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ORIGINAL RESEARCH

Greater and Lesser Occipital Nerve Blocks for Frequent and Severe Headaches in Children and Adolescents: A Protocolized Repetitive Intervention Study

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ABSTRACT

***Introduction*:** Headache management in children and adolescents remains challenging, particularly in patients with high headache-related disability, medication overuse, and comorbid conditions, for whom evidence-based preventive treatment options are limited and often ineffective. This study aimed to evaluate the clinical outcomes and safety of a protocolized, repetitive bilateral greater and lesser occipital nerve block (GONB/LONB) strategy in pediatric patients with frequent and severe headaches.

***Methods*:** This retrospective study included adolescents aged 11–18 years who underwent bilateral GONB and LONB for headache between 2018 and 2025. At each treatment session, 1 mL of 2% lidocaine was administered at each of four injection sites (bilateral GON and LON), corresponding to a total volume of 4 mL (80 mg) per session. Blocks were administered weekly for 4 weeks, followed by additional applications at 1 and 3 months. Headache severity and disability were evaluated using the visual analog scale (VAS) and the Pediatric Migraine Disability Assessment (PedMIDAS) before and after completion of the block protocol.

***Results*:** Forty-five patients (91.1% female) received a total of 258 bilateral GONB/LONB procedures. The mean number of headache days per month was 20.8 ± 7.9, and the mean headache duration was 11.6 ± 10.7 months. Significant reductions were observed in both VAS and PedMIDAS disability grades following treatment ($p < 0.001$). At the patient level, 41 of 45 patients (91.1%) met the predefined criteria for clinical response. No serious adverse events occurred.

***Conclusions*:** Protocolized repetitive bilateral GONB/LONB was well tolerated and was associated with reductions in headache severity and

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headache-related disability in this predominantly adolescent cohort. However, the uncontrolled retrospective design precludes attribution of these improvements specifically to the intervention. Prospective sham-controlled studies are needed to establish treatment-specific efficacy.

Keywords: Peripheral nerve block; Pediatric patients with headaches; Headache management; Headache in children and adolescents; Migraine in childhood

Key Summary Points

Why carry out this study?

Children and adolescents with frequent and severe headaches may experience substantial headache-related disability, while evidence-based preventive treatment options remain limited, particularly for patients with persistent symptoms despite conventional preventive therapy.

Although occipital nerve blocks are increasingly used in pediatric headache practice, evidence regarding protocolized, repetitive bilateral greater and lesser occipital nerve blocks (GONB/LONB) remains limited.

This study asked whether a protocolized series of repetitive bilateral GONB/LONB was associated with improvements in headache severity and headache-related disability and was well tolerated in children and adolescents with frequent and severe headaches.

What was learned from the study?

In the full cohort of 45 patients, median VAS scores decreased from 8.0 (IQR 7.0–9.0) at baseline to 4.0 (IQR 4.0–5.0) at follow-up, while median PedMIDAS disability grades decreased from 3.0 (IQR 3.0–4.0) to 1.0 (IQR 1.0–2.0) ($p<0.001$ for both); 41 of 45 patients (91.1%) met the predefined criteria for clinical response, and no serious adverse events occurred.

These findings indicate that protocolized repetitive bilateral GONB/LONB was well tolerated and was associated with reductions in headache severity and headache-related disability in this predominantly adolescent cohort with frequent and severe headaches despite conventional preventive treatment.

Because the study was retrospective and lacked a control or sham group, treatment-specific efficacy cannot be established; nevertheless, these findings provide clinically relevant observational data to inform the design of prospective randomized sham-controlled studies evaluating the treatment-specific efficacy and optimal protocol of repetitive bilateral GONB/LONB in pediatric headache populations.

INTRODUCTION

Headache is a highly prevalent neurological condition in children and adolescents and represents a major cause of disability during critical developmental years [1–3]. Among headache disorders, migraine and tension-type headache are the most common diagnoses, frequently leading to impaired academic performance, social functioning, and quality of life [1, 4]. Despite their high prevalence, evidence-based preventive treatment options for pediatric patients with headaches remain limited, and randomized controlled trials have often failed to demonstrate clear superiority of pharmacological agents over placebo [5–7].

As a result, children and adolescents with frequent, severe, or refractory headaches—particularly those with comorbid conditions or medication overuse—remain challenging to manage using conventional therapeutic strategies alone [8, 9]. In this context, peripheral nerve blocks, particularly the greater occipital nerve block (GONB), have emerged as a promising interventional option, supported by growing evidence in adults and an expanding yet still limited pediatric literature [10–15].

Previous pediatric studies have suggested that occipital nerve blockade (ONB) may provide rapid and clinically meaningful relief in selected patients; however, most reports are characterized by heterogeneous methodologies, variable injection protocols, and limited follow-up durations [10, 13, 16]. Moreover, most published studies have focused on single or non-standardized applications, and the longitudinal effects of repeated ONB—particularly when using a combined bilateral greater and lesser occipital nerve (GON/LON) approach—remain insufficiently explored.

Importantly, it is also unclear whether the clinical response to ONB in pediatric patients is influenced by headache phenotype, associated comorbidities, or accompanying clinical features, which limits the generalizability of existing findings.

Against this background, the present study aimed to evaluate the effectiveness and safety of a protocolized, repetitive bilateral GONB and LONB strategy applied within a single specialized headache center. By systematically assessing clinical outcomes during the repeated treatment protocol, we sought to characterize changes in headache severity and disability and to explore whether these changes differed across selected clinical characteristics.

METHODS

Study Population and Design

Medical records of adolescents aged 11–18 years who received nerve block treatment for headache between January 2018 and January 2025 were retrospectively reviewed. Patients were evaluated by one of the authors (TUC) at the Child and Adult Headache Outpatient Clinic of the Faculty of Medicine, Recep Tayyip Erdogan University (2018–2020) and at the Istanbul Goztepe Research Hospital (2020–2025). A total of 45 adolescents diagnosed with headache according to ICHD-3 criteria were included [8]. Medical records were reviewed to obtain demographic and clinical data, including age and sex. Patients with frequent or severe headache disorders who underwent GONB/LONB because of persistent headache burden despite conventional management were eligible for inclusion. Headache diagnoses were classified according to ICHD-3 and included chronic migraine, episodic migraine, chronic tension-type headache, overlapping primary headache phenotypes, trigeminal autonomic cephalalgias, and occipital neuralgia. Therefore, eligibility was based on clinical headache burden and indication for interventional treatment rather than restriction to chronic headache diagnoses alone. All patients received standard clinical care in accordance with current guidelines and expert consensus on the management of pediatric and adolescent headache disorders [9]. In our clinic, all children and adolescents presenting with severe recurrent or frequent headaches receive structured counseling before interventional treatment is considered. During this initial management phase, patients and their families are informed that daily lifestyle patterns and behavioral habits—including irregular sleep routines, insufficient hydration, skipped meals, unhealthy dietary choices, physical inactivity, excessive screen exposure, smoking, and stress-related factors—may contribute to increased headache frequency and symptom burden. Families are supported in identifying modifiable child-specific triggers and encouraged to implement targeted adjustments as a first-line strategy before or alongside pharmacologic or procedural interventions. Analgesic overuse was recorded when present, based on patient or caregiver report.

The study protocol was approved by the Ethics Committee of Medipol University (Approval No. E-10840098-202.3.02-2806) and was conducted in accordance with the ethical principles of the Declaration of Helsinki (1964) and its later amendments. At the time of the study, the local ethics committee at the institution where the clinical work was performed did not have authorization to review this type of research. Therefore, following the necessary institutional permissions from the centers where the patients were evaluated and treated, ethical approval for this retrospective study was obtained from the Ethics Committee of Medipol University. Routine clinical consent for the GONB/LONB procedure was obtained from the patient and/or

legal guardian before treatment and was separate from consent for research participation. The study was designed and reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines [11]. Owing to the retrospective study design and the use of anonymized clinical data, the requirement for written informed consent was waived by the ethics committee. Data analysis began in January 2025. Patients and the public were not involved in the design, conduct, reporting, or dissemination plans of this research.

Clinical Evaluation and Data Collection

All participants underwent detailed neurological and physical assessments. Demographic variables included patient age and sex. Additional clinical information was collected on headache characteristics, including diagnostic classification, headache duration (in months), age at headache onset, time since symptom chronification or worsening, the presence of associated neck pain, headache frequency, pain severity, headache location, family history of headache, and comorbid medical conditions. Standardized assessment tools routinely completed during clinical care and documented in the medical records were also collected, including the visual analog scale (VAS) for pain intensity and the Pediatric Migraine Disability Assessment (PedMIDAS) for headache-related disability. Headache-related functional impairment was evaluated using the PedMIDAS, which comprises six questions assessing the impact of headaches on daily activities at home and at school over a specified period [12]. The total score reflects the degree of disability, with higher values indicating greater functional limitation. Raw PedMIDAS scores were categorized according to established disability thresholds: 0–10, little or no disability; 11–30, mild disability; 31–50, moderate disability; and >50, severe disability. For the present analysis, these categories were coded as ordinal disability grades from 1 to 4, respectively (grade 1 = little or no disability, grade 2 = mild disability, grade 3 = moderate disability, and grade 4 = severe disability). Accordingly, the PedMIDAS values used in the statistical analyses represent ordinal disability grades rather than raw PedMIDAS scores. Patients received a standardized series of bilateral greater and lesser occipital nerve blocks (GONB/LONB), consisting of four initial weekly sessions followed by additional blocks at 1 and 3 months. Clinical outcomes, including headache severity and headache-related disability, were assessed using the visual analog scale (VAS) and PedMIDAS, respectively. Patients were classified as non-responders if they received at least four GONB/LONB interventions and demonstrated a reduction in headache frequency of less than 50%. Headache intensity was assessed using a self-reported numeric rating scale VAS ranging from 0 (no pain) to 10 (worst imaginable pain). Patients reporting pain intensity of ≥5/10 were considered to have moderate to severe headache. In addition, patients experiencing ≥4 headache days per month were considered to have frequent headaches for the purposes of study eligibility. To minimize selection bias inherent to the retrospective design, all consecutive patients who underwent GONB/LONB during the predefined study period were screened using the same prespecified eligibility criteria, rather than selecting cases according to treatment outcome. Of 47 patients who received ONB during the study period, only two were excluded from the final analysis because they were lost to follow-up after the first injection.

Occipital Nerve Blocks: A Treatment Protocol

The number of GONB/LONB procedures performed and the duration of follow-up after the block were recorded. Patients are considered eligible for ONB treatment if they continue to experience a clinically significant headache burden despite completion of a structured preinterventional self-management education pathway. Patients with persistent headaches occurring more than 4 headache days per month and who had an inadequate response to at least one prior preventive pharmacological treatment administered at an adequate therapeutic dose for a minimum of 3 months: (1) Persistent headache frequency (>4 per month), and/or

moderate-to-severe intensity (VAS ≥ 5), and/or functional disability following optimization of lifestyle and behavioral factors; (2) Correction of vitamin deficiencies; (3) Inadequate response to an adequate trial of preventive pharmacotherapy administered at full therapeutic dose for a minimum of 3 months.

Clear procedural explanations were provided to children and their families prior to treatment and provided informed consent to proceed with interventional management. The GON and LON were localized clinically using a landmark-based technique, with the external occipital protuberance and mastoid processes used as anatomical reference points. No ultrasound or other imaging guidance was used. All patients underwent bilateral GONB/LONB using a 25-gauge needle. At each of the four injection sites (bilateral GON and bilateral LON), 1 mL of 2% lidocaine (20 mg) was administered, corresponding to a total volume of 4 mL and a total lidocaine dose of 80 mg per treatment session (Fig. 1). The treatment protocol included weekly nerve block sessions for 4 weeks, followed by additional sessions at 1 and 3 months. Patients who did not demonstrate clinical improvement after completing the four initial weekly GONB/LONB sessions were classified as non-responders and discontinued further block treatment. Outcomes were assessed at 6 months via outpatient visits or telephone interviews, including headache frequency, VAS scores, and PedMIDAS.

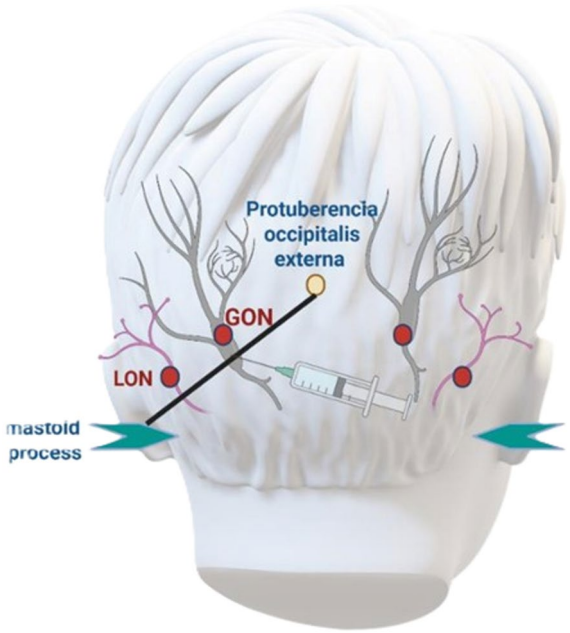


Fig. 1 Anatomical illustration of the greater and lesser occipital nerve block sites and anatomical landmarks used for the landmark-based injection technique. *GON* greater occipital nerve, *LON* lesser occipital nerve. Created with BioRender.com

Inclusion and Exclusion Criteria

Figure 2 presents the patient recruitment flowchart, aligned with the inclusion and exclusion criteria. A total of 47 pediatric patients received ONB therapy during the study period. Two of these patients were lost to follow-up after the first injection. Of the 45 patients who continued with the +1- and +3-month block sessions. Consequently, 45 patients were included in the final outcome analysis and 35 of these patients (77.8%) were continuing ONB therapy at approximately 6-month intervals. In addition, 6 patients (13.2%) reported that they would have continued treatment if not for travel or access-related limitations.

Statistical Analysis

All statistical analyses were performed using JASP Version 0.19.3. Descriptive statistics (mean ± SD, frequency, percentage) were calculated. and used to summarize demographic and clinical characteristics. Continuous variables were reported as mean ± standard deviation or median (interquartile range), as appropriate. Pre- and post-treatment comparisons of VAS scores and PedMIDAS disability grades in the full study cohort were performed using the Wilcoxon signed-rank test. These outcomes are presented as median and interquartile range (IQR). Changes in headache frequency were expressed as the percentage reduction in monthly headache days from baseline. Patients achieving a ≥ 50% reduction were classified as

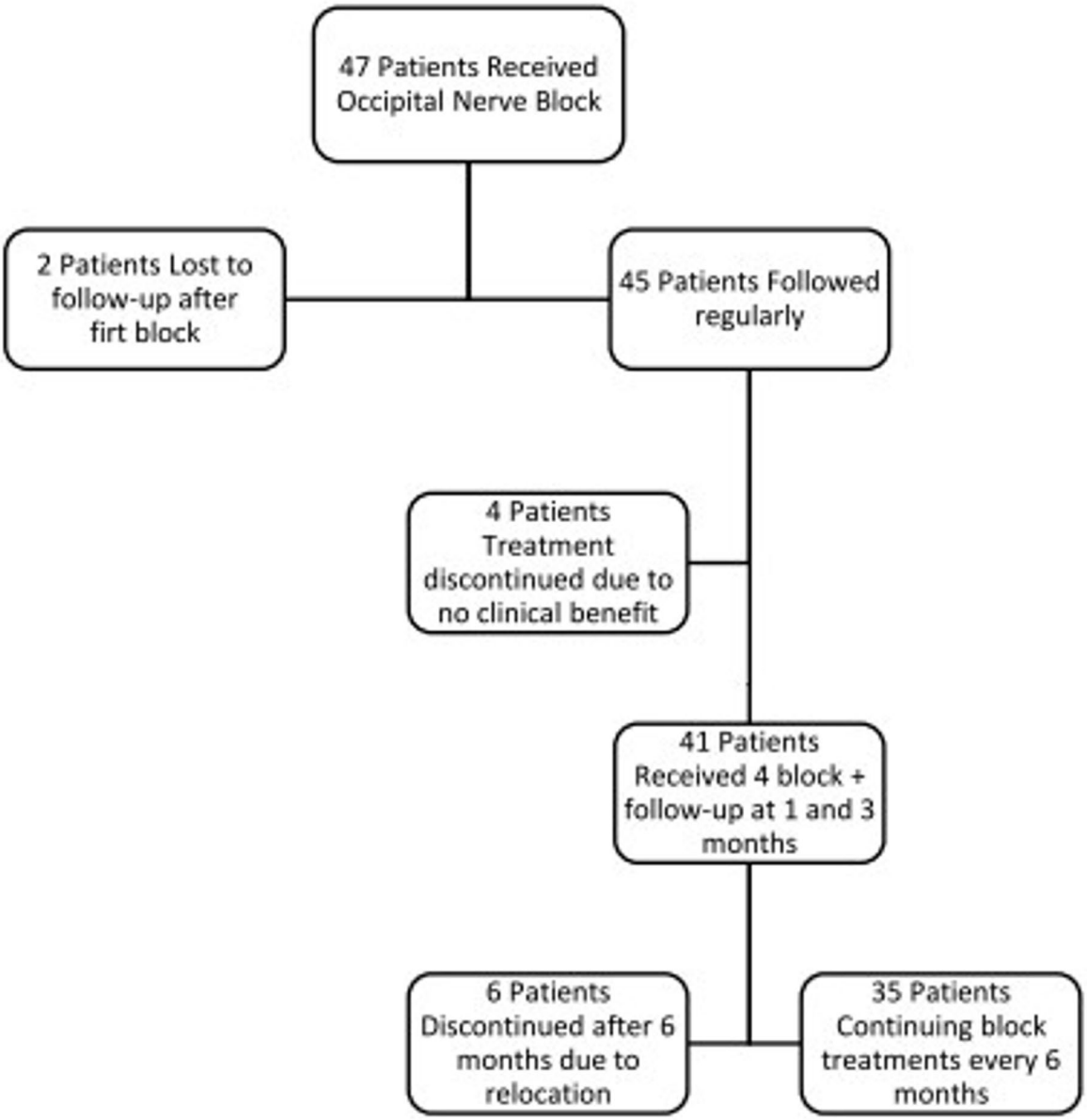


Fig. 2 Flowchart detailing the process of identifying and including the study sample

responders, and those with a ≥ 70% reduction were classified as high responders. Responder rates were calculated accordingly. Effect sizes were estimated to quantify the magnitude of treatment-related changes. Statistical significance was set at $p < 0.05$.

RESULTS

Demographic and Clinical Characteristics

Among the 2325 adolescents aged 11–18 years evaluated during the study period, headache was the presenting complaint in approximately 1242 patients. A total of 45 pediatric and adolescent

Table 1 Demographics and clinical characteristics of patients

Demographics and clinical characteristics	Value ($n = 45$)
Age at presentation, years, median (IQR)	16.0 (14.0–17.0)
Sex, female/male, *n* (%)	41 (91.1)/4 (8.9)
Baseline VAS score, median (IQR)	8.0 (7.0–9.0)
Baseline PedMIDAS disability grade, median (IQR)	3.0 (3.0–4.0)
Comorbidities, *n* (%)	
Asthma	4 (8.9)
Allergic conditions	3 (6.7)
Scoliosis	2 (4.4)
Eczema	1 (2.2)
Epilepsy	1 (2.2)
ADHD	1 (2.2)
Anxiety disorder	1 (2.2)
Post-traumatic stress disorder	1 (2.2)
Behçet's disease	1 (2.2)
Thalassemia	1 (2.2)
Hypothyroidism	1 (2.2)
Cardiac disease	1 (2.2)

PedMIDAS disability grades were coded as 1 = little/no disability, 2 = mild, 3 = moderate, and 4 = severe disability. Percentages are calculated on the basis of the total number of patients included in the final analysis

VAS visual analog scale, *PedMIDAS* Pediatric Migraine Disability Assessment Scale

patients were included in our study. The mean age at presentation was 15.5 ± 1.9 years, and most patients were female (91.1%). A family history of headache was reported in 64.4% (29/45) of cases, and comorbid medical conditions were present in 40% (18/45) of patients. Baseline demographic and clinical characteristics, including comorbidities, are summarized in Table 1.

Headache History

The mean age at headache onset was 13.2 ± 2.3 years, with an average chronicity or symptom-worsening duration of 11.6 ± 10.7 months. Among the 45 patients included in the study, the most common diagnosis was chronic migraine (CM), observed in 28 patients (62.2%). Episodic migraine (EM) was diagnosed in 9 patients (20.0%), while chronic tension-type headache (CTTH) was present in 4 patients (8.9%). Mixed headache phenotypes were less frequent, including CM with CTTH in 1 patient (2.2%) and CM with cluster headache in 1 patient (2.2%). In addition, occipital neuralgia and trigeminal autonomic cephalalgia (TAC) were each identified in 1 patient (2.2%) (Table 2). Neck pain accompanied the headache in 64.4% of patients, and most reported bilateral pain (77.8%). Most patients had previously received multiple preventive or supportive medications before the block intervention.

Table 2 Previous treatments and headache classification of the study cohort

Characteristics	*n* (%)
Headache classification	
Chronic migraine	28 (62.2%)
Episodic migraine	9 (20.0%)
Chronic tension-type headache	4 (8.9%)
Chronic migraine with chronic tension-type headache	1 (2.2%)
Chronic migraine with cluster headache	1 (2.2%)
Occipital neuralgia	1 (2.2%)
Trigeminal autonomic cephalalgias	1 (2.2%)
Previous treatments	
Magnesium supplementation	19 (42.2%)
Propranolol	14 (31.1%)
Vitamin B_{12}	6 (13.3%)
Vitamin D	6 (13.3%)
Flunarizine	6 (13.3%)
Amitriptyline	2 (4.4%)
Cyproheptadine	2 (4.4%)
Melatonin	2 (4.4%)
Verapamil	1 (2.2%)
Sertraline	1 (2.2%)
Iron supplementation	1 (2.2%)

Percentages are calculated on the basis of the total number of patients included in the final analysis ($n = 45$). Patients may have received more than one treatment

The most commonly used treatments included magnesium supplementation (42.2%) and propranolol (31.1%), followed by vitamin B_{12}, vitamin D, and flunarizine (each 13.3%). Medication overuse was identified in 20 of 45 patients (44.4%). Among these, 25% had high-frequency EM, whereas 75% were diagnosed with CM, indicating that medication overuse was more prevalent in the CM group. Smaller proportions of patients had received amitriptyline, cyproheptadine, melatonin, verapamil, sertraline, or iron supplementation (Table 2).

Course of Treatment

Across a 7-year period, a total of 258 bilateral GONB/LONB procedures were performed in 45 patients. At the patient level, 41/45 (91.1%) were classified as responders and 4/45 (8.9%) as non-responders. In the full study cohort ($n = 45$), including both responders and non-responders, significant pre–post improvements were observed in headache severity: median VAS score decreased from 8.0 (IQR 7.0–9.0) at baseline to 4.0 (IQR 4.0–5.0) at follow-up ($p < 0.001$). Similarly, PedMIDAS headache-related disability grades showed a substantial improvement, decreasing from a baseline mean of 3.15 ± 0.85 to 1.46 ± 0.78 after treatment; median decreased from 3.0 (IQR 3.0–4.0) to 1.0 (IQR 1.0–2.0) at follow-up ($p < 0.001$). These analyses included all 45 patients irrespective of treatment response (Fig. 3 and Table 3). The corresponding shifts in the distribution of VAS pain categories and PedMIDAS disability grades from baseline to follow-up are illustrated in Fig. 4

Subgroup analyses revealed no significant differences between clinical subgroups (presence vs. absence of comorbidities, family history of headache, lateralization, neck pain, or analgesic overuse) regarding the magnitude of change ($P_{between} > 0.05$). No statistically significant between-subgroup differences were identified; however, these exploratory analyses were limited by the small subgroup sizes and were not designed to establish equivalence across clinical phenotypes (Table 4).

Among the study population, 4 (8.8%) patients did not experience clinical benefit and subsequently discontinued treatment. An additional 13.2% (6/45) patients were unable to continue ONB sessions because of relocation and long travel distance to the clinic. The remaining 77.8% (35/45) patients have continued to attend scheduled follow-up visits and receive ONB treatments at approximately 6-month intervals. In addition, 13.2% (6/45) of patients reported that they would have continued treatment if

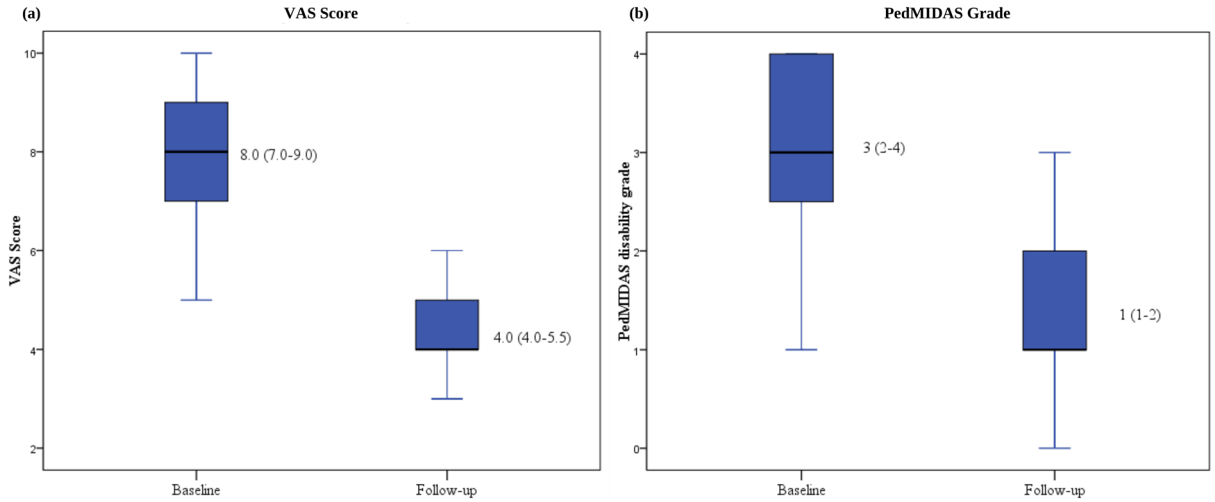


Fig. 3 Changes in headache intensity and headache-related disability from baseline to follow-up in the full study cohort ($n = 45$). **a** VAS scores and **b** PedMIDAS disability grades. Data are presented as median and IQR. Both VAS scores and PedMIDAS disability grades decreased significantly from baseline to follow-up ($p < 0.001$ for both comparisons). PedMIDAS values represent ordinal disability grades (1 = little or no disability, 2 = mild disability, 3 = moderate disability, and 4 = severe disability). *VAS* visual analog scale, *IQR* interquartile range, *PedMIDAS* Pediatric Migraine Disability Assessment

Table 3 Changes in headache intensity and disability following occipital nerve block in the full study cohort ($n = 45$)

Outcome measure	Baseline, median (IQR)	Follow-up, median (IQR)	Median change (IQR)	*p* value
VAS score	8.0 (7.0–9.0)	4.0 (4.0–5.0)	3.0 (2.0–4.0)	< 0.001
PedMIDAS disability grade	3.0 (3.0–4.0)	1.0 (1.0–2.0)	2.0 (1.0–2.0)	< 0.001

Data are presented as median (IQR). Analyses include the full study cohort ($n = 45$), irrespective of treatment response. PedMIDAS values represent ordinal disability grades (1–4). Pre–post comparisons were performed using the Wilcoxon signed-rank test

VAS visual analog scale, *PedMIDAS* Pediatric Migraine Disability Assessment Scale

not for travel or access-related limitations. Most patients (91%, 41/45) reported that they would recommend this treatment to others. In addition to headache-related outcomes, 17.8% (8/45) of patients reported improvement in associated symptoms following ONB therapy. Specifically, tinnitus improved in two patients, dizziness in two, motion sickness in one, and photophobia in one. One patient reported a reduction in nausea and vomiting during headache attacks. Additionally, improvement of localized eczema at the injection site was observed in one patient.

Safety and Side Effects

Mild and transient adverse events were reported in 20.0% (dizziness, hyperalgesia, tinnitus, transient numbness, and procedure-related headache exacerbation) of patients. Adverse events were significantly more frequent among patients without a family history of headache (37.5%) than with a family history of headache (10.3%) ($p = 0.032$) and among those with analgesic overuse (35.8%) ($p = 0.024$).

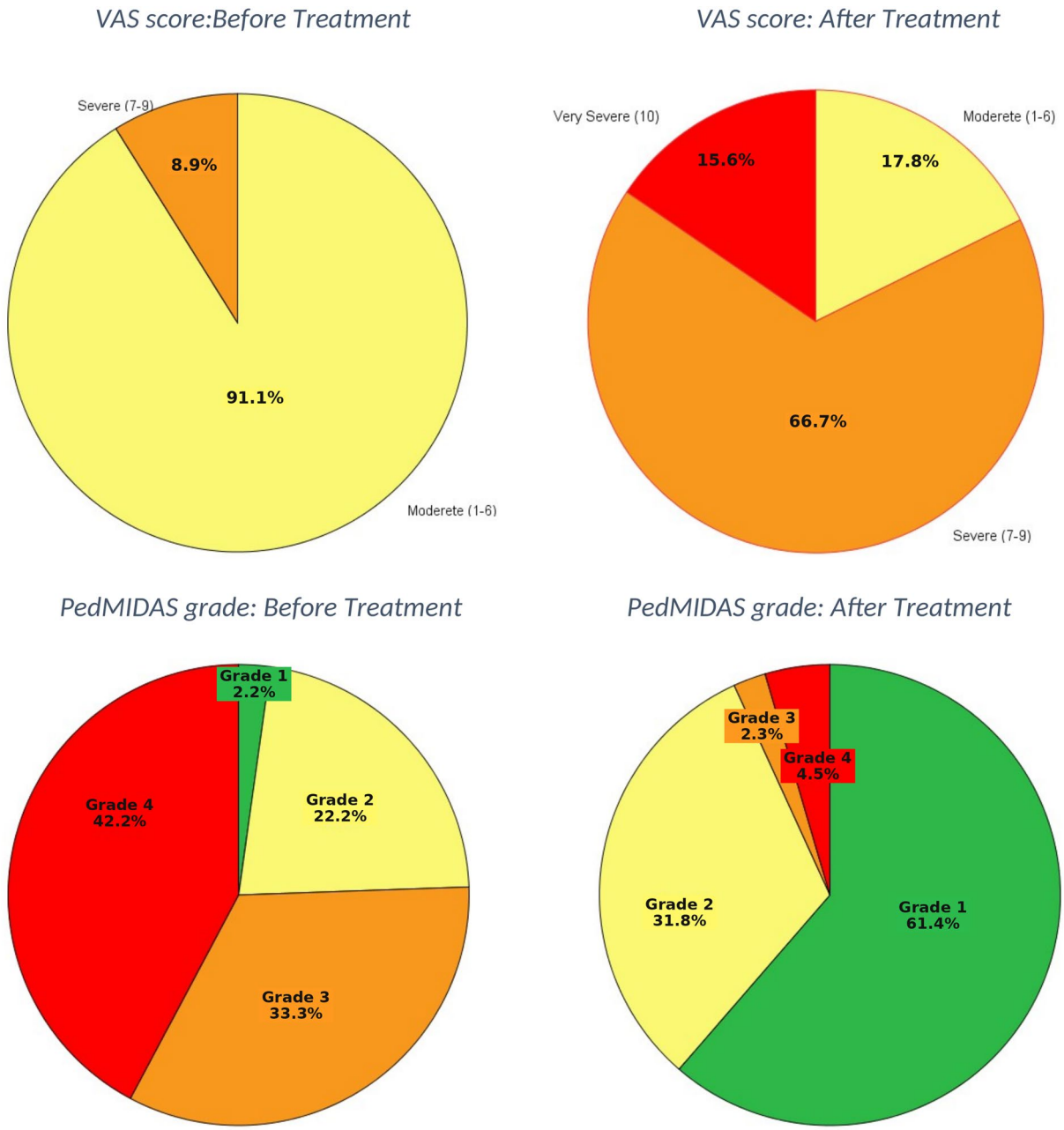


Fig. 4 Distribution of headache severity and headache-related disability categories before and after occipital nerve block treatment in the full study cohort ($n = 45$). Pie charts show VAS pain categories before (**a**) and after treatment (**b**), and PedMIDAS disability grades before (**c**) and after treatment (**d**). Percentages indicate the proportion of patients within each category. VAS categories were defined as mild (1–3), moderate (4–6), and severe (7–9). PedMIDAS disability categories were defined as grade 1 (0–10, little or no disability), grade 2 (11–30, mild disability), grade 3 (31–50, moderate disability), and grade 4 (≥ 51, severe disability). *VAS* visual analog scale, *PedMIDAS* Pediatric Migraine Disability Assessment Scale

Table 4 Changes in VAS and PEDMIDAS disability grades before and after occipital nerve blockade according to clinical characteristics

Outcome	Absent				Present				
	Before	After	Difference	P_{within}	Before	After	Difference	P_{within}	$P_{between}$
Comorbidity	$n=27$				$n=18$				
VAS	8.0 ± 1.4	4.7 ± 1.3	3.4 ± 1.4	< 0.001	7.8 ± 1.3	4.61 ± 1.8	3.2 ± 1.8	< 0.001	0.67
PEDMIDAS	3.2 ± 0.9	1.4 ± 0.7	1.7 ± 0.9	< 0.001	3.1 ± 0.8	1.5 ± 0.9	1.6 ± 0.9	< 0.001	0.66
Family history of headache	$n=16$				$n=29$				
VAS	8.2 ± 1.5	5.1 ± 2	3.12 ± 1.9	0.001	7.8 ± 1.32	4.4 ± 1.12	3.4 ± 1.4	< 0.001	0.65
PEDMIDAS	3.0 ± 0.8	1.6 ± 1	1.44 ± 0.9	0.001	3.2 ± 0.87	1.4 ± 0.628	1.8 ± 0.9	< 0.001	0.15
Headache laterality	Lateral ($n=10$)				Bilateral ($n=35$)				
VAS	7.9 ± 1.4	4.7 ± 1.2	3.2 ± 1.6	0.005	7.9 ± 1.4	4.6 ± 1.61	3.3 ± 1.6	< 0.001	0.65
PEDMIDAS	3.1 ± 0.7	1.6 ± 0.7	1.5 ± 0.8	0.007	3.2 ± 0.9	1.4 ± 0.81	1.7 ± 0.9	< 0.001	0.47
Medication overuse	$n=25$				$n=20$				
VAS	7.6 ± 1.4	4.4 ± 1.6	3.3 ± 1.5	< 0.001	8.3 ± 1.2	5.0 ± 1.4	3.3 ± 1.7	< 0.001	0.91
PEDMIDAS	3.1 ± 0.9	1.4 ± 0.8	1.7 ± 1	< 0.001	3.2 ± 0.8	1.55 ± 0.8	1.6 ± 0.8	< 0.001	0.72
Neck Pain	$n=10$				$n=29$				
VAS	8.1 ± 1.1	4.6 ± 1.5	3.5 ± 1.7	0.005	7.9 ± 1.8	4.76 ± 1.6	3.1 ± 1.6	< 0.001	0.62
PEDMIDAS	3.2 ± 0.6	1.5 ± 0.8	1.7 ± 0.9	0.007	3.3 ± 0.8	1.48 ± 0.8	1.8 ± 0.9	< 0.001	0.81

Values are presented as mean ± standard deviation. PedMIDAS values represent disability grades (1–4). P_{within} indicates within-group comparisons before and after treatment

VAS visual analog scale, *PedMIDAS* Pediatric Migraine Disability Assessment Scale

DISCUSSION

The present study found that a protocolized series of bilateral GONB/LONB was associated with improvements in both headache severity and headache-related disability in children and adolescents with frequent and severe headache disorders. In the full study cohort ($n=45$), including both responders and non-responders, headache severity decreased significantly from a median VAS score of 8.0 (IQR 7.0–9.0) at baseline to 4.0 (IQR 4.0–5.0) at follow-up ($p<0.001$). Headache-related disability also decreased significantly, with the median PedMIDAS disability grade decreasing from 3.0 (IQR 3.0–4.0) to 1.0 (IQR 1.0–2.0) ($p<0.001$). These analyses included all 45 patients irrespective of treatment response (Fig. 3 and Table 3). However, because of the retrospective uncontrolled design, these changes should be interpreted as treatment-associated rather than as evidence of a treatment-specific causal effect. Our cohort comprised a heterogeneous pediatric headache population, with CM representing the predominant diagnosis (62.2%), followed by EM (20.0%), CTTH (8.9%), and smaller proportions of mixed headache and other headache disorders, including TAC and occipital neuralgia. Exploratory subgroup analyses did not identify statistically significant differences in treatment-associated changes across the examined clinical characteristics; however,

the limited subgroup sizes preclude conclusions regarding equivalence or phenotype-independent effects. Given the small number of adverse events and subgroup sizes, the observed associations with family history and analgesic overuse should be considered exploratory.

Beyond their peripheral anesthetic action, ONB may influence central nociceptive processing by modulating the trigeminocervical complex, where C2 spinal afferents and trigeminal sensory pathways converge. Local anesthetics administered at the occipital nerves may reduce central sensitization by attenuating nociceptive transmission at the trigeminal nucleus caudalis [13, 14]. This mechanism has been proposed as a potential explanation for clinical effects extending beyond the duration of local anesthetic action. Consistent with this mechanistic framework, our findings indicate that ONB is associated with improvement not only in headache severity but also in functional disability among children and adolescents with frequent and severe headaches.

In line with contemporary clinical practice, a survey conducted by the Pediatric and Adolescent Section of the American Headache Society reported that approximately 80% of clinicians use peripheral nerve blocks in pediatric headaches management, with 69% preferring GONB [14]. Given the frequent bilateral distribution of headache symptoms in pediatric populations, the bilateral GONB/LONB blockade employed in our study may provide more comprehensive trigeminocervical modulation than unilateral GONB, which are more commonly reported in pediatric studies [15]. The GON and LON innervate complementary regions of the posterior scalp; therefore, simultaneously targeting both nerves may reduce nociceptive input from a wider occipital territory and potentially enhance modulation of the trigeminocervical complex. This may be particularly relevant in children with diffuse or bilateral occipital pain, although the present study was not designed to directly compare combined GON/LON blockade with GONB alone. This bilateral and combined approach may therefore represent an important refinement of interventional strategies in children with refractory headache disorders.

Most existing studies evaluating the efficacy of ONB in pediatric headaches populations consist of small case series, limiting statistical power and the ability to draw definitive conclusions [16–18]. Furthermore, most pediatric reports describe single-session nerve blocks [15, 19], and data on repeated block protocols with longer-term follow-up remain scarce [20]. In contrast, the present study systematically evaluated treatment outcomes following repeated bilateral GONB/LONB, with assessment conducted after the sixth application. This approach was deliberately chosen to capture cumulative therapeutic effects and to avoid underestimation of treatment response, as early assessments may fail to detect delayed or progressive improvement. Our observations suggest that clinical response may become more apparent over successive applications; however, the present study was not designed to determine the optimal number of treatment sessions.

Although the study was not designed as a Sequential Multiple Assignment Randomized Trial (SMART), the therapeutic positioning of ONB in our cohort conceptually parallels adaptive intervention strategies [21]. In SMART designs, treatment pathways evolve on the basis of individual responses, allowing therapies to be reassigned or continued according to clinical need [21]. Similarly, in our clinical practice, ONB was continued, modified, or discontinued according to cumulative response across successive applications, reflecting a pragmatic and patient-centered approach to care.

The relevance of these findings is further underscored by the CHAMP trial, which reported no significant superiority of commonly prescribed preventive medications over placebo in pediatric migraine populations [5]. Notably, approximately one-third of participants in CHAMP failed to improve, underscoring substantial variability in treatment response. Moreover, many patients typically encountered in tertiary pediatric patients with headaches clinics—including those with continuous daily headache, medication overuse, high PedMIDAS scores, prior adequate preventive trials, or significant psychiatric and medical comorbidities—were excluded from CHAMP, limiting the generalizability of its findings to routine clinical

practice [4]. In contrast, the present study specifically targeted children and adolescents with frequent and severe headaches who had not achieved adequate benefit from standard preventive pharmacological therapies. The substantial placebo response observed in pediatric migraine prevention trials such as CHAMP further underscores the need for sham-controlled studies before the treatment-specific efficacy of ONB can be established.

Despite the substantial burden of migraine in children and adolescents, evidence-based preventive pharmacological options remain limited and often suboptimal [8]. Topiramate is currently the only medication approved by the US Food and Drug Administration for migraine prevention in adolescents aged 12–17 years [5]. Interventional alternatives such as botulinum toxin injections have demonstrated reductions in headache frequency of approximately 50–69% in pediatric CM; however, high treatment costs and the requirement for multiple injection sites limit their feasibility and acceptability in younger patients [22–24]. For other pediatric headache disorder, including CTTH and TAC, randomized placebo-controlled trials are largely unavailable, resulting in continued uncertainty regarding optimal management strategies [25]. Across existing studies, no consistent differences in efficacy or adverse event rates have been reported between steroid-containing and steroid-free ONB protocols [15, 16, 18, 19, 26], a finding that aligns with the high response rates observed in our cohort using repeated blockade strategies.

Survey data from the USA indicate that bilateral GONB is most commonly utilized for CM among pediatric patients with headaches disorders, consistent with the predominance of CM in our study population [14]. Interventional therapies are increasingly employed in children and adolescents with migraine and status migrainosus [27, 28]. Importantly, in line with previous reports, medication overuse did not attenuate treatment response in our cohort, and no association was observed between analgesic overuse and block efficacy [26]. Given the high prevalence of medication overuse in pediatric CM, these findings further support the role of ONBs as a valuable therapeutic option in this challenging subgroup [29].

Beyond reductions in headache severity and disability, ONB was associated with improvement in several headache-related and autonomic symptoms in a subset of patients, including tinnitus, dizziness, photophobia, nausea, and vomiting. These observations are consistent with prior reports suggesting broader neuromodulatory effects of ONB beyond pain relief alone [30]. A substantial proportion of patients (77.8%) continued treatment at approximately 6-month intervals, and a high recommendation rate (91%) indicates favorable patient perception of treatment benefit and acceptability. In our cohort, clinical improvement was observed during the repeated treatment period; however, the uncontrolled study design does not allow the observed changes to be distinguished from the natural course of headache, regression to the mean, or placebo and expectancy effects.

Interestingly, improvements in PedMIDAS disability grades were more pronounced than reductions in VAS scores, suggesting that ONB therapy may exert a greater impact on functional disability and cumulative headache burden than on peak pain intensity alone. While VAS reflects momentary pain perception, PedMIDAS captures the broader functional consequences of headache over time and may therefore be more sensitive to sustained therapeutic benefit. Patients were counseled at baseline that the treatment goal was the reduction of disability rather than complete pain freedom, within a stepwise management framework. These observations suggest that repeated GONB/LONB may have a potential role as a bridging intervention in selected adolescents with substantial headache burden; however, this possibility requires confirmation in prospective controlled studies.

Structured follow-up, including early intensive monitoring and assessment at 6 months, allowed evaluation of both immediate and sustained treatment effects. The improvements observed during the study period are clinically encouraging; however, their persistence and treatment specificity cannot be established from the present retrospective uncontrolled design. Headache disorders in adolescents may fluctuate over time, and spontaneous improvement,

regression to the mean, and placebo or expectancy effects may have contributed to the observed changes. Therefore, longer-term prospective studies with standardized follow-up and an appropriate control or sham group are needed to determine whether repeated GONB/LONB provides sustained treatment-specific benefit.

Limitations

Several limitations should be acknowledged. The cohort was diagnostically heterogeneous, although the large majority of patients had chronic or episodic migraine (37/45, 82.2%). The small numbers of patients with other headache diagnoses preclude meaningful diagnosis-specific comparisons and limit conclusions regarding the applicability of these findings across different headache phenotypes. An important limitation is the absence of a concurrent control or placebo/sham group. Consequently, the observed reductions in headache severity and disability and the high clinical response rate cannot be attributed exclusively to the GONB/LONB intervention. Pediatric headache disorders, particularly migraine, may show substantial spontaneous fluctuation over time and clinically meaningful placebo or expectancy responses. In addition, because patients were selected for intervention during periods of frequent and severe headache burden, regression to the mean may have contributed to some of the observed improvement. Therefore, although the magnitude and persistence of the within-patient changes are clinically encouraging, the present findings should be interpreted as an association with treatment rather than definitive evidence of treatment efficacy. Prospective randomized sham-controlled studies are required to determine the treatment-specific effect of repetitive bilateral GONB/LONB. Therefore, the present findings demonstrate an association between treatment and clinical improvement rather than a treatment-specific causal effect. Treatment outcomes were evaluated after repeated ONB applications rather than after the initial block, an approach intentionally selected to capture cumulative therapeutic effects; however, this limits conclusions regarding the immediate efficacy of a single application and precludes differentiation between early responders and non-responders. The retrospective design also restricts causal inference and introduces potential selection bias. The study population predominantly comprised adolescents, with relatively limited representation of younger children. Therefore, the present findings should not be extrapolated to pre-adolescent children, and further studies are needed to evaluate the safety and clinical outcomes of this approach in younger pediatric populations. Additionally, all procedures and clinical assessments were performed by a single physician, which may have introduced operator-dependent bias and limited generalizability to other clinical settings. Prospective, multicenter studies with standardized protocols and involvement of multiple clinicians are therefore warranted to validate and extend these findings.

CONCLUSIONS

Children and adolescents with high headache-related disability, medication overuse, and comorbid conditions represent a particularly vulnerable subgroup for whom effective treatment options remain limited. In this context, ONB therapy—using a combined bilateral GON/LON approach—emerges as a practical, low-cost, and well-tolerated interventional option that is associated with clinically meaningful improvements in headache severity and disability. Given the high baseline headache burden in this cohort, regression to the mean, spontaneous fluctuation in headache severity, and placebo or expectancy effects associated with an interventional procedure may have contributed to the observed improvement. However, because of the uncontrolled retrospective design, these improvements cannot be attributed specifically to the intervention. Prospective randomized sham-controlled studies are needed to establish the treatment-specific efficacy of this approach in adolescents with frequent and severe headaches.

In this predominantly adolescent, migraine-predominant cohort, a protocolized series of repetitive bilateral greater and lesser occipital

nerve blocks (GONB/LONB) was well tolerated and was associated with reductions in headache severity and headache-related disability in patients with frequent and severe headaches. Although improvements were observed across the examined clinical subgroups, the small subgroup sizes preclude conclusions regarding phenotype-independent effects.

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Data Availability. The datasets generated and/or analyzed during the current study are not publicly available because they contain sensitive clinical data from pediatric participants and are subject to institutional and ethical restrictions. De-identified data are available from the corresponding author on reasonable request, subject to approval by the relevant ethics committee and institutional regulations.

Declarations

Conflict of Interest. Tuğba Uyar Cankay, Ömer Lütfi Gündoğdu, Bahar Taşdelen, Derya Uluduz, and Aynur Özge declare that they have no competing interests.

Ethical Approval. The study protocol was approved by the Ethics Committee of Medipol University (Approval No. E-10840098-202.3.02-2806) and was conducted in accordance with the ethical principles of the Declaration of Helsinki (1964) and its later amendments. At the time of the study, the local ethics committee at the institution where the clinical work was performed did not have authorization to review this type of research. Therefore, following the necessary institutional permissions from the centers where the patients were evaluated and treated, ethical approval for this retrospective study was obtained from the Ethics Committee of Medipol University. Routine clinical consent for the GONB/LONB procedure was obtained from the patient and/or legal guardian before treatment and was separate from consent for research participation. The study was designed and reported in accordance with the Strengthening

the Reporting of Observational Studies in Epidemiology (STROBE) guidelines [11]. Owing to the retrospective study design and the use of anonymized clinical data, the requirement for written informed consent was waived by the ethics committee. Data analysis began in January 2025. Patients and the public were not involved in the design, conduct, reporting, or dissemination plans of this research.

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