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A 1064-Nm Laser in the Routine Treatment of Telangiectasia of the Lower Leg: A Cohort Study

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Abstract

Background and objectives: The Neodymium-Doped Yttrium-Aluminum-Garnet (ND: YAG) laser has proven effective in the treatment of leg telangiectasias, yet the literature lacks consensus on the optimal settings. This study aims to assess the efficacy of the 1064nm Nd:YAG laser for the treatment of leg telangiectasias in a safety focused setting.

Materials and methods: Records of 42 patients with lower leg telangiectasia who underwent laser treatment between December 2019 and March 2023 were assessed. Laser parameters have been adjusted to prioritize overall safety. Two months after the treatment Global Aesthetic Improvement Score (GAIS) and the extent of vessel clearance were evaluated on a scale ranging between 0% and 100%. Patients rated their satisfaction on an 11-point Likert scale and their perception of pain during the treatment on a 6-point scale. Narratives of all adverse events were examined.

Results: The mean patient satisfaction was 8.4 ± 0.7 (mean ± SD). The mean GAIS score was 81.4% ± 0.8% (mean ± SD). Vessel clearance of 60% and greater was achieved in 52% of patients. Mean patient satisfaction was 8.4 ± 0.7 (mean ± SD). Both GAIS score and vessel clearance were positively correlated with patient satisfaction (correlation coefficient 0.8 and 0.6, respectively). All patients experienced mild crusting at the site of the treatment which resolved spontaneously within up to two weeks. Two instances of hyperpigmentation self-resolved within six and seventeen weeks.

Conclusion: The treatment of leg telangiectasias with the 1064 nm Nd:YAG laser has proven to be safe and effective. The results achieved through a cautious approach in laser settings appear to be comparable to or better than, previous research in a variety of settings.

Keywords: Laser therapy •Telangiectasias • ND • YAG

Introduction

Telangiectasias are visible dilatations of the subpapillary plexus in the dermis, colloquially known as “spider veins”. Etiologically and anatomically, the condition is highly heterogenous and manifests in a wide spectrum of diseases, including collagenosis, cirrhosis, and congenital vascular malformations [1]. Telangiectasias of the lower legs are linked to Chronic Venous Disorders (CVD) [1]. Since its inception, the Clinical-Etiology-Anatomy-Pathophysiology (CEAP) classification views the lower-leg telangiectasia as an Anatomic (A) class AS (subscript S designating its superficial nature) and a Clinical (C) class C1 condition [2,3]. Subcategorization of the C1 class to discriminate between telangiectasia and reticular veins was suggested by the CEAP C working group but was not approved by the CEAP task force in the 2020 update, which also omitted the vessel-diameter–based description of telangiectasia (<1 mm in diameter) and reticular veins (between 1 and 3 mm in diameter) present in the 2004 revision [3,4]. The clinical class is further characterized by a subscript indicating the presence (symptomatic, s) or absence (asymptomatic, a) of symptoms, such as pain, burning, or itching [5]. The pathophysiology of lower-leg telangiectasias remains ambiguous, with venous reflux and venous hypertension, arteriolo-venous micro-shunt, primary venous dilatation, and involvement of adipose and connective tissue suggested as the underlying mechanisms at fault [1]. Epidemiological studies have established that the condition is highly prevalent but yielded somewhat conflicting results with regard to sex predisposition and relation to age [6-8].

Sclerotherapy, with liquid or foam, is considered the treatment of choice [9,10]. However, in a randomized trial, Physician Global Assessment (PGA) grades of blinded experts did not differ for patients treated by administering sclerotherapy with polidocanol or long-pulsed 1064-nm Nd:YAG laser using fluences between 100 and 200 joules per square centimeter with a spot size of 3 to 7 millimeters and pulse width of 10 to 50 milliseconds [11]. On the safety side, while laser treatment may be associated with a little more pain [11], it causes less hyperpigmentation [5] and does not lead to systematic neurological, respiratory, and vascular complications which may occur with sclerotherapy [9]. In two large consecutive randomized comparisons from the Ianosi group, Nd:YAG laser showed superiority over sclerotherapy with polidocanol when used to treat vessels with diameter smaller than 1 millimeter [12,13]. Further, a recent Cochrane review found no difference in resolution or improvement of telangiectasias when laser was compared to sclerotherapy [5], and a very recent network meta-analysis concluded that the 1064-nm Nd:YAG laser is superior to sclerotherapy, except when the latter is conducted with 72% chromated glycerin [14]. The published findings informed the consensus statement of the Society for Vascular Surgery (SVS), American Venous Forum (AVF) and American Vein and Lymphatic Society (AVLS) and the clinical practice guidelines of the European Society for Vascular Surgery (ESVS), which advocated use of lasers in certain populations, such as patients with needle phobia, sclerosant allergy, sclerotherapy failure, and presence of small veins with telangiectatic matting [9,10].

While clinical results with the Nd:YAG laser for coagulation of leg telangiectasia are mostly satisfactory, there is no consensus on optimal settings [14,15]. According to the literature, a wide range of parameters are used clinically to coagulate leg veins from 0.1 to 4 mm. Specifically, fluences range from 90 to 400 J/cm^2, pulse durations range from 10 to 100ms, and spot sizes range from 1 to 10 mm [15].

The current retrospective cohort report provides a complete account of the author’s experience with a 1064-nm Nd:YAG laser for effective management

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of lower leg telangiectasia. Parameters were adjusted with an emphasis on safety, aiming for lower energy settings to minimize adverse effects while maintaining efficacy.

Materials and Methods

This is a report of a retrospective cohort of patients routinely treated for telangiectasia in San Luca Medical Clinic, Tirana, Albania. The study was approved by the Ethics Committee of the Ministry of Health and Social Protection of Albania (approval number: NIPTL82009018B). Informed consent for publication of results was obtained from all patients whose data are used in this report. Records of patients who had a stable body weight within the six months that preceded the study treatment, whose affected leg veins ranged between 50 and 130 millimeters in length and had superficial vessels that were less than 2 mm in diameter, were included in the study. Reasons for exclusion included pregnancy, concurrent diagnosis of varicose veins (C2), and history of adverse reaction to phototherapy, immunosuppression, radiotherapy targeting the index lesion area, or keloid or hypertrophic scars.

Duplex ultrasound was performed in all patients, as part of the clinic's routine aimed to exclude associated venous incompetence. Patients were evaluated in the upright position with Valsalva maneuver.

Treatments were administered with a long-pulse 1064-nm Nd:YAG laser device (Harmony XL Pro with a Cooled Long Pulse applicator, Alma Lasers Ltd., Caesarea, Israel) by a physician with more than a decade of experience with laser treatment for the indication. Follow-up was performed two months after the last treatment.

Images were taken with a digital single-lens reflex camera (EOS 2000D; Canon, Tokyo, Japan), equipped with a superzoom lens (18-200 mm f/3.5-6.3 DC; Sigma Corporation, Kanagawa, Japan) mounted on a tripod and preset and locked in magnification, f-stop, and exposure control. Participants were seated in an examination room against an even, non-reflecting, monochromatic (black) screen. The examination room temperature was maintained at 24 °C. Photographs were standardized for lighting and camera angle and position to the target.

Efficacy

The physician who performed the treatment also performed the evaluations of effectiveness. The Global Aesthetic Improvement Scale (GAIS) ranging between 0% and 100%, in 10% increments, was used for grading of change in the target site appearance. Additionally, vessel clearance was assessed, in agreement with the definitions in Nakano LCU, et al. [5], as less than 20% (Grade 1), 20% to 40% (Grade 2), 40% to 60% (Grade 3), 60% to 80% (Grade 4), and more than 80% (Grade 5).

In addition, patients were requested to rate their satisfaction with the outcome of the treatment at the time of the follow-up visit. Satisfaction was graded on an 11-point Likert scale (0 – maximum dissatisfaction, 10 – maximum satisfaction).

Safety

Patients were requested to self-assess the pain associated with the treatment immediately after the first treatment session. A 5-point scale questionnaire was given to the patients to communicate their pain perception.

Adverse events

Narrative records of adverse events that occurred until the end of the follow-up, whether considered related to the study device and/or procedure or not, were reviewed and events were coded with the Medical Dictionary for Regulatory Activities (MedDRA; version 26.1). Mapping to the National Cancer Institute (NCI) Common Terminology Criteria for Adverse Events (CTCTAE) v. 5.0 was attempted, for severity grading purposes. The Inter-national Medical Device Regulators Forum (IMDRF) technical document IMDRF terminologies for categorized Adverse Event Reporting (AER): terms, terminology structure and codes Annex E (Health Effects – Clinical Signs, Symptoms and Conditions Terms and Codes) was consulted at the time of event coding.

Statistical analysis

Continuous variables were summarized by a mean, median, standard deviation, minimum, and maximum, and categorical variables by a count and percentage. Regression analysis was conducted to identify predictive factors influencing outcomes, as measured by the GAIS scores. Pearson correlation was used to analyze the relationship between patients' satisfaction and the outcomes as measured by GAIS scores and vessel clearance scores. Additionally, a two-sample t-test was performed to assess if there were any differences between GAIS scores and vessel clearance scores. A significance level of 0.05 was chosen, and results with a p-value below this threshold were considered statistically significant. For the statistical analysis GAIS score and patient satisfaction scales were normalized to range from 1 to 5. Analyses were performed using Microsoft Excel.

Results

Participant disposition and demographics

Records of 42 of the 51 patients treated for lower leg telangiectasia between December 2019 and March 2023 were included in this study. Records of nine patients with concurrent varicose veins were excluded. There were no cases of loss to follow-up and outcome data were available for all patients. All patients were female. Forty were of Mediterranean and 2 of Slavic descent. The mean age of the patients was 40.4 years (SD, 11.4; range, 21-62). Skin type of 14 and 28 patients was classified as Fitzpatrick Type II and III, respectively. None of the patients had been administered any laser treatments prior to the treatment detailed in this report. Three of the 42 patients experienced pain or itching in the area affected by telangiectasia prior to the treatment. Table 1 presents patients' characteristics.

All treated vessels were superficial and less than 2 millimeters in diameter on duplex ultrasound. None of the patients presented femoral or saphenofemoral junction reflux. Six had minor unilateral popliteal vein reflux, not related to the leg with greater telangiectasia. Eight presented with superficial infragenicular perforator veins (1-2) with a diameter between 4 and 5 millimeters.

Treatment regimen

Both legs were treated in each patient, with one through four single-run treatments administered with the device set to discharge frequency of 1 Hz and fixed pulse duration of 10 milliseconds, delivering energy between 100 and 170 joules per square centimeter, with a spot size of 2 millimeters. Consecutive sessions were administered six through eight weeks apart. Local anesthetics were not applied.

Effectiveness

The GAIS-graded improvement score ranged between 70% and 90%,

Table 1. Patients' characteristics.

Patients' Characteristics		
Gender, n (%)	Male	0
	Female	42 (100%)
Age, years	Mean (SD)	40.4 (11.4)
	Median	40
	Range	21-62
Skin type n (%)	Fitzpatrick II	14 (33%)
	Fitzpatrick III	28 (67%)
	Pain or itch before treatment n (%)	3 (7%)
	Previous laser treatment, n (%)	0
Number of treatments n (%)	1	32 (76%)
	2	14 (33%)
	3	2 (5%)
	4	1 (2%)

with a mean of 81.4 ± 0.8% (mean ± SD). GAIS-graded improvement at the 2-month follow-up visit is presented in Table 2.

Vessel clearance of 60% and greater was achieved in 22 patients (52%). Vessel clearance at the 2-month follow-up visit is presented in Table 3.

Figures 1-4 show examples of vessel clearance between 60% and 100%.

Mean patient satisfaction was 8.4 ± 0.7 (mean ± SD). All patients rated their satisfaction between 7 and 10, with 37 of the 42 patients (88%) selecting grades 8 and higher. The mean patient satisfaction was 8.4 ± 0.7 (mean ± SD).

The GAIS score was positively correlated with patient satisfaction (correlation coefficient=0.8), and similarly, vessel clearance grade was also positively correlated with patient satisfaction (correlation coefficient =0.6). A positive correlation was also found between GAIS score and vessel clearance Grade (correlation coefficient= 0.78). However, the mean GAIS score was significantly higher than the mean vessel clearance grade (t-test, $p<0.01$). Linear regression analysis revealed that age has no impact on GAIS score (R Square=0.000002; Multiple R =0.002; Significance F=0.99). Also, the number of treatments was found to have no impact on GAIS score (R Square=0.08; Multiple R =0.09; Significance F=0.57). Similarly, age was found to have no impact on vessels clearance (R Square=0.01; Multiple R =0.08; Significance F=0.6) but there was a moderate positive impact of the number of treatments on vessel clearance (R Square=0.21; Multiple R =0.45; Significance F=0.02). Scatter plots of these relationships can be found in Supplementary Information.

Safety and tolerability

The adverse events that occurred in the study were classified as CTCAE Grade 1. All patients experienced mild crusting at the site of the treatment which resolved spontaneously within up to two weeks and did not require any intervention. Two instances of hyperpigmentation self-resolved within six and seventeen weeks. No other adverse events were reported. Self-assessed grading of pain during treatment ranged between 2 and 4, with 29 of the 42 patients (69%) grading their pain as 2, and 3 patients (7%) grading it as 4. The mean (SD) pain grade was 2.4 (0.6).

Discussion

At 1,064 nm, the Nd:YAG laser effectively penetrates deep into the dermis and blood vessels, with minimal absorption by melanin, adequate absorption by hemoglobin, and a reduced risk of hyperpigmentation. All of these characteristics make the Nd:YAG laser an excellent choice for treating telangiectasias of the lower extremities [16].

However, selecting the appropriate settings can be a complex decision influenced by several factors. At 1,064 nm, hemoglobin absorption is good but not at its peak, so a relatively high fluence is initially required for optimal performance. The absorbed energy then causes a temperature rise in the target area. At a critical temperature, hemoglobin converts to methemoglobin (Met-Hb), which has a higher level of absorption in the near-infrared spectrum,

Table 2. Physician assessment GAIS-level improvement.

Grade	Improvement, %	Number of Subjects
7	60-70	10
8	70-80	16
9	80-90	16

Table 3. Physician assessment of vessel clearance.

Grade	Extent of Vessel Clearance, %	Number of Subjects
1	0-20	0
2	20-40	4
3	40-60	16
4	60-80	16
5	80-100	6

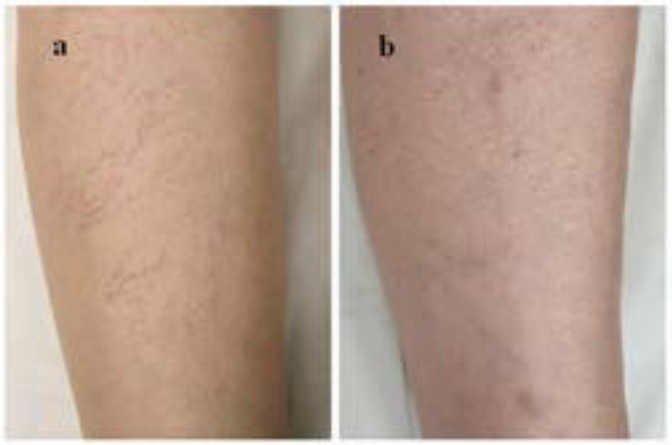

Figure 1. a) Vessel clearance of 80% observed in a 50-year-old patient, skin type III, at baseline and **b)** Compared to two months after treatment with two treatments at four weeks apart.

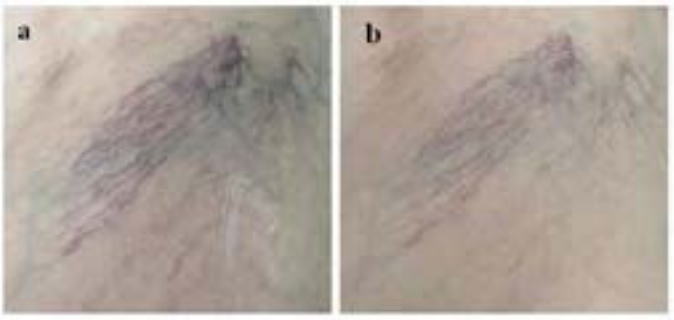

Figure 2. a) Vessel clearance of >60% observed in a 55-year-old patient, skin type III, at baseline and **b)** Compared to two months after treatment with one treatment.

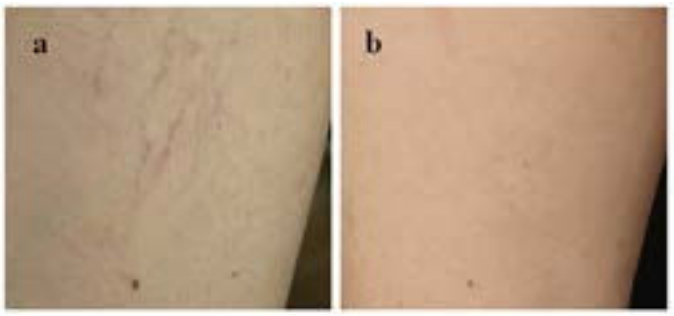

Figure 3. a) Vessel clearance of 100% observed in a 50-year-old patient, skin type III, at baseline and **b)** Compared to two months after treatment with four treatments at four weeks apart.

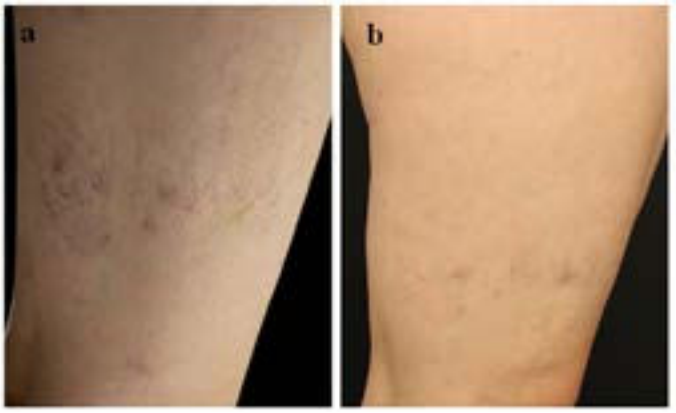

Figure 4. a) Vessel clearance of 100% observed in a 50-year-old patient, skin type III, at baseline and **b)** Compared to two months after treatment with six treatments at four weeks apart.

making lower fluences preferable. This laser-induced formation of Met-Hb in the target vein presents a challenge in selecting the optimal fluence [14,16]. In addition, achieving thermal damage to vessels requires a delicate balance of effective spot size, but with careful consideration to avoid overheating the skin [14]. Determining the optimal pulse duration is further complicated by another critical factor, the Thermal Relaxation Time (TRT). TRT is the time it takes for heated tissue to lose half of its accumulated heat. Achieving balance means ensuring that the selected pulse duration is aligned with the TRT. Longer pulses run the risk of causing thermal damage to non-vascular structures. Meanwhile, shorter pulses may inadvertently exceed the tissue's ability to dissipate heat, resulting in unintended effects such as collateral damage to vessels and possible effects on adjacent tissues. The critical parameter, TRT, is dependent on vessel diameter, with millisecond pulses required for optimal results in non-capillary vessels [16,17]. Abnormal leg veins typically have diameters of up to a few millimeters, but this can vary considerably within a single patient [14,16]. In addition, these veins vary in appearance from small red superficial telangiectasias rich in oxygenated hemoglobin to thicker bluish veins characterized by lower levels of oxyhemoglobin. This inherent diversity in vessel characteristics further challenges the selection of appropriate treatment strategies [12].

In an attempt to optimize the treatment of leg vascular lesions with the Nd:YAG laser, several methods have been described. Based on a mathematical model, one study recommended the use of a fluence range of 100-200 J/cm^2, the smallest possible spot size adapted to the vessel size, and a pulse duration of 10-100 ms, depending on TRT, increasing with vessel diameter [14]. Another case series study used a non-uniform pulse sequence with an initial 5ms pulse to stimulate Met-Hb formation and a second longer pulse of 10-15ms, as well as a low fluence range of 90 to 120 J/cm^2. Complete disappearance of vessels was observed in 72% of patients, 6 months after the last treatment [18]. In another study a single treatment of long-pulsed 1064nm Nd:YAG laser with a 5mm spot size, a pulse duration of 20ms and a fluences of 120 to 220 J/cm^2 was used for treatment of C1 leg veins on skin type IV patients, with 71.87% vessel clearance at 1-month post treatment. The parameters were selected based on the clinicians' experience [19].

Few studies reported on the combination of 1064nm with other wavelengths in vascular lesion treatments to reduce the amount of Nd:YAG 1064nm energy, for example the usage of 585nm wavelength in combination with Nd:YAG 1064 nm on Port Wine Stains (PWS) and the usage of 755nm wavelength and 1064nm Nd:YAG sequentially in the treatment of Rosacea [20]. Based on this, Zerbinati N, et al. presented a multicenter study to evaluate the efficacy and safety of sequential 755-nm Alexandrite and 1064-nm Nd:YAG lasers for the treatment of spider angiomas, spider veins, leg telangiectasias, and PWS. Leg telangiectasias started at 24 J/cm^2 for the 755-nm and 70 J/cm^2 for the 1064-nm Nd:YAG and increased in subsequent sessions to maximum fluences of up to 36 J/cm^2 for the 755-nm Alexandrite and up to 150 J/cm^2 for the 1064-nm Nd:Yag. The delay between pulses was dependent on the diameter of the target vessel, taking into account the total exposure time relative to the TRT of the vessel. A 6ms pulse duration was used for the Alexandrite followed by a 2-4 ms delay and an 8 ms pulse duration for the 1064 nm Nd:Yag. 65.6% of patients had 75% to 100% clearance of leg telangiectasias 6 months after the last treatment [20]. Although some of these methods suggest low energy settings, they may require cumbersome treatments involving pulse sequences, wavelengths and/or device combinations.

In their review of the 1064-nm Nd:YAG Harmony XL Pro, Nguyen CN and Gold MH [21] concluded that the device is safe and effective for the treatment of venous anomalies of the face and leg. They presented recommended parameters for skin types I-III, including a 2 mm spot size, a 10 ms pulse duration, and a fluence range of 150-260 J/cm^2. Consistent with this, in the present study, similar spot size and pulse duration were applied with the same Nd:YAG laser device for the treatment of leg telangiectasias in skin type II and III patients. However, the selection fluence was lower, at 100-170 J/cm^2 as a potential practice to minimize adverse events. There was an impressive 81.4% improvement 2-months after the last treatment and patients' satisfaction was high with 88% of patients scoring 8 or higher. In addition, more than half of the patients had 60% or more vessels clearance 2 months after the last treatment. These remarkable results demonstrate the effectiveness of the treatment as perceived by both the physician and the patients. When assessing clinical outcome measures, the mean GAIS score was significantly higher than the mean vessel clearance score. Analysis of the associations of these two measures with patients' satisfaction revealed that GAIS is more strongly associated with patient satisfaction than vessel clearance (r=0.8 and r=0.6, respectively). In other words, the high level of improvement indicated by the GAIS score in this study serves as a more accurate measure of treatment efficacy especially considering that achieving patient satisfaction in aesthetic treatments is the primary goal.

In the assessment of predictive factors, patient age and the number of treatments were evaluated to determine their impact on treatment outcome. Age was not found to have a statistically significant effect on treatment outcome as measured by both GAIS and vessel clearance scales. In addition, the number of treatments was not found to have a significant effect on GAIS scores. However, the number of treatments was moderately associated with a positive effect on vessel clearance. It is likely that this observed association is due to the careful balance between safety and efficacy in this study, with safety being the primary consideration in the selection of treatment parameters. It is expected that some patients may require additional treatments to achieve the desired results. Educating patients prior to treatment, according to these findings, should be considered to better manage patient expectations regarding the number of treatments required for optimal results, which may contribute to higher patient satisfaction.

The study has several limitations that should be considered. First, the study was retrospective. Second, the study did not include all skin types. In addition, longer follow-up is recommended for future research.

Conclusion

This study demonstrates the efficacy of using the 1064 nm Nd:YAG laser at lower energy levels in the treatment of leg telangiectasias and contributes to the knowledge and application of safe practices to optimize treatment settings.

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Institutional Review Board Statement

The study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of the Ministry of Health and Social Protection of Albania (approval number: NIPTL82009018B).

Informed Consent Statement

Written informed consent has been obtained from the patient(s) to publish this paper.

Data Availability Statement

All data is contained within the article only. No supplementary material exists.

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Conflicts of Interest

The authors declare no conflict of interest.

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