• Letter to the Editor •

Nd:YAG laser peripheral iridotomy for reverse pupillary block: a case report

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Dear Editor,

In this case, we discuss a teenager who experienced severe eye pain and elevated intraocular pressure (IOP) caused by reverse pupillary block, which was successfully resolved using Neodymium-doped yttrium aluminum garnet (Nd:YAG) laser peripheral iridotomy (LPI). In general, the mechanism of IOP elevation including 1) the iris closely contacting the anterior surface of crystalline lens, leading to the pupillary block, 2) trabecular pathway lesions that increase resistance to aqueous outflow. Such acute IOP increases are commonly seen in closed-angle glaucoma, typically affecting older women with shorter axial lengths and shallower anterior chambers[1-2]. In the prodromal phase, symptoms may include mild eye discomfort and headaches, while major acute attacks can cause severe eye pain, intense headaches, nausea, and vomiting. In this case, the teenager male patient suffered from eye pain, along with nausea and vomiting, all signs of a sudden rise in IOP. His IOLMaster measurements indicated a longer eye axial length and a deeper anterior chamber. Ultrasound biomicroscopic (UBM) imaging showed that his iris was concave backwards and touching both the lens and zonules. It's thought that his uncommon eye shape—a bigger cornea, deeper chamber, and longer axis—led to this concave iris, causing reverse pupillary block (RPB). This is the opposite of the usual forward bulge seen in pupillary block cases, which is uncommon in medical practice.

CASE REPORT

Ethical Approval The study was conducted in accordance with the principles of the Declaration of Helsinki. The informed consent was obtained from the subject.

The patient, a 17-year-old male, has been suffering from persistent eye discomfort and exhaustion in both eyes for over a year. In the past four weeks, he experienced recurrent episodes of severe eye pain, accompanied by nausea, vomiting, and blurred vision. These acute episodes often followed excessive reading and lasted for approximately 30 to 40min. The eye pain could be alleviated by ceasing reading. The patient sought medical attention at a local clinic, where the primary diagnosis was suspected to be dry eye syndrome and infective conjunctivitis. Treatment involved the administration of artificial tears and anti-infective eye drops. However, the patient's condition did not improve with this treatment; on the contrary, it became more severe, thus he attended to the hospital. His best corrected visual acuity was 1.0 [right eye (OD)] and 0.8 [left eye (OS)]. IOP was 24 mm Hg (OD) and 22 mm Hg (OS). Both conjunctivae were clear, the corneas were transparent, with no keratic precipitates or Tyndall effect, a deep anterior chamber, open peripheral angles, mid-peripheral iris concavity, rounded pupils, and clear crystalline lenses (Figure 1). Dilated pupil examination showed that the cup/disc ratio was 0.3 in both eyes, with a clear neural rim border. Refraction showed OD: -1.50 diopter sphere (DS) and OS: -0.50 DS. Measurements using the IOLMaster700 (Carl Zeiss Meditec AG, Inc., Oberkochen, Germany) indicated an ocular axial of 24.62 mm for OD and 24.06 mm for OS (Figure 2). UBM (Aviso; Quantel Medical, Inc., Bozeman, MT, USA) revealed open angles in all quadrants, posterior iris concavity, and contact between the iris and the crystalline lens. Gonioscopy demonstrated an open anterior chamber angle with visible pigmentation in the trabecular meshwork, graded I-II. The diurnal IOP measurements and visual field test showed no significant abnormalities. The patient was diagnosed with RPB

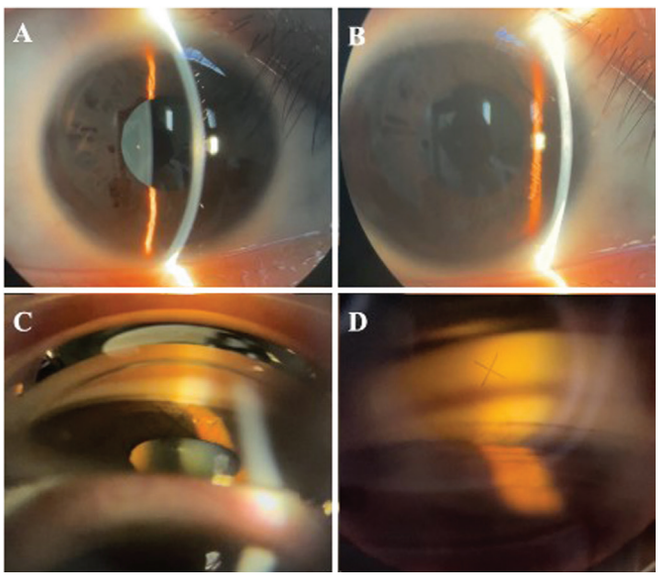

Figure 1 Image of the patient's anterior chamber of right eye A: Iris root is posteriorly concave; B: Depth of the peripheral anterior chamber exceeds 2 corneal thicknesses; C: Gonioscopy examination showed an open anterior chamber angle in the right eye, displaying brownish-black pigmentation within the trabecular meshwork, graded I-II; D: Gonioscopy image showed an open anterior chamber angle in the right eye, with pigment graded I-II after performing laser peripheral iridectomy.

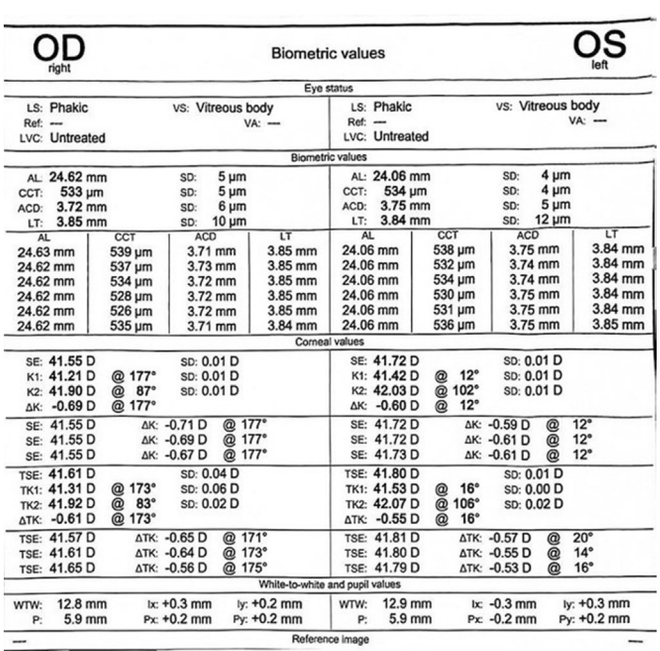

Figure 2 Patient's IOLMaster700 results The measurements showed a long AL, a deep ACD and a large cornea diameter (WTW), with normal corneal thickness in both eyes. AL: Axial length. CCT: Central cornea thickness. ACD: anterior chamber depth; LT: Lens thickness; SE: Spherical equivalent; K1: Flat keratometry; K2: Steep keratometry; WTW: White to white; OD: Right eye; OS: Left eye.

[both eyes (OU), associated secondary high IOP (OU), and refractive error (OU).

The patient underwent sequential Nd:YAG LPI in both eyes, one month apart. We targeted on the mid-peripheral iris at the 6 o'clock position. The day following LPI, the IOP was 15 mm Hg (OD) and 17 mm Hg (OS), and the patient felt a rapid relief of eye discomfort. At the one-month postoperative examination, IOP was 20 and 19 mm Hg, respectively. By the six-month follow-up, the patient reported a significant reduction in eye pain, and the acute episode never happened again ever since LPI. Visual acuity was 0.6 in the right eye (-1.50 DS, corrected to 1.0) and 0.8 in the left eye (-0.50 DS, corrected to 1.0). IOP measured 18 mm Hg (OD) and 14 mm Hg (OS), with smooth incision margins, a flat iris, and open anterior angles in both eyes, showing pigmentation grade I-II (Table 1). UBM confirmed a flat iris configuration in both eyes (Figure 3).

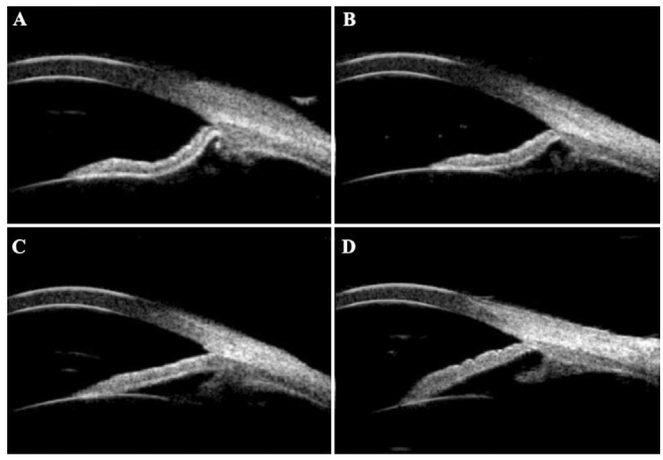

Figure 3 UBM examination before Nd:YAG laser in both eyes Prior to Nd:YAG laser treatment, UBM examination revealed an open chamber angle at 6:00 position in the right eye (A), with the iris concave and in contact with the lens surface and zonules. Similarly, the left eye (B) displayed a concave iris at 6:00 position. Six months after Nd:YAG laser treatment in both eyes, UBM examination showed an open anterior angle and a flat iris in the right eye (C), with similar findings in the left eye (D). UBM: Ultrasound biomicroscope.

Table 1 Comparisons between pre- and post-Nd:YAG LPI

Parameters	Pre-LPI		Post-LPI	
	OD	OS	OD	OS
Best corrected visual acuity (Snellen decimal)	0.8	1.0	1.0	1.0
Intraocular pressure (mm Hg)	24	22	18	14
Central anterior chamber depth (mm)	3.72	3.75	3.68	3.70
Pigmentation grade (Scheie)	I-II	I-II	I-II	I-II
Iris concavity (mm)	0.61	0.58	0.25	0.30
Iridolenticular contact (mm)	2.85	1.45	2.32	0.98

LPI: Laser peripheral iridotomy; OD: Right eye; OS: Left eye.

Best corrected visual acuity is measured with Snellen Visual Chart. IOP is measured with Goldmann tonometer. Anterior chamber depth, iris concavity and iridolenticular contact are measured with ultrasound microscope. Iris concavity is quantified as the maximum perpendicular distance from the posterior iris surface to a line extending from the iris

root to the most peripheral point of iridolenticular contact. Scheie pigmentation grade is measured with gonioscopy examination.

DISCUSSION

Iris concavity denotes a backward bowing of the midperipheral iris, which can be quantitatively assessed through anterior segment optical coherence tomography and UBM[3-4]. Previous research has indicated that iris concavity is relatively prevalent in the general population, particularly among individuals with myopia[5-7]. The iris concavity can lead to RPB. The posterior concavity of the iris closely adheres to the anterior surface of the crystalline lens, thereby creating a RPB and forming a structure similar to a "flap"[8-9]. Aqueous humor flows unidirectionally from the posterior to the anterior chamber, with no reverse flow, resulting in elevated pressure within the anterior chamber. This pressure gradient worsens the iris's posterior concavity, causing the peripheral iris pigment epithelium to come into contact with the zonules, potentially enhancing pigment dispersion. These pigment particles are then transported by the aqueous humor to the trabecular meshwork, where they accumulate over time. This accumulation stimulates immune cells in the trabecular meshwork to phagocytize the pigment, initiating an inflammatory response that increases filtration resistance and may ultimately lead to secondary glaucoma. According to this hypothesis, RPB happens before pigment dispersion. For patients experiencing RPB without associated trabecular meshwork dysfunction, prompt relief of the pupillary block and restoration of the normal iris configuration are effective strategies to prevent the onset of glaucoma[8,10-11].

In this patient's case, the acute episode of increased IOP occurred after excessive reading and was relieved by stop reading, suggesting that RPB is not a persistent condition. The adaptability of the iris is attributed to the ciliary muscle. Contraction of the ciliary muscle facilitates accommodation, where the muscle pulls the iris root backward, creating a concave shape. This action relaxes the crystalline lens ligaments, increases the crystalline lens's anterior-posterior diameter, and allows the crystalline lens to move forward, thereby enhancing the contact between the iris and the crystalline lens, leading to RPB[4,9,12]. Accommodation can be induced by various factors, including lighting conditions, focusing on near objects, physical exertion, and the use of glasses[9-11]. Consequently, the iris's flexibility enables the rapid onset and resolution of RPB, potentially accounting for the patient's acute episodes. This highlights the need to investigate potential underlying pathology in young myopic patients presenting with comparable symptoms, rather than attributing their symptoms solely to conditions such as "eye fatigue" or "dry eye."

Gonioscopy was performed on the patient, revealing grade I-II trabecular meshwork pigmentation in both eyes. Postoperatively, the pigmentation grade was still grade I-II. There were no deposits of pigment on the posterior cornea or granules on the anterior surface of the crystalline lens. Zonular fiber pigmentation was excluded based on UBM imaging, which demonstrated smooth lens zonules and the absence of pigment deposits. These findings indicated that the acute episodes of eye pain were not caused by pigment dispersion. To ascertain whether there was any progression towards glaucoma, diurnal IOP measurements and visual field tests were conducted, demonstrating normal results and showing no evidence of optic nerve damage.

In this case, the patient experienced significant relief from their symptoms following Nd:YAG LPI, with their IOP normalizing. UBM imaging revealed a flattening of the iris post-operatively. UBM measurements demonstrated a reduction in the anterior chamber depth, iris concavity, and iridolenticular contact. These findings suggest that the acute episode of ocular hypertension was due to RPB. The creation of a hole in the peripheral iris facilitated communication between the anterior and posterior chambers, obviating the pressure gradient and allowing the IOP to normalize while also flattening the iris. Additionally, the trabecular meshwork function was preserved; had it been compromised, the IOP would have remained elevated post-surgery. Accordingly, in cases where patients present with iris concavity and elevated IOP, prompt LPI effectively alleviates RPB, decreasing IOP thereby reducing the potential for the development of open angle glaucoma[12-13]. Moreover, by flattening the iris, LPI prevents pigment dispersion and diminishes the likelihood of secondary glaucoma.

This case emphasizes the significance of assessing iris morphology in patients with deep anterior chambers and elevated IOP, where anterior segment optical coherence tomography and UBM are indispensable diagnostic methods for the detection of RPB. The iris concavity is predominantly observed in adolescents and myopic individuals. In China, the prevalence of myopia among children and adolescents stands at 52.7%, with a concerning trend towards earlier onset and increased severity[14], which warrants clinical concern.

ACKNOWLEDGEMENTS

Conflicts of Interest: Zhang ZY, None; **Liang ZQ,** None; **Bao YZ,** None.

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