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Longitudinal structural changes in the optic nerve in ischemic optic neuropathy: a case report

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Purpose: *To describe the case of longitudinal structural changes in the optic disc in ischemic optic neuropathy.*

Methods: *A 63-year-old male patient (two eyes) was under observation for three months, from August to October 2024. Informed consent to use medical records for research purposes was obtained from the patient. Ethical approval was obtained from the local ethics committee (committee meeting minutes of March 24, 2022). Visual acuity and ophthalmoscopy OU were done and optic coherence tomography (OCT) OS was performed in August and October, 2024, and OCT OD was performed in October, 2024. Automated perimetry and OCT angiography (OCTA) OU were performed in October, 2024.*

Results: *The 63-year-old male patient was examined and diagnosed with "optic atrophy OS and non-arteritic ischemic optic neuropathy (NAION) OU". The OCT study of structural components of the optic disc OS showed a 54.9% reduction in the average thickness of retinal nerve fiber layer (RNFL) of the optic disc and a 4.4% reduction in the thickness of the inner retinal complex (GCL++) in October compared to August 2024. In August 2024, RNFL thickness and GCL++ thickness in the superior and inferior segments were thicker in the left eye than in the right eye. In October 2024, the thickness of both layers in the inferior segment became thicker than the thickness of the superior segment for the left eye, likely reflecting the expansion of swelling to the inferior segment. In October 2024, it was in the inferior segment of the peripapillary region that OCTA showed a reduction in vessel density along with dilated and tortuous capillaries.*

Conclusion: *Studies of longitudinal structural changes in the optic disc reflect the role of localized swelling as a consequence of impaired blood perfusion in NAION, and confirm an increase in the affected area, likely due to secondary factors.*
ear layers provided no indication of neurodegenerative changes at this time point.

Keywords:
non-arteritic ischemic optic neuropathy (NAION), OCT, optic disc, hypoperfusion

Introduction

Ischemic optic neuropathy is a major cause of sudden uniocular loss of vision in middle-aged adults [1]. In the United States, the estimated annual incidence of non-arteritic ischemic optic neuropathy (NAION) ranges from 2.3 to 10.2/100,000 for the population over 50 years old [2]. The vast majority of cases with NAION are idiopathic and the precise pathogenesis of NAION is still unknown [3], but it has been hypothesized that transient hypoperfusion of the short posterior ciliary arteries causes acute ischemia to the optic disc, resulting in axonal swelling [4].

Symptoms are believed to include painless unilateral vision loss and partial or complete optic disc pallor associated with decreased blood supply to the optic disc. A cascade of pathologic events and local compartment syndrome associated with optic disc edema [5] cause secondary damage to the optic nerve which can be corrected by treatments specified in Fig. 1.

Therefore, investigation of structural changes in the optic disc and peripapillary and perimacular areas is important for understanding longitudinal damage in NAION.

The purpose of this report was to describe the case of longitudinal structural changes in the optic disc in NAION.

Methods

A 63-year-old patient diagnosed with bilateral NAION was under observation at Ophthalmology Department, Ivano-Frankivsk National Medical University, for three months, from August to October 2024. Informed consent to use medical records for research purposes was obtained from the patient. Ethical approval was obtained from the local ethics committee (committee meeting minutes of March 24, 2022).

Visual acuity and ophthalmoscopy OU were done and optic coherence tomography (OCT; Topcon Corp., Tokyo, Japan; Glaucoma analysis report) OS was performed in August and October, 2024, and OCT OD was performed only in October, 2024. Computer perimetry (Medmont Studio, Version 6.2.7.1, Full test) and OCT angiography

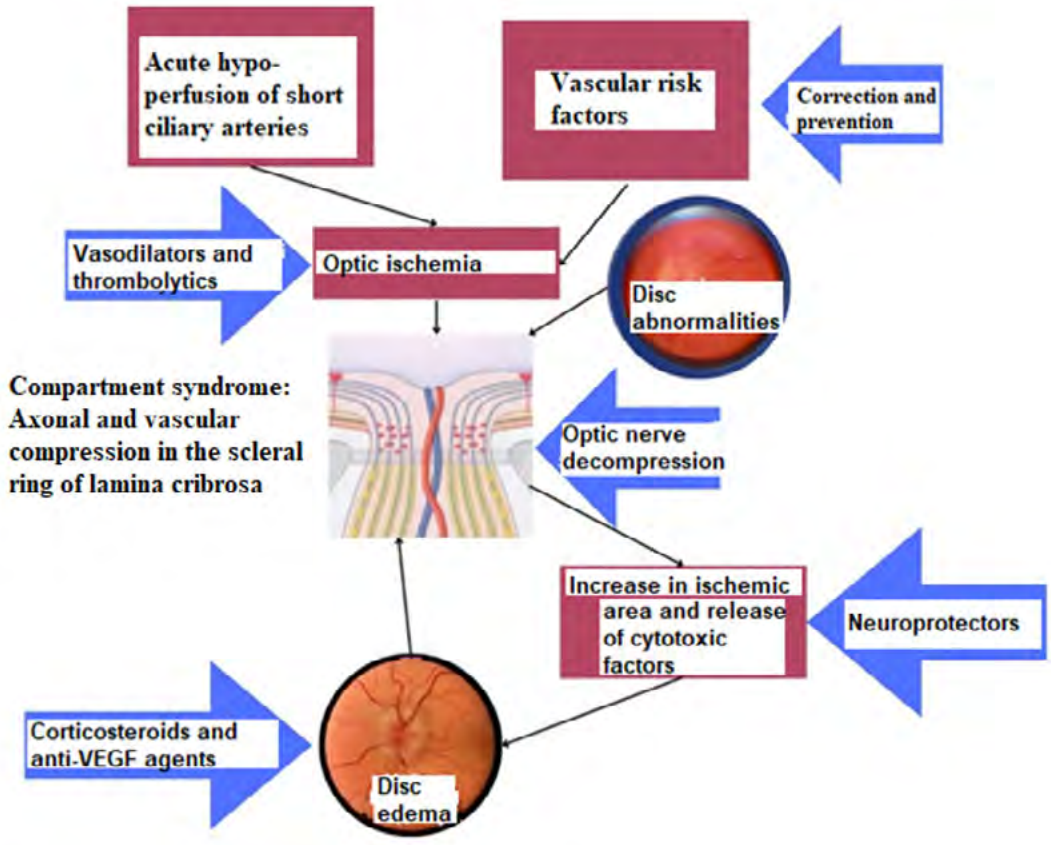

Fig. 1. Pathogenesis and management strategy for non-arteritic ischemic optic neuropathy. Red boxes denote types of longitudinal damage. Blue arrows denote means to correct damage

(TOPCON, OCT Angiography report) were performed in October, 2024. Examination was conducted at Ophthalmology Department, Ivano-Frankivsk National Medical University, and LUX VISION center.

Results

In August, 2024, a 63-year-old patient first presented to an ophthalmologist at a local polyclinic, complaining of low vision in his left eye, which he believed was due to increased blood pressure (150/90 mmHg). Thereafter he was examined at various clinics of Ivano-Frankivsk.

At that time, visual acuity was 1.0 OD and 0.6 OS, respectively, and did not improve with optical correction. The left optic disc was hyperemic, with blurred margins, and partial excavation. Soft exudates in the peripapillary area and angiosclerosis due to a high blood pressure were observed in both eyes. After the patient received inpatient treatment for "essential hypertension and dyscirculatory encephalopathy" at the neurology department, he visited an ophthalmologist at LUX VISION center in October, 2024.

Visual acuity was 1.0 OD and 0.6 OS, respectively, and did not improve with optical correction. The right optic disc was hyperemic, with blurred margins, and partial excavation, whereas the left optic disc was pale and monotonous. In addition, angiosclerosis with signs of peripapillary edema was present in both eyes.

Perimetry was done. Visual fields showed blind spot enlargement and arcuate scotoma OD and an inferior altitudinal defect OS (Fig. 2). Mean deviation (MD) was -3.36 dB OD and -7.36 dB OS.

The clinical diagnosis of "left optic atrophy and bilateral NAION" was made after a final consultation with an ophthalmologist in October, 2024.

The patient was referred for contrast magnetic resonance imaging (MRI) of the brain, orbits and spinal cord, which found no abnormality. A secondary diagnosis of "di-

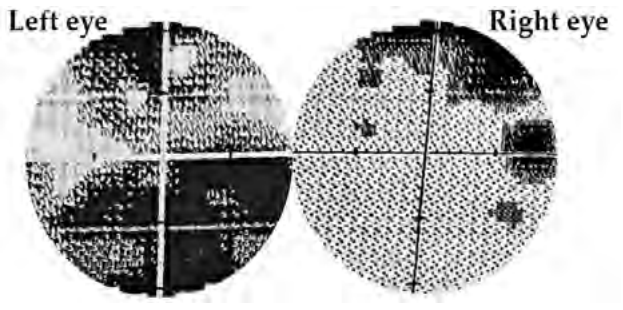

Fig. 2. Perimetry, October 2024. Medmont Studio. Full test

scirculatory encephalopathy and ischemic heart disease" was made after consultations with neurologists and cardiologists. Temporal artery ultrasound was performed and erythrocyte sedimentation rate was assessed to exclude arteritic ischemic optic neuropathy; the results were within normal ranges. The patient was treated by the neurologist.

OCT (Topcon Corp., Tokyo, Japan; Glaucoma analysis report) was performed at several time points in August and October, 2024 (Fig. 3). In August, average retinal fiber layer (RNFL) thickness was 97 µm OD and 226 µm OS, with a percentage difference between eyes of 57.1%. In October, the average RNFL thickness OS decreased to 102 µm, i.e., by 54.9% compared to previous measurements. Additionally, the thickness of the inner retinal complex (GCL++) OS decreased from 113 to 108 µm, i.e., by 4.4% compared to previous measurements (Table 1).

A difference in the transformation of superior and inferior segments of the optic disc on the affected side was noted. In August 2024, RNFL thickness of the superior and inferior quadrants was 1.5 times thicker, and GLC++ thickness was 64.9% thicker in the left eye than in the right eye. In October 2024, RNFL thickness of the superior quadrant was 23.5% thinner, and GLC++ thickness was 61.7% thicker OS compared to OD. During the study period, RNFL thickness and GLC++ thickness of the inferior quadrant on the affected side decreased by 28.7% and increased by 4.1%, respectively. In August 2024, RNFL thickness of the superior quadrant was 11.5% thinner compared to the RNFL thickness of the inferior quadrant OD, and GLC++ thickness of the superior quadrant was 12.1% thicker compared to GLC++ thickness of the inferior quadrant OD (Table 2).

In October 2024, OCT angiography showed dilated and tortuous peripapillary capillaries OU and loss of vessel density in the inferior nasal quadrant OS (Fig. 5A). B-scan showed hyporeflective foci in the RNFL of the optic

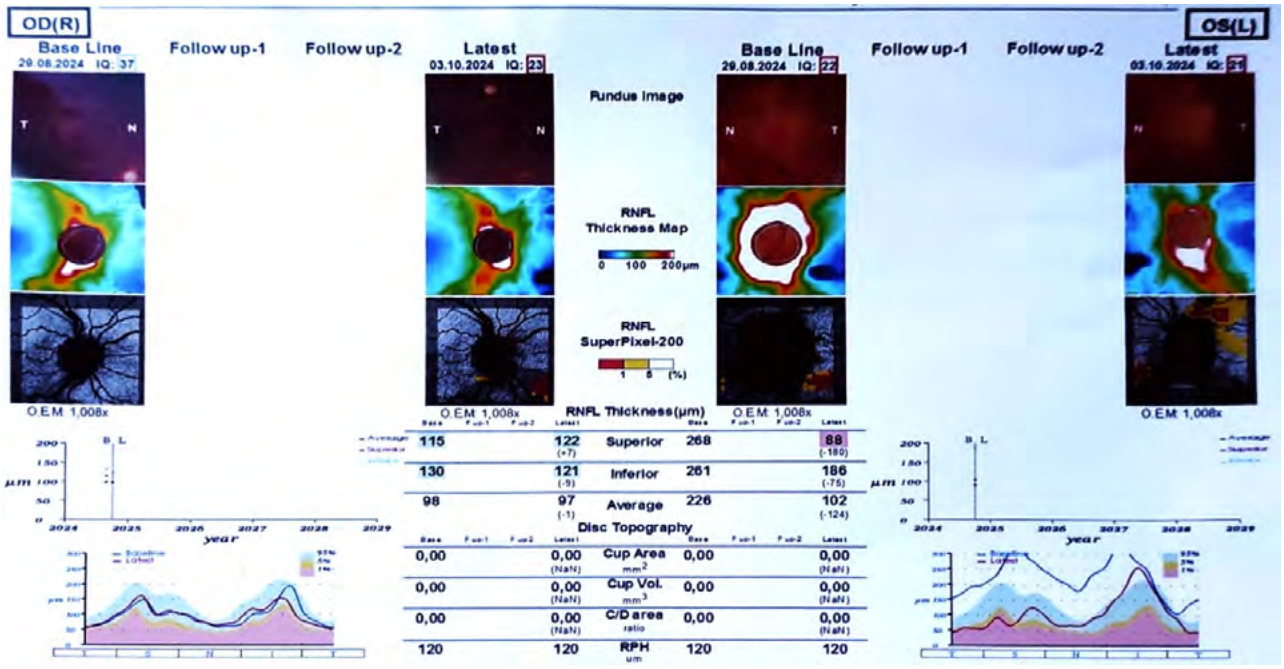

Fig. 3. Longitudinal changes in OCT of the optic nerve (Topcon; Glaucoma Analysis Report – Macula) of a 63-year-old male patient

Table 1. Longitudinal changes in the structural components of the optic nerve as assessed by optic coherence tomography (OCT; Topcon, Glaucoma Analysis Report – Macula)

Characteristic	August, 2024	October, 2024	Percentage difference*
Average RNFL thickness OD, µm	97	112	
Average RNFL thickness OS, µm	226	102	54.9↓
Percentage difference**	↑57.1	↑5	
Average GCL++ thickness OD, µm	112	112	
Average GCL++ thickness OS, µm	113	108	4.4%↓

Note: OD, oculus dexter or right eye; OS, oculus sinister or left eye; *, difference between time points; **, difference between the left and right eyes; ↓, a reduction in the characteristic; ↑, an increase in the characteristic

Table 2. Longitudinal changes in the structural components of the optic nerve and retina as assessed by optic coherence tomography (OCT; Glaucoma Analysis Report – Macula)

Characteristic	Segment	Right eye		Left eye		Percentage difference[1]		Percentage difference[2]
		August 2024	October 2024	August 2024	October 2024	August 2024	October 2024	
Average RNFL thickness, μm	Superior	115	121	268	88	↑ 57.1	↓ 23.5	↓ 67.2
	Inferior	130	122	261	186	↑ 50.2	↑ 30.1	↓ 28.7
Percentage difference[3]		↓ 11.5		↓ 2.6	↑ 52.7			
Average GCL++ thickness, μm	Superior	36	35	109	94	↑ 66.9	↑ 61.7	↓ 13.8
	Inferior	41	44	117	122	↑64.9	↑66.4	↑ 4.1
Percentage difference[3]		↑ 12.1		↑ 6.8	↑ 22.9			

Note: [1], difference between the left and right eyes; [2], difference between time points for the left eye; [3], difference between the superior and inferior segments; ↓, a reduction in the characteristic; ↑, an increase in the characteristic

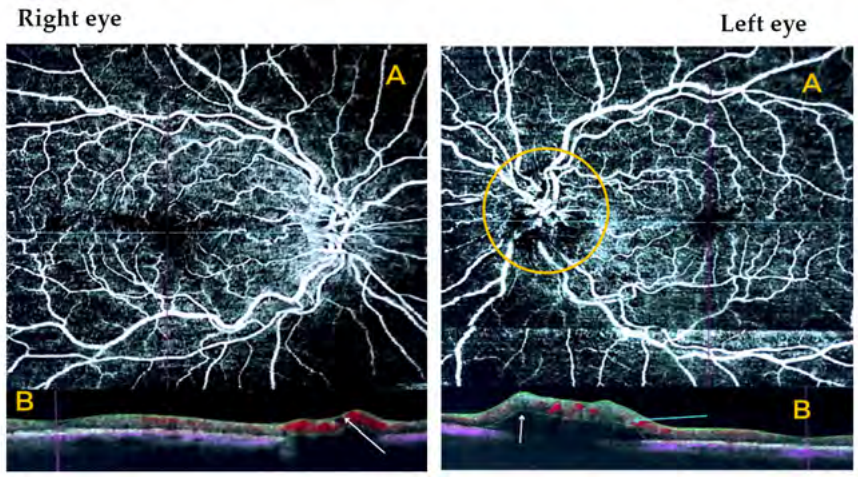

Fig. 4. OCTA (Topcon; Angiography Report) of a 63-year-old male patient. (A) Superficial capillary plexus, autofluorescence effect. (B) Structural B-scan OCT. Note hypoperfusion of the superficial plexus (yellow circle), hyporeflective foci (white arrow) and hyperreflective foci (blue arrow)

disc OU and hypereflective foci in the peripapillary region OS (Fig. 5B).

OCT angiography showed reduced vessel density in the superficial and deep plexuses OS compared to OD in the inferior quadrant (Fig. 6).

Discussion

Three-month changes in optic disc structure were examined in a 63-year-old patient clinically diagnosed with "optic atrophy OS and NAION OU".

At the initial stage of the disease (August 2024), ophthalmoscopy showed a hyperemic optic disc with blurred margins and partial excavation OS, likely corresponding to optic disc swelling. A similar picture with optic disc swelling in early NAION was reported by various authors [6]; the prevailing theory is that NAION is caused by hypoperfusion of the short posterior ciliary arteries supplying the optic nerve [7].

At the later time point of the disease course (October 2024), a similar picture was noted in the right eye, whereas the left optic disc became monotonously pale, corresponding to optic atrophy. Apoptosis of retinal ganglion cells and loss of nerve fibers as signs of anterior ischemic optic neuropathy were also noted by Levin and Louhab [8].

The OCT study of structural components of the optic disc OS showed a 54.9% reduction in the average thickness of RNFL and a 4.4% reduction in the thickness of GLC++ in October compared to August 2024, reflecting a reduction in the severity of swelling.

In August 2024, RNFL thickness and GLC++ thickness in the superior and inferior segments were thicker in the left eye than in the right eye. In October 2024, the thickness of both layers in the inferior segment became thicker than the thickness of the superior segment for the left eye, likely reflecting the expansion of swelling to the inferior segment. Hashimoto and colleagues [9] investigated the longitudinal changes in the circumpapillary RNFL thickness in progressive and non-progressive NAION. They reported that progressive NAION showed development of optic disc swelling from the superior to the interior portion of the optic disc. Additionally, they noted that swelling of the superior portion of the optic disc has a greater tendency to progression and recurrence.

In the current study, in October 2024, it was in the inferior segment of the peripapillary region that OCTA showed a reduction in vessel density along with dilated and tortuous capillaries, which was also reported in the literature

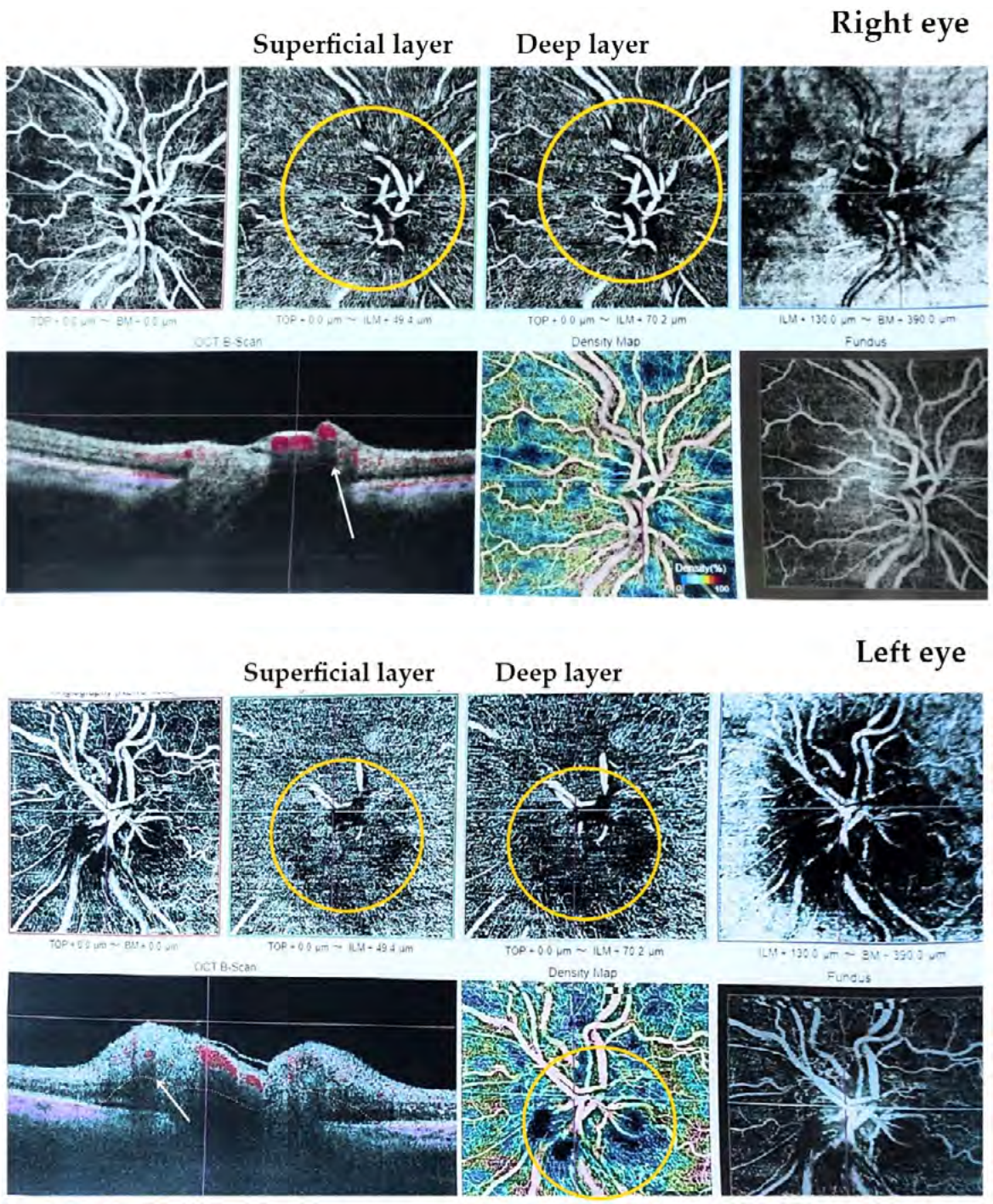

Fig. 5. Vessel density in the peripapillary region for the patient (Topcon, OCT Angiography Report). Note the radial peripapillary vascular network (yellow circle) and hyporeflective foci (white arrow)

[10]. Gandhi and colleagues [9] noted diffuse loss of microvasculature cuff and vascular network around the optic disc in all the eyes with NAION [11].

Conclusion

Studies of longitudinal structural changes in the optic disc reflect the role of localized swelling as a consequence of impaired blood perfusion in NAION, and confirm an increase in the affected area, likely due to secondary factors.

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Disclosures

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