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Original Research

Intraocular pressure changes after Nd:YAG laser capsulotomy: a retrospective cohort study from ECWA Eye Hospital, Nigeria

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Abstract

Purpose: Nd:YAG laser capsulotomy is an effective treatment for posterior capsule opacification (PCO) but may be associated with postoperative increases in intraocular pressure (IOP), particularly in high-risk patients. This study evaluated the incidence of IOP elevation following Nd:YAG laser capsulotomy, the management strategies used, and clinical outcomes at a tertiary eye hospital in Nigeria.

Methods: This retrospective cohort study included 162 patients aged 40–80 years who underwent Nd:YAG laser capsulotomy for PCO and completed at least one year of follow-up. Data on demographic characteristics, IOP measurements, visual acuity outcomes, and post-procedure management were extracted from medical records. Changes in IOP and visual acuity before and after the procedure were analyzed, and outcomes were compared between patients with and without pre-existing glaucoma.

Results: Mean IOP increased significantly after the procedure (from 14.2 ± 2.1 mmHg pre-procedure to 16.7 ± 3.2 mmHg post-procedure, $p<0.001$). IOP elevation (≥21 mmHg) occurred in 9.26% of patients at one month and declined to 1.85% at one year following treatment with topical IOP-lowering medications. Patients with glaucoma experienced a higher incidence of IOP elevation compared with those without glaucoma (25% vs. 10%). Visual acuity improved significantly after capsulotomy, with the proportion of patients achieving good visual acuity (>6/12–6/5) increasing from 18% to 35%.

Conclusions: Nd:YAG laser capsulotomy significantly improves visual acuity but may cause transient IOP elevation, particularly in patients with glaucoma. Careful postoperative monitoring and timely use of topical IOP-lowering therapy are essential to achieving favorable outcomes in resource-limited settings.

Keywords: Nd:YAG laser, Capsulotomy, Intraocular pressure, Posterior capsule opacification, Glaucoma, Visual acuity, Resource-limited settings

Introduction

Posterior capsule opacification (PCO) is a common late complication following cataract surgery and remains a leading cause of reduced visual acuity after an initially successful procedure [1,2]. Neodymium-doped yttrium aluminum garnet (Nd:YAG) 1064-nm laser capsulotomy is the standard treatment for PCO and is widely recognized as an effective and minimally invasive method for visual rehabilitation [3–5]. Despite its established efficacy, Nd:YAG laser capsulotomy is associated with postoperative complications, most notably transient or sustained elevations in intraocular pressure (IOP) [3,6,7]. Increased IOP following Nd:YAG capsulotomy is clinically relevant because even short-term elevations may have adverse consequences, particularly in susceptible individuals. Proposed mechanisms include obstruction of the trabecular meshwork by capsular debris, inflammatory responses, and alterations in aqueous humor dynamics [6,7]. If unrecognized or inadequately managed, post-procedure IOP elevation may contribute to optic nerve damage, especially in patients with pre-existing glaucoma or ocular hypertension [13,14].

The burden of glaucoma is particularly high in sub-Saharan Africa, where prevalence rates are among the highest globally and patients often present with advanced disease [8–12]. In this context, careful monitoring and management of IOP following Nd:YAG laser capsulotomy are especially important. Previous studies have emphasized the importance of IOP control in glaucoma-related interventions and highlighted the potential consequences of poorly managed postoperative IOP elevations [15–17]. However, much of the existing literature on Nd:YAG capsulotomy–related IOP changes originates from high-resource settings, and data from resource-limited environments remain comparatively sparse. At Evangelical Church Winning All (ECWA) Eye Hospital, Kano, Nd:YAG laser capsulotomy is routinely performed for the management of PCO. However, there is limited longitudinal evidence describing the incidence of post-capsulotomy IOP elevation, the effectiveness of routine management strategies, and clinical outcomes in this setting. This represents an important gap in the literature, particularly given the high prevalence of glaucoma and the constraints on long-term ophthalmic follow-up in many low-resource health systems. Therefore, this study aims to evaluate the incidence of increased IOP following Nd:YAG laser capsulotomy at ECWA Eye Hospital, analyze the management strategies employed, and assess the clinical outcomes over follow-up. By providing real-world data from a resource-limited setting, the study seeks to inform clinical practice and support safer application of Nd:YAG laser capsulotomy, particularly among patients at increased risk of IOP-related complications.

Materials and Methods

Ethical considerations

This study received ethical approval from the Human Research Ethics Committee of ECWA Eye Hospital (ECWA/HREC/001/2023) and was conducted in accordance with the principles of the Declaration of Helsinki. The study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for cohort studies. The study was registered in the Research Registry with the unique identifying number 10751. Informed consent was obtained from all patients prior to the Nd:YAG laser capsulotomy and for the use of their anonymized clinical data for research purposes.

Study design and population

This study was a retrospective cohort study conducted at Evangelical Church Winning All (ECWA) Eye Hospital, Kano, Nigeria. Data were obtained from hospital medical records, including Nd:YAG laser procedure registers, outpatient clinic charts, and intraocular pressure monitoring records. Patients who underwent Nd:YAG laser capsulotomy between January 2023 and December 2023 were included, with follow-up extending through December 2024. Eligible patients were adults aged 40–80 years who had documented pre-procedure and post-procedure intraocular pressure measurements and completed at least one year of postoperative follow-up. Baseline demographic data, ocular diagnoses, intraocular pressure readings, visual acuity measurements, laser energy parameters, and prescribed postoperative medications were extracted. Patients with pre-existing glaucoma or uveitis were included to reflect real-world clinical practice. Patients with glaucoma were analyzed as a predefined subgroup to assess the incidence of post-capsulotomy intraocular pressure elevation relative to patients without glaucoma. Patients with uveitis were included in the overall cohort but were not analyzed as a separate subgroup due to limited numbers and the retrospective nature of the data. For patients who underwent Nd:YAG laser capsulotomy in both eyes during the study period, only the first treated eye was included in the analysis to avoid inter-eye correlation.

Sample size consideration

As this was a retrospective cohort study, no formal a priori sample size or power calculation was performed. Instead, all consecutive patients who met the inclusion criteria during the study period were included, consistent with real-world observational practice.

Inclusion criteria

Patients eligible for inclusion were individuals who underwent Nd:YAG laser capsulotomy at ECWA Eye Hospital for the management of posterior capsule opacification. The study included adults aged 40–80 years with documented pre-procedure and post-procedure intraocular pressure measurements and who completed a minimum follow-up period of one year. Patients with pre-existing ocular conditions such as glaucoma or uveitis were included to reflect routine clinical practice. Only patients with a pre-laser intraocular pressure of ≤20 mmHg were eligible for inclusion to allow assessment of procedure-related intraocular pressure changes.

Exclusion criteria

Patients were excluded if they had incomplete medical records, declined follow-up visits, or had a history of additional ocular surgeries that could confound intraocular pressure outcomes. Patients with pre-laser intraocular pressure >20 mmHg were excluded to minimize confounding from uncontrolled baseline ocular hypertension and to better isolate intraocular pressure changes attributable to the Nd:YAG laser procedure. Patients with systemic conditions such as diabetes mellitus or hypertension were excluded only when these conditions were poorly controlled or associated with documented ocular complications, as such factors could independently influence intraocular pressure measurements in this retrospective analysis.

Pre-procedure preparation

Nd:YAG laser capsulotomy was performed using a slit-lamp–mounted neodymium-doped yttrium aluminum garnet (Nd:YAG) laser operating at a wavelength of 1064 nm (Visulas YAG III, Carl Zeiss Meditec, Germany). All procedures were carried out by trained ophthalmologists. Topical anesthetic (amethocaine) eye drops were instilled prior to the procedure. A central posterior capsulotomy was created using a cruciate or circular pattern, targeting an opening of approximately 3–4 mm to ensure adequate visual axis clearance. Laser energy settings ranged from 1 to 5 mJ per pulse and were titrated according to the density of the posterior capsule opacification. The number of laser shots varied depending on capsule thickness, with total delivered energy per session ranging from approximately 20 to 80 mJ. Care was taken to focus the laser posterior to the intraocular lens optic to minimize the risk of lens pitting. Intraocular pressure was measured before the procedure and during postoperative follow-up visits according to the study protocol.

Patient positioning and laser alignment

The patient was positioned comfortably in front of a specialized YAG laser generator, similar to a slit lamp used during eye

examinations. Stability was maintained by placing the patient's chin on a support and their forehead against a brace. The eyelids were held widely apart using either a speculum or the index and thumb fingers. Patients were instructed to focus on a specific light source to assist with alignment. The YAG laser machine was carefully adjusted to align with the cloudy posterior capsule, ensuring precise targeting for optimal results.

Laser application

The procedure was initiated by pressing the laser button to release controlled energy, which created small, precise incisions in the clouded posterior capsule. The laser energy vaporized the obscured portion of the capsule, allowing light to pass through to the retina. The incisions were systematically applied across several areas of the central posterior capsule. This safe and efficient procedure typically lasted only a few minutes per eye.

Post-procedure care and follow-up

Following Nd:YAG laser capsulotomy, patients received standard postoperative care based on clinical assessment. A topical antibiotic and corticosteroid regimen was routinely prescribed to reduce the risk of infection and postoperative inflammation. Topical corticosteroids included dexamethasone 0.1% or prednisolone acetate 1%, administered for a short duration according to clinical response. Intraocular pressure–lowering medications were not prescribed routinely to all patients. Topical beta-blockers (e.g., timolol 0.5%) or other hypotensive agents were initiated selectively in patients who demonstrated elevated intraocular pressure during post-procedure assessment or who were considered at higher risk, such as those with pre-existing glaucoma. Additional IOP-lowering therapy was adjusted during follow-up visits based on measured intraocular pressure. Patients were reviewed at scheduled follow-up visits, including at one month, three months, six months, and one year after the procedure, during which intraocular pressure and visual acuity were assessed.

Statistical analysis

Statistical analyses were performed using SPSS version 25.0 and GraphPad Prism version 9.0. Continuous variables were summarized as mean ± standard deviation, while categorical variables were expressed as frequencies and percentages. Pre- and post-procedure intraocular pressure (IOP) values were compared using paired t-tests, and categorical outcomes, including visual acuity categories and the incidence of IOP elevation, were compared using chi-square tests. Longitudinal changes in IOP across follow-up visits (1 month, 3 months, 6 months, and 1 year) were evaluated using repeated measures analysis of variance. Kaplan–Meier survival analysis was used descriptively to evaluate the time to first documented intraocular pressure elevation following Nd:YAG laser capsulotomy, given the time-dependent nature of this outcome and to illustrate the temporal pattern of IOP spikes during follow-up. Subgroup analyses compared outcomes between patients with and without pre-existing glaucoma. To enhance reproducibility and minimize overinterpretation, statistical analyses were limited to predefined clinical questions, and findings were interpreted in conjunction with their clinical relevance. A p-value of <0.05 was considered statistically significant.

Results

A total of 162 patients who underwent Nd:YAG laser capsulotomy and completed one year of follow-up were included in the analysis. The demographic and baseline clinical characteristics of the study population are summarized in **Table 1**. The mean age of the patients was 58.7 years, and both sexes were almost equally represented. Pre-existing ocular conditions included cataract in all patients, with a subset having glaucoma or uveitis. The distribution of intraocular pressure (IOP) before the procedure and at one-year follow-up is shown in **Table 2.** While most patients had baseline IOP within the range of 11–20 mmHg, a proportion developed IOP ≥21 mmHg during follow-up. Changes in visual acuity before and after Nd:YAG laser capsulotomy are presented in **Table 3**. There was a shift toward better visual acuity categories following the procedure. Intraocular pressure measurements across follow-up visits at 1 month, 3 months, 6 months, and 1 year are summarized in **Table 4**. The number and proportion of patients with elevated IOP decreased over time. The timing and frequency of IOP elevation during follow-up are presented in **Table 5**. Most IOP elevations were observed within the first month after the procedure, with fewer cases recorded at later visits.

The distribution of intraocular pressure (IOP) across follow-up visits is presented in **Table 4**. No patient had an IOP ≥21 mmHg

Table 1. Patients' clinical and demographic data.

Parameter	Data
Total number of patients	162
Gender distribution	Male: 82 (50.62%)
	Female: 80 (49.38%)
Age (years)	Mean ± SD: 58.7 ± 9.4
Age range	40–80
Pre-existing ocular conditions	Cataract (all patients), glaucoma, uveitis
Pre-procedure IOP (mmHg)	0–10: 25 (15.43%)
	11–20: 137 (84.56%)
Laser energy per pulse	1–5 mJ
Total laser energy per session	20–80 mJ
Follow-up duration	1 year

Table 2. Distribution of intraocular pressure before Nd:YAG laser capsulotomy and at 1-year follow-up.

IOP Range (mmHg)	Pre-procedure (%)	Post-procedure (1-year follow-up) (%)
0–10	15.43	16.67
11–20	84.56	74.41
≥21	0.00	9.26

Table 3. Visual acuity before and after procedure.

Visual outcome	Visual acuity range	Pre-procedure frequency	Post-procedure frequency
Blindness	NPL-6/60	52	23
Mild	>6/60–6/24	30	18
Fair	>6/24–6/12	50	63
Good	>6/12–6/5	30	57

Table 4. Intraocular pressure distribution during follow-up.

IOP range (mmHg)	1 month	3 months	6 months	1 Year
0–10	25	17	25	27
11–20	135	74	100	120
21–30	0	7	14	12
31–40	0	1	1	1
41–50	0	0	1	2
≥51	0	0	0	0

Patient numbers vary across follow-up visits due to missed clinic visits at specific time points.

IOP: Intraocular Pressure; mmHg: Millimeter Mercury

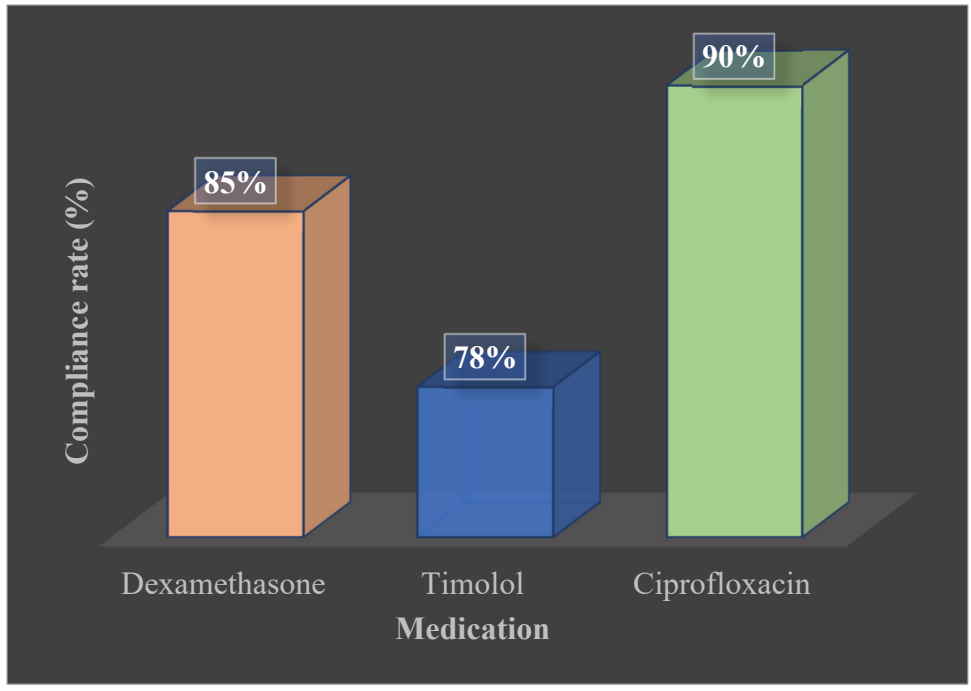

Figure 1. Reported compliance with prescribed post-procedure medications. Compliance was recorded in 138 of 162 patients (85%) for dexamethasone, 126 of 162 patients (78%) for timolol, and 146 of 162 patients (90%) for ciprofloxacin.

before the procedure. At the 1-month follow-up, 15 patients were recorded with IOP ≥21 mmHg, while 12 patients had IOP ≥21 mmHg at the 1-year follow-up. Across all follow-up visits, the majority of patients had IOP values within the 11–20 mmHg range.

Medication adherence during the follow-up period is shown in Figure 1. Reported compliance rates were 85% for topical corticosteroids, 78% for timolol, and 90% for ciprofloxacin.

The distribution of intraocular pressure spikes over time is presented in **Table 5**. Intraocular pressure elevation was recorded in 15 patients (9.26%) at the 1-month follow-up, decreasing to 10 patients (6.17%) at 3 months, 5 patients (3.09%) at 6 months, and 3 patients (1.85%) at the 1-year follow-up.

Table 6 summarizes the statistical analyses performed in the study. A significant difference was observed between pre-procedure and post-procedure intraocular pressure (IOP) values (paired t-test, $p<0.0001$). Visual acuity categories differed significantly before and after Nd:YAG laser capsulotomy (chi-square test, $p<0.0001$). Longitudinal analysis demonstrated significant changes in IOP across follow-up visits (repeated measures ANOVA, $p<0.001$). Correlation analyses showed weak but statistically significant associations between laser energy and post-procedure IOP ($r = 0.21$, $p = 0.01$), as well as between laser energy and visual acuity improvement ($r = 0.18$, $p = 0.04$). Subgroup analysis indicated a higher incidence of intraocular pressure elevation among patients with pre-existing glaucoma compared with those without glaucoma (25% vs. 10%, $p = 0.03$).

Discussion

This study evaluated intraocular pressure (IOP) changes and visual outcomes following Nd:YAG laser capsulotomy in a resource-limited setting with a high burden of glaucoma. Overall, the findings confirm that Nd:YAG laser capsulotomy is associated with a short-term increase in IOP in a subset of patients, while providing meaningful improvement in visual acuity for most individuals treated for posterior capsule opacification. Post-procedure IOP elevation observed in this study is consistent with previous reports identifying transient IOP rise as a known complication of Nd:YAG laser capsulotomy [3,20]. Prior studies have attributed this phenomenon to factors such as obstruction of aqueous outflow by capsular debris and inflammatory responses [6,7]. In our cohort, IOP elevations were most frequently observed early during follow-up, a pattern that has been similarly described in other clinical settings [21,22]. The decline in the number of patients with elevated IOP over subsequent visits suggests that these elevations were not sustained in most cases. Improvement in visual acuity following capsulotomy was evident across the cohort and aligns with established evidence supporting the effectiveness of Nd:YAG laser capsulotomy in restoring visual function compromised by posterior capsule opacification [23,24]. Similar improvements have been reported in both high-resource and resource-limited settings, reinforcing the procedure's role as a standard intervention for PCO [3,5]. The shift toward better visual acuity categories observed in this study is consistent with these reports, although direct comparison of effect size across studies is limited by differences in study design and outcome measures. The temporal pattern of IOP elevation observed using Kaplan–Meier analysis demonstrated that IOP spikes occurred predominantly within the first month after the procedure. This finding supports existing recommendations for early post-procedure monitoring, particularly in patients with known risk factors [21]. Patients with pre-existing glaucoma showed a higher incidence of IOP elevation compared with those without glaucoma, which is in agreement with previous studies highlighting increased susceptibility in this subgroup [6,7]. These observations underscore the importance of individualized postoperative surveillance in patients with glaucoma. In resource-limited settings, Nd:YAG laser capsulotomy remains a widely accessible intervention for managing posterior capsule opacification, as it is typically performed as an outpatient procedure and does not require consumables beyond routine ophthalmic care.

Table 5. Distribution of intraocular pressure spikes over time with percentages.

Follow-up interval	Number of patients with IOP spikes	Percentage
1 Month	15	9.26%
3 Months	10	6.17%
6 Months	5	3.09%
1 year	3	1.85%

Table 6. Summary of primary and secondary statistical analyses.

Analysis	Statistic	Result
Pre- and post-procedure IOP	Paired t-test	$t(161) = -6.32$, $p<0.0001$
Visual acuity improvement	Chi-square test	$\chi^2 = 45.7$, $p<0.0001$
Longitudinal IOP trends	Repeated measures ANOVA	$F(3, 483) = 15.6$, $p<0.001$
Laser energy vs. Post-procedure IOP	Pearson correlation	$r = 0.21$, $p = 0.01$
Laser energy vs. Visual acuity	Pearson correlation	$r = 0.18$, $p = 0.04$
IOP spike incidence	Kaplan-Meier analysis	Median time to first IOP elevation: 1 month; cumulative probability at 1 year: 15%
Impact of glaucoma on IOP Spikes	Subgroup analysis	Higher in glaucoma group (25% vs. 10%, $p = 0.03$)

Although this study did not include a formal economic evaluation, the ability to restore vision without the need for repeat intraocular surgery may have practical cost advantages in such settings. Future studies incorporating formal cost analyses would be valuable in further characterizing the economic implications of Nd:YAG laser capsulotomy in low-resource environments

Weak but statistically significant correlations were identified between laser energy and post-procedure IOP, as well as visual acuity improvement. Given the modest correlation coefficients, these findings should be interpreted cautiously and viewed as exploratory rather than indicative of strong predictive relationships. Similar weak associations have been reported in prior studies, suggesting that while laser energy may contribute to postoperative outcomes, it is likely one of multiple interacting factors [20]. Medication use and reported adherence were documented as part of routine postoperative care; however, adherence was based on clinical records and patient reports rather than objective measurement. As such, conclusions regarding the impact of medication compliance on outcomes should be interpreted with caution. While appropriate postoperative treatment is widely regarded as important for minimizing complications, this study was not designed to directly evaluate the causal relationship between medication adherence and IOP outcomes. Future research should focus on prospective studies with standardized follow-up schedules to better define the temporal profile of intraocular pressure changes after Nd:YAG laser capsulotomy. Studies incorporating objective measures of medication adherence, detailed energy parameters, and formal cost-effectiveness analyses would further strengthen the evidence base. In addition, multicenter studies involving diverse patient populations may improve the generalizability of findings and help refine postoperative monitoring strategies for high-risk groups such as patients with glaucoma.

Limitations

This study has several limitations that should be considered when interpreting the findings. First, the retrospective design limits the ability to establish causal relationships between Nd:YAG laser capsulotomy and observed changes in intraocular pressure or visual outcomes. Retrospective analyses are inherently subject to selection bias and reliance on the accuracy and completeness of existing medical records. Second, the use of record-based data may have introduced information bias, as documentation quality varied across patient records. Some clinical variables, including medication adherence and symptom reporting, were based on routine clinical notes rather than standardized or objective assessments. As a result, these variables could not be evaluated in greater detail. Third, follow-up attendance was not uniform across all time points. Although only patients with at least one year of follow-up were included, missed clinic visits at intermediate time points may have influenced the longitudinal assessment of intraocular pressure trends and event timing. In addition, the exclusion of patients with uncontrolled systemic comorbidities, while intended to reduce confounding, may limit the generalizability of the findings to broader patient populations encountered in routine practice. Finally, the single-center nature of the study may restrict extrapolation of the results to other clinical settings with different patient demographics, treatment protocols, or healthcare resources. Despite these limitations, the study provides useful real-world data on intraocular pressure changes and visual outcomes following Nd:YAG laser capsulotomy in a resource-limited setting, and it highlights areas for future prospective studies with standardized follow-up and objective outcome measures.

Conclusion

Nd:YAG laser capsulotomy was associated with improvement in visual acuity and a measurable incidence of postoperative intraocular pressure elevation in this cohort. Intraocular pressure increases were observed predominantly in the early post-procedure period and were not sustained in most patients during follow-up. These findings suggest that Nd:YAG laser capsulotomy can be performed with acceptable outcomes when appropriate postoperative monitoring and intraocular pressure management are in place, particularly in patients at higher risk such as those with glaucoma. Regular follow-up remains important for early detection and management of pressure elevations. The results add to existing evidence on Nd:YAG laser capsulotomy outcomes and provide context-specific data from a resource-limited setting, while highlighting the need for further prospective studies to better define long-term safety profiles.

Abbreviations

IOP: Intraocular Pressure; PCO: Posterior Capsule Opacification; Nd:YAG: Neodymium-doped Yttrium Aluminum Garnet; SD: Standard Deviation; ANOVA: Analysis of Variance

Authors Contribution

MOA, AJO, UI: Conceptualization. MOA, UI, AJO: Methodology. MOA, AJO, UI, OK: Investigation. SE, SN, MOA, AJO, JDP, IBB, KOU: Data Curation and formal analysis: EJD: Writing of original manuscript draft. MOA, EOB, EJD: Review and Editing. JDP, EJD, MOA, AJO: Statistical Analysis and validation. All authors read and approved the final manuscript.

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Consent for Publication

Not applicable.

Competing Interests

There is no conflict of interest.

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