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• Letter to the Editor •

Micropulse transscleral laser therapy for secondary angle-closure glaucoma in nanophthalmos: a case report

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Dear Editor,

The choice of surgical intervention for nanophthalmos patients with secondary angle-closure glaucoma poses a challenging decision for ophthalmologists. Because nanophthalmos patients who have undergone filtration surgery or other intraocular procedures are more susceptible to severe complications, including choroidal effusion, malignant glaucoma, and explosive choroidal hemorrhage, all of which can lead to vision loss[1]. This dilemma is particularly pronounced in patients with shorter axial lengths. Micropulse transscleral laser therapy (M-TLT), also known as micropulse transscleral cyclophotocoagulation (MP-TSCPC), is a non-incisional laser therapy surgery for glaucoma[2]. In 2015, Golan and Kurtz[3] were the first to report four patients with secondary angle-closure glaucoma in nanophthalmos with axial lengths ranging between 17 and 19 mm (mean 18 mm) who were successfully treated with M-TLT, and choroidal detachment was observed in all patients (recovery spontaneously in two patients and recovery after systemic steroid treatment in the other two), of which two had a slight decrease in visual acuity. This case report describes a nanophthalmos patient with secondary angle-closure glaucoma who underwent two sessions of M-TLT in her left eye with an extremely short axial length (14.30 mm), and there have been no reports of treatment with M-TLT in nanophthalmos patient with such a short axial length. With a one-year follow-up and without the use of any intraocular pressure (IOP)-lowering medications, the patient exhibited well-controlled IOP, and no surgery-related complications. This case serves as a reference for the treatment of similar patients.

Ethical Approval This case report was approved by the Medical Ethic Review Committee of Chengdu First People's Hospital (YJS No.025, 2024). The study was conducted in accordance with the principles of the Declaration of Helsinki. The informed consent was obtained from the subject.

Case Report A 44-year-old female nanophthalmos patient with secondary angle-closure glaucoma, unresponsive to previous bilateral peripheral iridectomy six years ago, continued to experience elevated IOP in the left eye. She had been on a long-term regimen of timolol, brinzolamide, brimonidine, and latanoprost eye drops, with IOP fluctuating between 19–31 mm Hg in the left eye. Upon admission, her visual acuity was recorded as 0.1 unaided and 0.4 corrected (+16.00 DS) in the right eye, and 0.06 unaided and 0.2 corrected (+16.00 DS) in the left eye. IOP was 14.2 mm Hg in the right eye and 26 mm Hg in the left eye. Slit-lamp examination revealed a transparent cornea in the right eye (Figure 1A), shallow central anterior chamber, peripheral anterior chamber less than 1/4 of corneal thickness, patent iridotomy at the 10 o'clock position, and a 2.5 mm pupil responsive to light with a cloudy lens (C2N1P0). In the left eye (Figure 1B), the cornea was transparent, the central anterior chamber extremely shallow, peripheral anterior chamber absent, patent iridotomy at the 10 o'clock position, visible atrophy in the 12 o'clock position, a 2.5 mm pupil responsive to light, and a cloudy lens (C1N1P0). Fundus photography showed a cup-to-disc ratio (C/D) of 0.3 in both eyes, with no visible central foveal reflection. Spaeth angle grading revealed A10b in both eyes (Figure 2). Ultrasound biomicroscopy (UBM) demonstrated a central anterior chamber depth of 1.56 mm in the right eye, closed angle, and a discernible peripheral iridotomy, with a narrow gap in the entire ciliary body upper chamber. In the left eye, the central anterior chamber depth was 0.97 mm, angle closure, discernible peripheral iridotomy, and no apparent abnormalities in the entire ciliary body upper chamber.

Axial lengths were 15.05 mm in the right eye and 14.30 mm in the left eye. Central corneal thickness (CCT) measured 529 μm in the right eye and 523 μm in the left eye. Visual field testing revealed superior arcuate defects in both eyes (mean deviation: right eye -9.07, left eye -7.66). Optic disc optical coherence tomography (OCT) and OCT angiography (OCTA) showed thinning of the retinal nerve fiber layer and reduced blood flow density around the optic disc in both eyes. Macular OCT exhibited an uneven surface reflectivity band in the macular region of both eyes. B-scan ultrasonography indicated thickening of the sclera in both eyes. The patient was diagnosed with 1) bilateral true nanophthalmos; 2) bilateral secondary angle-closure glaucoma; 3) bilateral high hyperopia; 4) bilateral epiretinal membrane on admission. The patient consented to and underwent left eye M-TLT under local anesthesia.

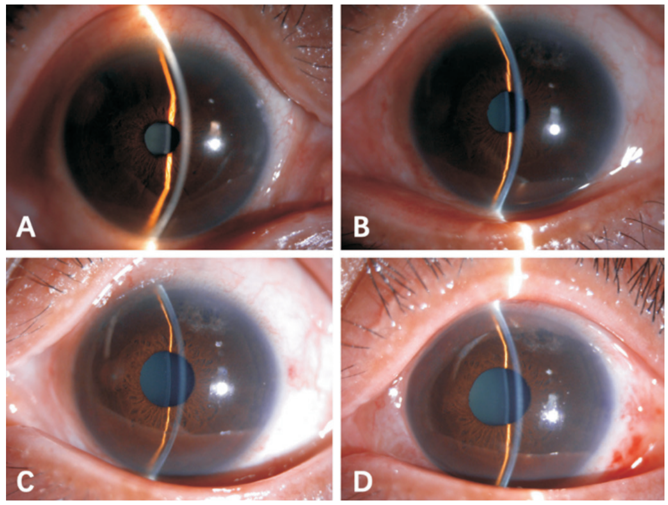

Figure 1 The images of the anterior segment A: The patient's right eye image before surgery; B: The patient's left eye image before surgery; C: The patient's left eye image on 1 postoperative day; D: The patient's left eye image on 1 postoperative day of the repeated surgery.

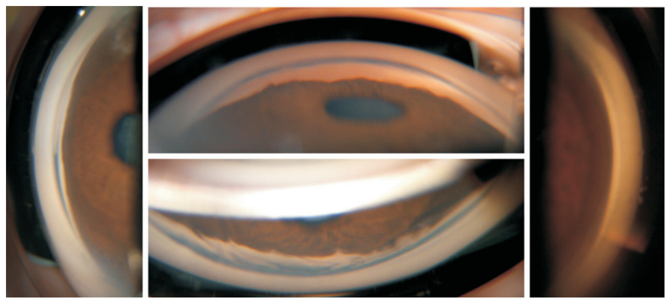

Figure 2 The image of anterior chamber angle structure before surgery.

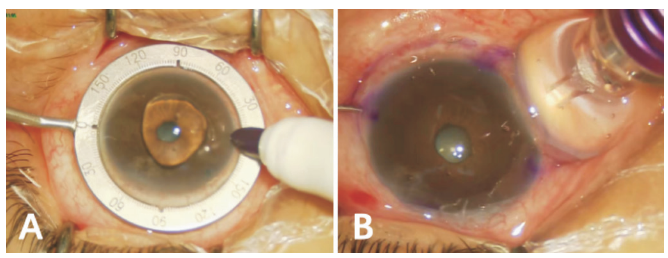

Figure 3 The patient's intraoperative photography A: The operator is using a corneal fixation ring and a marking pen; B: The laser probe was positioned 1–2 mm posterior to the corneal edge.

Surgical Procedure The patient underwent peribulbar block anesthesia with 1.5 mL each of 2% lidocaine and ropivacaine. Corneal landmarks were identified by marking positions at 12:00, 1:30, 3:00, 4:30, 6:00, 7:30, 9:00, and 10:30, 1 mm posterior to the corneal edge, using a corneal fixation ring and a marking pen (Figure 3A). An appropriate amount of coupling agent was applied over the conjunctiva. The Cyclo G6 laser with an MP3 probe (MicroPulse-P3, Iridex Corporation, Mountain View, CA, USA) was utilized for laser transmission, with a laser power of 2000 mW and a duty cycle of 31.33%. The laser probe was positioned 1–2 mm posterior to the corneal edge (Figure 3B), perpendicular to the ocular surface, targeting the flat part of the ciliary body. The laser was scanned continuously in the upper half of the eye from 9:30 to 2:30, with a scanning or dwell time of 20s/hemi-eye, repeated four times for a total of 80s. The procedure was then repeated in the lower half from 3:30 to 8:30. The total treatment range for both eye hemispheres was 300°, with a total pulse time of 160s. Care was taken to avoid the 3 o'clock and 9 o'clock positions to prevent damage to the ciliary nerve and posterior ciliary artery. The procedure concluded with the application of tobramycin dexamethasone eye ointment, sterile gauze coverage, and proceeded smoothly within a duration of 12min.

On the first postoperative day, the patient's left eye exhibited a best-corrected visual acuity (BCVA) of 0.2, IOP of 28 mm Hg, and slight conjunctival congestion (Figure 1C). Anti-inflammatory treatment was initiated with prednisolone acetate eye drops and diclofenac sodium eye drops, along with timolol and brinzolamide eye drops for IOP reduction. At 1wk postoperatively, the patient's left eye BCVA improved to 0.3, with an IOP of 22 mm Hg. After 1mo, the left eye BCVA was 0.25, with an IOP of 28 mm Hg. The patient was advised to discontinue prednisolone acetate eye drops and initiate oral acetazolamide for IOP reduction. Considering that the maximum IOP-lowering effect of M-TLT is often observed 2–3mo postoperatively[4], further observation was recommended for one month. If the IOP remains poorly controlled, it may be worth considering a repeat treatment. At 2mo postoperatively, the patient's left eye IOP increased to 37 mm Hg, leading to readmission for repeat surgery. The procedure, operator, steps, and laser parameters remained consistent with the initial surgery. On the first day after the repeat procedure (Figure 1D), the patient's left eye BCVA was 0.25, with an IOP of 33 mm Hg, the pupil measured 3.5 mm and mild conjunctival congestion. Prednisolone acetate eye drops, diclofenac sodium eye drops were prescribed for anti-inflammatory. Brimonidine eye drops, timolol and brinzolamide eye drops were prescribed for IOP-lowering purposes. One week later, the patient's left eye BCVA remained at 0.25, with an IOP of 24 mm Hg, and the pupil measured 3.5 mm. Due to the persistent dilation of the pupil, pilocarpine eye drops were added nightly to induce miosis. At 1mo postoperatively, the left eye BCVA was 0.25, with an IOP of 20 mm Hg, and the pupil measured 2.5 mm. Pilocarpine eye drops, brimonidine eye drops, and prednisolone acetate eye drops were discontinued. At 3mo postoperatively, the left eye BCVA was 0.25, with an IOP of 16 mm Hg. Diclofenac sodium eye drops and timolol and brinzolamide eye drops were discontinued. At 6mo postoperatively, the left eye BCVA was 0.25, with an IOP of 20 mm Hg. One year after surgery, the left eye BCVA was 0.25, with an IOP of 15 mm Hg. At the one-year follow-up, the patient remained medication-free, with a 42.3% reduction in IOP, and no surgery-related complications were observed.

DISCUSSION

Nanophthalmos is a rare ocular developmental disorder characterized by short axial length, shallow anterior chamber, thickening of the sclera and choroid, and an increased lens-to-eye volume ratio, often leading to secondary angle-closure glaucoma[2]. Initial treatments typically involve medications and laser interventions. However, when persistent elevated IOP occurs, medications may have limited efficacy, and their prolonged use can lead to drug resistance or induce ocular surface drug toxicity[5]. Regarding laser treatments, laser peripheral iridotomy (LPI) is recommended to alleviate pupil block, with argon laser peripheral iridoplasty (ALPI) as an adjunct when necessary[2]. However, its effectiveness diminishes as peripheral anterior synechiae develop, making it challenging to adequately regulate IOP. In this case report, LPI failed due to the patient' thick iris in initial treatment, peripheral iridectomy was performed. Despite the prolonged use of four IOP-lowering medications postoperatively, the left eye continued to exhibit high IOP, necessitating surgical intervention. Current surgical options for treating nanophthalmos secondary angle-closure glaucoma include filtration surgery, combined filtration surgery with sclerectomy, punch sclerostomy, and vortex decompression, and combination of vitrectomy, lensectomy, and IOL implantation, among others. However, these surgeries often pose challenges in avoiding complications that may impact visual acuity. Given the patient's shorter axial length of left eye (14.30 mm), the risk associated with intraocular surgery was deemed higher. Consequently, a non-invasive ciliary body-destructive surgery, specifically M-TLT, also known as MP-TSCPC, was considered and selected. Compared with the traditional continuous-wave transscleral cyclophotocoagulation (CW-TSCPC), it has the lower incidence of side effects and collateral damage[6]. The exact mechanism of action of M-TLT is not entirely clear. It is possible that it exerts its IOP-lowering effect through a combination of more than 1 mechanism of action[7], including 1) reducing aqueous humor production is achieved by causing subthreshold cell damage to ciliary epithelial cells; 2) probably through the uveoscleral pathway to lower IOP; as a 32% increased uveoscleral outflow was observed in enucleated human eyes treated with noncontact laser cyclophotocoagulation. However, there is still no sufficient and direct evidence; 3) pilocarpine-like effect increases the aqueous humor outflow of trabecular pathway. Micropulse acts on the longitudinal fibers of the ciliary muscle, causing contraction of the fibers and therefore displacement of the scleral spur in a posterior and inward direction, which causes enlargement of the trabecular spaces and expansion of the Schlemm canal area to facilitate the drainage of aqueous humor. The safety and efficacy of M-TLT have been demonstrated in several studies[8-9]. However, Lim *et al*[10] reported that 6% to 47% of eyes require repeated treatment to achieve the desired IOP lowering effect. The effect of M-TLT on lowering IOP is certain, but the reason for repeated treatment is that some patients have a strong ability to repair and regenerate the ciliary epithelium, or the laser energy of one surgery is not enough to reduce IOP to the desired effect, or it is also related to the precise operation and experience of the surgeon. Similarly, this patient after repeated treatment exhibited a 42.3% reduction in IOP after one year, with well-maintained IOP without the use of any IOP-lowering medications. In summary, in our case, repeated M-TLT effectively and safely reduced IOP and the need for IOP-lowering medications in a nanophthalmos patient with secondary angle-closure glaucoma, avoiding the complications associated with incisional surgeries and achieving satisfactory outcomes. However, given the regenerative capacity of ciliary epithelium, continued observation is essential, and repeat treatment may be considered if necessary. Therefore, we propose that repeated M-TLT can be considered as a therapeutic approach for managing nanophthalmos secondary angle-closure glaucoma, with the potential to be a preferred treatment option, pending further extensive clinical observations for validation.

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Conflicts of Interest: Yu P, None; **Hu BY,** None; **He Y,** None; **Jing L,** None; **Fan HY,** None; **Shu J,** None; **Zeng LZ,** None.

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