Excyclorotation Causing False Positive Errors of the Retinal Nerve Fiber Layer Deviation Map in the Optical Coherence Tomography

박수환, 김수진, 신종훈
Su Hwan Park, MD, Su Jin Kim, MD, PhD, Jonghoon Shin, MD
양산부산대학교병원 안과
Department of Ophthalmology, Pusan National University Yangsan Hospital, Yangsan, Korea

Measuring the retinal nerve fiber layer (RNFL) using spectral-domain optical coherence tomography (SD-OCT) has been the essential evaluation for detecting optic nerve disease. Despite technological advancements in SD-OCT, the color-coded deviation map that provides information as color-code maps on abnormal RNFL thickness as “outside normal limits” or “borderline” according to an internal normative database has had the limitation to the high rate of false positive results for glaucoma detection. This error can cause unnecessary treatment in the subjects without optic nerve disorder. To better recognize the false positive pattern of SD-OCT in the patients with excyclorotation, we present 2 cases referred to Pusan National University Yangsan Hospital for evaluation.

Key words: Excyclorotation; Optical coherence tomography; Retinal nerve fiber layer

Introduction

Measuring the retinal nerve fiber layer (RNFL) using spectral-domain optical coherence tomography (SD-OCT) has been the essential evaluation for detecting optic nerve disease. Despite technological advancements in SD-OCT, the color-coded deviation map that provides information regarding abnormal RNFL thickness as “outside normal limits” or “borderline,” according to an internal normative database, is associated with the limitation of a high rate of false-positive results for glaucoma detection. This error can lead to the administration of unnecessary treatment for subjects without optic nerve disorder. Then, we present 2 patients with excyclorotation to be misinterpreted as the false positive pattern of SD-OCT.

Case Report

Case 1

A 58-year-old woman was referred to our hospital for exotropia and suspected glaucoma. On ophthalmic examination, the visual acuity was 20/30 in the right eye and 20/25 in the left eye, the spherical equivalent was -0.25 diopters (D) in the right eye and -0.25 D in the left eye. The patient had exotropia of 40 prism diopters (PD) and the V-pattern. Her exotropia increased to 45 PD on upgaze and decreased to 35 PD on downgaze. The fundus examination results were unremarkable, and abnormal optic disc or retinal nerve fiber defect was detected; however, excyclorotation of both eyes with a fovea-disc angle of 22° was noted. The fovea-disc angle was defined as the angle between the horizontal line thorough the disc center and the line connecting...
the fovea and the disc center (Fig. 1A).

Cirrus SD-OCT® (Carl Zeiss Meditec, Inc., Dublin, CA, USA) showed a normal average RNFL thickness, but the spatial distribution of the arcuate bundles on the deviation plot seemed to be abnormal, resulting in inferotemporal thinning in both the eyes and superotemporal thinning in the left eye (Fig. 2). Quantifying the shift in peaks on the RNFL temporal-superior-nasal-inferior-temporal (TSNIT)
Figure 2. Fundus photographs, (A) this image shows the excyclotorsion with a fovea-disc angle of 15° in the right eye and of 12° in the left eye. Optical coherence tomography, (B) retinal nerve fiber layer (RNFL) temporal-superior-nasal-inferior-temporal plot shows the temporal shift of the superotemporal peak of both eyes. Visual field, (C) both eyes have no abnormal defect in automated visual field. ONH = optic nerve head; OU = oculus unitas; OD = oculus dexter; OS = oculus sinister; C/D = cup/disc; TEMP = temporal; SUP = superior; NAS = nasal; INF = inferior; S = superior; N = nasal; I = inferior; T = temporal.
plot revealed a 14° nasal shift of the inferotemporal peak of the right eye, 15° temporal shift of the superotemporal peak of the right eye, 17° nasal shift of the inferotemporal peak of the left eye, and 18° temporal shift of the superotemporal peak of the left eye (Fig. 1B).

Case 2

A 25-year-old woman with a history of bilateral medial rectus recession performed at another hospital 5 years ago was referred to our hospital for esotropia and suspected glaucoma. On ophthalmic examination, the visual acuity was 20/25 in each eye, the spherical equivalent was -7.0 D in the right eye and -6.5 D in the left eye, and the patient had an esotropia of 12 PD. The fundus examination results were unremarkable; however, excyclorotation with a fovea-disc angle of 15° in the right eye and of 12° in the left eye was detected (Fig. 2A). Quantifying the shift in peaks on the RNFL TSNIT plot revealed a 25° nasal shift of the inferotemporal peak of the right eye and 24° nasal shift of the inferotemporal peak of the left eye but no shift of the superotemporal peak of either eye (Fig. 2B). Automated visual fields showed no abnormal defects in either eye (Fig. 2C).

Discussion

Our cases showed that the false-positive analysis of the RNFL deviation map in SD-OCT was associated with excyclorotation of the eyeball. To the best of our knowledge, this is the first report of false-positive findings of SD-OCT in patients with excyclorotation.

Previously, in case of skew deviation, nasal displacement on the RNFL profile by ocular cyclotorsion led to the false low probability plot of the RNFL deviation map on SD-OCT. Owing to excyclorotation in our patients, the inferior RNFL bundle of both eyes was displaced nasally or the superior RNFL bundle of both eyes was displaced temporally in comparison of the normal database in the deviation map. Subsequently, owing to this displacement in patients without glaucoma, the red colors indicate decrease in the RNFL thickness in < 1% of the normal distribution, despite no visual field defect corresponding to these areas of RNFL thinning analyzed by SD-OCT.

Kim et al. demonstrated that the false-positive rate of diagnosing glaucoma in RNFL maps was 30.8%, and longer axial length and smaller disc area were factors associated with the abnormal RNFL maps in patients with glaucoma. Another study reported that the fovea position relative to the optic disc in myopic eyes was an essential determinant for normal RNFL distribution. In addition, Hwang et al. revealed that the artifact in the analysis of Cirrus SD-OCT was affected by head tilt, which induced the RNFL peak location shift by changing the fovea-disc angle.

In our cases, excyclorotation induced an increase in the fovea-disc angle, and these changes were associated with the superotemporal RNFL measurements with a temporal peak location shift and inferotemporal RNFL thicknesses with a nasal peak location shift. Therefore, a false-positive error in the deviation map of Cirrus SD-OCT was noted for our patients. Although OCT measurement is a useful tool for evaluating optic nerve disorders and assessing ocular torsion, clinicians should carefully interpret the abnormal color codes during the RNFL analysis using SD-OCT in patients with excyclorotation.

Conflicts of Interest

None of the authors has any financial or proprietary interest in any material or method mentioned.

References

1. Chen JJ, Kardon RH, Longmuir RA. Diagnostic features of retinal nerve fiber layer rotation in skew deviation using optical coherence tomography. J Neuroophthalmol 2014;34:389-92.
2. Kim KE, Jeoung JW, Park KH, et al. Diagnostic classification of macular ganglion cell and retinal nerve fiber layer analysis: differentiation of false-positives from glaucoma. Ophthalmology 2015;122:502-10.
3. Yamashita T, Kii Y, Tanaka M, et al. Relationship between supernormal sectors of retinal nerve fibre layer and axial length in normal eyes. Acta Ophthalmol 2014;92:e481-7.
4. Choi JA, Kim JS, Park HY, et al. The foveal position relative to the optic disc and the retinal nerve fiber layer thickness profile in myopia. Invest Ophthalmol Vis Sci 2014;55:1419-26.
5. Hwang YH, Lee JY, Kim YY. The effect of head tilt on the measurements of retinal nerve fibre layer and macular thickness by spectral-domain optical coherence tomography. Br J Ophthalmol 2011;95:1547-51.

6. Celik HU, Cavuoto KM, Kostic M, et al. Utilizing optical coherence tomography for objective assessment of ocular torsion. J AAPOS 2019;23:e21.

국문초록

歡迎側軸撮影의 망막신경섬유층 편위사진의 위양성을 유발하는 외회선 2예

목적: 빛간섭단층촬영에서 망막신경섬유층 편위사진의 위양성을 유발하는 외회선을 보인 2예를 보고하고자 한다.
증례요약: (증례 1) 양안 외회선을 보인 58세 여자 환자가 망막신경섬유층의 편위사진에서 최고점의 편위에 의하여, 비정상으로 보였다. (증례 2) 양안 외회선을 보인 25세 여자 환자가 망막신경섬유층의 최고점 편위에 의해 비정상으로 결과가 나왔으나, 시신경 이상과 관련한 시야 결손은 보이지 않았다.
결론: 빛간섭단층촬영은 시신경과 안구회선을 평가하는 데 유용하지만, 외회선에서 망막신경섬유층의 위양성 결과를 주의하여 해석해야 한다.