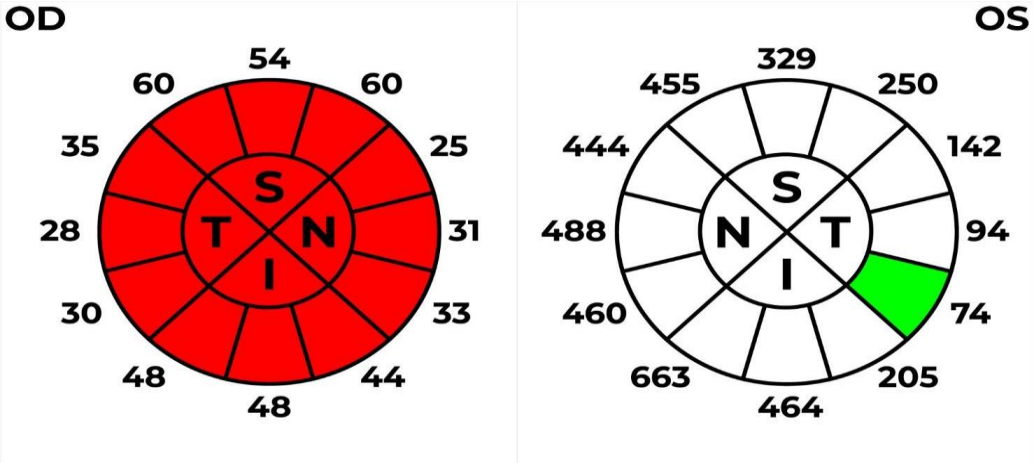

Fig. 4. Sectoral analysis of patient A.'s NFL, 4 years after the onset of neuritis symptoms. According to the MRI, there is a violation of pneumotization of both maxillary sinuses and an ethmoid sinus cyst on the right

In 5 patients who sought consultation up to six months after the onset of the first symptoms of neuritis, the thickness of the NFL on the side of the lesion was greater compared to the opposite side (by 2.34–29.57%), and in those who consulted later, 3 people, on the contrary, the indicator was higher on the contralateral side from 1.89 to 87.91 %. This may indicate different dynamics of changes in NFL retinal thickness depending on the period after the onset of symptoms.

The correlation coefficient between the period that passed from the moment of the first symptoms of neuritis and the consultation and the average thickness of the NFL of the retina for the ipsilateral side ($r = -0.85$ ($p>0.05$) for the contralateral side $r = -0.64$ ($p> 0.05$).

The regression for the ipsilateral side is described by equation

$$y=–4.91x+609.73$$

and regression for the contralateral side

$$y=–4.12x+622.71,$$

where x is the period between the appearance of the first symptoms and the consultation, y is the average thickness of the nerve fiber layer of the retina.

That is, a negative correlation was found between the period between the appearance of the first symptoms and the consultation and the thickness of the nerve fiber layer of the retina in both eyes. The obtained regression equations make it possible to predict the dependence of the NFL thickness of the retina on the period between the appearance of the first symptoms of neuritis and the consultation. For the ipsilateral side, with each month of decreasing time between the onset of neuritis symptoms and the consultation, a 4.91 μm reduction in NFL thickness was expected. For the contralateral side, a 4.12 μm decrease.

4. Discussion of research results

8 patients with progressive atrophy of the optic nerve caused by secondary neuritis combined with sinusitis were examined.

Neuro-ophthalmological consultation was carried out at different time intervals from the onset of symptoms (from 3 months to 4 years). In most patients (62.5 %), the course of neuritis was monophasic. Damage to the opposite side was observed in 5 people (62.5 %).

All these differences complicate the statistical processing of data. That is why, in the literature, there is no unequivocal opinion regarding the connection between the pathology of the accessory sinuses and optic neuropathy. For example, one of such studies is "Relationship between chronic rhinosinusitis and optic neuropathy: A population-based study" by Hwang S.H., et al., published in the "American Journal of Rhinology & Allergy" in 2015 [4]. In this study, the authors state that they found no evidence for a link between chronic rhinosinusitis and optic neuropathy.

As for the results of the sectoral NFL analysis, red-yellow sectors were found on the side of the lesion in 4 people (50 %), which indicates a decrease in the thickness of nerve fibers by 5–20 % compared to the average statistical norm. Similar symptoms can be interpreted as a sign of atrophy of the optic nerve [5].

Several authors [6] substantiate the connection between sinusitis and atrophy of the optic nerve, while others [7] deny it.

Patient M., who came to a neuro-ophthalmology consultation at the earliest after the onset of symptoms, 3 months later, had white sectors on both eyes, which can be interpreted as edema, which may be the result of inflammation or infiltration of the nerve.

There are descriptions in the literature that confirm the possibility of swelling of the optic nerve in sinusitis [8, 9]. In particular, the article "Orbital complications of acute sinusitis: a 10-year retrospective review" by M.F. McNab and B.C. Wright, published in Clinical & Experimental Ophthalmology in 2001. In this article, the authors investigated orbital complications of acute sinusitis between 1990 and 2000. In particular, they indicate the possibility of optic nerve swelling up to 50 % with sinusitis. Some authors consider mucocele (stagnant fluid in the sinuses) to be the cause of infiltration of the optic nerve in diseases of the paranasal sinuses. Under such conditions, compression of the optic nerve and other structures of the orbit occurs, which leads to a decrease in visual acuity and other ophthalmological symptoms.

On the other hand, Ondoni cells are involved in the development of sinusitis and sinus polyps, which can also cause inflammation and infiltration of tissues, including nerve tissue [10].

In patient A., who came to a neuro-ophthalmology consultation at the latest, 4 years after the onset of symp-

toms, only red sectors with a decrease in NFL thickness of more than 20 % were noted on the side of the lesion, which can be interpreted as atrophy of the optic nerve. On the opposite side were white sectors.

According to the literature, infectious processes in the sinuses can affect the trophism of the optic nerve due to the destruction of the vascular network that nourishes the sheath of the nerve, which provokes its ischemia and the development of atrophy.

A negative correlation was found between the appearance of the first symptoms of neuritis and the consultation and NFL thickness of the retina in both eyes. Therefore, it can be assumed that a delay in the start of treatment can lead to the progression of the disease and deterioration of the state of the nervous system, which is also confirmed in the literature, where the correlation between the time of the patient's visit to the doctor and the results of the treatment of the disease was investigated.

In the studied cases, progression was reflected by the involvement of the opposite side of the lesion.

Study limitations. The main limitation is the high degree of patient differences and the complexity of statistical data analysis. The differences relate to the primary manifestations, terms of the patient's treatment, and the course of the neuritis. All this does not allow to classify the disease, to determine the main diagnostic criteria.

Prospects for further research. A more detailed study of the structural and functional aspects of damage to the optic nerve because of diseases of the accessory sinuses will help to develop optimal treatment methods, and thereby prevent irreversible bilateral vision loss.

5. Conclusions

A study of signs of optic nerve atrophy caused by secondary neuritis associated with sinusitis by OCT revealed a negative correlation between the time between the appearance of the first symptoms and the consultation and the thickness of the retinal nerve fiber layer in both eyes.

The obtained regression equations make it possible to predict the dependence of the NFL thickness of the retina on the period between the appearance of the first symptoms of neuritis and the consultation. For the ipsilateral side, with each month of decreasing time between the onset of neuritis symptoms and the consultation, a 4.91 μm reduction in NFL thickness was expected. For the contralateral side, a 4.12 μm decrease.

To improve the diagnosis of optic nerve atrophy caused by secondary neuritis combined with sinusitis, the use of OCT parameters will help to obtain a more complete picture of the condition of the optic nerve and determine the optimal treatment plan.

Conflict of interest

The authors declare that they have no conflict of interest in relation to this research, whether financial, personal, authorship or otherwise, that could affect the research and its results presented in this article.

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Data availability

Data will be made available on reasonable request.

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